Pilbara Minerals

TSF Options 2 and 5

Pilgangoora Project

Biological Survey

Pilbara, Western Australia

Prepared for
Pilbara Minerals Limited by
Animal Plant Mineral Pty Ltd.

November 2022

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EXECUTIVE SUMMARY

Animal Plant Mineral Pty Ltd was commissioned by Pilbara Minerals Limited to undertake a Detailed flora and vegetation and Targeted terrestrial vertebrate fauna survey of the Tailings Storage Facility (**TSF**) Options 2 and 5 areas. The TSF Options 2 and 5 areas are considered for additional tailings storage capacity, or other purposes, at the Pilgangoora Lithium Project, located 84 kilometres (**km**) south-east of Port Hedland in the Pilbara region of Western Australia (**WA)**. Option 2 is 354 hectares (**ha**) (2 km x 1.6 km) and Option 5 is 329 ha (1.8 km x 1.8 km).

Field survey was conducted in October 2022. The rainfall in Winter/Spring preceding the survey was approximately double the average for the period. The higher-than-average winter rainfall is a result of a high total monthly rainfall in May of 123.8 millimetres (**mm**), which is almost 4.5 times higher than the long-term average of 52.3 mm for the same period. No adverse weather conditions occurred that would impact the results of the survey. The timing of the flora and vegetation survey was outside of the recommended Supplementary survey period for the region, however seasonal conditions were good following a wetter than average winter. Survey timing was within that recommended for mammals and reptiles (EPA 2020).

Three vegetation types are described for the Study Areas and are different to those described during baseline surveys for the Pilgangoora Project. No vegetation of conservation significance was recorded, and current extent of regional vegetation units is close to pre-European extent. Vegetation is predominantly in very good condition with the main disturbances being moderate to high cattle grazing and vegetation clearing for mining and pastoral activity. Completely Degraded areas comprise 10.4 ha or 2.9% of the TSF Option 2, and 12.8 ha or 3.9% of TSF Option 5.

No Threatened or Priority flora are known to occur in the Study areas or were recorded during the survey. Nine Priority flora species identified in the desktop study possibly occur, due to the presence of suitable habitat. Seasonal conditions may be a constraint on the detectability of seven annual/herbaceous Priority flora that possibly occur.

No Declared weeds or Weeds of National Significance were recorded. Six weeds were recorded - *Cenchrus ciliaris, Cenchrus setiger, Flaveria trinervia, Malvastrum americanum, Triumfetta pentandra* and *Aerva javanica.*

Two fauna habitats are described for the Study Areas:

- FH1 – Undulating plains (78.2% of Option 2, 89.2% of Option 5); and
- FH2 – Ephemeral creeks (18.9% of Option 2, 6.9% of Option 5).

No Threatened or Priority fauna species are known to occur in the Study Areas. Database records from the local area indicate that 15 conservation significant fauna may possibly occur or are likely to occur.

Targeted survey for conservation significant fauna identified:

- Western pebble-mound mouse is present and 13 mound locations recorded;
- Foraging habitat suitable for the Grey falcon occurs and may be used by local populations;
- Foraging and dispersal habitat suitable for the Northern quoll occurs, but no evidence of presence was recorded, despite critical habitat known to occur 4 km to the west; and

- Possible habitat for the Night parrot, Greater bilby, Brush-tailed mulgara, and Ghost bat, but no evidence of their presence was recorded.

CONTENTS

FIGURES

TABLES

PLATES

APPENDICES

PROJECT TERMS

Abbreviation	Meaning
The Project	Pilgangoora Lithium Project
TSF	Tailings Storage Facility

UNITS OF MEASURE

Unit	Measure
%	Percentage
°C	Degrees Celsius
ha	Hectare
km	Kilometre
m	Metre
mm	Millimetre

LIST OF ABBREVIATIONS

Abbreviation	Meaning
APM	Animal Plant Mineral Pty Ltd
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
DBCA	Department of Biological Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEE	Department of Energy and the Environment
DMIRS	Department of Mines, Industry Regulation and Safety
DWER	Department of Water and Environment Regulation
DPIRD	Department of Primary Industries and Regional Development
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Areas
IBRA	Interim Biogeographic Regionalisation for Australia
IBSA	Index of Biodiversity Surveys for Assessment
MI	Migratory
MNES	Matters of National Environmental Significance
OS	Other Specifically Protected
PEC	Priority Ecological Community
P	Priority
PMST	Protected Matters Search Tool

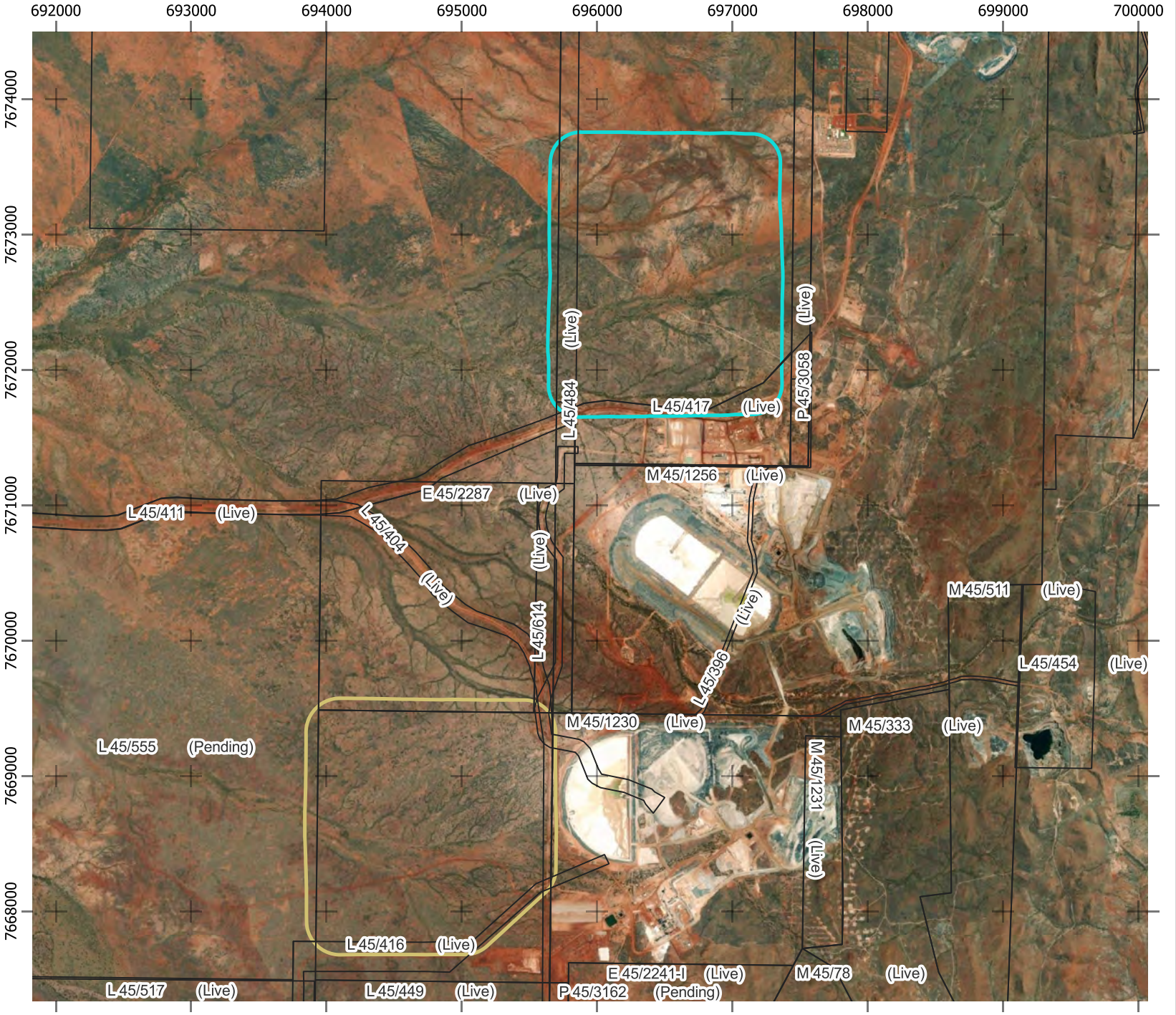
Abbreviation	Meaning
TEC	Threatened Ecological Community
T	Threatened
VU	Vulnerable
WA	Western Australia
WONS	Weeds of National Significance

1 INTRODUCTION

1.1 PROJECT AND LOCATION

Animal Plant Mineral Pty Ltd (**APM**) was commissioned by Pilbara Minerals Limited to undertake a Detailed flora and vegetation and Targeted terrestrial vertebrate fauna survey of the Tailings Storage Facility (**TSF**) Options 2 and 5 areas. The TSF Options 2 and 5 areas are considered for additional tailings storage capacity, or other potential expansions, at the Pilgangoora Lithium Project, located 84 kilometres (**km**) south-east of Port Hedland in the Pilbara region of Western Australia (**WA**).

Option 2 is 354 hectares (**ha**), measuring 2 km by 1.6 km. Option 5 is 329 ha, measuring 1.8 km by 1.8 km. Collectively they are referred to as the Study Areas and are shown in Figure 1-1.



Legend

- Pilgangoora Project Tenements
- TSF Option 2
- TSF Option 5

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 31/10/2022

Project Location

Prepared for:
Pilbara Minerals

Figure: 1-1

1.2 SCOPE OF WORK

The scope of work includes a Detailed flora and vegetation and Targeted terrestrial vertebrate fauna survey of the TSF Options 2 and 5 areas.

Survey data accompanies this report in a format suitable for submission to the Index of Biodiversity Surveys for Assessment (**IBSA**) online portal.

1.2.1 Flora and Vegetation

The flora and vegetation survey was conducted in accordance with the Environmental Protection Authority's (**EPA**) *Technical Guidance - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* (2016) at a Detailed level of assessment.

The aims of the desktop study were to:

- Establish vegetation associations previously determined for the site;
- Identify threatened (**T**) and priority (**P**) flora and threatened ecological communities (**TECs**) previously recorded on site;
- Identify weed species previously determined as present on site, in particular any Declared weeds; and
- Identify potentially suitable habitat for conservation significant flora known from the region.

The aims of the field survey were to:

- Determine vegetation associations on the site;
- Identify species present on site including T and P Flora;
- Locate and identify, as far as possible, weed species, in particular any Declared weeds;
- Map the vegetation and locations of T and P species; and
- Identify conservation significant features of the flora and vegetation.

1.2.2 Terrestrial Fauna

The scope of work was to conduct a basic and targeted terrestrial vertebrate survey in accordance with the EPA's fauna guidelines: *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (2020).

The aims of the desktop study were to:

- Identify species previously determined as present on-site including T and P Fauna (under the provisions of the *Biodiversity Conservation Act 2016* (**BC Act**) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (**EPBC Act**);
- Identify habitat types previously determined as present on site regarded as suitable for T and P fauna; and
- Identify introduced species previously determined as present on site.

The aims of the field survey were to conduct:

- Targeted quoll survey using unbaited camera traps;

- Bat survey using acoustic monitoring devices;
- Record incidental fauna observations;
- Conduct spotlight survey, without physical capture/collection of individuals; and
- Record habitats suitable for T and P fauna.

2 BACKGROUND AND SUPPORTING INFORMATION

2.1 RELEVANT LEGISLATION

2.1.1 Commonwealth Government EPBC Act

The Commonwealth EPBC Act is administered by the Department of Climate Change, Energy, the Environment and Water (**DCCEEW**). It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance (**MNES**).

If a project has the potential to significantly impact on MNES it is to be referred to the DCCEEW for determination on whether the matter is a 'controlled action' and therefore requiring assessment.

The EPBC Act provides for the identification and listing of species under several categories listed in Appendix A. The EPBC Act also provides for the development of conservation advice and recovery plans, development of a register of critical habitat, recognition of key threatening processes and the development of threat abatement plans.

2.1.2 Western Australia BC Act

The BC Act provides a statutory basis for the listing of T species, specially protected species, extinct species, TECs, collapsed ecological communities, critical habitat and key threatening processes in WA. The BC Act provides for the listing of T flora and fauna species and ecological communities under specified conservation categories listed in Appendix A. Species and communities listed under the BC Act are protected and require authorisation by the Minister to take or disturb.

Species may also be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest to science. Species of special conservation interest, migratory species and species subject to international agreements are known as Specially Protected Species in the BC Act.

2.1.3 Western Australia Priority species and communities

Flora and fauna species and communities are listed by the Department of Biodiversity, Conservation and Attractions (**DBCA**) as P where they are considered to have a greater level of significance than other native species and communities. This generally occurs where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to T species and communities categories. Whilst P species and communities are not specifically listed in the BC Act, all flora and fauna are protected in WA following the provisions in Part 10 of the BC Act. This protection applies even when a species is not listed as T or specially protected. The categories covering P species and communities are listed in Appendix A.

2.1.4 BAM Act

Plants may be 'Declared' by the Agriculture Protection Board under the *Biosecurity and Agriculture Management Act 2007* (WA) (**BAM Act**). Declared Plants are gazetted under three categories (C1-C3) which define the action required. Details of the definitions of these categories are provided in Appendix

A. A declaration may apply to the whole State, to districts, individual properties or even to single paddocks. If a plant is 'Declared', landholders are obliged to control that plant on their properties.

2.1.5 Weeds of National Significance

The DCCEEW, along with the State and Territory governments, has endorsed 32 Weeds of National Significance (**WONS**). Four major criteria were used in determining WONS:

- The invasiveness of a weed species;
- A weed's impact;
- The potential for spread of a weed; and
- Socio-economic and environmental values.

Each WONS has a national strategy and a national coordinator, responsible for implementing the strategy. WONS are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts (DAWE 2020).

2.1.6 Guidelines

The terrestrial biological assessment was conducted in accordance with the above Commonwealth and State legislation, as well as EPA requirements for environmental surveys as outlined below:

- Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020a); and
- Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016).

Relevant species-specific survey and assessment guidelines include:

- Survey Guidelines for Australia's T Bats (Department of the Environment Water Heritage and the Art (**DEWHA**) 2010a).
- Survey Guidelines for Australia's T Birds (DEWHA 2010b);
- Survey Guidelines for Australia's T Mammals (Department of Sustainability Environment Water Population and Communities (**DSEWPAC**) 2011a); and
- Survey Guidelines for Australia's T Reptiles (DSEWPAC 2011b).

Relevant guidance for the preparation of spatial datasets to accompany this report are:

- Guidelines for biological survey and mapped data (Department of the Environment and Energy (**DEE**) 2018); and
- Instructions for the preparation of data packages for IBSA (EPA 2020b).

2.2 LAND USE

The majority of the Study Areas lie within the Wallareenya pastoral lease (N050365). The current land use is cattle grazing.

Active mining operations and exploration activities occur within the Pilgangoora Lithium project, east of the Study Areas.

2.3 CLIMATE

The Pilbara has very hot summers, mild winters and low and variable rainfall. It is classified as hot desert in northern and inland areas and hot grasslands in the north-west. The climate of the Chichester subregion of the Pilbara is described as semi-desert-tropical, receiving 300 millimetres (**mm**) of rainfall annually (Kendrick and McKenzie, 2001).

The nearest Bureau of Meteorology (**BoM**) weather station with a long historical record is at Port Hedland Airport (BoM Site Number: 004032), approximately 75 km northeast of the Study Areas. Port Hedland Airport has recorded rainfall from 1942 – 2022 (80 years), and temperature from 1948 – 2022 (74 years). The climate data recorded for the region over these periods is shown in Figure 2-1. Monthly mean maximum temperature ranges from 36.8°C in March to 27.4°C in July. Monthly mean rainfall ranges from 90.2 mm in February to 0.9 mm in October, with a mean annual rainfall of 317.7 mm (BoM 2022).

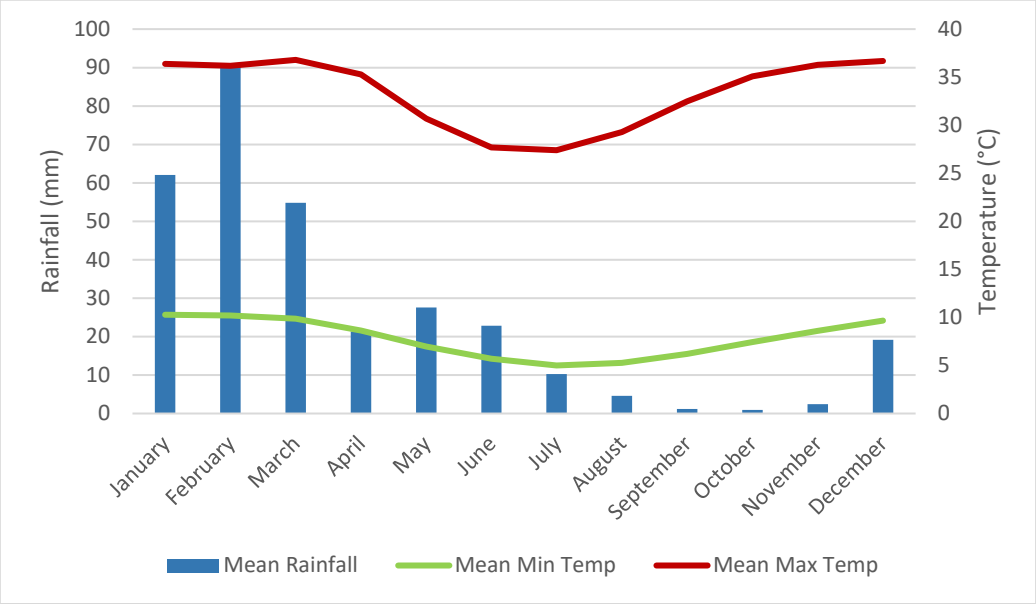


Figure 2-1. Temperature and rainfall averages for Port Hedland Airport weather station (Station No. 004032) (BoM 2022)

2.4 GEOLOGY

The Pilbara 2014 Geological Information Series dataset (Geological Survey of Western Australia 2014) features a 1:100 000 scale surface geology compilation. The digital layers are based on published maps from the 1994-2005 Pilbara Craton Mapping Project, carried out by the Geological Survey of Western Australia and Geoscience Australia under the North Pilbara National Geoscience Mapping Accord. The Study Areas are within the Wodgina (2655) map area.

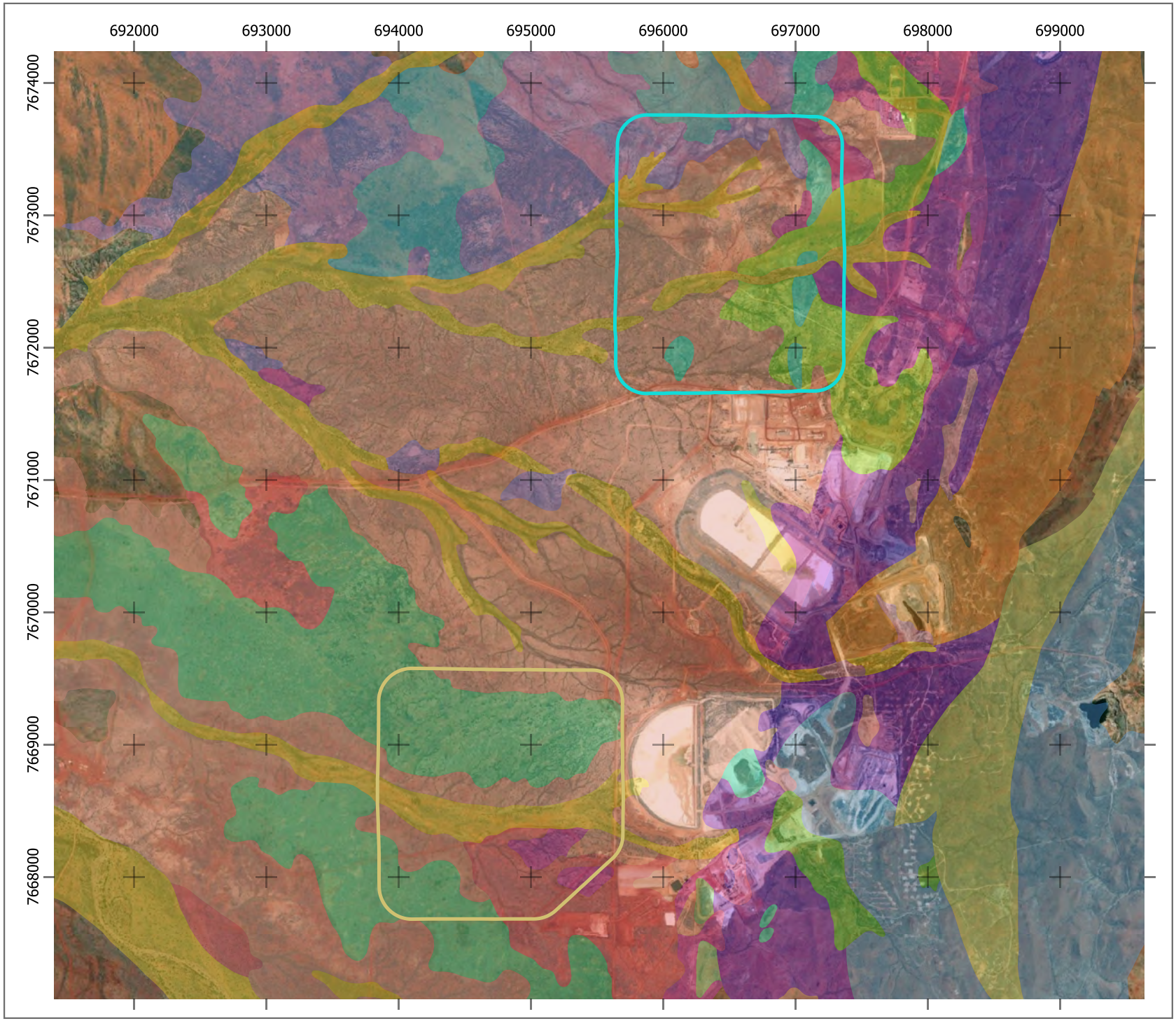
Option 2 contains the following eight geological formations:

- A-KEe-mu; Euro Basalt; Metamorphosed ultramafic rock;
- A-CLmo-xmgm-mgg; Motherin Monzogranite; Interleaved metamonzogranite, metagranodiorite, gneiss, and pegmatite; moderately to strongly foliated; intruded by abundant sheets of massive to weakly foliated muscovite-bearing metamonzogranite and pegmatite;
- A-CLmo-jmgm-mwa; Motherin Monzogranite; Interleaved seriate to porphyritic metamonzogranite, hornblende--biotite metagranodiorite, and pegmatite; strongly foliated and banded, locally gneissic; contains greenstone enclaves and pendants;
- _S1; Sandplain unit; Sandplain deposits; sand of mixed residual, sheetwash, and eolian origin; unconsolidated;
- _R1-g-pg; Residual or relict unit; Residual quartzofeldspathic sand, with quartz and rock fragments; overlying and derived from mass-wasting of granitic rocks; unconsolidated;
- _C1; Colluvial unit; Colluvial sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits; unconsolidated;
- _A2-d-k; Alluvial unit; Partly consolidated alluvial gravel, sand, and silt; local carbonate cement; dissected by present-day drainage; and
- _A1c; Alluvial unit; Sand, silt, and gravel in active drainage channels; includes clay, silt, and sand in poorly defined drainage courses on floodplains; unconsolidated.

Option 5 contains the following five geological formations:

- _C1; Colluvial unit; Colluvial sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits; unconsolidated;
- _A2-d-k; Alluvial unit; Partly consolidated alluvial gravel, sand, and silt; local carbonate cement; dissected by present-day drainage;
- _A1i; Alluvial unit; Mixed floodplain deposits; sand, silt, and clay adjacent to main drainage channels; numerous small claypans; unconsolidated;
- _A1f-cb-vb; Alluvial unit; Clay, silt, sand, and basaltic or doleritic gravel on floodplains; gilgai surface in areas of expansive clay; derived from ferromagnesian parent rock; unconsolidated; and
- _A1c; Alluvial unit; Sand, silt, and gravel in active drainage channels; includes clay, silt, and sand in poorly defined drainage courses on floodplains; unconsolidated.

The geology of the Study Areas is shown in Figure 2-2.



Legend

- TSF Option 2
- TSF Option 5
- _A1c
- _A1f-cb-vb
- _A1i
- _A2-d-k
- _C1
- _C2
- _R1-g-pg
- _S1
- A-CLmo-jmgm-mwa
- A-CLmo-xmgm-mgg
- A-DA-mats
- A-KEe-bk
- A-KEe-mba
- A-KEe-mbaq
- A-KEe-mu
- A-mty-P
- A-SR-gp

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 31/10/2022

Geology of the Study Area

Prepared for:
Pilbara Minerals

Figure: 2-2

The soils of the Study Areas were mapped by Tille (2006). The Study Areas are situated in the Fortescue Province, in the western edge of the Nullagine Hills Zone, with influences from the Abydos Plains and Hills Zone.

The Nullagine Hills Zone is characterised by:

"Hills and ranges (with some stony plains) on volcanic and sedimentary rocks of the Pilbara Craton (including the Hamersley Basin). Stony soils with red shallow loams and sands. Spinifex grasslands with kanji and snappy gum. Located in the north-eastern Pilbara around Marble Bar and Nullagine (Tille 2006)."

The Abydos Plains and Hills Zone is characterised by:

"Stony plains (with some hills) on granitic rocks of the Pilbara Craton (East Pilbara Terrane). Red deep sandy duplexes and red shallow loams with stony soils, red sandy earths and red loamy earths. Spinifex grasslands with kanji (and some tussock grasslands). Located in the northern Pilbara between Yandeyarra Community, Bamboo Springs Station and Marble Bar (Tille 2006)."

2.5 BIOGEOGRAPHIC REGIONALISATION

The Interim Biogeographic Regionalisation for Australia (IBRA, version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (Thackway and Cresswell 1995). The mapping completed by Beard (1975) provides the basis for the IBRA bioregions. IBRA mapping (Version 7), places the Project within the Pilbara Bioregion.

The Pilbara Bioregion is characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges. Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses.

The Pilbara Bioregion is further subdivided into the Chichester (PIL1), Fortescue (PIL2), Hamersley (PIL3) and Roebourne (PIL4) Sub-regions. The Project lies entirely within the Chichester Sub-region.

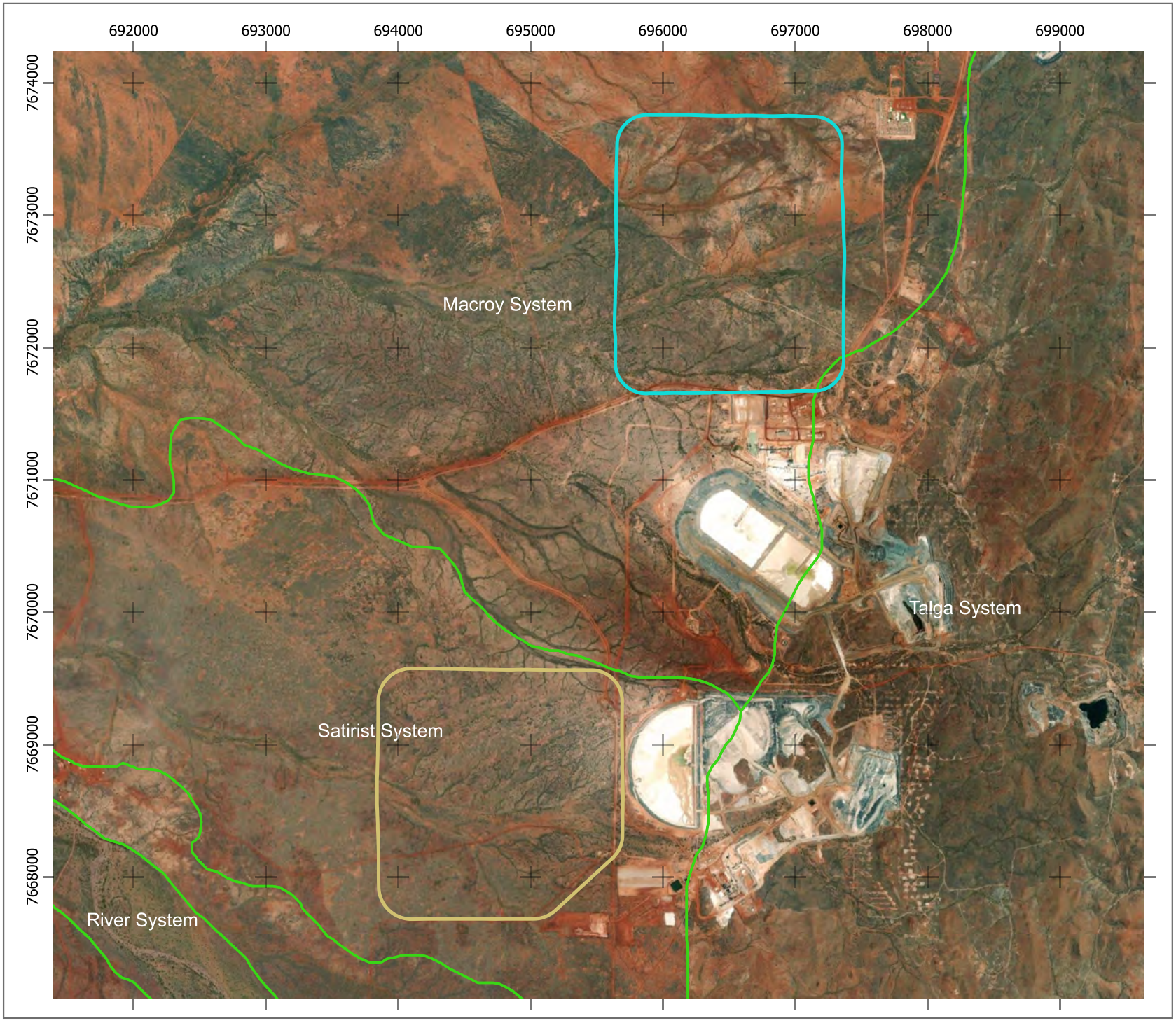
The Chichester Sub-region comprises the northern section of the Pilbara Craton and is comprised of undulating Archaean granite and basalt plains and includes significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges (Kendrick and McKenzie, 2001).

2.6 LAND SYSTEMS

Land Systems of the Pilbara region are described by van Vreeswyk *et al.* (2004). Mapping of Land Systems is available from Department of Primary Industry and Regional Development (**DPIRD**, 2019a). The Study Areas falls within three soil landscape systems, as listed in Table 2-1 and illustrated in Figure 2-3.

Table 2-1. Land Systems of the Study Areas

Land System	Geology	Description
Macroy	Level to gently undulating stony and gritty surfaced plains with occasional granite tor fields and domes and closely to moderately spaced dendritic tributary drainage floors, relief up to 25 metres (**m**)	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands
Talga	Hill and ridge tracts of mafic and ultramafic rocks (greenstones), other metamorphics and chert, relief up to 100 m	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands
Satirist	Quaternary alluvium and colluvium; clay, gravel and pebble deposits, minor Lower Proterozoic or Archaean chert, quartzite, shale and agglomerate	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.



Legend

- TSF Option 2
- TSF Option 5
- Soil Landscape Mapping BestAvailableDPIRD_027

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 31/10/2022

Land Systems of the Study Area

Prepared for: Pilbara Minerals

Figure: 2-3

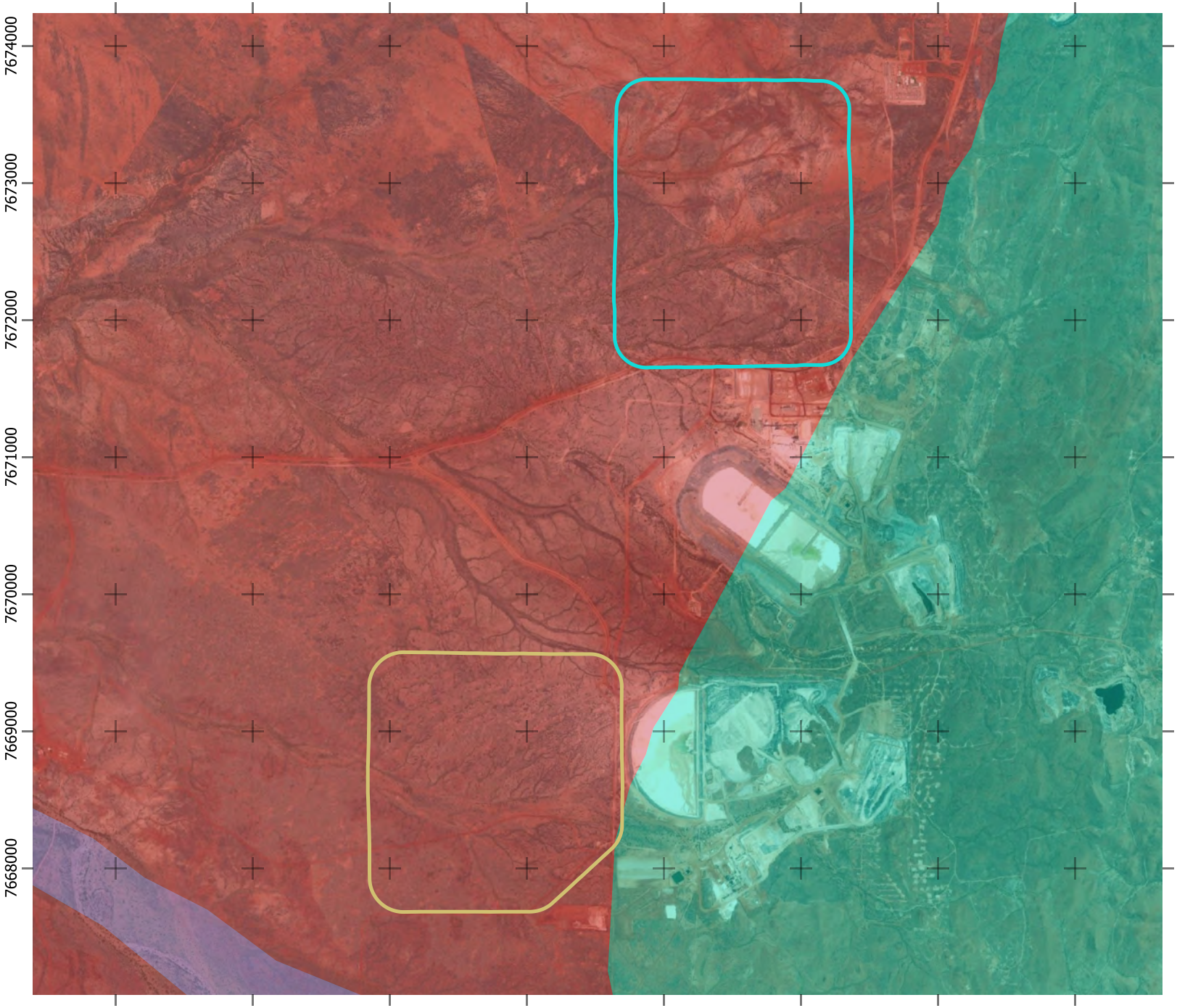
2.7 REGIONAL VEGETATION

The Study Areas are located within the Eremaean Botanical Province and contains one pre-European Beard vegetation association of the George Ranges System, and one vegetation association of the Abydos Plain – Chichester System as shown in Figure 2-4. The remaining extent of these vegetation associations is outlined in the most recent DBCA Statewide Vegetation Statistics table dated 2018 and summarised in Table 2-2 below.

Vegetation Associations within the Study Areas have over 99% pre-European Vegetation extent remaining. Conservation significance ranking of vegetation associations occurring within the Study Areas are of 'Least Concern'.

Table 2-2 Pre-European Beard Vegetation Associations within the Study Areas

Unit	Vegetation Description	Pre-European Extent (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent within DBCA Managed Lands (%)
82	Hummock grassland with scattered bloodwoods and snappy gum *Triodia* spp., *Corymbia dichromophloia, Eucalyptus leucophloia*	2,565,901	2,553,206	99.51	11.57
93	Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp	3,044,310	3,040,641	99.88	1.96



Legend

- TSF Option 2
- TSF Option 5
- 82: Hummock grassland with scattered bloodwoods and snappy gum Triodia spp. Corymbia dichromophloia Eucalyptus leucophloia
- 93: Hummock grassland with scattered shrubs or mallee Triodia spp. Acacia spp. Grevillea spp. Eucalyptus spp
- 619: Riverine; rivergum E. camaldulensis

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 31/10/2022

Pre-European Vegetation of the Study Area

Prepared for:
Pilbara Minerals

Figure: 2-4

2.8 ENVIRONMENTALLY SIGNIFICANT AREAS

2.8.1 Conservation Estate

The Western Australian Conservation Estate includes land and waters vested in the Conservation and Parks Commission under the *Conservation and Land Management Act 1984*. The Conservation Estate is managed by the Parks and Wildlife Service of DBCA to protect WA's biodiversity, and includes National Parks, Nature Reserves, Conservation Reserves, and other areas managed primarily for biodiversity conservation (DEE 2016).

A search of the Collaborative Australian Protected Area Database returned no conservation estates located within 50 km of the Study Areas. The nearest gazetted terrestrial conservation estate is Mungaroona Range, 85 km to the south-west of the Study Areas.

2.8.2 Environmentally Sensitive Areas

Environmentally Sensitive Areas (**ESA**) are areas that are defined by the Department of Water and Environment Regulation (**DWER**) (2019) as:

- A declared World Heritage property as defined in s.13 of the EPBC Act;
- An area that is included on the Register of the National Estate, because of its natural heritage value under the Australian Heritage Council Act 2003;
- A defined wetland and the area within 50 m of the wetland;
- The area covered by vegetation within 50 m of T flora, to the extent to which the vegetation is continuous with the vegetation in which the T flora is located;
- The area covered by a TEC;
- A Bush Forever site;
- Areas covered by the Gnangara Mound Crown Land Policy and Western Swamp Tortoise Policy;
- Areas covered by lakes, wetlands and fringing vegetation of the Swan Coastal Plain Lakes Policy, including Southwest Agricultural Zone Wetlands Policy and Swan and Canning Rivers Policy; and
- Protected wetlands as defined in the Environmental Protection (Southwest Agricultural Zone Wetlands) Policy 1998.

The Australian Wetlands Database includes nationally significant wetlands (as listed in the directory of important wetlands), wetlands listed under the Ramsar convention, wetlands that are representative, rare or unique, or wetlands that are considered of international importance (DEE 2019). The nearest wetlands listed in the Directory of Important Wetlands within 150 km of the Study Areas are the Leslie (Port Hedland) Saltfields System, 80 km to the north, the De Grey River System, 85 km to the north-east, and the Fortescue Marshes, 130 km to the south-west.

Environmentally Sensitive Areas can be viewed on the DWER clearing permit system map viewer. There are no ESA's within the Study Areas.

3 METHODOLOGY

3.1 DESKTOP STUDY

The desktop study provides background information on the known attributes of flora, vegetation and fauna of the Study Areas.

3.1.1 Database Searches

A search for EPBC Act MNES was undertaken using the DCCEEW Protected Matters Search Tool (**PMST**). The PMST identifies EPBC listed flora and fauna species and communities based on predicted distributions of the species and/or their habitat, in conjunction with species records. The PMST may predict the occurrence of a species or community in an area where there are no documented records, or documented records are historic. Therefore, for this search, a search area of 30 km from a central coordinate of 697208, 7669697 (GDA 1994, MGA Zone 50) was applied to ensure relevancy for the habitats present within and adjacent to the Study Areas.

The conservation codes are described in Appendix A. The results of the PMST search are included in Appendix B.

The DBCA maintains databases for records of T and P species and communities. A request was made for a search of DBCA databases for T and P flora and fauna and the presence of TECs or Priority Ecological Communities (**PECs**). A 30 km buffer was applied to the fauna, flora, TEC and PEC search from a central coordinate of 697193, 7669699 (GDA 1994, MGA Zone 50).

Introduced flora and fauna records from within 30 km were obtained from the NatureMap database.

Table 3-1 lists the database searches conducted for the desktop study.

Table 3-1. Database Searches

Attribute	Search Area	Database	Location
Threatened and Priority Ecological Communities	30 km radius	DBCA	Figure 4-2; Section 4.1.2
	30 km radius	PMST	Appendix B
Threatened Flora	30 km radius	DBCA	Figure 4-1; Section 4.1.1
	30 km radius	PMST	Appendix B
Introduced Flora	30 km radius	NatureMap	Section 4.1.3
Threatened Fauna	30 km radius	DBCA	Figure 5-1; Section 5.1.1
	30 km radius	PMST	Appendix B
Introduced Fauna	30 km radius	NatureMap	Section 5.1.2

The DBCA fire history database (DBCA 2022) was consulted to identify local fire history.

3.1.2 Literature Review

Flora, vegetation and terrestrial vertebrate fauna surveys have been conducted in the local area for the Pilgangoora Project. The following local surveys were reviewed, and the results incorporated into the Desktop Study:

- Baseline Vertebrate Fauna Survey, Pilgangoora. Prepared on behalf of Pilbara Minerals Limited by 360 Environmental. Publication date: May 2016.
- Pilgangoora Access Road Borrow Pits - Flora and Vegetation Assessment. Prepared on behalf of Pilbara Minerals Limited by MMWC Environmental Pty Ltd. Publication date: July 2016.
- Pilgangoora Project Area – Flora, Vegetation and Fauna Assessment. Prepared on behalf of Pilbara Minerals Limited by MMWC Environmental Pty Ltd. Publication date: July 2016
- Pilgangoora Project – Stage 2 Expansion Desktop Environmental Assessment. Prepared on behalf of Pilbara Minerals Limited by Ecologia Environmental. Publication date: 26 October 2018.
- Pilbara Leaf-nosed Bat Survey, Pilgangoora Prepared for Pilbara Minerals Limited by 360 Environmental November 2015
- Pilbara Leaf-nosed Bat Roost Survey, Pilgangoora Prepared for Pilbara Minerals Limited by 360 Environmental February 2016
- Northern Quoll Survey on mining tenement M45/1266. Prepared for Pilbara Minerals Limited by Terrestrial Ecosystems, January 2020.
- Lynas Find Biological Survey - Prepared for Pilbara Minerals Limited by APM, October 2022.

3.1.3 Likelihood of Occurrence

Threatened and Priority flora, fauna and communities returned from the database searches and literature review were assessed for their likelihood of occurrence within the Study Areas using the likelihood of occurrence criteria listed in Table 3-2.

Table 3-2. Likelihood of occurrence criteria

Likelihood of occurrence	Criteria
Recorded	Identified from database records or field survey as occurring within the Study Area
Likely	Suitable habitat is present in the Study Area and the species has previously been recorded within 15 km
Possible	Suitable habitat is present within the Study Area and the species has previously been recorded between 15 – 30 km of the Study Area
Unlikely	No suitable habitat is present in the Study Area

3.2 FIELD SURVEY

3.2.1 Survey Personnel and Timing

The terrestrial vertebrate fauna survey was carried out by Dr Mitchell Ladyman. The flora and vegetation field survey was undertaken by Dr Neil Pettit assisted by Mr Danah Blache.

Acoustic analysis and bat call identification was conducted by Dr Kyle Armstrong and Yuki Konishi at Specialised Zoological, a scientific consultancy business that specialises in bats, bioacoustics and genetic identification. Dr Armstrong has 20 years' experience in environmental consultancy specialising in bats.

Table 3-3 lists the personnel involved in the field survey.

Table 3-3. Field Survey Personnel

Survey Date	Personnel	Experience	Description
4th – 8th October 2022	Dr Mitchell Ladyman	20+ years	Terrestrial vertebrate fauna survey
	Dr Neil Pettit	25+ years	Flora and vegetation survey
	Danah Blache	under instruction	

Autonomous recording devices installed during the field survey were collected at a later date.

3.2.2 Survey Conditions

The summer rainfall prior to survey was approximately average (BoM 2022). The rainfall in the Winter/Spring preceding survey was approximately double the average for the period. The higher-than-average winter rainfall is a result of a high total monthly rainfall in May of 123.8 mm, which is almost 4.5 times higher than the long-term average of 52.3 mm for the same period.

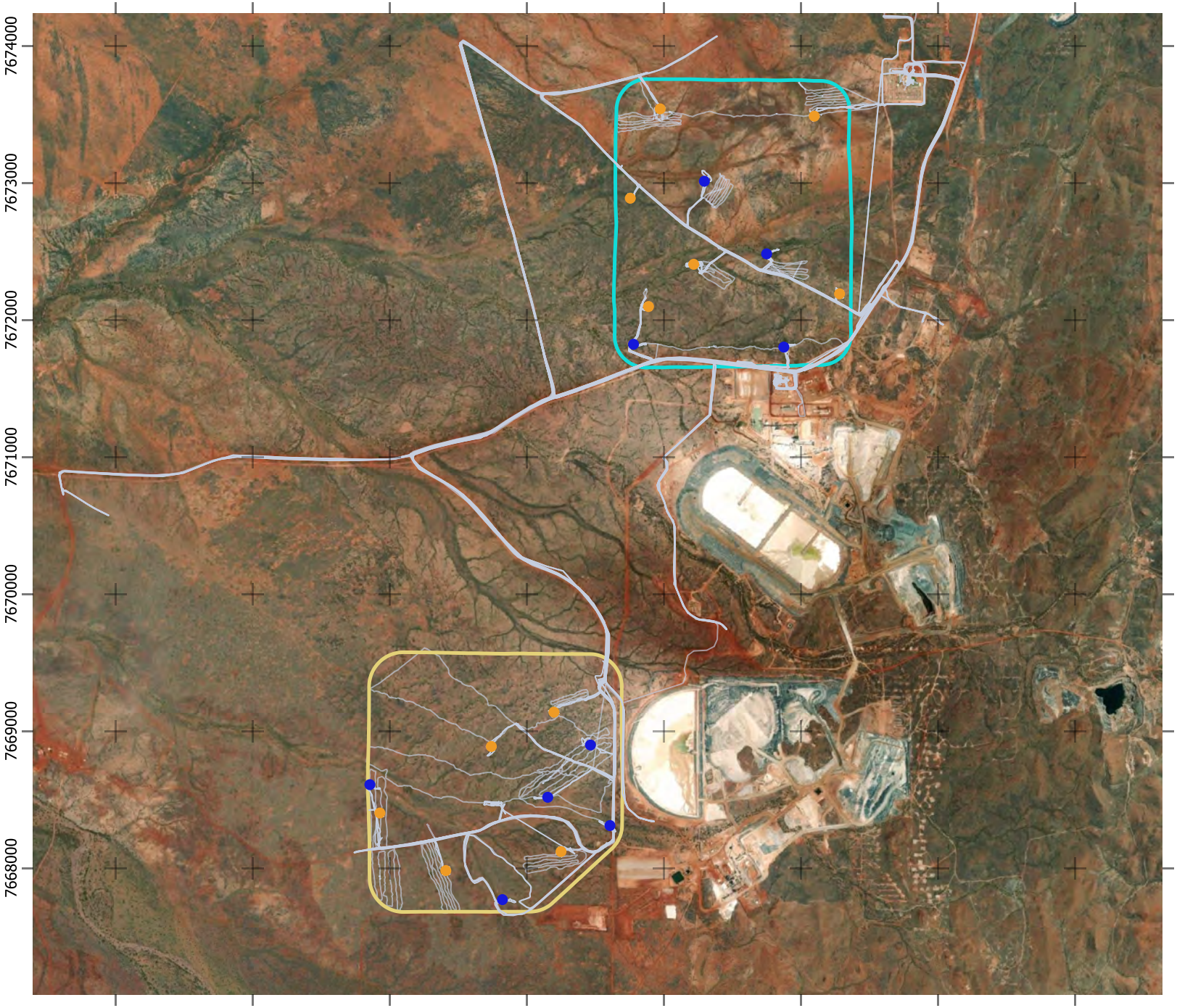
During the survey period, daytime temperatures reached a maximum of between 29.6 and 35.7 °C and a minimum of between 18.3 and 19.9°C overnight, which is typical of the time of year (BoM 2022). No rainfall was recorded during the survey period and no adverse weather conditions occurred that would impact the results of the survey.

The Study Areas are within the Eremaean botanical province. Recommended timing for flora and vegetation survey is 6-8 weeks post wet season (March – June) for Primary survey, and a Dry season survey (after winter rainfall if available) for Supplementary survey (EPA 2016). The timing of the field survey was outside of the recommended Supplementary survey period for the region, however seasonal conditions were good following a wetter than average winter. It is likely that some annual flora were absent at the time of survey.

Survey timing was within that recommended for mammals and reptiles (EPA 2020).

3.2.3 Flora and Vegetation

A detailed survey was conducted for flora and vegetation. Vegetation was sampled using 12 quadrats of 50 x 50 m and seven relevés of approximately the same size (Figure 3-1). Quadrats are vegetation survey plots which are accurately measured out as 50 x 50 m (or an area equivalent to 2500 m^2) and marked at the north-west corner using a handheld Global Positioning System (**GPS**) unit. Relevés are 'unmarked quadrats', where a centre point is marked and an area equivalent to that of a quadrat is visually approximated around this point for the purpose of estimating species composition and cover.



Legend

- TSF Option 2
- TSF Option 5
- Quadrat
- Releve
- Tracklogs

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 01/11/2022

Flora Survey Sites

Prepared for:
Pilbara Minerals

Figure: 3-1

Field data at each survey site was recorded on a pro-forma data sheet and included the parameters listed in Table 3-4. The attributes of Detailed survey sites are provided in Appendix C.

Table 3-4. Parameters recorded at each Detailed site

Variable	Parameters
Collection attributes	Personnel/recorder; date, quadrat dimensions and marking method, photographs of the quadrat, site code.
Physical features	Landform, slope, aspect, soil attributes, ground surface cover, litter, rock type and physical attributes.
Location	Coordinates recorded in GDA94 datum using a hand-held GPS (Garmin) to accuracy approximately ± 5 m.
Vegetation	Dominant growth form, height, cover and species for the three traditional strata (upper, mid and ground) compatible with NVIS Level V (ESCAVI 2003).
Vegetation condition	Vegetation condition was assessed using the condition rating scale devised by Trudgen (1988).
Disturbance	Level and nature of disturbances (*e.g.* weed presence, fire and time since last fire, impacts from grazing, vegetation clearing, erosion).
Flora	List of all species within the quadrat including weeds and listing species average height, cover and abundance.

A flora inventory was compiled from taxa listed in Detailed survey sites and from opportunistic floristic collections throughout the Study Areas, with at least one collection made for every taxon encountered. Specimens were identified by an experienced botanical taxonomist in the Western Australia Herbarium (**WAH**) using published reference material. The nomenclature applied is consistent with Florabase (WAH 1998-).

The conservation status of all recorded flora was determined from the DBCA Wildlife Conservation Rare Flora Notice 2022, T and P Flora List 6 October 2022, and the EPBC Act List of T Flora (DCCEEW 2022). The Western Australian Organisms List database was consulted to determine if any are BAM Act Declared Plants (DPIRD 2021), and the Weeds of National Significance list to determine any WONS (DAWE 2020).

The vegetation associations were described based on their structure and species composition, as defined by quadrat and releve data, and field observations. Vegetation was mapped in the field using handheld GPS units and aerial photographs, then digitised as map figures using GIS software. Vegetation is described at the association level (Executive Steering Committee for Australian Vegetation Information (ESCAVI 2003) and referred to as Vegetation Types (EPA 2016).

Vegetation Condition was assigned using the scale developed for the Eremaean and Northern Botanical Provinces adapted from Trudgen (1988) as recommended in EPA (2016). Table 3-5 lists the six potential categories.

Table 3-5. Vegetation Condition Scale

Vegetation Condition	Eremaean and Northern Botanical Provinces adapted from Trudgen (1988)
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; *i.e.* areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs

Conservation significant flora was Targeted searched using traverses on foot and logged using a handheld GPS.

For consistency with the existing Pilgangoora operations, data analysis was applied using the method presented by MMWC Environmental (2016). A species by site matrix was prepared that included the data from the current field survey and that presented by MMWC Environmental (2016). The Primer 7 (Clarke and Gorley, 2015), software was used to perform floristic composition vegetation classification. Data was square root transformed and a resemblance matrix was constructed using the Bray Curtis similarity measure. A cluster analysis was performed using group averages. The SIMPROF routine was used to test the hypothesis that the species and/or abundances are different at each group of sites using 999 permutations and a significance level of 5%.

The completeness of the survey was tested using a species accumulation curve and applying the Michaelis-Menton model to estimate the species richness of the Study Areas.

3.2.4 Fauna

Fauna habitat assessments were performed at 25 locations. Descriptive data was recorded including soil type, landform, presence of microhabitats, disturbances and images were recorded. Site photos are included in Appendix D.

Targeted search was conducted for signs of conservation significant fauna using traverses on foot, with tracklogs recorded on a handheld GPS. Signs include scats, prints, slough skin, scratchings made during foraging and other diggings, burrows and mounds. Traverses were conducted during daylight hours. Additional traverses outside of the TSF Option areas were made by vehicle to inspect the surrounding habitats.

Eight motion-triggered cameras were deployed throughout the Study Areas between the 4th and 21st of October 2022. Table 3-6 lists the camera locations and operational days by target habitat.

Table 3-6. Motion-triggered camera setup and duration

Area	Targeted Fauna Habitat	Location (GDA 1994 MGA zone 50)	Camera	Trap nights
Option 2	Creek	695873, 7672225	MSC04	16
Option 5	Plains	695424, 7669233	MSC06	17
Option 5	Plains	695413, 7668137	MSC07	16
Option 2	Plains	697421, 7672046	MSC10	16
Option 2	Plains	697068, 7673526	MSC11	14
Option 5	Creek	695612, 7668308	MSC12	16
Option 5	Creek	694835, 7668460	MSC14	17
Option 2	Creek	695652, 7673136	MSC16	16
Total				**128**

Four Anabat Swift acoustic bat recording devices were deployed for between 11 and 17 nights between the 4th and 21st of October 2022 for a total of 59 trap nights. Table 3-7 lists the acoustic bat recording devices deployed, the habitat type targeted, and the number of trap nights.

Bat call analysis was performed by Dr Kyle Armstrong of Specialised Zoological. A technical report with specifications on the analysis method is included as Appendix E. The scope of the analysis was limited to the detection of the conservation significant Ghost bat *Macroderma gigas* and Pilbara leaf-nosed bat *Rhinonicteris aurantia*. Attention was also given to determining if the Northern leaf-nosed bat *Hipposideros stenotis,* is present. This species is generally not known to occur in the Pilbara but database records from 2012 indicate it may be present in the local area.

Table 3-7. Acoustic bat recording device location and duration

Area	Habitat	Location (GDA 1994 MGA zone 50)	Acoustic Bat Recorder	Trap nights
Option 2	Creek	695871, 7672225	622904	16
Option 5	Creek	695611, 7668308	642029	11
Option 5	Creek	694819, 7668471	660630	17
Option 2	Creek	696909, 7671805	660654	15
Total				**59**

Four Phillips DVT-7110 Digital Voice-Tracer Sound Recording devices were deployed for recording bird calls in .wav format, with the Night parrot as the target. Devices were deployed for three nights from the 4th to the 7th of October 2022, for a total of twelve trap nights. Locations were selected that provided the highest potential habitat quality. Habitat quality for Night parrot was assessed with reference to habitats described and depicted by the Night Parrot Recovery Team (2022).

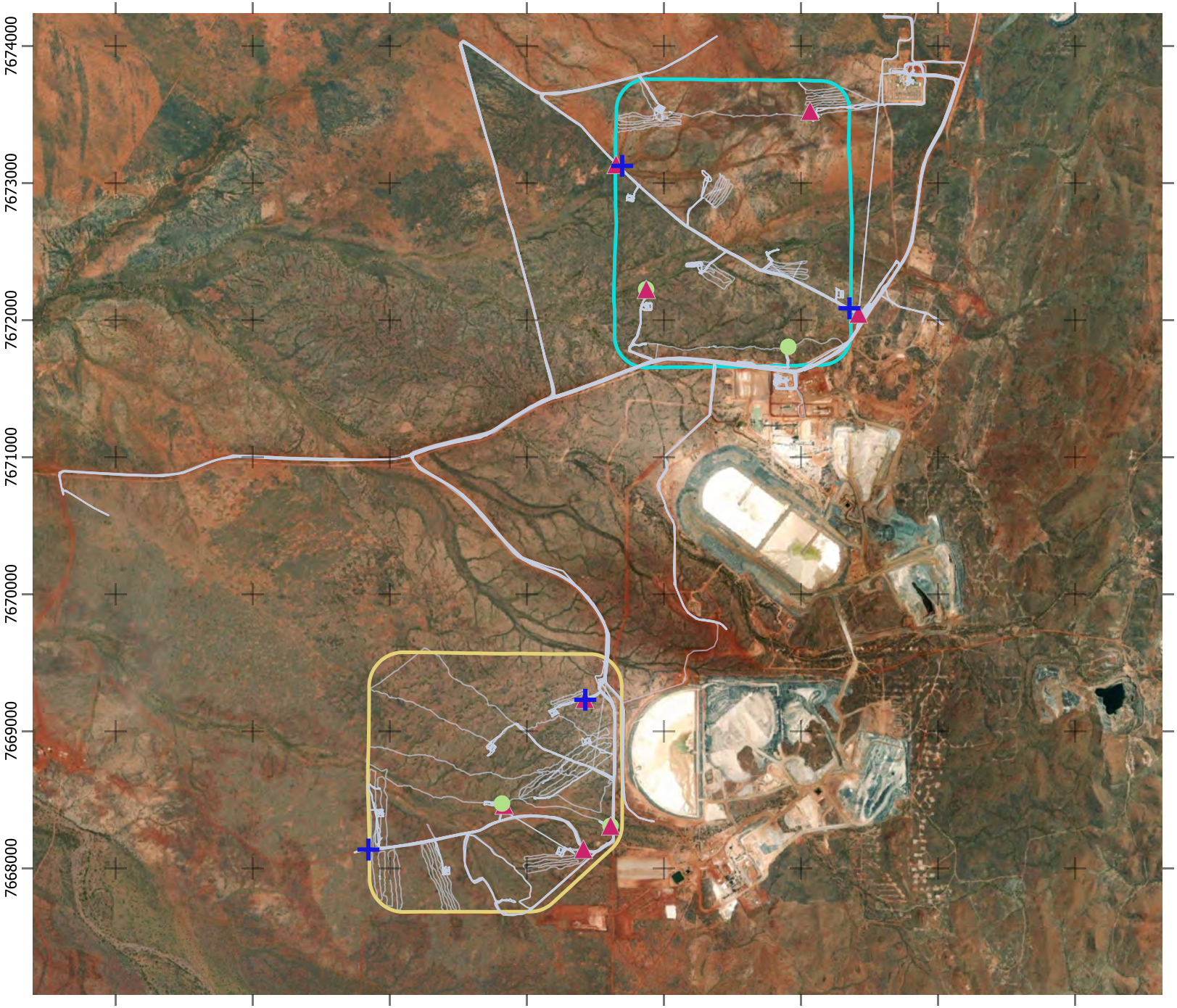
Table 3-8 lists the recording devices deployed in each habitat type, and the number of trap nights.

Table 3-8. Acoustic bird recording devices

Area	Habitat	Location (GDA 1994 MGA zone 50)	Acoustic Bird Recorder	Trap nights
Option 5	Plains	695427, 7669228	NP001	3
Option 2	Plains	697356, 7672086	NP002	3
Option 5	Plains	693844, 7668135	NP003	3
Option 2	Creek	695696, 7673126	NP004	3
Total				**12**

Acoustic recordings were assessed with reference to the calls available on the Night Parrot Recovery Team (2022) website. Sound files recorded between 17:00 and 06:30 and were assessed for Night parrot calls from 18:30 – 20:30 (2 hours post-sunset) and from 03:00 – 05:00 (2 hours pre sunrise). In addition to listening to call playbacks, a spectrograph of bird calls were viewed using the Audacity® software package. A profile of Night parrot calls was created by playing the calls available on the Night Parrot Recovery Team (2022) website, for comparison with recorded bird calls. The assessments were also made with reference to descriptions of known vocalisations of the Night parrot as published by Leseberg *et al.* (2019).

Nomenclature within this report is applied according to the WA Checklist of Terrestrial Vertebrates (Western Australian Museum, 2022). Figure 3-2 shows the location of motion-triggered cameras, bat acoustic recording devices and targeted searches. Detailed fauna habitat assessments were made at the locations where cameras and acoustic recording devise were deployed, and during traverses.



Legend

- TSF Option 2
- TSF Option 5
- Acoustic recorder - Bats
- Acoustic recorder - targeting Night Parrot
- Motion triggered camera
- Targeted Search Tracklogs

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 01/11/2022

Fauna Survey Sites

Prepared for:
Pilbara Minerals

Figure: 3-2

3.3 CONSTRAINTS

Several limitations may arise during field survey EPA (2016 and 2020). These potential survey limitations are listed below in Table 3-9 with comments on the constraint to the outcomes of the survey.

Table 3-9. Survey Constraints

Factor	Impact of survey outcomes
Access Problems	Not a constraint All of the Study Areas were accessed.
Experience levels	Not a constraint The personnel were suitably qualified
Scope: Flora and Vegetation	Not a constraint Survey was carried out at a level of Detailed assessment
Scope: Fauna	Not a constraint The survey was carried out at a level of Targeted and basic assessment, suitable for the size and intensity of the proposed Project and the availability of previous local survey.
Timing, weather, season, cycle	Not a constraint The Study Areas are within the Eremaean Botanical district. Rainfall in the season prior to survey was higher than average and therefore, weather and seasonal conditions were not a constraint. No inclement weather occurred during the survey period that would impact the detection of target fauna. Survey timing was within that recommended for mammals and reptiles. Conditions were unsuitable for water birds and amphibians, however the assessment of habitat availability for these groups was possible.
Sources of information	Not a constraint Previous biological reports and database records are available for the locality and region.
Completeness: Flora and vegetation	Not a constraint The scope was completed. Four plant specimens (3% of the collection) were not able to be determined to the species level due to sterile specimens. Modelling indicates the survey captured 84% of the floristic richness in the area.
Completeness: Fauna	Not a constraint The scope was completed. The survey resulted in no ambiguous identifications of bat calls, bird calls or photos.

4 FLORA AND VEGETATION RESULTS

4.1 DESKTOP STUDY

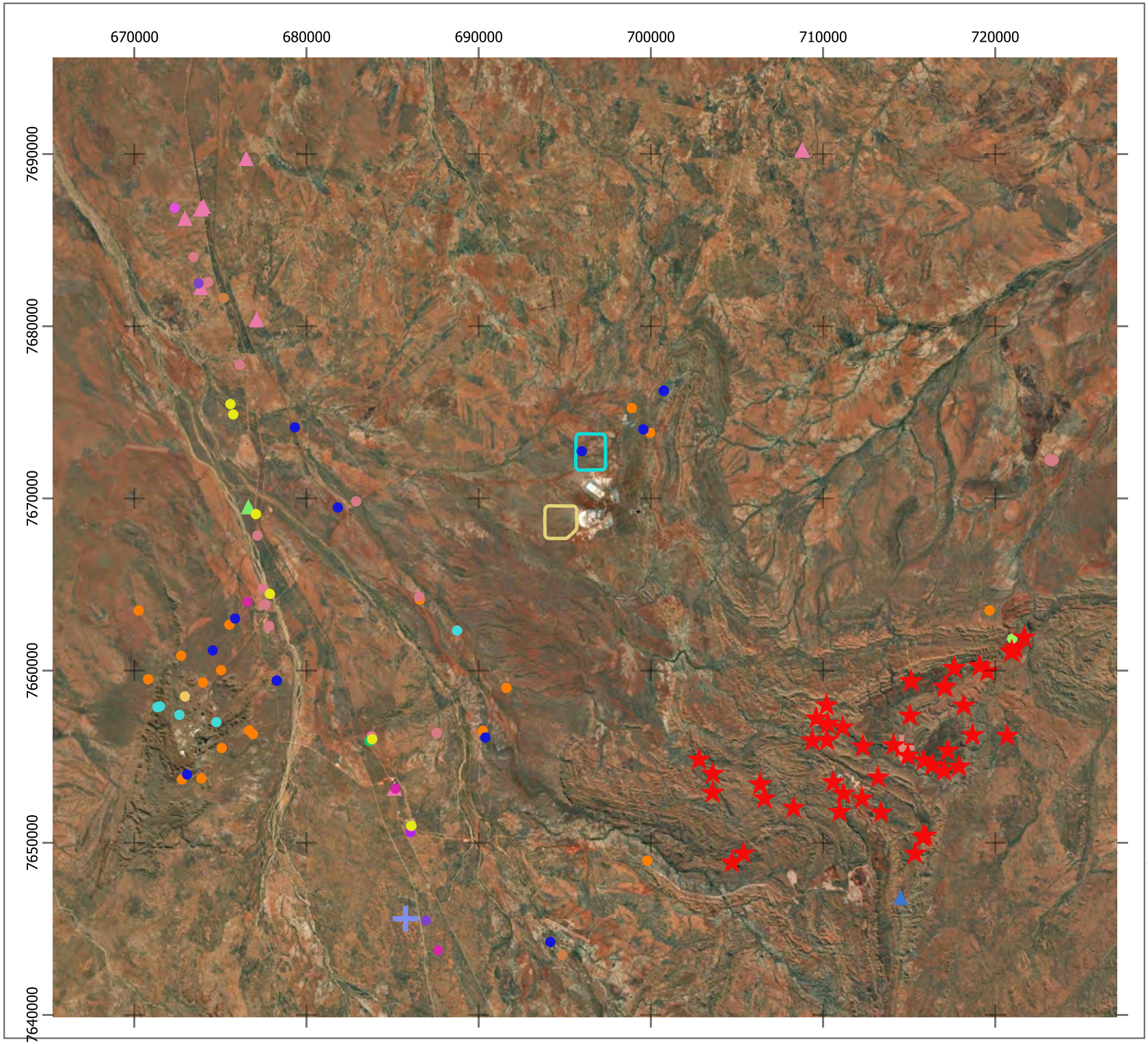
4.1.1 Significant Flora

No T Flora listed under the BC Act or EPBC Act have been previously recorded within the Study Areas. One P Flora species has been previously recorded in the Option 2, *Triodia chichesterensis* which is listed as P3 in WA.

One T flora species has been recorded within 30 km, *Quoya zonalis* (formerly *Pityrodia* sp. Marble Bar, listed as Endangered under the EPBC Act and BC Act). Two P1, thirteen P3, and three P4 species have records within 30 km of the Study Areas.

No additional T species were returned from the PMST or literature review, however a local record of *Rothia indica* subsp. *australis* (APM 2022) increased the likelihood of occurrence from Possible to Likely.

T and P flora returned from the DBCA database with records within 30 km of the Study Areas are shown in Figure 4-1.



Legend

TSF Option 2
TSF Option 5

Threatened
- Quoya zonalis

Priority 1
- Acacia leeuweniana
- Themeda sp. Panorama (J. Nelson et al. NS 102)

Priority 3
- Eragrostis crateriformis
- Euphorbia clementii
- Euploca mutica
- Gomphrena leptophylla
- Gymnanthera cunninghamii
- Nicotiana umbratica
- Phyllanthus hebecarpus
- Rothia indica subsp. australis
- Stylidium weeliwolli
- Terminalia supranitifolia
- Triodia basitricha
- Triodia chichesterensis
- Vigna triodiophila

Priority 4
- Bulbostylis burbidgeae
- Goodenia nuda
- Ptilotus mollis

Scale: @ A4
1: 300,000

0 5 10 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 01/11/2022

Threatened and Priority Flora Database Records

Prepared for:
Pilbara Minerals

Figure: 4-1

An assessment of the likelihood of occurrence of these 19 species within the Study Areas was performed using the criteria listed in Table 3-2. The results of the assessment are listed in Table 4-1.

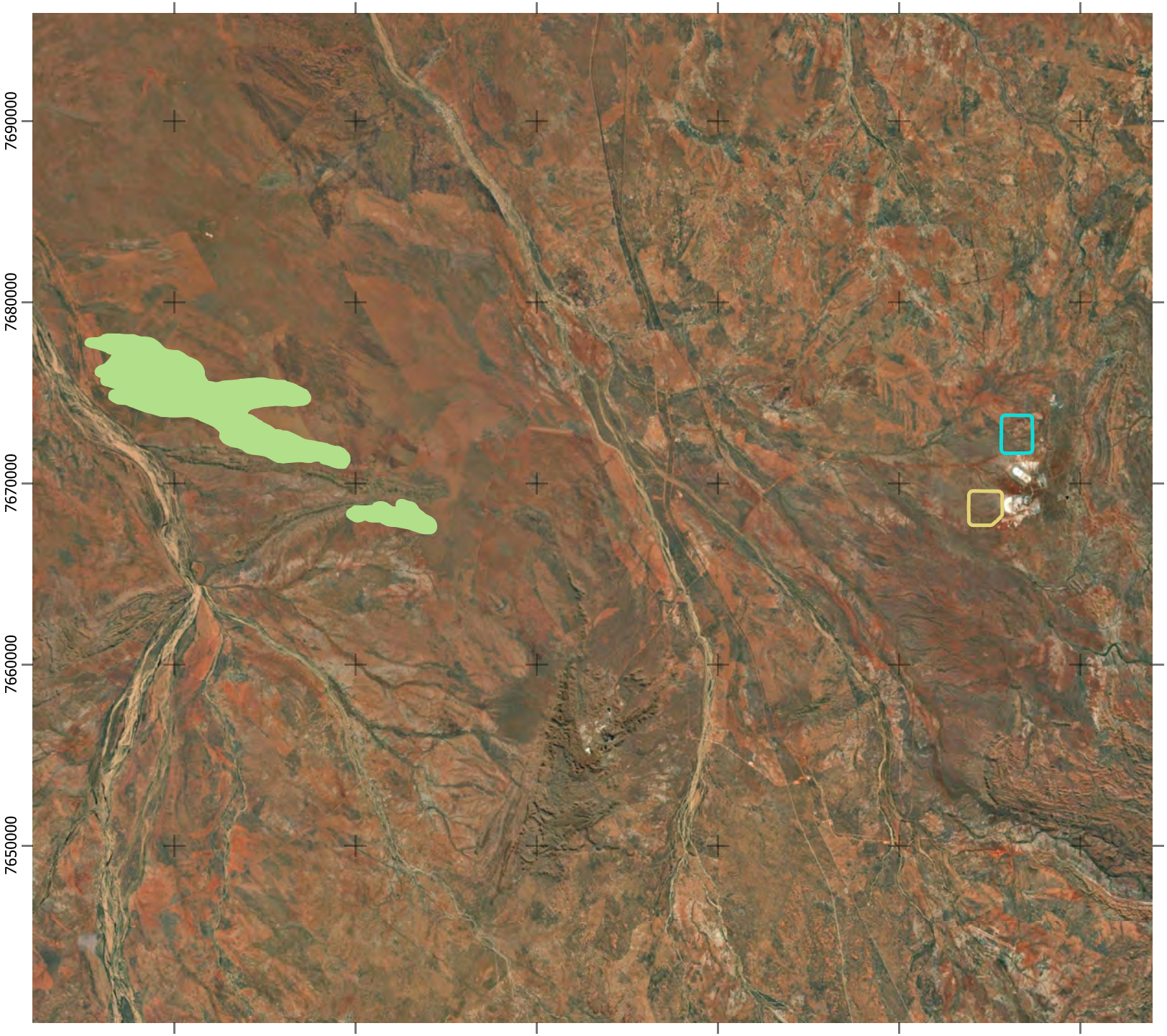
Table 4-1. Threatened and Priority Flora Likelihood of Occurrence

Species	Cons. Code		Preferred Habitat	Likelihood of Occurrence
	BC Act	EPBC Act		
Acacia leeuweniana	P1		Gritty, skeletal red-grey sandy loam, light orange-brown gravelly sand, on granite. In rock fissures in outcrops, among boulders.	Unlikely to occur.
Bulbostylis burbidgeae	P4		Granitic soils. Granite outcrops and cliff bases.	Unlikely to occur.
Eragrostis crateriformis	P3		Clayey loam or clay. Creek banks, depressions.	Possible. Suitable habitat in clay depressions.
Euphorbia clementii	P3		Gravelly hillsides, stony grounds.	Likely. Suitable habitat in stony rises.
Euploca mutica	P3		Hummock grassland and sandplains.	Likely. Suitable habitat in sandy rises.
Gomphrena leptophylla	P3		Open flats, sandy creek beds, edges salt pans and marshes, stony hillsides.	Possible. All habitats suitable.
Goodenia nuda	P4		Has been previously found in drainage lines of red-brown loamy sand or sandy loam and in disturbed roadside areas	Possible. Suitable habitat in creeks and roadsides.
Gymnanthera cunninghamii	P3		Sandy soils.	Possible. Suitable habitat in sandy creeks.
Nicotania umbratica	P3		Typically grows in shelter of large boulders on rocky outcrops and in shallow soils	Unlikely to occur.
Phyllanthus hebecarpus	P3		Granite boulders/outcropping	Unlikely to occur.
Ptilotus mollis	P4		Stony hills and screes.	Unlikely to occur.
Quoya zonalis	EN	EN	Steep, rocky, sandstone conglomerate and granite slopes in skeletal, brown, sandy loam soils of the Capricorn Land System	Unlikely to occur.

Rothia indica subsp. *australis*	P3	Sandy soils. Seasonally inundated areas, sandhills and flats.	Likely. Suitable habitat in depressions and sandy rises.
Stylidium weeliwolli	P3	Gritty sand soil, sandy clay. Edge of watercourses.	Possible. Sandy creek edges.
Terminalia supranitifolia	P3	Sand. Among basalt rocks.	Unlikely to occur.
Themeda sp. Panorama (J. Nelson *et al.* NS 102)	P1	Has been found growing along watercourses and creeklines and on rocky substrate	Unlikely to occur.
Triodia basitricha	P3	Occurs on rocky and gravelly slopes of mountains or low hills.	Unlikely to occur.
Triodia chichesterensis	P3	Occurs on sand or loam over rocky or gravelly substrates, often with quartzite.	Recorded.
Vigna triodiophila	P3	Local record among dolerite boulders on very steep upper slope. Stony red-brown clay loam.	Unlikely to occur.

4.1.2 Significant Vegetation

There are no TECs listed under the BC Act or EPBC Act known to occur within the Study Areas. One Priority 3 Ecological Community is located approximately 30 km west of the Study Areas; the Gregory Land System (Figure 4-2).



Legend

- TSF Option 2
- TSF Option 5
- Gregory Land System

Scale: @ A4
1: 300,000

0 5 10 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 01/11/2022

Threatened and Priority Ecological Communities Database Records

Prepared for:

Pilbara Minerals

Figure: 4-2

4.1.3 Introduced Flora Species

NatureMap returned eight introduced flora, including three species that are classed as Declared pests in WA, and two WONS. Eight introduced flora species have been recorded locally by MMWC Environmental (2016), including one Declared pest.

Table 4-2 lists the introduced flora species recorded within 30 km of the Study Areas. Where a local record and a database record is available, the local record is adopted as the source.

Table 4-2. Introduced Flora Records within 30 km of the Study Areas

Species	Common Name	BAM Act Listing	WONS	Source
Aerva javanica	Kapok Bush	Permitted – S11	No	MMWC
Arivela viscosa (formerly *Cleome viscosa)*	Tickweed	Permitted – S11	No	Database
Boerhavia coccinea	Tar Vine	Permitted – S11	No	Database
Calotropis procera	Rubber Bush	Declared Pest – S22(2) (Exempt)	No	Database
Cenchrus ciliaris	Buffel Grass	Permitted – S11	No	MMWC
Cenchrus setiger	Birdwood Grass	Permitted – S11	No	MMWC
Chloris barbata	Purpletop Chloris	Permitted – S11	No	MMWC
Cynodon dactylon	Couch Grass	Permitted – S11	No	MMWC
Flaveria trinervia	Speedy Weed	Permitted – S11	No	MMWC
Opuntia elata	Prickly Pear	Declared Pest – S11(2) (C3 Restricted)	Yes	Database
Opuntia stricta	Common Prickly Pear	Declared Pest – S11(2) (C3 Restricted)	Yes	MMWC
Passiflora foetida var. *hispida*	Stinking Passion Flower	Permitted – S11	No	MMWC
Tamarix aphylla	Athel Pine	Declared Pest – S22(2) (Exempt)	Yes	MMWC

4.2 FIELD SURVEY

4.2.1 Flora

A total of 123 species of flora were recorded within the Study Areas, comprising 117 native species and six introduced species. Four specimens in the collection (3% of the collection) could not be identified beyond genus level due to the lack of flowering parts or fruiting bodies.

The Fabaceae (pea family, 29 native) Poaceae (grass family, 19 native, two introduced), Malvaceae (13 native species) and Amaranthaceae (eight native species, one introduced) were the most species-rich families recorded. Twenty-eight families were recorded across the Study Areas.

The complete list of plant species recorded within the Study Areas is presented in Appendix F. The mean species richness was 23 species per quadrat, slightly less than the MMWC Environmental (2016) survey which included 49 detailed sites with an average species richness of 25.

A species accumulation curve was performed with a modelled Michaelis-Menton species richness of 146, indicating that the floristic survey was approximately 84% complete.

The survey recorded 29 species not previously recorded for the Pilgangoora Project area. These species are identified in Appendix F and bring the total richness for the Pilgangoora Project area to 260 including subspecies, and varieties.

Floristic groups identified in the cluster analysis were organised into vegetation types and are discussed in the following section.

The introduced flora species recorded are detailed in Section 4.2.6.

4.2.2 Vegetation Types

The DBCA fire history database did not identify any fire activity within the Study Areas. Field survey identified that some areas within the Study Areas were recently burned and were regenerating. Fire history was estimated based upon the level of regeneration given the good growth conditions following significant rainfall in the 2022 calendar year.

Three vegetation types are described for the Study Areas, as summarised in Table 4-3 and detailed in the subsections below. As the TSF options areas are considered as an extension to the existing Pilbara Minerals Pilgangoora Project, the vegetation coding system previously used at the site has been retained and extended. MMWC Environmental (2016) described vegetation type using the numerals 1 to 6 and the letters a to c to group sites by landform and floristics respectively. APM (2022) adopted the approach and described vegetation types using the numerals 6 to 11. Vegetation types reported here are labelled from 12 onwards and are different from those recorded previously.

Distribution of vegetation types at a scale of 1: 15,000 is shown in Figure 4-3. The dendrogram resulting from the cluster analysis is shown in Appendix C, followed by the site data sheets and photos.

Table 4-3. Vegetation Types

Code	Landform	Vegetation description	Option 2		Option 5	
			ha	%	ha	%
12a	Undulating plains	Isolated low *Corymbia hammersleyana* over mid to tall, isolated shrubs of *Acacia tumida, Acacia adsurgens* and *Acacia inaequilatera* with hummock grassland of *Triodia angusta, Triodia wiseana* and *Triodia lanigera*	277.5	78.2	293.6	89.2
13a	Creeks	Low open woodland of *Eucalyptus camaldulensis*, *Corymbia hammersleyana* and *Eucalyptus victrix*; sparse mid to tall shrubland of *Acacia tumida, Acacia stellaticeps* and *Acacia bivenosa* over	66.9	18.9	20.8	6.3

Code	Landform	Vegetation description	Option 2		Option 5	
			ha	%	ha	%
		*Triodia epactia, *Cenchrus ciliaris* and **Cenchrus setiger* tussock/hummock grassland.				
14a	Drainage depression	*Corymbia hammersleyana* low open woodland over sparse forbland/low shrubland of *Streptoglossa odora*, *Goodenia lamprosperma* and *Solanum diversiflorum*.	0	0	2.0	0.6
D		Disturbed – clear of vegetation	10.4	2.9	12.8	3.9

Legend

- TSF Option 2
- 12a: Isolated low Corymbia hammersleyana over mid to tall isolated shrubs of Acacia tumida Acacia adsurgens and Acacia inaequilatera with hummock grassland of Triodia angusta Triodia wiseana and Triodia lanigera
- 13a: Low open woodland of Eucalyptus camaldulensis Corymbia hammersleyana and Eucalyptus victrix; sparse mid to tall shrubland of Acacia tumida Acacia stellaticeps and Acacia bivenosa over Triodia epactia *Cenchrus ciliaris and *Cenchrus setiger tussock/hummock grassland.
- D: Disturbed clear of vegetation

Scale: @ A4
1: 15,000

0 200 400 m

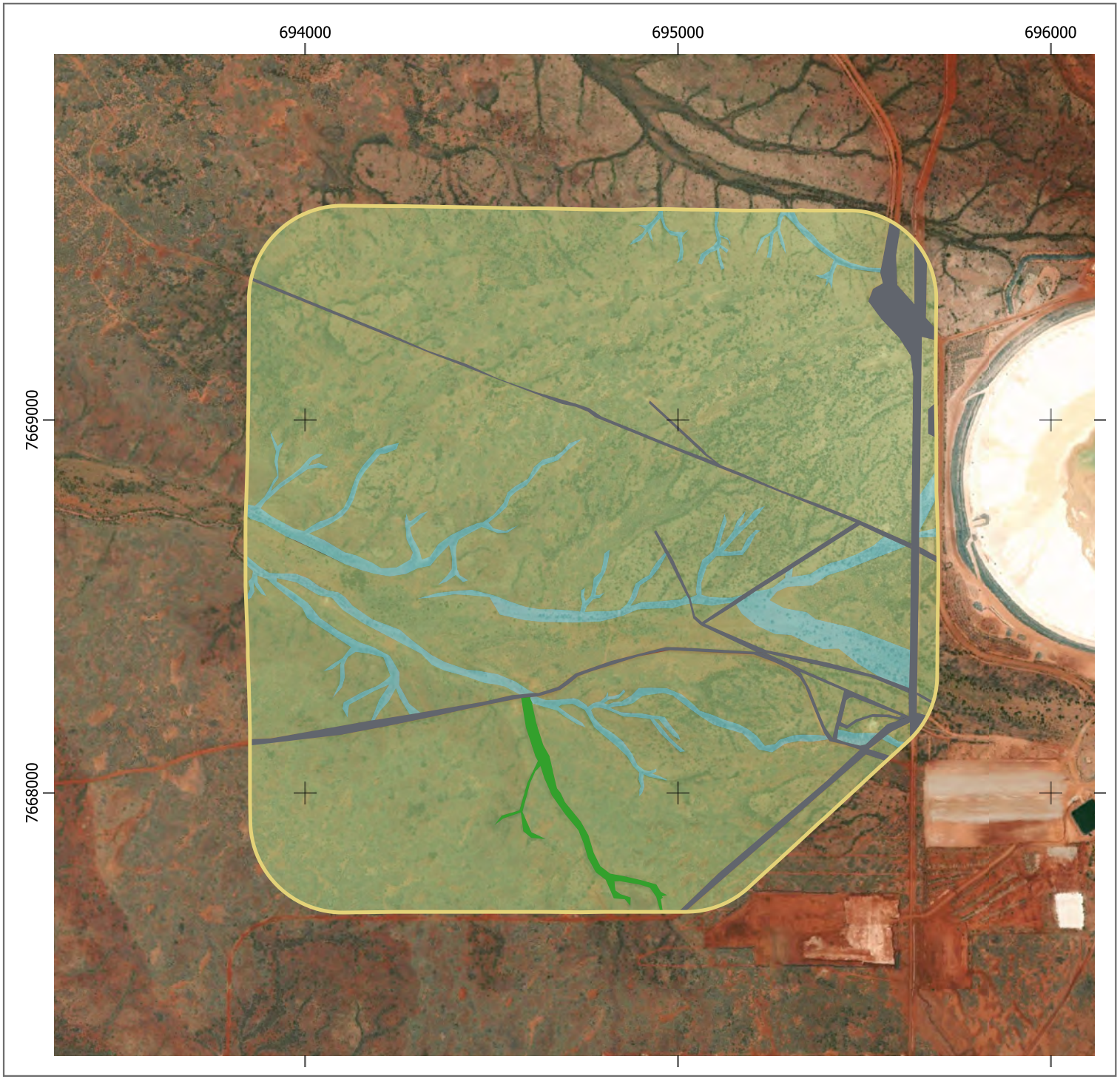
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH | Approved: ML | Date: 09/11/2022

Vegetation - TSF Option 2

Prepared for:
Pilbara Minerals

Figure: 4-3a



Legend

- TSF Option 5
- 12a: Isolated low Corymbia hammersleyana over mid to tall isolated shrubs of Acacia tumida Acacia adsurgens and Acacia inaequilatera with hummock grassland of Triodia angusta Triodia wiseana and Triodia lanigera
- 13a: Low open woodland of Eucalyptus camaldulensis Corymbia hammersleyana and Eucalyptus victrix; sparse mid to tall shrubland of Acacia tumida Acacia stellaticeps and Acacia bivenosa over Triodia epactia *Cenchrus ciliaris and *Cenchrus setiger tussock/hummock grassland.
- 14a: Corymbia hammersleyana low open woodland over sparse forbland/low shrubland of Streptoglossa odora Goodenia lamprosperma and Solanum diversiflorum.
- D: Disturbed
  clear of vegetation

Scale: @ A4
1: 15,000

0 200 400 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH | Approved: ML | Date: 09/11/2022

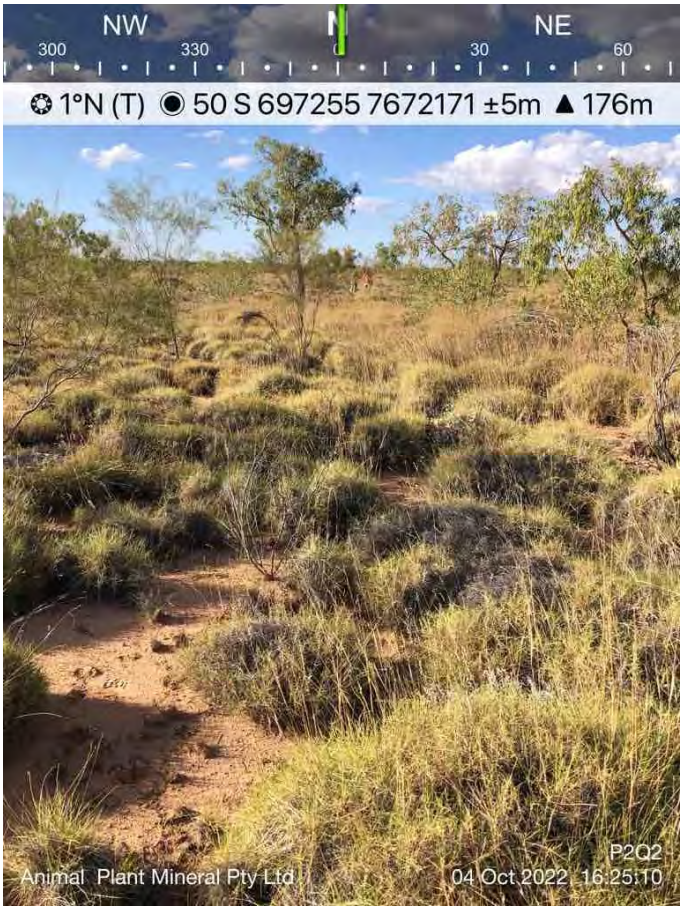
Vegetation - TSF Option 5

Prepared for:
Pilbara Minerals

Figure: 4-3b

Landform: Undulating Plains

Vegetation Type: 12a



Isolated low *Corymbia hammersleyana* over mid to tall, isolated shrubs of *Acacia tumida, Acacia adsurgens* and *Acacia inaequilatera* with hummock grassland of *Triodia angusta, Triodia wiseana* and *Triodia lanigera.*

The ground layer is the dominant vegetation stratum and is characterised by a diverse hummock grassland of *Triodia angusta, Triodia wiseana, Triodia lanigera, Triodia epactia* and *Triodia brizoides*. Tussock grasses such as *Eriachne mucronata, Eragrostis eriopoda* and *Heteropogon contortus* occasionally occur in low numbers.

This community occurs on the higher ground, on undulating plains between the drainage features. The soils are variable from sandy to clayey. The higher areas are sandy and sometimes have a cover of small stones at the surface. The lower areas have a higher clay content and evidence of seasonal inundation is present. The *Acacia* mid story occurs in higher density in areas where run on occurs such as shallow drainage depressions but is generally a tall and sparse or isolated shrub layer. The occasional *Corymbia hammersleyana* overstory occurs where this vegetation type adjoins creek areas. Occasionally on the highest ground, very low (*e.g.*, one m high) rock outcrops are present.

Condition: Impacts from cattle grazing are low. No weeds were recorded. The condition of this vegetation is Very Good. Some areas are recovering from recent fire and are regenerating.

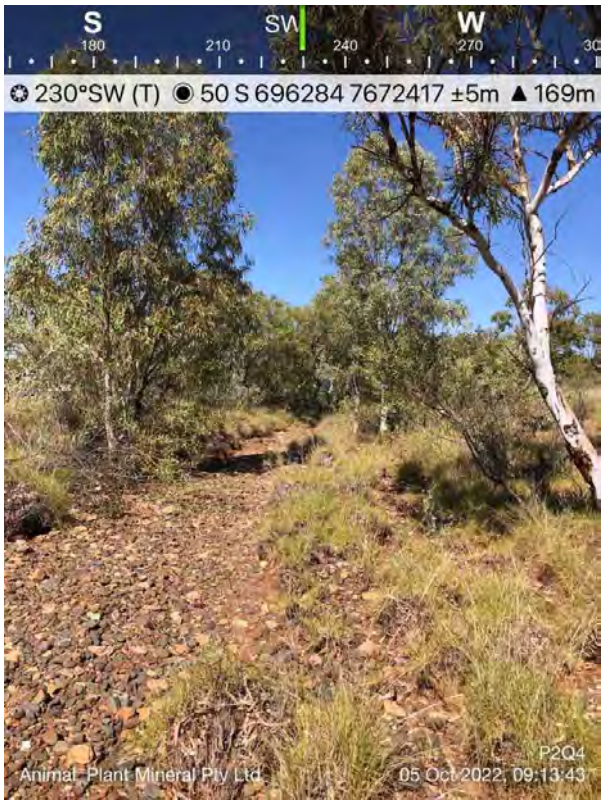
Detailed sites: P2Q1, P2Q2, P2Q3, P2Q5, P2Q6, P2R2, P5Q1, P5Q2, P5Q3, P5Q5, P5Q6, P5R4.

Total richness: 76 species. Average richness: 20.4 species

Introduced/exotic taxa: *Flaveria trinervia* occasionally present.

Conservation significant species: None recorded

Landform – Creek



Vegetation Type: 13a Low open woodland of *Eucalyptus camaldulensis*, *Corymbia hammersleyana* and *Eucalyptus victrix*; sparse mid to tall shrubland of *Acacia tumida, Acacia stellaticeps* and *Acacia bivenosa* over *Triodia epactia, *Cenchrus ciliaris* and **Cenchrus setiger* tussock/hummock grassland.

This community occurs in the creeklines with a rocky sandy loam soil. Riparian banks are often present with alluvial loamy soils. Creeks are all ephemeral with no permanent pools present.

Condition: Impacts from cattle grazing are moderate, and agricultural weeds **Cenchrus setiger* and **C. ciliaris* are present, and heavily grazed. The environmental week Kapok is also often present. The condition of this vegetation is Good.

Detailed sites: P2Q4, P2R1, P2R3, P2R4, P5Q4, P5R1, P5R2, P5R5.

Total richness: 83 species. Average richness: 27.5 species

Introduced/exotic taxa: The exotic agricultural grasses *Cenchrus setiger* (Birdwood grass) and *Cenchrus ciliaris* (Buffel Grass) are dominant species in the understory within this vegetation type. The environmental week *Aerva javanica* (Kapok) is common in low numbers. *Flaveria trinervia, Triumfetta pentandra* and *Malvastrum americanum* occasionally present.

Conservation significant species: None recorded

Landform – Degraded drainage depression

Vegetation Type: 14a *Corymbia hammersleyana* low open woodland over sparse forbland/low shrubland of *Streptoglossa odora*, *Goodenia lamprosperma* and *Solanum diversiflorum*.

This community occurs in a first order creek line, with red loam soils with a granite gravel cover. This community is highly degraded, with no midstory present and the groundcover degraded by high intensity grazing. Groundcover is dominated by disturbance colonists and unpalatable species, with some heavily grazed weedy **Cenchrus* grasses present. There is an overstory of low *Corymbia hamersleyana* in the southern extent, in the northern extent the overstory is lacking.

Condition: Impacts from cattle grazing are high, erosion is present and the agricultural weed **Cenchrus ciliaris* is present and heavily grazed. The condition of this vegetation is Poor.

Detailed sites: P5R3

Total richness: 17 species.

Introduced/exotic taxa: **Cenchrus ciliaris* is present. Likely also **Cenchrus setiger*, low detectability due to heavy grazing.

Conservation significant species: none recorded.

4.2.3 Vegetation Condition

Vegetation condition across the Study Areas was within the categories Good, Poor and Completely Degraded, with most of the Study Areas in Good condition (Table 4-4; Figure 4-4). The primary sources of disturbance on site are moderate to high grazing impact from cattle and roads to support the pastoralism activities, and several weed species, primarily through the creek lines and predominantly grasses valued for pastoralism. Additional tracks are present in support of the nearby mining activity.

The Study Areas have recent fire (< 2 years) in some of the plains areas, otherwise being long unburned.

Table 4-4. Vegetation condition within the Study Areas

Vegetation Condition	TSF Option 2		TSF Option 5	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Very Good	277.5	78.2	293.6	89.2
Good	66.9	18.9	20.8	6.3
Poor	0	0	2.0	0.6
Completely Degraded	10.4	2.9	12.8	3.9

Legend

- TSF Option 2
- TSF Option 5
- Very Good
- Good
- Poor
- Completely Degraded

Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 09/11/2022

Vegetation Condition

Prepared for:
Pilbara Minerals

Figure: 4-4

4.2.4 Significant Flora

No species listed as T under the EPBC Act or BC Act were recorded during the survey.

No Priority flora species were recorded.

A database record for *Triodia chichesterensis* is within the Option 2 area. The species has a limited distribution and has been found only in a narrow area in the central Chichester region of the Pilbara of WA. The areas immediately to the west and east of its known distribution are poorly explored, but it is likely to be restricted to an area <100 km beyond current collections, given intensive collecting efforts in the Pilbara (Anderson *et al*. 2017). Collection records indicate that florets are observed between February–April and in August.

The Study Areas are in the central part of the range of this species, which is significant from the perspective of determining it from the closely related *Triodia lanigera* (Anderson *et al*. 2017). Where the two co-occur in the south it can be difficult to determine them based on morphological and distributional parameters. Where the two co-occur in the north, there is a subtle but consistent substrate change that marks the shift in species, with *T. lanigera* occurring on sandier soils and *T. chichesterensis* on rockier soils with quartzite pieces. In the northern species range, it can usually be morphologically distinguished from *T. lanigera* by its shorter and less hairy leaves and less branched inflorescences.

The database record within the Option 2 area was recorded on rocky soils with quartzite. It is likely that *Triodia chichesterensis* is present within the Option 2 area, likely restricted to low rises with rocky soils containing quartzite.

An additional eight species were determined to be possibly occurring or likely to occur based upon the availability of suitable habitat. Of these, one is a perennial shrub and would therefore have been present at the time of survey. The remaining seven are annual herbs or small herbaceous perennials that may not have been present due to seasonal conditions.

4.2.5 Significant Vegetation

No vegetation types occurring within the Study Areas are analogous to any known TEC's or PEC's.

Two species that may be associated with groundwater dependant ecosystems were recorded in the Study Areas. These are *Eucalyptus camaldulensis* and *Eucalyptus victrix*, recorded in vegetation type 13a. The Bureau of Meteorology Groundwater Dependent Ecosystems (**GDE**) Atlas indicates this area has a low potential for terrestrial GDE from the national assessment.

4.2.6 Introduced Flora

Six introduced flora species were recorded in the Study Areas and are listed in Table 4-5. No Declared Weeds or WONS were recorded.

Table 4-5. Introduced Flora Recorded in the Study Areas

Species	Common name	Description
BAM Act S11 - Permitted		
Aerva javanica	Kapok	Erect, much-branched perennial herb, 0.4-1.6 m high. Flowers white from January to October. Often found growing on sandy soils and along drainage lines.
Cenchrus ciliaris	Buffel grass	Tufted or sometimes stoloniferous perennial, grass-like or herb. 0.2 - 1.5 m high. Flowers purple from February to October. Grows on white, red, or brown sand, stony red loam, or black cracking clay.
Cenchrus setiger	Birdwood grass	Erect, tussocky, stoloniferous perennial, herb or grass-like. Grows to 0.5 m high. Flowers cream to purple from April to May. Grows on brown sands, red loam, or pindan soils on sand dunes, plains, rangelands, stony hillsides, or floodplains.
Flaveria trinervia	Speedy weed	An erect, annual herb preferring wet areas. Often in disturbed areas.
Malvastrum americanum	Spiked malvastrum	Erect perennial, herb or shrub, 0.5-1.3 m high. Fl. yellow-orange, Apr to Jul. Orange/red/yellow sands, gritty alluvial sand, black/brown clay, alluvial cracking clays, limestone, calcrete. Stony ridges and hillsides, floodplains, along drainage lines.
Triumfetta pentandra	-	Woody annual, herb or shrub, to 1.5 m high. Fl. yellow-green, Apr to May. Brown sand, black clayey sand, red-brown clay, sandstone. Sandbank above river flood plain, forest edges, coastal sites, disturbed areas.

The agricultural weeds *Cenchrus ciliaris* and *C. setiger* were recorded in the plains on the western side of the Study Areas where cattle grazing occurs at a high intensity, and tracks are frequent. Where found, these weeds were heavily grazed.

The environmental weed *Aerva javanica* was most common on the high ridge line and infrequent in the rocky hills. The remaining weeds were recorded in low numbers predominantly in the creeks.

5 TERRESTRIAL VERTEBRATE FAUNA RESULTS

5.1 DESKTOP STUDY

5.1.1 Significant Fauna

The DBCA database returned 16 species of significant fauna that have previously been recorded within 30 km of the Study Areas. Of these, four are listed as migratory bird species (**MI**) and one as Other Specifically Protected (**OS**). Record locations of T and P fauna in relation to the Study Areas are shown in Figure 5-1.

No T or P fauna species have previously been recorded within the Study Areas.

The PMST returned 11 additional species, six T and five MI. These are species that do not have records within 30 km but where modelling has identified that suitable habitat is known to occur or may occur.

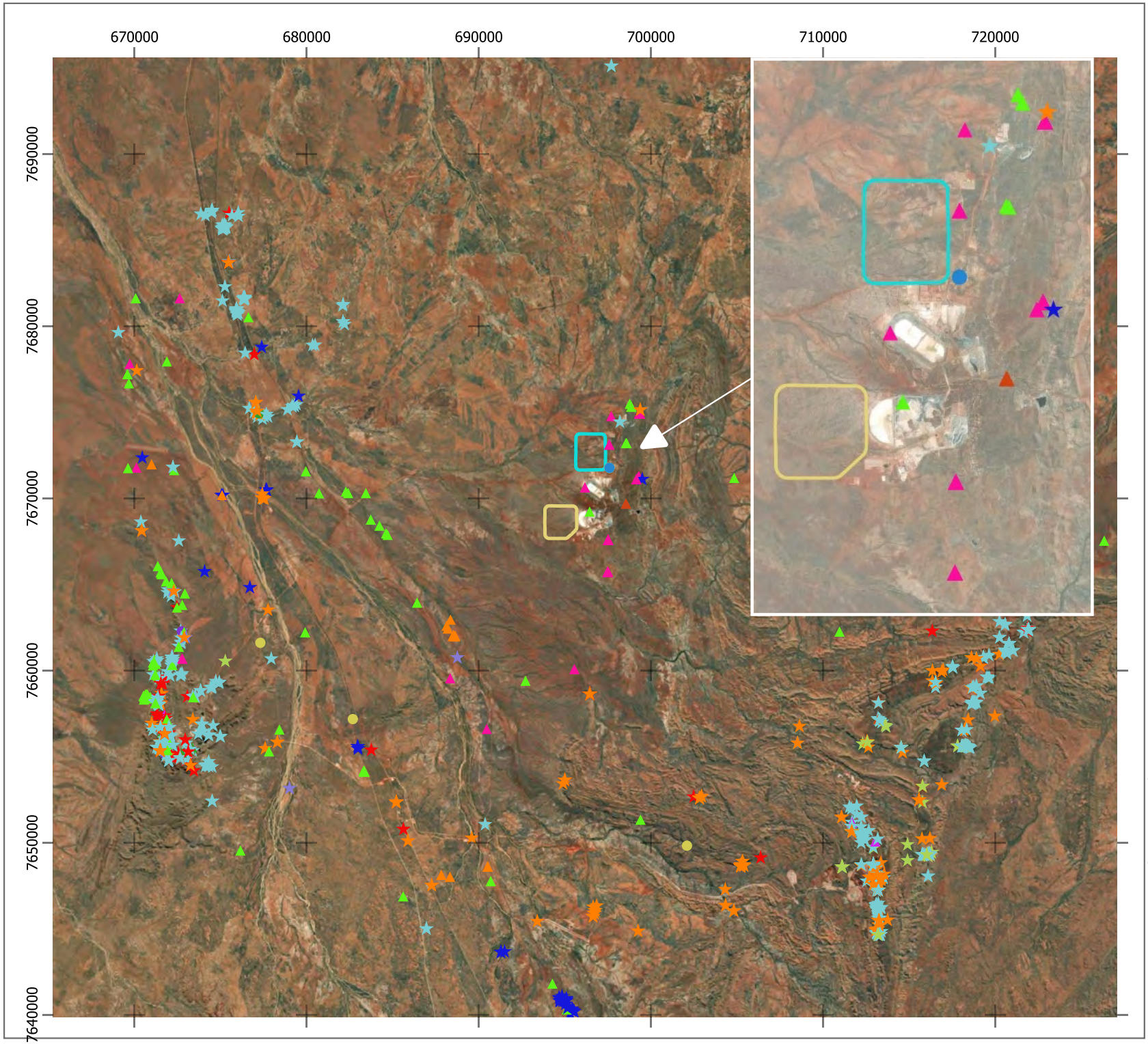
The Literature review returned additional information about the locations and abundance of Pilbara leaf-nosed bat and Northern quoll records.

Database search results of T, P and MI fauna within 30 km of the Study Areas are listed in Table 5-1, with the outcome of the likelihood of occurrence assessment. The complete assessment including the preferred habitat relative to those available in the Study Areas and records in the local area is included in Appendix G.

5.1.2 Introduced Fauna

NatureMap records for eight introduced fauna recorded within 30 km of the Study Areas were returned and are listed below:

- Camel (*Camelus dromedarius*);
- Cat (*Felis cattus*);
- Cattle (*Bos taurus*);
- Dog (*Canis lupus*);
- Donkey (*Equus asinus*)
- Fox (*Vulpes vulpes*)
- Horse (*Equus caballus*); and
- House mouse (*Mus musculus*).



Legend

TSF Option 2
TSF Option 5

Threatened

- Dasyurus hallucatus
- Falco hypoleucos
- Liasis olivaceus barroni
- Macroderma gigas
- Macrotis lagotis
- Rhinonicteris aurantia (Pilbara)

Priority

- Anilios ganei
- Dasycercus blythi
- Hipposideros stenotis
- Lagorchestes conspicillatus leichardti
- Pseudomys chapmani
- Sminthopsis longicaudata

Migratory and Other Specially Protected

- Actitis hypoleucos
- Apus pacificus
- Charadrius veredus
- Falco peregrinus

Scale: @ A4
1: 300,000

0 5 10 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 02/11/2022

Threatened and Priority Fauna Database Records

Prepared for:
Pilbara Minerals

Figure: 5-1

Table 5-1. Significant fauna database records and likelihood of occurrence

Species	Common Name	Conservation Code		Assessment of Occurrence
		BC Act	EPBC Act	
Actitis hypoleucos	Common sandpiper	MI	MI	Possible. No saline or coastal habitats available. Freshwater habitats are likely to be seasonally present in the drainage lines, however there are no permanent or semi-permanent pools. The undulating plains habitat would receive run-on following significant rainfall. Clay in the lower areas suggests inundation occurs following significant rainfall. Wading habitat would be available at these times.
Calidris acuminata	Sharp-tailed sandpiper	MI	MI	
Calidris ferruginea	Curlew sandpiper	CR	CR, MI	
Calidris melanotos	Pectoral sandpiper	-	MI	
Numenius madagascariensis	Eastern curlew	CR	CR, MI	
Apus pacificus	Fork-tailed swift	MI	MI	Possible. Utilises a broad array of habitats.
Charadrius veredus	Oriental plover	MI	MI	Likely. Suitable habitat in the seasonally inundated areas.
Erythrotriorchis radiatus	Red goshawk	VU	VU	Unlikely. Not within the known range of the species distribution.
Falco hypoleucos	Grey falcon	VU	VU	Likely. All areas are suitable for foraging. No suitable nesting habitat.
Falco peregrinus	Peregrine falcon	OS	-	Likely. All areas are suitable for foraging. No suitable nesting habitat.
Glareola maldivarum	Oriental pranticole	MI	MI	Possible. Suitable habitat in the seasonally inundated areas.
Hirundo rustica	Barn swallow	MI	MI	Possible. Suitable habitat in the seasonally inundated areas.
Motacilla cinerea	Grey wagtail	MI	MI	Unlikely. No opportunities for fast flowing water.
Motacilla flava	Yellow wagtail	MI	MI	Possible. Suitable habitat in the seasonally inundated areas.
Pezoporus occidentalis	Night parrot	CR	EN	Possible. No local records. Habitat modelling includes the Study Areas at the extremity of the species potential extent. Foraging resources are limited.

Species	Common Name	Conservation Code		Assessment of Occurrence
		BC Act	EPBC Act	
Rostratula australis	Australian painted-Snipe	EN	EN	Unlikely. No habitat occurs in the Study Areas. Vegetation too open to provide well vegetated shallows.
Dasycercus blythi	Brush-tailed mulgara	P4	-	Possible. Sandy rises in the undulating plains habitat is suitable.
Dasyurus hallucatus	Northern quoll	EN	EN	Likely. Suitable foraging habitat in the creeks but of low quality. No suitable denning habitat available.
Hipposideros stenotis	Northern leaf-nosed bat	P2	-	Unlikely. Not within the known range of the species distribution.
Lagorchestes conspicillatus leichardti	Spectacled hare-wallaby	P4	-	Unlikely. Historic records nearby however habitat is too open to be suitable.
Macroderma gigas	Ghost bat	VU	VU	Likely. Foraging habitat available. No roosting habitat available.
Macrotis lagotis	Greater bilby	VU	VU	Possible. Suitable habitat includes the undulating plains habitats.
Pseudomys chapmani	Western pebble-mound mouse	P4	-	Present. Mounds located in the undulating plains where suitable pebbles occur.
Rhinonicteris aurantia	Pilbara leaf-nosed bat	VU	VU	Likely. No roosting habitat available, foraging quality of habitats is Low.
Sminthopsis longicaudata	Long-tailed dunnart	P4	-	Unlikely. No suitable habitat.
Anilios ganei	Gane's blind snake (Pilbara)	P1	-	Unlikely. No suitable habitat.
Liasis olivaceus subsp. *baronni*	Pilbara olive python	VU	VU	Unlikely. No suitable habitat.
Liopholis kintorei	Great desert skink	VU	VU	Unlikely. No records in the local area. May occur 10 km to the east.

5.2 FIELD SURVEY

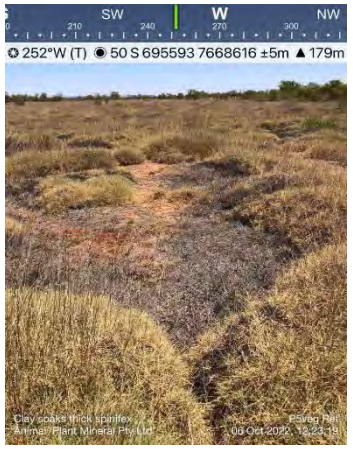
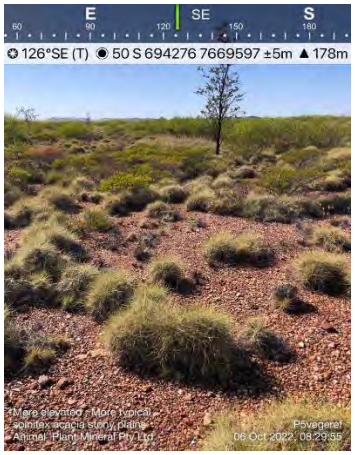
5.2.1 Fauna Habitats

The Study Areas are characterised by undulating plains dissected by ephemeral creeks. There are higher ranges to the east and water sheds from these into the Study Areas and continues through to the west. The presence of water is ephemeral and no permanent or semi-permanent water is available. The undulating plains has stony surface on the highest areas, sand surface on the lower rises and clay soils in the depressions. This arrangement is often referred to as gilgai. The lower clay areas are likely to be inundated following significant rainfalls.

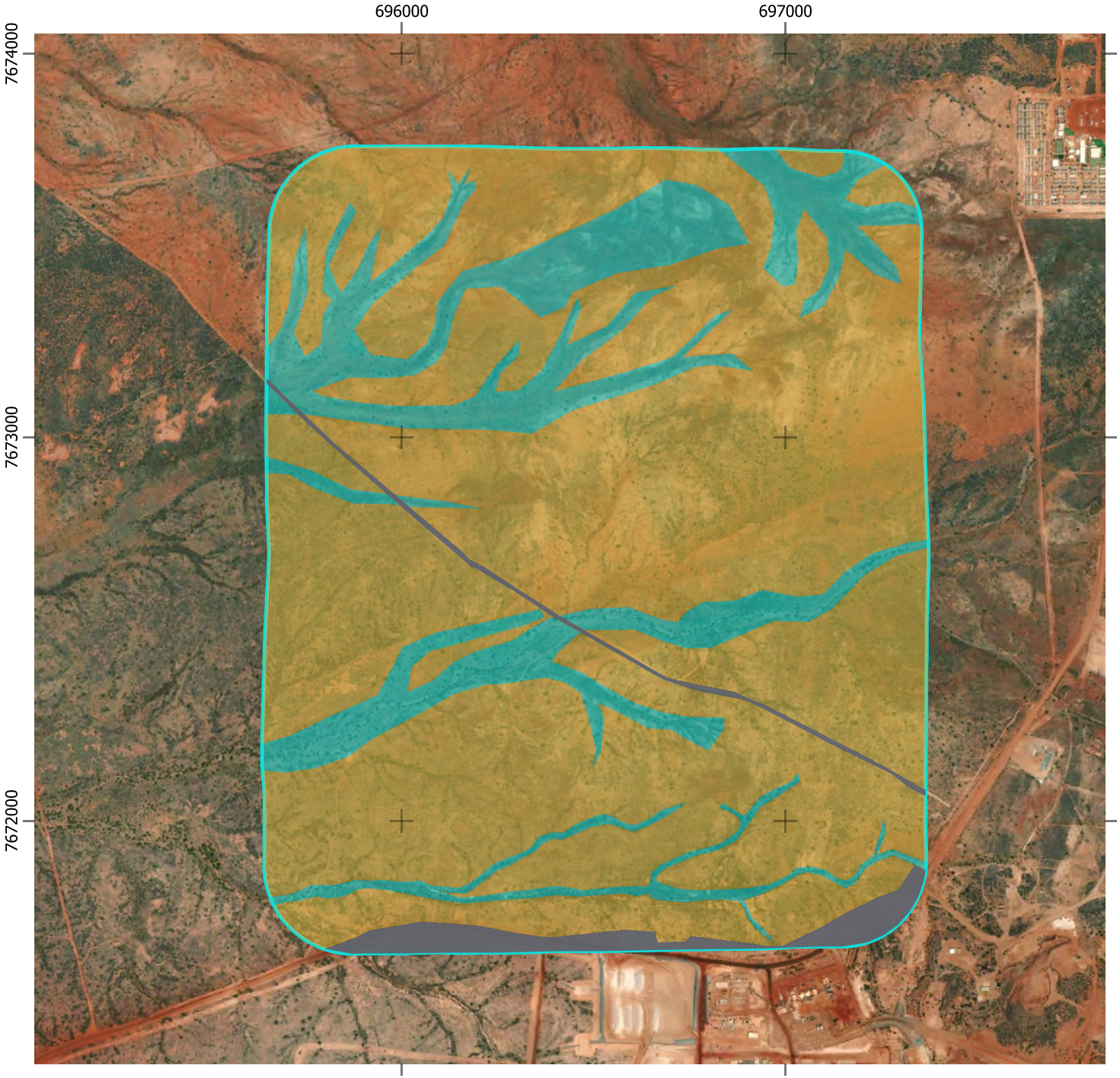
Two fauna habitats are described for the Study Areas and are summarised in Table 5-2 below. Whilst the inundated clay depressions offer a different set of microhabitats to the sandy and stony rises, the scale of the patterning is too fine to be described as separate habitats and they are grouped as undulating plains.

The distribution of fauna habitats is shown in Figure 5-2. Photos of the habitat assessment locations are shown in Appendix D.

Table 5-2. Fauna Habitats within the Study Areas

Habitat Code	Name	Sites	Description	Photo	Extent in Study Area (ha)	
					Option 2	Option 5
FH1	Undulating plains	MSC06 MSC07 MSC10 MSC11 NP001 NP002 NP003 BM01 BM02 BM03 BM04 BM05 BM06 BM07 BM08 BM09 BM10 BM11	Undulating plains with clay soils in the lowest areas interspersed with higher ground of sandy and stony surface soils. Seasonal inundation likely to occur in the lower areas. Sandy rises suitable for burrowing species. Stony areas suitable for pebble mound mouse. Hummock grasses in some areas are large. The vegetation consists of Isolated low *Corymbia hammersleyana* over mid to tall, isolated shrubs of *Acacia tumida, Acacia adsurgens* and *Acacia inaequilatera* with hummock grassland of *Triodia angusta, Triodia wiseana* and *Triodia lanigera*	 	277.5 (78.2%)	293.6 (89.2%)

Habitat Code	Name	Sites	Description	Photo	Extent in Study Area (ha)	
					Option 2	Option 5
FH2	Ephemeral creeks	MSC04 MSC12 MSC14 MSC16 AS622904 AS642029 AS660630 AS660654 NP004 RV001	Ephemeral creeklines with rocky sandy loam soil. Riparian banks are often present with alluvial loamy soils. Creeks are all ephemeral with no permanent or semi-permanent pools present. Sandy soils is suitable for burrowing species. Occasional trees but generally of insufficient size to have hollows and no fallen hollow branches observed. This habitat may act as a wildlife corridor for birds, bats, mammals, and reptiles. The condition of the habitat is poor, the cover of weedy grasses is high, there is a low leaf litter or accumulation of dead wood to provided microhabitats, and a high grazing pressure. The vegetation consists of Low open woodland of *Eucalyptus camaldulensis*, *Corymbia hammersleyana* and *Eucalyptus victrix*, sparse mid to tall shrubland of *Acacia tumida, Acacia stellaticeps* and *Acacia bivenosa* over *Triodia epactia, *Cenchrus ciliaris* and **Cenchrus setiger* tussock/hummock grassland.		66.9 (18.9%)	22.8 (6.9%)
D	Disturbed				10.4 (2.9%)	12.8 (3.9%)



Legend

- TSF Option 2
- FH1 Undulating Plains
- FH2 Ephemeral Creeks
- D Disturbed

Scale: @ A4
1: 15,000

0 200 400 m

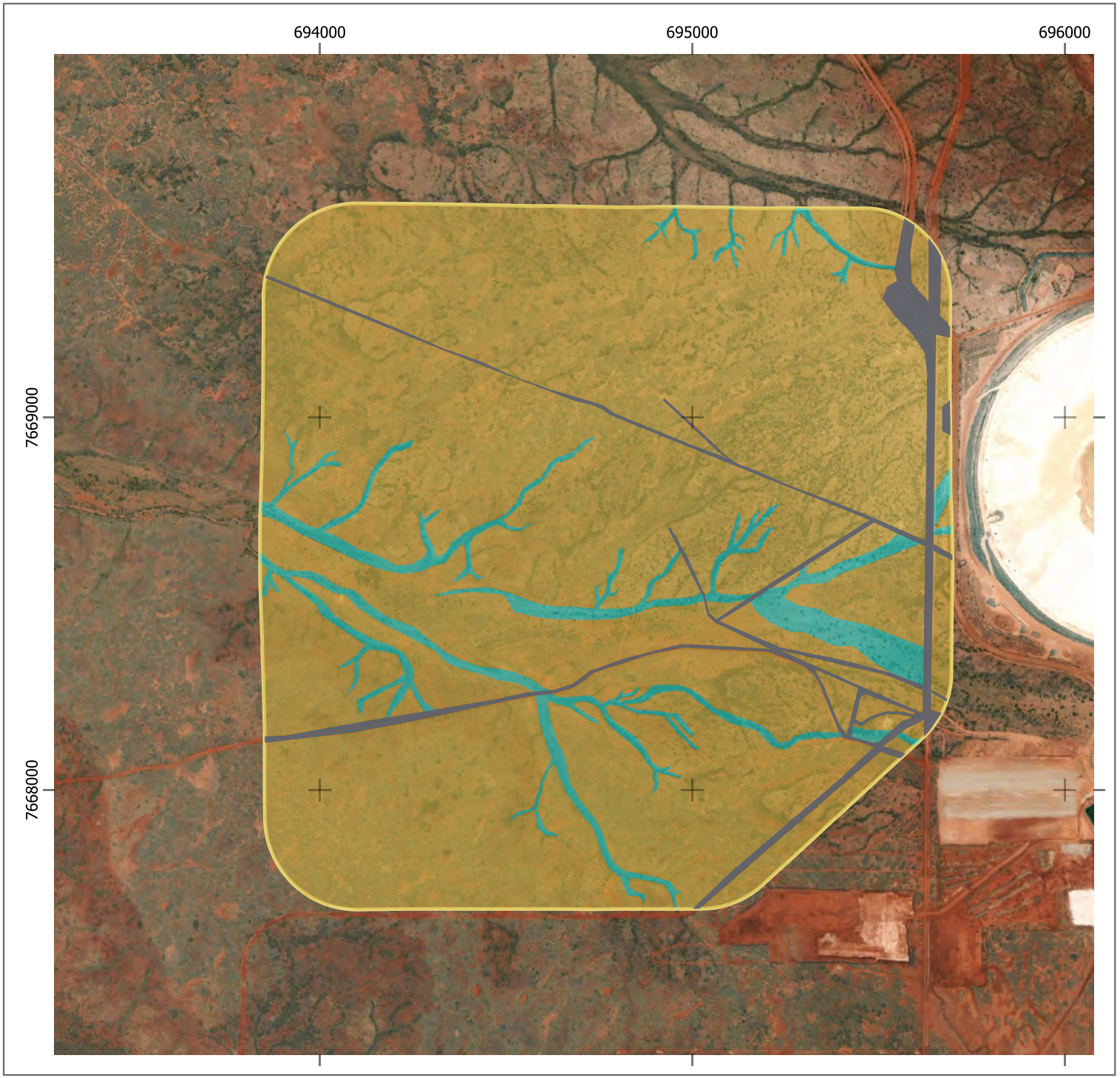
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH | Approved: ML | Date: 24/11/2022

Fauna Habitat - TSF Option 2

Prepared for:
Pilbara Minerals

Figure: 5-2a



Legend

- TSF Option 2
- FH1 Undulating Plains
- FH2 Ephemeral Creeks
- D Disturbed

Scale: @ A4
1: 15,000

0 200 400 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH | Approved: ML | Date: 24/11/2022

Fauna Habitat - TSF Option 5

Prepared for:
Pilbara Minerals

Figure: 5-2b

5.2.2 Acoustic bat recorders

The recording dataset comprised a total of 59 recording nights from four bat detector units.

Acoustic processing of the bat detector recordings was conducted separately for each of Ghost bat Pilbara leaf-nosed bat and Northern leaf-nosed bat using methods optimised for the detection of their unique echolocation call types.

No call sequences of the target species were detected.

5.2.3 Motion triggered cameras

Motion-triggered cameras returned 17 captures of individuals, where records from the same species were separated by more than one hour.

One capture of a conservation significant species was made at MSC014 of a Pebble mound mouse.

Non-target captures returned a diversity of species, including Introduced fauna. Table 5-3 lists the incidental records from the motion-triggered cameras.

Table 5-3. Non-target captures

Common name	Species name	Number of captures
Birds		
Torresian crow	*Corvus orru*	1
Spinifex pigeon	*Geophaps plumifera*	2
Magpie lark	*Grallina cyanoleuca*	3
Mammals		
Cow	*Bos taurus*	3
House mouse	*Mus musculus*	3
Pebble mound mouse	*Pseudomys chapmanii*	1
Reptiles		
Ring-tailed dragon	*Ctenophorus caudicinctus*	1
Striped skink	*Ctenotus* sp.	1
Monitor	*Varanus gouldii*	1

All captures were of good image quality and were able to be identified.

Three captures were of cattle, which is expected as the land is within a station and pastoralism is the active land use within all the surveyed areas. The introduced House mouse was captured on three occasions.

5.2.4 Acoustic bird recording devices

No Night parrot calls were recorded in the 48 hours of assessed recordings.

5.2.5 Traverses

During traverses, the following fauna signs were identified:

- One digging sign that cannot be discluded as bilby signs;
- One abandoned and collapsed burrow system that may once have hosted Brush-tailed mulgara; and
- 13 Western pebble mouse mounds (five active, four intermediate and four inactive).

No signs of Northern quoll, Night parrot or Spectacled hare-wallaby were observed.

No T or MI bird species were observed, however seasonal conditions were unsuitable.

Notes were taken on habitat quality, disturbances, and the availability/unavailability of habitat micro-niches.

5.2.6 Conservation Significant Fauna

5.2.6.1 Northern Quoll

In the Pilbara region, the species tends to prefer the Rocklea, Macroy and Robe land systems (Biota Environmental Services 2008). These land systems are comprised of basalt hills, mesas (and buttes of limonites), high and low plateaux, lower slopes, occasional tor fields and stony plains supporting either hard or soft spinifex grasslands (van Vreeswyk *et al.* 2004).

The Northern quoll has also been recorded in other land systems which are comprised of sandstone and dolomite hills and ridges, shrublands, sandy plains, clay plans and tussock grasslands and coastal fringes including dunes, islands and beaches (Biota Environmental Services 2008).

Northern quoll has been recorded on several occasions within the Pilgangoora Project area (DBCA Database record, Ecologia Environmental 2018; Terrestrial Ecosystems 2020, APM 2022). Locally this species seems to be most encountered in the boulder hill tops habitat of the north/south tending ridgeline running along the eastern half of the Pilgangoora Project area. This is the most rugged landform in the local area, at the highest elevations. Boulders on the ridge tops form a mosaic of cracks and crevices large enough to provide denning habitat for the quoll. Two camera records and three quoll scats were recorded in this habitat by APM (2022). Ecologia Environmental (2018) recorded five scats and Terrestrial Ecosystems (2020) made captures on 12 cameras within this habitat type.

Within 30 km of the Study Areas, species records are predominantly occurring within rocky outcrop habitats. There are also occasional records in the Turner River and larger tributaries of the Turner River, 16 km to the west of the Study Areas.

There is no possible denning habitat for the Northern quoll in the Study Areas as rocky boulder outcrop habitats are not present and trees are of insufficient size to have developed hollows and very sparse litter is present. Foraging or dispersal habitat is recognised to be any land comprising predominantly native vegetation in the immediate area (*i.e.* within 1 km) of shelter habitat, quoll records or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (CoA 2016).

Habitat critical to the survival of the Northern quoll and populations important for the long-term survival of the Northern quoll are defined in CoA (2016) and are present in the Pilgangoora Project area.

Habitat critical to the survival of the Northern quoll relevant to the Pilgangoora Project area includes:

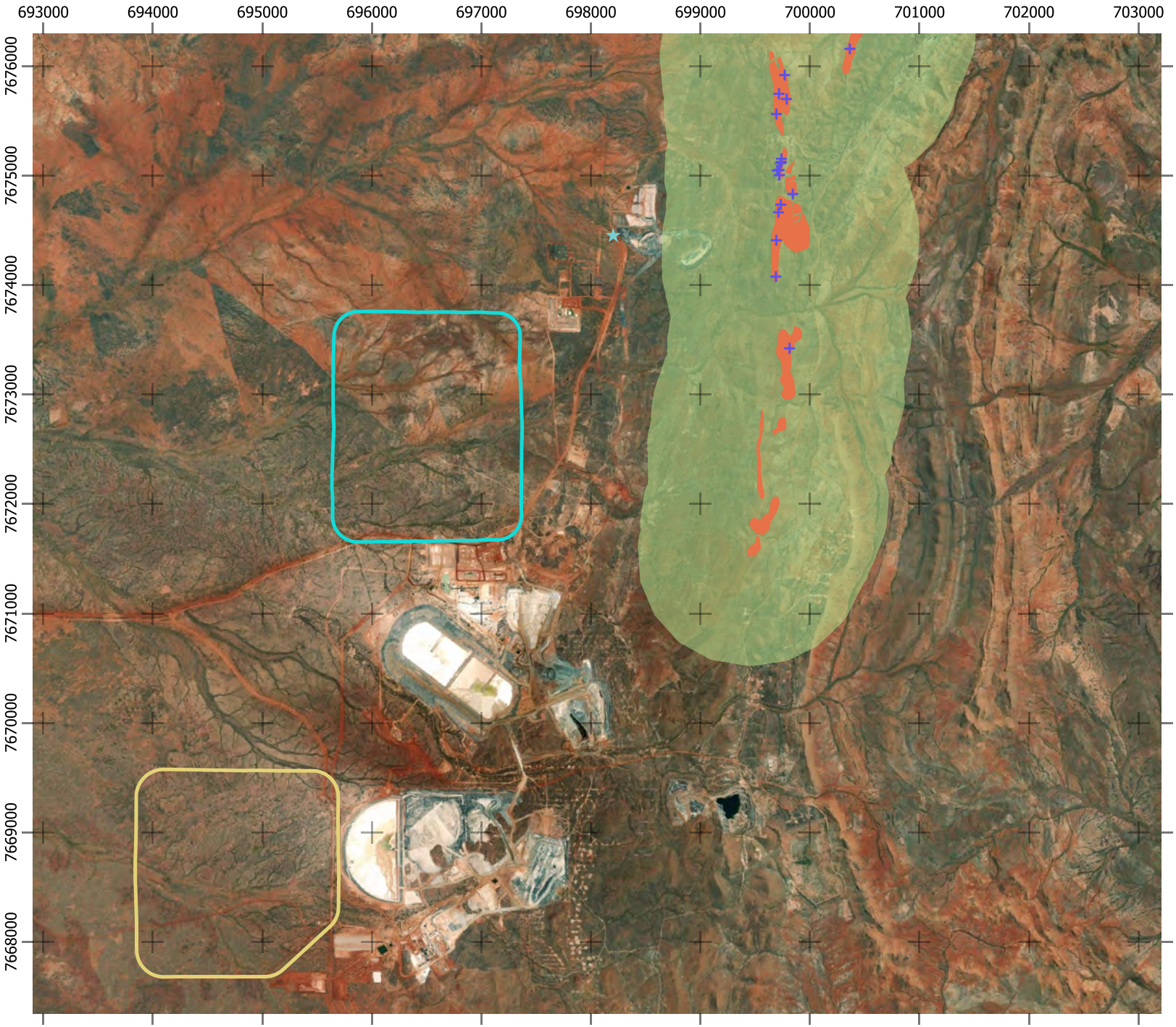
- Rocky outcrop habitat in the range 4 km to the east of the Study Areas;
- areas of native vegetation within 1 km of Rocky outcrop habitat; and
- dispersal and foraging habitat associated with or connecting the population within the Rocky outcrop habitat to other nearby populations or foraging habitats.

No quoll records or signs were recorded in creeks. Whilst in other environs creek lines would be a dispersal and foraging habitat for Northern quoll, in the Study Areas this habitat type does not appear to be frequented by the species.

All habitats occurring within the Study Areas may be utilised by the species, at some time, to forage and or during dispersal activities; however, their significance to the species will vary depending on resource availability and connectivity.

An opportunistic sighting of Northern quoll was made in 2018 1.5 km to the northwest of the Option 2 Study Area near to the entrance of an active mining area, demonstrating the species moves reasonable distances from the core shelter habitat, including into disturbed areas. Foraging habitat within the Study Areas is likely to vary depending on resource availability, which may be seasonally dependant.

Figure 5-3 shows the location of Northern quoll records, Rocky outcrop habitat, areas within 1 km of the Rocky outcrop habitat and the database record. These areas are defined by CoA (2016) as habitat critical to the survival of Northern quoll. The Study Areas do not intersect with these habitats. It is possible the Northern quoll occasionally uses the Study Areas for foraging and dispersal, but the areas do not provide critical habitat.



Legend

- TSF Option 2
- TSF Option 5
- Northern quoll database record (2018)
- Northern quoll records Pilgangoora project studies
- Rocky Outcrop habitat
- 1 km buffer applied to Rocky outcrop habitat

Scale: @ A4
1: 50,000

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 02/11/2022

Northern Quoll

Prepared for:
Pilbara Minerals

Figure: 5-3

5.2.6.2 Ghost Bat

A recent review of Ghost bat (Bat Call WA 2021a) updates the knowledge base on ecology, threats, and survey requirements for the species.

Ghost bats move between a number of caves seasonally or as dictated by weather conditions and/or foraging opportunities, so they require a range of cave sites (Richards *et al*. 2008). They disperse widely when not breeding but may concentrate in relatively few roost sites when breeding. In the Pilbara, except for the large abandoned mine colonies, ghost bats are often present either singly or in small groups (usually less than 15). These have been shown to move periodically, either seasonally or as dictated by prey availability. Their vagrant foraging strategy relates to patchy, locally unreliable rainfall events (and prey biomass) across much of its foraging habitat in the Pilbara and elsewhere in other semi-arid parts of its broader Australian range. Hence the relatively small groups that must move from roost to roost to access their ephemeral patchy food resource.

Extensive survey activity in the last decade has led to the proposal of 4 categories of roosting habitat used by ghost bats in the Pilbara region (Bullen 2021):

- Category 1 maternity/diurnal roost sites with permanent ghost bat occupancy;
- Category 2 maternity/diurnal roost caves with regular occupancy;
- Category 3 diurnal roost caves with occasional occupancy; and
- Category 4 nocturnal roost caves with opportunistic usage.

Within the Study Areas there are no Category 1, 2, 3 or 4 sites/caves available to this species.

In the Pilbara, Ghost bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia spp.*) on sand or stony ground. Isolated trees and trees on the edge of thin thickets on the plains, or trees along the edges of watercourse woodlands, appear to be preferred vantage points (Bullen unpublished data). In the Study Areas there are scattered *Corymbia hamersleyana* and *Eucalyptus camaldulensis* trees available for perching.

No Ghost bats were recorded during the acoustic survey, however acoustic recorders are not suited to Ghost bat detection during foraging as the species seldom uses its echolocation away from caves.

The Ghost bat is listed in the PMST as known to occur within the local area and the DBCA database has records for the species within a 30 km radius. Ghost bats are known to travel up to 15 km from a roost site for foraging and up to 30 km in one night to alternative roosting sites, indicating the Study Areas may be within range of Category 1, 2 or 3 roosts.

It is possible that the Study Areas offer foraging habitat to Ghost bat across all habitats.

5.2.6.3 Pilbara Leaf-Nosed Bat

A recent review of Pilbara leaf-nosed bat (Bat Call WA 2022) updates the knowledge base on ecology, threats, and survey requirements for the species. It is generally encountered in rocky areas that provide opportunity for roosting, in particular the ironstone Hamersley Range, the ridgelines granite boulder piles and disused mines of the eastern Pilbara, and also along medium and major drainage lines that radiate away from rocky uplands.

Pilbara leaf-nosed bat roost during the day beyond the twilight zone in caves and underground mines with stable, warm and humid microclimates because of its poor ability to maintain its heat and water balance (Churchill *et al*. 1988; Jolly 1988; Churchill 1991; Baudinette *et al*. 2000; Armstrong 2001). There is a possibility that some roosts exist in the deeper spaces amongst granite tor rockpiles in the eastern Pilbara, (Armstrong and Anstee 2000; Armstrong 2001) although recent survey work is yet to identify any (Bat Call WA 2022). The Pilbara leaf-nosed bat does not roost in overhangs (shallow structures where the rear wall can be observed from the entrance), as these do not support warm, humid microclimates (TSSC, 2016). A suggestion that this species becomes 'forest dwelling' in the wet season of the monsoonal northern areas (Churchill 1991, 1995) has not been supported, and is very unlikely in the Pilbara region (Armstrong 2001).

Roosts have been categorised according to importance to the survival of the species into four categories (TSSC 2016):

- Category 1 - Permanent diurnal maternity roosts where seasonal presence of young is proven;
- Category 2 - Permanent diurnal roosts where presence of young is unproven;
- Category 3 - Semi-permanent diurnal roosts; and
- Category 4 - Nocturnal refuge.

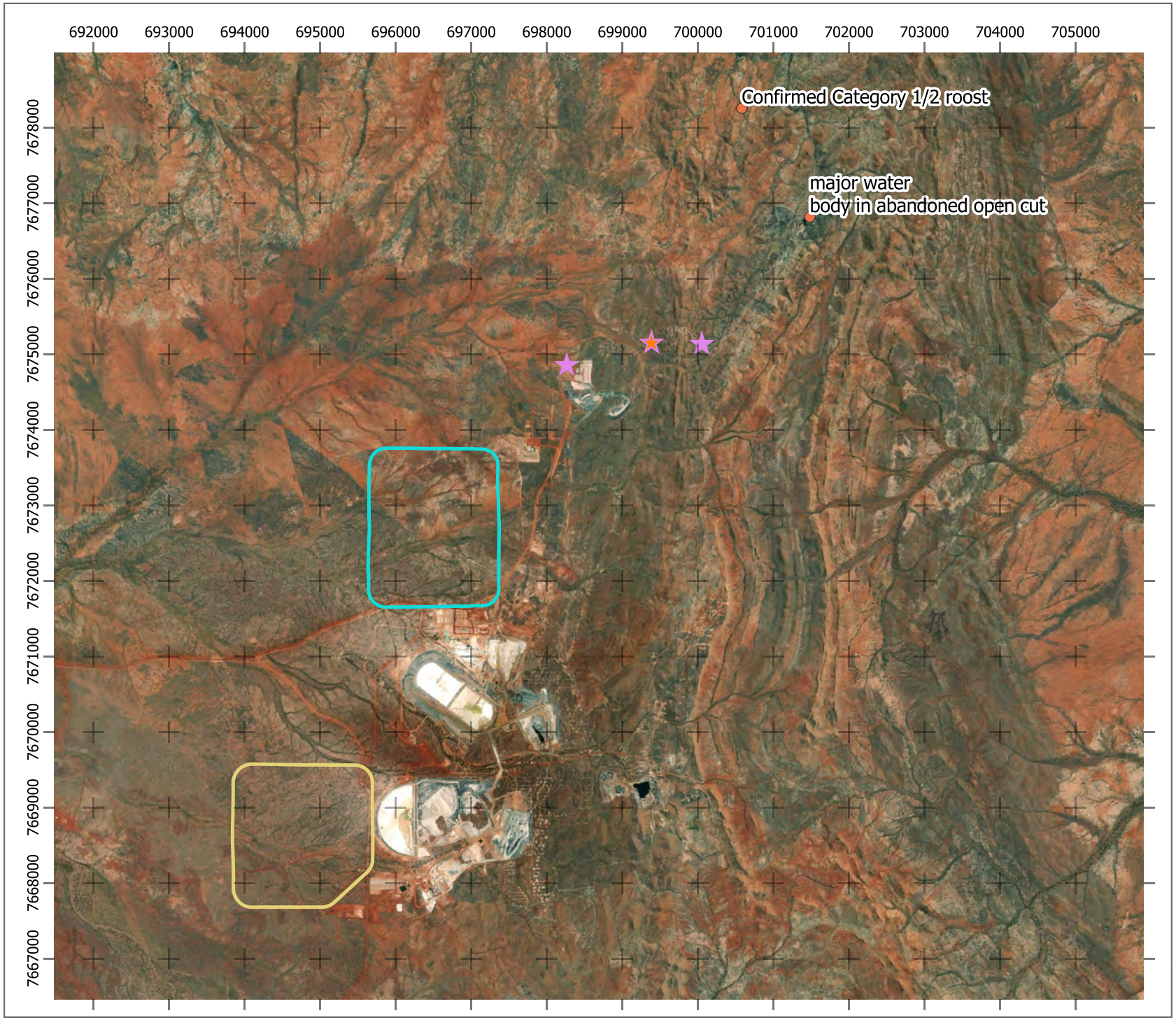
The Pilbara leaf-nosed bat was recorded locally during Targeted survey for individuals and roosts for the Pilgangoora Project (360 Environmental 2015, 2016). A Category 1 or 2 roost was located, and high-quality foraging habitat was identified at a major water body in an abandoned open cut pit. The roost site and confirmed foraging habitat are 5.5 km from the Study Areas to the northeast and are shown in Figure 5-4. An estimate of the number of Pilbara leaf-nosed bat at the roost based on ultrasonic calls and video counts ranged between 25-50. There are additional known permanent diurnal category 1 or 2 Pilbara leaf-nosed bat roosts approximately 20 km to the southwest and southeast of the Study Areas (Bat Call WA 2022).

Generally, the Pilbara leaf-nosed bat is most encountered within 20 km of its permanent diurnal roosts (Bullen 2013), but in the months where climatic conditions are least challenging for the species (April-May) they have been recorded further afield (Bat Call WA 2022). Echolocation based records indicate that it can complete round trips of 50 km or longer in a night under favourable conditions (Bat Call WA 2022).

The Study Areas do not contain any roosts described as Category 1, 2, 3 or 4. The Study Areas are within range of three Category 1/2 roosts.

Pilbara leaf-nosed bat was not recorded during acoustic survey within the Study Areas.

Habitat types found in the Pilbara have been scaled and a foraging habitat rating applied (Bat Call WA 2022). Habitats in the Study Areas conform to the description of *Open plain with one layer of vegetation structure (excluding scattered trees).* These are of low habitat rating. Pilbara leaf-nosed bat are unlikely to forage in the Study Areas but may traverse while crossing to more productive areas.



Legend

- TSF Option 2
- TSF Option 5
- Pilbara leaf-nosed bat database record
- Pilbara leaf-nosed bat acoustic records APM (2022)

Scale: @ A4
1: 70,000

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 02/11/2022

Pilbara leaf-nosed bat

Prepared for:
Pilbara Minerals

Figure: 5-4

5.2.6.4 Grey Falcon

The Grey falcon occurs in most of the drier parts of Australia (Schoenjahn 2018). Its distribution is centred on inland drainage systems where there is an average annual rainfall of less than 500 mm. Its main habitat is timbered lowland plains, particularly Acacia shrublands that are crossed by tree-lined watercourses. It generally occurs at low densities across inland Australia (BirdLife International 2019).

The Grey falcon hunts far out into tussock grassland and open woodland. It nests in old nests made by other birds, usually nests in the tallest trees along watercourses, particularly river red gum (TSSC 2020). Prey species include doves, pigeons, small parrots and cockatoos, and finches, but a variety of other bird prey species has been recorded, as well as mammals and lizards (TSSC 2020).

Local records are centred on the Turner River and major tributaries. The closest record is 10 km from the Study Areas to the southeast. The Study Areas are suitable foraging habitat for this species, and within range of the population likely to be nesting in the Turner River riparian zone. There are river red gum present in small patches in the Study Areas, however they are too small to provide nesting opportunities.

5.2.6.5 Night Parrot

The Study Areas are within the area where Night parrot is modelled as *may occur*. Very limited information is available on the Night parrot, however some information on habitat characteristics where the species has persisted is available.

DBCA (2017) summarises habitat characteristics. Night parrot roosting and nesting sites are in clumps of dense vegetation, primarily old and large spinifex (*Triodia*) clumps, but sometimes other vegetation types. Often the vegetation in these habitats will be naturally fragmented and therefore well protected from fire. Little is known about foraging sites, but favoured sites are likely to vary across the range of the species. In Queensland, Night parrots have been shown to feed in areas rich in herbs including forbs, grasses and grass-like plants, and it is likely that such areas may also be important in WA. *Triodia* is likely also to provide a good food resource for Night parrot, in times of mass flowering and seeding, but they also rely heavily on a range of other food species. *Sclerolaena* has been shown to be a source of food and moisture.

The species and growth pattern of the spinifex in some of the FH1 habitat in the Study Areas may be suitable for the Night parrot. There are no samphire or chenopod habitats proximal to the Study Areas, however the gilgai may seasonally support a diversity of herbs and other potential forage species. Night parrots have been known to fly up to 40 km or more in a night during foraging expeditions, so foraging habitat is not necessarily within or adjacent to roosting areas.

An interim guideline for preliminary surveys of Night parrot in WA (DPAW 2017) identifies when and where Night parrot surveys may be required. The Study Areas are on the north-western edge of the area classed as a high priority for survey. Due to the inclusion of the site in the high priority survey area and the presence of potentially suitable spinifex habitat, passive acoustic survey was conducted at locations where the best spinifex habitat was found. Four devices were deployed for a total of five trap nights. No Night parrot calls were recorded.

Foot traverses through the FH1 habitat where the largest and oldest hummock grasses occur did not encounter any signs of individuals of Night parrot.

While the habitat is potentially suitable, there are no historic records of Night parrot in the area and very few records of extant individuals. While it remains possible that the species could colonise in the future there is no evidence that they are currently present.

5.2.6.6 Greater Bilby

Extant populations of bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (typically sandy for burrow excavation). Bilby occupies three major vegetation types; open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990). Laterite and rock feature substrates are an important part of Greater bilby habitat, which support shrub species such as Acacia, and spinifex hummocks which are quite uniform and discrete, providing runways between hummocks, enabling easier movement and foraging (Southgate *et al.* 2007).

The species is identified by the PMST as known to occur within 30 km of the Study Areas. Database results returned 41 records within a 30 km radius of the Study Areas, the closest being one record to the east of Pilgangoora made in 1979. Recent records are from surveys conducted for the rail corridors that pass the Study Areas to the west.

Suitable habitat occurs in the Study Areas across the undulating plains habitat. Extensive foot transects were walked across these habitats at 10-20 m intervals. No burrows were located. Indeterminate signs were recorded in one location within Option 2. Scratchings were recorded as shown in Plate 5-1. The scratchings lacked attributes common to digging lizards and other species expected to occur. Large galls were also found in the location that appeared to have been broken open to retrieve the insect inside (Plate 5-2). Whilst there is no certainty these signs were left by bilby, and no commonly accepted understanding of bilby eating gall forming larvae, there is insufficient evidence to discount the possibility of bilby occurrence.

This species has the potential to occupy the Study Areas as bilbies can be relatively transient across their distribution. No burrows were observed suggesting any recent use may be for foraging only and transitory in nature.

Plate 5-1. Digging beneath an Acacia shrub, with galls beside the hole

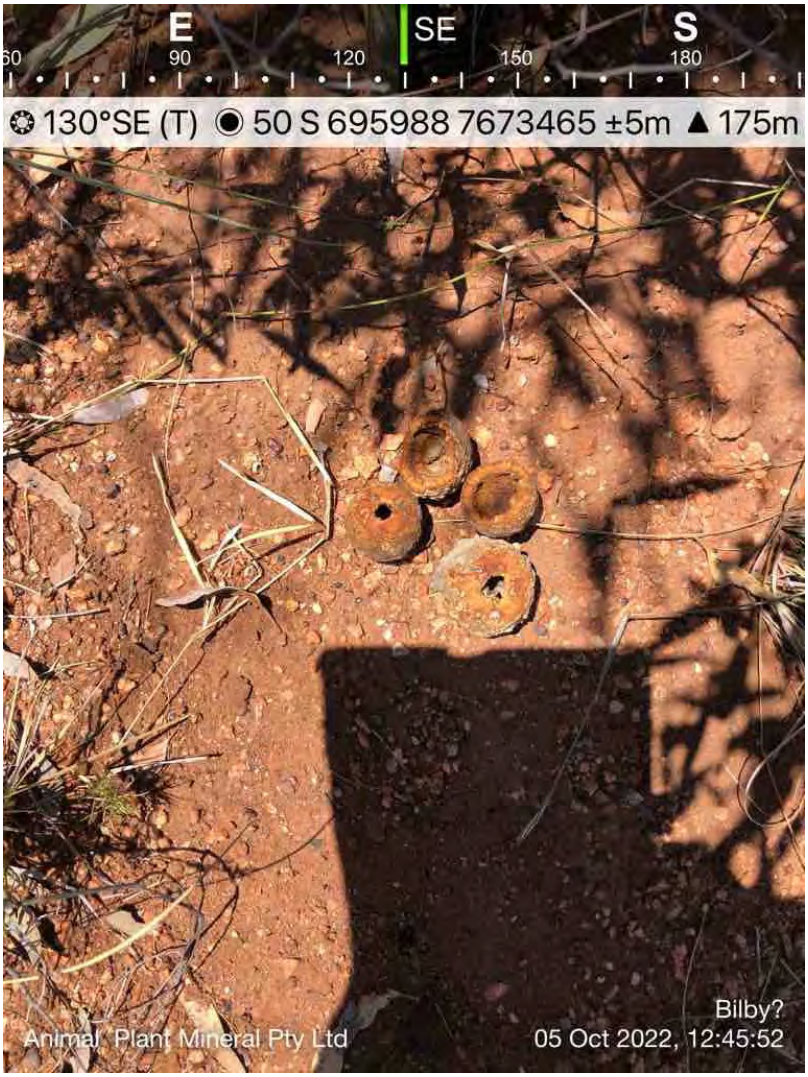


Plate 5-2. Galls broken open

5.2.6.7 Western Pebble Mount Mouse

The Western pebble-mound mouse is endemic to the Pilbara where it is found on stony hillsides with hummock grassland (Menkhorst and Knight, 2010). This species builds pebble mounds from small stones, which typically cover areas from 0.5-9.0 m^2. The mounds are characteristic of the species. Pebble mounds are restricted to areas with suitable class stones and are usually found on gentle slopes and spurs that are often vegetated by hard spinifex (Van Dyck and Strahan 2008). Active mounds are characterised by the conical shape of the mound with clear, distinct entrance holes (Anstee 1996). Mounds are often sited close to narrow ribbons of Acacia dominated scrub that grow along incised drainage lines (Van Dyck and Strahan 2008).

Targeted searches were performed using foot transects in suitable habitat. Thirteen mounds were recorded. The status of mounds was assessed according to the method published in Anstee (1996). The Anstee (1996) index is most accurate at predicting the status of mounds with very high (classed as active) or very low (classed as inactive) scores. Mounds with intermediate activity could be either active or inactive, depending on whether they are in the process of being activated or degrading following abandonment. Mound locations and status are listed in Table 5-4.

Table 5-4. Western Pebble-mound Mouse mound status and location

Status	Location (GDA 1994; MGA zone 50)
Active	695778, 7673491
Active	695859, 7673449
Active	695950, 7673431
Active	695146, 7668064
Active	693972, 7668364
Intermediate	695116, 7668632
Intermediate	696824, 7673506
Intermediate	696567, 7673489
Intermediate	695750, 7673481
Inactive	695118, 7668689
Inactive	696727, 7673495
Inactive	695820, 7673452
Inactive	696030, 7673419

5.2.6.8 Brush-tailed Mulgara

Brush-tailed mulgara is widespread, but patchily distributed in sandy regions of arid central Australia and WA. It inhabits hummock grass plains, sand ridges, and mulga shrubland on loamy soils (Menkhorst and Knight, 2010). It uses the open space between vegetation, a microhabitat that is known to support important prey species and may forage in termite mounds (Molyneux *et al*. 2018).

The Brush-tailed mulgara constructs burrows or utilises those of other species. Burrows may provide access to prey items, protection from predators and have thermoregulation benefits (Molyneux *et al*. 2018).

Local records are to the west of the Study Areas with the closest records 15 km to the southwest. Records originate from biological surveys assessing the impact of rail lines servicing the Pilbara region.

Suitable habitat occurs in the sandy areas of the undulating plain, however the preferred sand dune habitat is not present.

Targeted searches were conducted in suitable habitat for signs (tracks and burrow entrances) of the Mulgara. One location was marked where connected burrows appeared to be present. These were highly degraded and collapsed, indicating they are not currently in use, but may have once been occupied by Mulgara. Based on somewhat limited habitat, in that sandy rises are infrequently occurring, and the indication of an abandoned burrow, the Mulgara is considered as possibly occurring in the Study Areas.

5.2.6.9 Spectacled Hare-wallaby (mainland)

The Spectacled hare-wallaby inhabits tropical tussock or hummock grassland with mid-dense or sparse tree and shrub cover (Menkhorst and Knight, 2010). In the Pilbara this species has declined drastically, possibly due to fox predation and because frequent burning of spinifex grassland has prevented the development of the large hummocks required for shelter (Van Dyck and Strahan 2008).

There are many local records, in the surrounding foothills and plains habitats. These records are from the early 1990's.

No signs or records of Spectacled hare-wallaby were made in the Study Areas, despite targeted searches for individuals or signs (*e.g.* scats), motion triggered camera deployment and spotlighting. The species was not recorded during the detailed and reconnaissance fauna surveys for the Pilgangoora Project (360 Environmental 2016) or the Lynas Find extension (APM 2022). The absence of the species is likely a consequence of the broader regional decline.

Historic records indicate it is possible for the species to occur, however the habitat does not provide the shelter that would be required to persist under predation. The lack of shrubland indicates the quality of the habitat is poor.

5.2.6.10 Migratory birds

The undulating plains may provide seasonally available habitat to migratory birds including threatened species such as the Curlew sandpiper and Eastern curlew. The habitat does not contain preferred habitat for these species, and it is likely that due to the proximity to the more preferred habitats available on the coast, the value of these habitats is low. The Study Areas are not within or near to any locations where nationally or internationally significant aggregations occur.

6 CONCLUSIONS

6.1 FLORA

The flora and vegetation survey recorded a total of 123 taxa within the Study Areas which is comparable to the number of taxa recorded in other previous local surveys: 116 taxa (63 genera from 26 families) recorded by APM (2022) at the Lynas Find Deposit; 195 taxa (101 genera and 39 families) recorded by MMWC Environmental (2016) at the Pilgangoora Project, and 122 taxa (67 genera and 38 families) recorded by Outback Ecology (2009) at Wodgina.

The flora and vegetation of the Study Areas is generally typical of the Pilbara, and of the adjacent lands surrounding the Study Areas.

6.2 FLORA OF CONSERVATION SIGNIFICANCE

No T or P flora was recorded in the Study Areas.

One P3 species *Triodia chichesterensis* was previously recorded within the Option 2 area. It can be difficult to distinguish from *Triodia lanigera* outside of the northern part of the range. *Triodia lanigera* was common in the Study Areas and it is likely that *Triodia chichesterensis* is present in the stony rise areas where quartzite is present.

An additional eight species were determined to be possibly occurring or likely to occur based upon the availability of suitable habitat. Of these, one is a perennial shrub and would therefore have been present at the time of survey. The remaining seven are annual herbs or small herbaceous perennials that may not have been present due to seasonal conditions.

6.3 INTRODUCED FLORA

No weeds Declared under the BAM Act or classed as WoNS were recorded in the Study Areas. Six weeds were recorded, two species of agricultural grasses in the genus *Cenchrus* and the environmental weed Kapok were the most commonly recorded. *Cenchrus* grasses are valued by pastoralists and as the underlying land use is pastoralism it is not unexpected to record these weedy grasses. Whilst not being attributed any formal classification under weed management legislation, *Cenchrus* grasses are known to adversely alter fire regimes, which is a threatening process for some T fauna in the region.

Weeds were predominantly recorded in the creek habitats.

6.4 VEGETATION OF CONSERVATION SIGNIFICANCE

There are no recognised TECs, PECs or ESAs located within or adjacent to the Study Areas.

None of the vegetation types described for the Study Areas are analogous to any known TECs or PECs. The nearest record of a TEC or PEC to the Study Areas is the Gregory Land System (P3 PEC), approximately 50 km away from the Study Areas.

The Chichester Subregion includes seven Ecosystems at Risk which are subject to a range of threatening processes (Kendrick and McKenzie 2001). None of these ecosystems are relevant to the Study Areas.

Two species that have been associated with GDEs were recorded in the vegetation type 13a. The Bureau of Meteorology GDE Atlas indicates the Study Areas have a low likelihood of dependency. The red gum and coolabah within the 13a vegetation type are of low height and stem diameter, likely to be a consequence of intermittent water availability, supporting the assessment of a low likelihood of access to groundwater.

Regional Vegetation Associations within the Study Areas as described by Beard have over 99% pre-European Vegetation extent remaining. Conservation significance ranking of vegetation associations occurring within the Study Areas are of 'Least Concern'.

6.5 FAUNA OF CONSERVATION SIGNIFICANCE

The survey recorded multiple active Pebble mound mouse mounds. The Pebble mound mouse is known to occur in the area and its presence within the Study Areas is confirmed. The suitability of mound building habitat is confined by the availability of suitable size pebbles, which occur on the higher rises.

The Northern quoll is known to occur in the local area and critical habitat has been identified in the ridgeline to the east of the Study Areas. The Study Areas are more than 1 km from this critical habitat. The Study Areas contain habitats that are of possible value to the Northern quoll for foraging and dispersal however, they are of low quality. No signs of the Northern quoll were recorded and no captures on cameras were obtained. It is possible the Northern quoll occasionally uses the Study Areas however, they do not constitute critical habitat.

The Pilbara leaf-nosed bat is known to occur in the local area and diurnal roosts occur within the range of the Study Areas. The quality of habitat for the Pilbara leaf-nosed bat is limited to low quality foraging– the species may occasionally use the site for foraging or in transit to other more productive areas.

The Ghost bat is known to occur in the local area and diurnal roosts are known to occur within range of the Study Areas. The Study Areas are suitable foraging habitat for the Ghost bat. The Ghost bat was not recorded during the acoustic survey however the method has limitation with detection of the species. The species is likely to occur within the Study Areas, for foraging purposes only.

The Grey falcon is known to occur in the local area and the Study Areas are within foraging range of the species. Grey falcon nesting in the Turner River area are likely to visit the Study Areas at some times for the purpose of foraging.

During periods of inundation, the Study Areas are likely to sustain habitat suitable for migratory shorebirds. The quality of the habitat is likely to be lower than those available in the near coastal areas, as reflected in the lack of records from the site and immediate surrounds. There are no nationally or internationally significant aggregations of migratory species known to occur within or near the Study Areas.

An abandoned burrow that may once have hosted Brush-tailed mulgara was recorded. The burrow was collapsed, however there were indications of a multi-entranced burrow system as used by the Brush-tailed mulgara. Suitable habitat is limited to the sandy rises that occur sporadically throughout the undulating plains. No further signs were recorded. Whilst the Study Areas are likely to contain suitable habitat, there is no evidence of the species being currently present.

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APPENDICES

APPENDIX A: CONSERVATION AND DECLARED CATEGORIES

Conservation categories for threatened species and communities protected under Federal legislation are defined under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Environment Protection and Biodiversity Conservation Regulations 2000* are listed in Tables A.1. and A.2.

Table A.1: Categories and definitions for threatened flora and fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Conservation Category	Definition
Extinct	Taxa with no reasonable doubt that the last member of the species has died.
Extinct in the wild	Taxa known to survive only in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriated seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (E)	Taxa are not critically endangered; and are facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (V)	Taxa are not critically endangered or endangered; and are facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation dependent (CD)	Taxa are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or the following subparagraphs are satisfied: i) the taxa is a species of fish; ii) the taxa is the focus of a management plan that provides management actions necessary to stop the decline of, and support the recovery of, the taxa so that its chances of long term survival in nature are maximized; iii) the management plan is in force under a law of the Commonwealth or of a State or Territory; and iv) Cessation of the management plan would adversely affect the conservation status of the taxa. Fish includes all taxa of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals/reptiles.

Table A.2: Definitions for Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999*.

Conservation Category	Definition
Critically endangered	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	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

For Section 182 of the EPBC Act and 179 of the EPBC Act Threatened Ecological Communities and Native species are in the Critically Endangered, Endangered or Vulnerable category if they meet any of the criteria for the category mentioned in Table A.3:

Table A.3: Criteria for listing Threatened Species and Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Regulations 2000*

Threatened Species				
Item	**Criterion**	**Category**		
		Critically Endangered	**Endangered**	**Vulnerable**
1	It has undergone, is suspected to have undergone, or is likely to undergo in the immediate future:	A very severe reduction in numbers	A severe reduction in numbers	A substantial reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is:	Very restricted	Restricted	limited
3	The estimated total number of mature individuals is: And: (a) Evidence suggests that the number will continue to decline at: or (b) The number is likely to continue to decline and its geographic distribution is:	Very low A very high rate Precarious for its survival	Low A high rate Precarious for its survival	limited A substantial rate Precarious for its survival
4	The estimated total number of mature individuals is:	Extremely low	Very low	low
5	The probability of its extinction in the wild is at least:	50% in the immediate future	20% in the near future	10% in the medium term future
Threatened Ecological Communities				
Item	**Criterion**	**Category**		
		Critically Endangered	**Endangered**	**Vulnerable**
1	Its decline in geographic distribution is:	Very severe	Severe	substantial
2	Its geographic distribution is: And the nature of its distribution makes it likely that the action of a threating process could cause it to be lost in:	Very restricted The immediate future	restricted The near future	limited The medium term future
3	For a population of a native species that is likely to play a major role in the community, there is a: To the extent that restoration of the community is not likely to be possible in:	Very severe decline The immediate future	Severe decline The near future	Substantial decline The medium term future
4	The reduction in its integrity across most of its geographic distribution is: As indicated by degradation of the community or its habitat, or disruption of important community processes, that is:	Very severe Very severe	severe severe	substantial substantial
5	The rate of continuing detrimental change is: As indicated by	Very severe	severe	substantial

	(a) A rate of continuing decline in its geographic distribution, or a population of a native species that is believed to play a major role in the community, that is: or	Very severe	severe	serious
	(b) Intensification, across most of its geographic distribution, in degradation, or disruption of important community processes, that is:	Very severe	severe	serious
6	A quantitative analysis shows that its probability of extinction, or extreme degradation over all its geographic distribution, is:	At least 50% in the immediate future	At least 20% in the near future	At least 10% in the medium term future

In Western Australia, the *Biodiversity Conservation Act 2016* (BC Act) provides for the statutory listing of Threatened Ecological Communities, under the categories listed in Table A.4.

Table A.4: Definitions and criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities. Department of Environment and Conservation (2013).

PD : Presumed Totally Destroyed
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.
CR : Critically Endangered
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).
En : Endangered
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.
C) 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).

VU : Vulnerable

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.

In Western Australia, possible Threatened Ecological Communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5 (Table A.4).

Table A.5: Definitions and criteria for Priority Ecological Communities Department of Environment and Conservation (2013).

P1: Priority One – Poorly-known ecological communities
Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. 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.
P2: Priority Two – Poorly-known ecological communities
Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200 ha). At least some occurrences are not believed to be under immediate 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.
P3: 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 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.
P4: 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.
P5: 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.

In Western Australia, 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 listed in Table A.6.

The definition of flora includes algae, fungi and lichens. The definition of 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).

Table A.6: Conservation codes for Western Australian flora and fauna under the *Biodiversity Conservation Act 2016* (DBCA 2019).

Code	Conservation Category	Definition
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 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of 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.		
CR	**Critically Endangered**	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 under section 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**	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**	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 under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of 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 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 4 of 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 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 25 of 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 15 of 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 14 of 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 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

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.

Table A.7: Priority species under Western Australian *Biodiversity Conservation Act 2016*.

P1: Priority One – Poorly known taxa
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.
P2: Priority Two – Poorly known taxa
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.
P3: Priority Three – Poorly known taxa
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.
P4: Priority Four: Rare, near threatened and other taxa 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.

The management of introduced species in Western Australia is regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). The BAM Act seeks to establish a biosecurity regulatory scheme to prevent serious animal and plant pests from entering the State and becoming established, and to minimise the spread and impact of any that are already present within the State.

The list of declared pests is provided under the BAM Act. Declared animal and plant pests fall into three categories as Gazetted under the *Biosecurity and Agriculture Management Regulations 2013*. These categories are outlined in Table A.7.

Table A.8: Declared pests control categories as gazetted under the *Biosecurity and Agriculture Management Regulations 2013.*

Category	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

References

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Department of Environment and Conservation (2013). Definitions, categories and criteria for threatened and priority ecological communities. Accessed 25/04/20 https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf

APPENDIX B: PMST SEARCH RESULTS

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 01-Nov-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	13
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	22
Key Ecological Features (Marine):	None
Biologically Important Areas:	1
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.		
Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
MAMMAL		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Pityrodia sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4)		
[88310]	Endangered	Species or species habitat known to occur within area
REPTILE		
Liasis olivaceus barroni		
Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area
Liopholis kintorei		
Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica		
Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis as Rostratula benghalensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Abydos Direct Shipping Ore (DSO) Project, Stage 2	2013/6985	Controlled Action	Post-Approval
Abydos Direct Shipping Ore Project	2012/6345	Controlled Action	Post-Approval
Additional Rail Infrastructure between Herb Elliott Port Facility and Cloudbreak Mine Site	2010/5513	Controlled Action	Post-Approval
Development of the Wodgina Direct Shipping Ore Project, Stage 2	2011/5975	Controlled Action	Post-Approval
Miralga Creek Project, Pilbara region, WA	2019/8601	Controlled Action	Post-Approval
North Star Hematite Project	2012/6530	Controlled Action	Post-Approval
North Star Magnetite Project	2012/6689	Controlled Action	Post-Approval
Panoram Copper-Zinc mine	2007/3310	Controlled Action	Completed
Roy Hill to Port Hedland Rail Line and Associated Infrastructure	2010/5424	Controlled Action	Post-Approval
Wodgina Direct Shipping Ore Project	2009/5167	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Not controlled action			
Development of iron ore resources in eastern Pilbara region, including port at P	2004/1562	Not Controlled Action	Completed
Expansion of the Talison Minerals Storage Facility, Wodgina Mine	2008/4675	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
Pilbara Bulk Ore Transport System Project, WA	2016/7637	Not Controlled Action	Completed
Pilbara Transmission Project, Pilbara, WA	2018/8349	Not Controlled Action	Completed
Rail and Port Facilities	2001/474	Not Controlled Action	Completed
Sulphur Springs Copper-Zinc Mining Project, Pilbara Region, WA	2013/6899	Not Controlled Action	Completed
Wodgina Lithium Mine Expansion, Pilbara, NT	2018/8194	Not Controlled Action	Completed
Not controlled action (particular manner)			
Additional Rail Infrastructure	2012/6314	Not Controlled Action (Particular Manner)	Post-Approval
Atlas Boodarie Link Project, WA	2012/6506	Not Controlled Action (Particular Manner)	Post-Approval
Mine the Hercules Deposit under the Wodgina Direct Shipping Ore Project Stage 3	2013/6789	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Mine the Hercules Deposit under the Wodgina Direct Shipping Ore Project ??? Stage 3	2013/6777	Referral Decision	Completed

Biologically Important Areas		
Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica		
Wedge-tailed Shearwater [84292]	Breeding	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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APPENDIX C: DETAILED FLORA AND VEGETATION SURVEY SITES

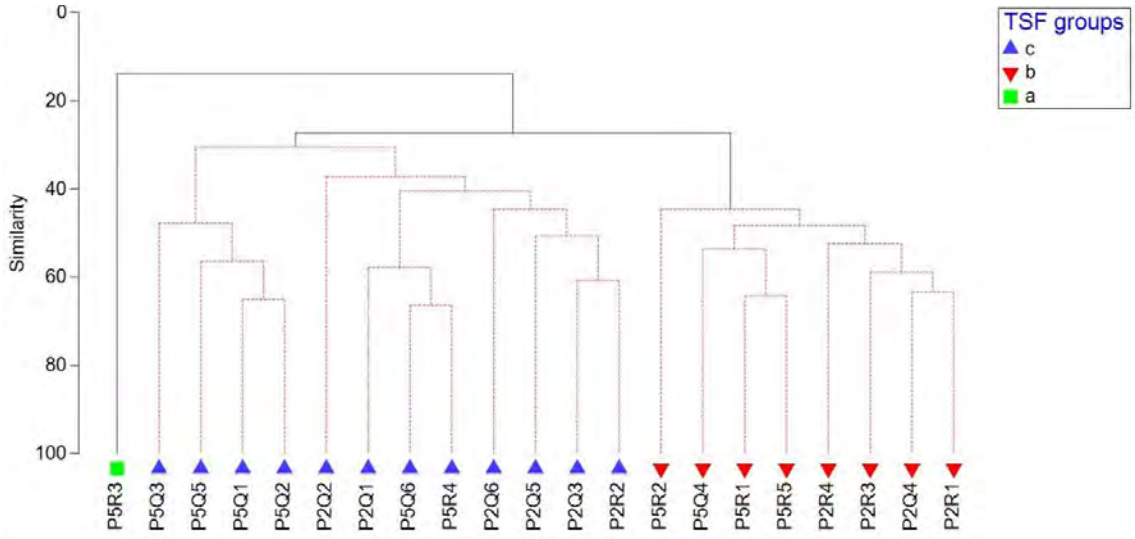
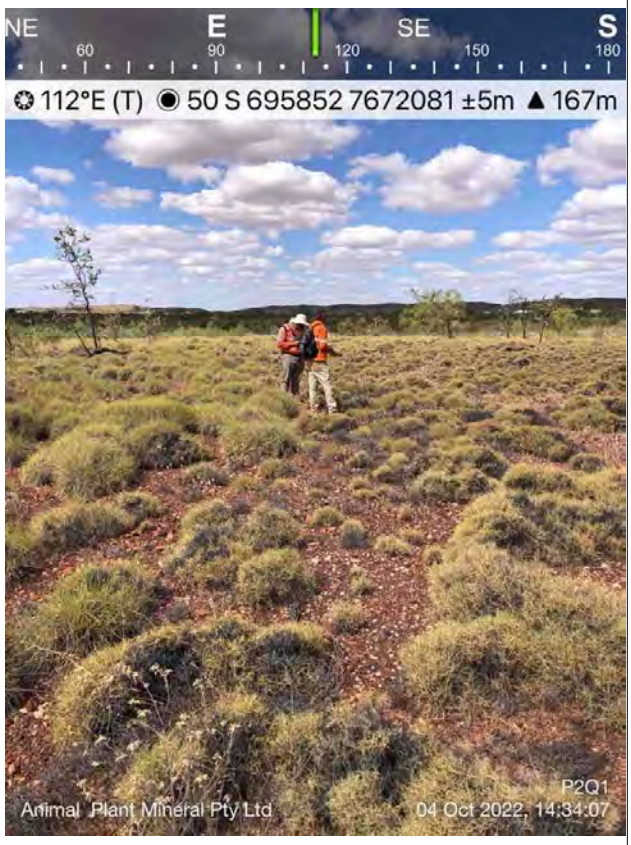


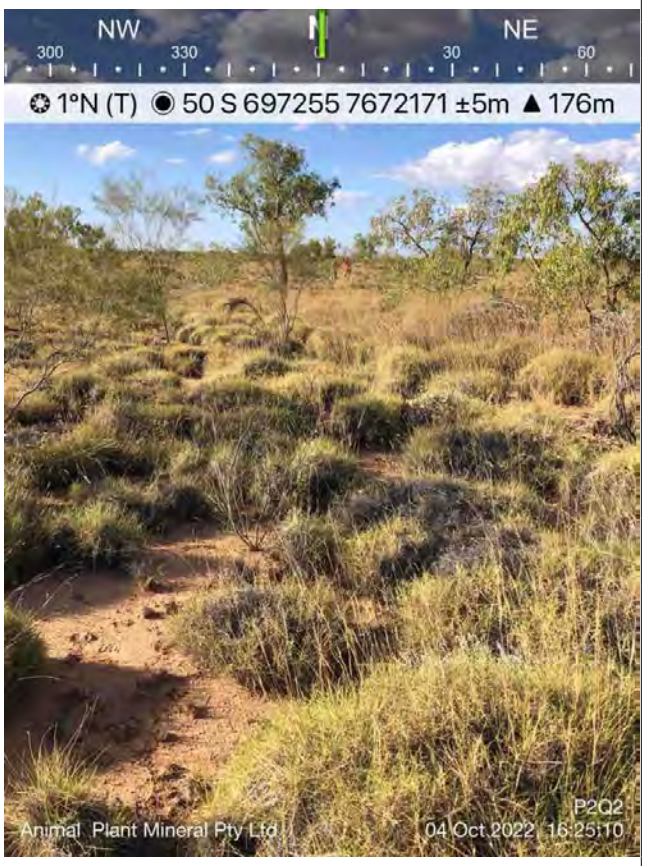
Figure C-1. Dendogram resulting from the cluster analysis of detailed vegetation sites

Job	PIL002
Site	P2-Q1
Date	4/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Dry, warm
Rock Type	Quartz, ironstone, granite
Soil Type	Clay loam
Soil Colour	Red
Landform	Undulating plains
Surface Rocks Size	0.1 - 10 cm, angular
Surface Rocks Cover	70%
Slope aspect	-
Vegetation Description	Triodia bunch grassland with occasional Acacia small tree and isolated *Corymbia hamersleyana*
Condition/Disturbances	Good



Strata	Cover (%)	Height (m)	Species
Overstorey	1	4	*Corymbia hamersleyana*
Understorey	4.1	3	*Acacia tumida, Acacia adsurgens* and *Acacia inaequilatera*
Groundcover	45	0.8	*Triodia wiseana, Triodia epactia* and *Triodia lanigera*
Notes	Quadrat, 50 x 50 m		

Job	PIL002
Site	P2 - Q2
Date	4/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Dry, warm
Rock Type	Granite, ironstone
Soil Type	Sandy loam
Soil Colour	Brown
Landform	Flat open plain
Surface Rocks Size	0.5 - 10 cm, angular
Surface Rocks Cover	80%
Slope aspect	Flat
Vegetation Description	Hummock grassland of Triodia *Triodia lanigera Triodia wiseana,* and *Triodia epactia* With emergent *Acacia tumida, Acacia bivenosa, Acacia orthocarpa* and isolated *Corymbia hamersleyana*
Condition/ Disturbances	Good

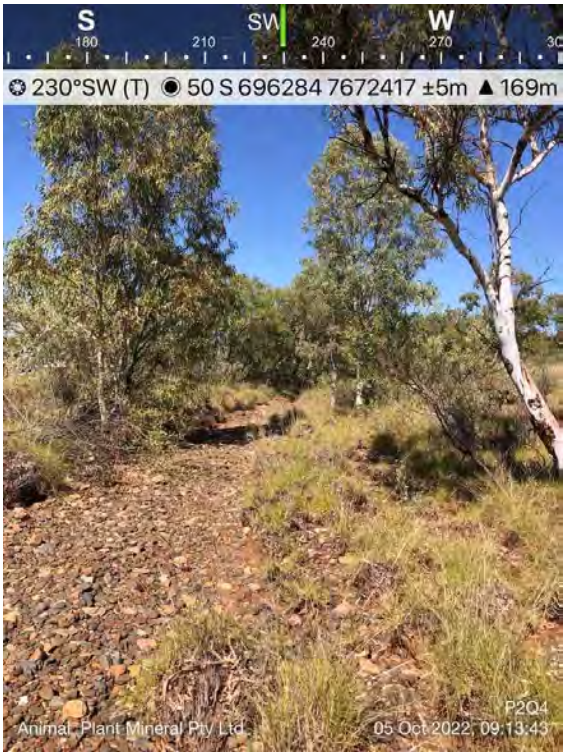


Strata	Cover (%)	Height (m)	Species
Overstorey	5	4	*Corymbia hamersleyana*
Understorey	2	0.6	*Acacia tumida, Acacia bivenosa, Acacia orthocarpa*
Groundcover	47	0	*Triodia lanigera Triodia wiseana,* and *Triodia epactia*
Notes	Quadrat, 50 x 50 m		

Job	PIL002
Site	P2 - Q3
Date	5/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Heavy dew, warm
Rock Type	Quartz, ironstone
Soil Type	Loamy
Soil Colour	Red
Landform	Upslope, 1st order drainage line
Surface Rocks Size	0.1 - 2 cm, angular
Surface Rocks Cover	20%
Slope aspect	Very gentle slope, channel to the east
Vegetation Description	Acacia shrubland with isolated Corymbia hamersleyana and Triodia hummock grassland
Condition/Disturbances	PIL002

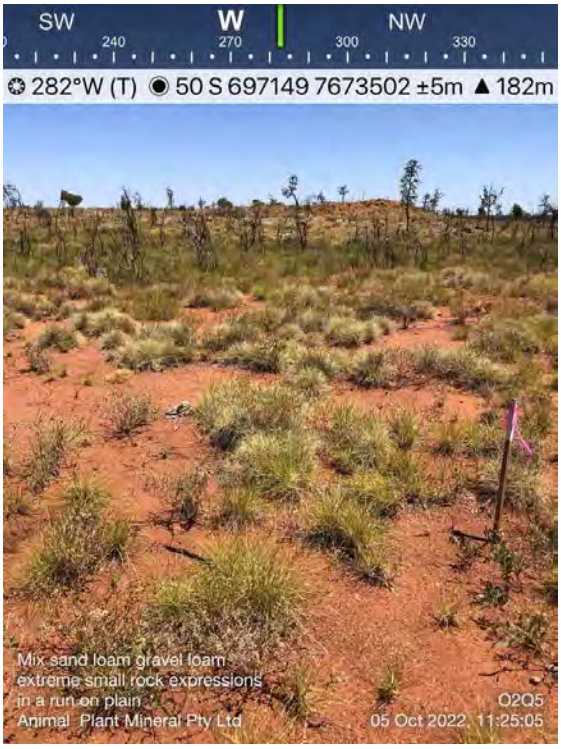
Strata	Cover (%)	Height (m)	Species
<1	4.5	<1	*Corymbia hamersleyana*
18	0.8	2.2	*Acacia tumida, A. adsurgens, A. inaequilatera*.
40	0.4	40	*Triodia lanigera. Triodia epactia, Triodia brizoides*
Notes	Quadrat, 50 x 50 m		

Job	PIL002
Site	P2 - Q4
Date	5/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	-
Seasonal Conditions	Warm, dry
Rock Type	Granite
Soil Type	Sandy loam
Soil Colour	Red
Landform	Secondary creekline (dry) ephemeral
Surface Rocks Size	1 - 10 cm, rounded
Surface Rocks Cover	In creek - 80%; on bank - 1%
Slope aspect	Gentle slope, east flowing
Vegetation Description	Open redgum woodland, sparse Acacia tall shrubland and Triodia hummock grassland
Condition	Good. Cenchrus and Kapok weeds. Moderate grazing.



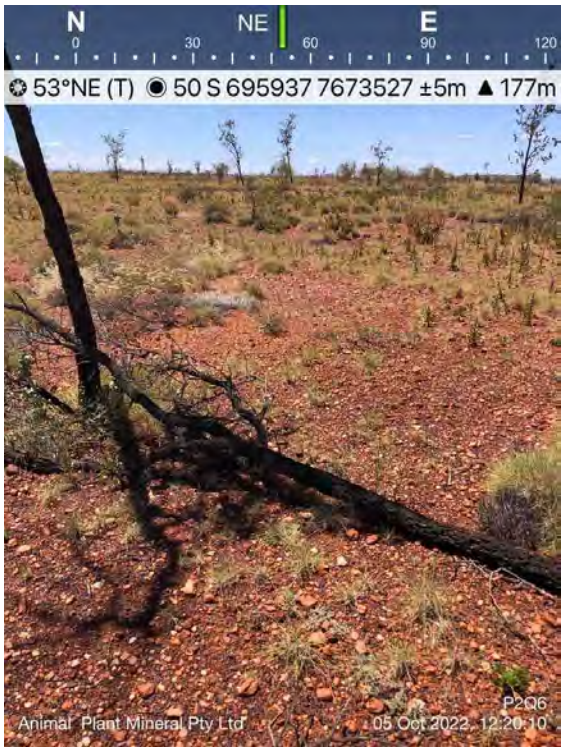
Strata	Cover (%)	Height (m)	Species
Overstorey	7	4	*Eucalyptus camaldulensis, Corymbia hamersleyana*
Understorey	9	2	*Acacia tumida, A. stellaticeps, Santalum lanceolatum*
Groundcover	41.1	0.8	*Triodia epactia, Triodia lanigera, Cenchrus ciliaris*
Notes	Quadrat, 25 x 100 m		

Job	PIL002
Site	P2 - Q5
Date	5/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	2 years
Seasonal Conditions	Dry, warm; dry soil
Rock Type	Schist, quartz
Soil Type	Sand
Soil Colour	Red
Landform	Undulating hillslope with some rock outcrops
Surface Rocks Size	1 - 15 cm, angular
Surface Rocks Cover	10%
Slope aspect	Slight slope to the east
Vegetation Description	Hummock grassland with some sparse Acacia shrubland and isolated C. hammersleyana - recovering from fire
Condition	Good



Strata	Cover (%)	Height (m)	Species
Overstorey	1	3	*Corymbia hammersleyana*
Understorey	10.9	1.5	*Acacia tumida, A. adsurgens, A. inaequilatera.*
Groundcover	16	0.2	*Triodia wiseana, T. epactia, T. lanigera*
Notes	Quadrat, 50 x 50 m Walking transect between P2 Q5 and Q6 indicated similar veg. community across the whole area		

Job	PIL002
Site	P2 - Q6
Date	5/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	2 years
Seasonal Conditions	Warm and dry soil surface
Rock Type	Schist, ironstone, quartz
Soil Type	Sandy loam
Soil Colour	Red
Landform	Flat stony plain
Surface Rocks Size	0.1 - 10 cm, rounded and angular
Surface Rocks Cover	70%
Slope aspect	Flat
Vegetation Description	Open hummock grassland of Triodia sp. with scattered tall *Acacia inaequilatera* recovering from recent fire
Condition	Good. Recovering from recent fire



Strata	Cover (%)	Height (m)	Species
Overstorey	-	-	
Understorey	2	3.5	*Acacia tumida, A. inaequilatera*
Groundcover	20	0.3	*Triodia lanigera, T. brizoides*.
Notes	Quadrat, 50 x 50 m		

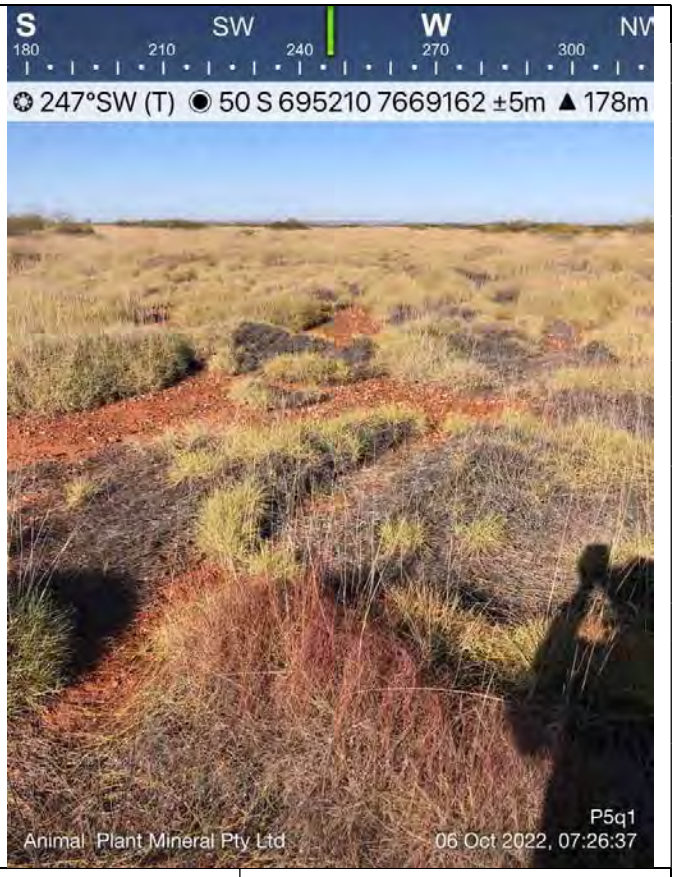
Job	PIL002		
Site	P2 - R1		
Date	5/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Dry, warm		
Rock Type	Granite, quartzite		
Soil Type	Loam sand		
Soil Colour	Red		
Landform	Ephemeral stream channel + riparian banks		
Surface Rocks Size	0.5 - 10 cm, rounded		
Surface Rocks Cover	In channel - 60%; Riparian banks - 5%		
Slope aspect	Very low slope flowing to the west		
Vegetation Description	Low Eucalyptus camaldulensis open woodland, sparse Acacia tall shrubland, Cenchrus tussock grassland.		
Condition	Good. Moderate Cattle grazing on stream banks. Cenchrus weeds,		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	6.5	5	*Eucalyptus camaldulensis, Corymbia hamersleyana*
Understorey	5.1	2.5	*Acacia tumida, A. bivenosa, A. stellaticeps*
Groundcover	30.3	0.6	*Cenchrus ciliaris, Triodia epactia, Cenchrus setiger*
Notes	Releve, 25 x 100 m		

Job	PIL002		
Site	P2 - R2		
Date	5/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	3 years		
Seasonal Conditions	Dry soil + warm		
Rock Type	Laterite, quartzite		
Soil Type	Loamy sand		
Soil Colour	Red		
Landform	Flat undulating rocky plain		
Surface Rocks Size	0.5 - 10 cm, angular		
Surface Rocks Cover	15%		
Slope aspect	Flat		
Vegetation Description	Sparse tall Acacia shrubland with Triodia open hummock grassland		
Condition	Very good		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey			
Understorey	7.3	3.5	*Acacia tumida, Acacia adsurgens* and *Acacia inaequilatera.*
Groundcover	25	0.3	*Triodia epactia, T. lanigera*
Notes	Releve, 50 x 50 m		

Job	PIL002		
Site	P2 - R3		
Date	5/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Warm, dry		
Rock Type	Granite, quartzite		
Soil Type	Sandy loam		
Soil Colour	Red		
Landform	Creekline and riparian banks of ephemeral creek; some surface water remaining (hence, heavily cattle use)		
Surface Rocks Size	0.5 - 10 cm, angular		
Surface Rocks Cover	Creekbed - 20%; Riparian banks - 2%		
Slope aspect	Very gentle slope to west (direction of flow)		
Vegetation Description	Isolated Eucalyptus/Corymbia low woodland, open Acacia mid shrubland, with Cenchrus tussock grass/ Triodia hummock grassland		
Condition	Good. Moderate grazing. Cenchrus weeds.		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	0.5	4	*Corymbia hamersleyana, Eucalyptus victrix*
Understorey	14	1.2	*Acacia tumida, A. stellaticeps, A. bivenosa*
Groundcover	32	0.6	*Cenchrus ciliaris, Triodia epactia, T. lanigera.*
Notes	Releve, 25 x 100 m		

Job	PIL002		
Site	P2 - R4		
Date	7/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Dry, warm		
Rock Type	Granite		
Soil Type	Sand / loamy sand		
Soil Colour	Brown		
Landform	Ephemeral creekline + riparian banks		
Surface Rocks Size	0.1 - 15 cm, rounded		
Surface Rocks Cover	20%		
Slope aspect	Stream flow to the east		
Vegetation Description	Eucalyptus camaldulensis low open woodland, sparse Acacia tall shrubland with mixed perennial tussock grass understorey		
Condition	Good. Grazing, Cenchrus weeds.		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	10	4.5	*Eucalyptus camaldulensis*
Understorey	2	2	*Acacia tumida, A. stellaticeps, A. bivenosa*
Groundcover	16	0.8	*Triodia epactia, Cenchrus ciliaris and Themeda triandra*
Notes	Releve, 100 x 50 m		

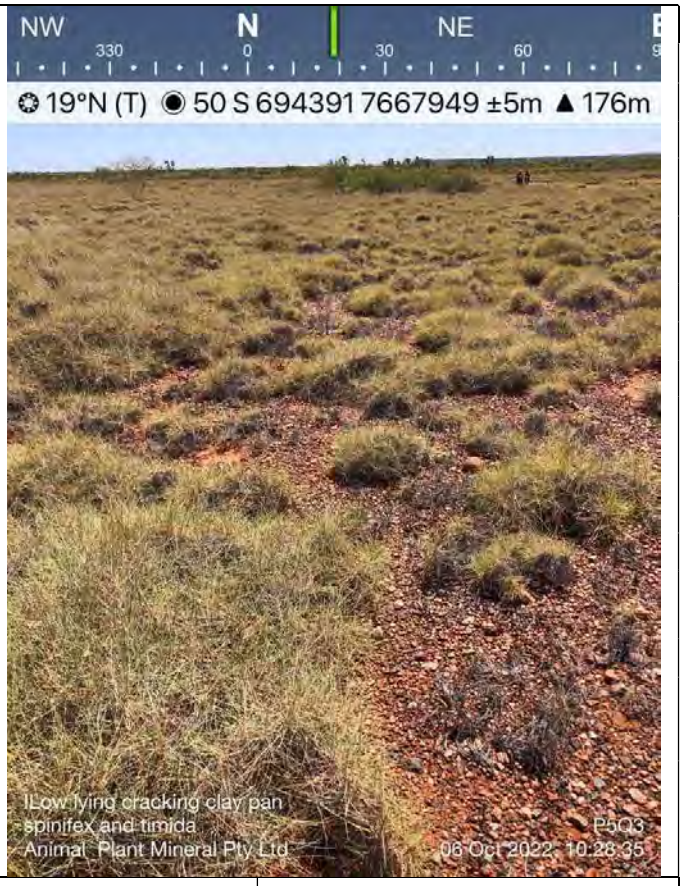
Job	PIL002
Site	P5 - Q1
Date	6/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Warm + dry
Rock Type	Quartzite, granite
Soil Type	Sandy loam
Soil Colour	Red
Landform	Flat plain; run on area with clay soil and gilgai terrain adjacent
Surface Rocks Size	1 -10 cm, angular
Surface Rocks Cover	60%
Slope aspect	Flat
Vegetation Description	Triodia Hummock grassland with tall, isolated Acacia spp. shrub
Condition	



Strata	Cover (%)	Height (m)	Species
Overstorey			
Understorey	6.5	2	*Acacia adsurgens* *Acacia bivenosa* *Petalostylis labicheoides*
Groundcover	70	1	*Triodia angusta, T. epactia*
Notes	Quadrat, 50 x 50 m		

Job	PIL002		
Site	P5 - Q2		
Date	6/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Warm, dry		
Rock Type	Granite, quartz		
Soil Type	Sandy loam, clay loam		
Soil Colour	Red		
Landform	Flat stony plain partly run on area with gilgia clay		
Surface Rocks Size	0.1 - 10 cm angular		
Surface Rocks Cover	40%		
Slope aspect	Flat		
Vegetation Description	Open Triodia hummock grassland with scattered Acacia mid shrubs.		
Condition	Very good		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey			
Understorey	5.6	1.5	*Acacia adsurgens, A. bivenosa, Petalostylis labichiodes.*
Groundcover	35	0.8	*Triodia angusta, T. lanigera, T. epactia*
Notes	Quadrat, 50 x 50 m Area from this Quadrat to NW corner was walked and the vegetation was uniform throughout (same as P5Q1, P5Q2) (See photos)		

Job	PIL002
Site	P5 - Q3
Date	6/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Dry, warm
Rock Type	Quartzite, granite
Soil Type	Sany loam / loamy clay
Soil Colour	Red
Landform	Stony flat plain with interspersed clayey gilgai areas of around 10 m diameter
Surface Rocks Size	1 - 10 cm, angular
Surface Rocks Cover	40%
Slope aspect	Flat Gilgai area
Vegetation Description	Triodia Hummock grassland with sparse tall Acacia spp.;
Condition	Very good

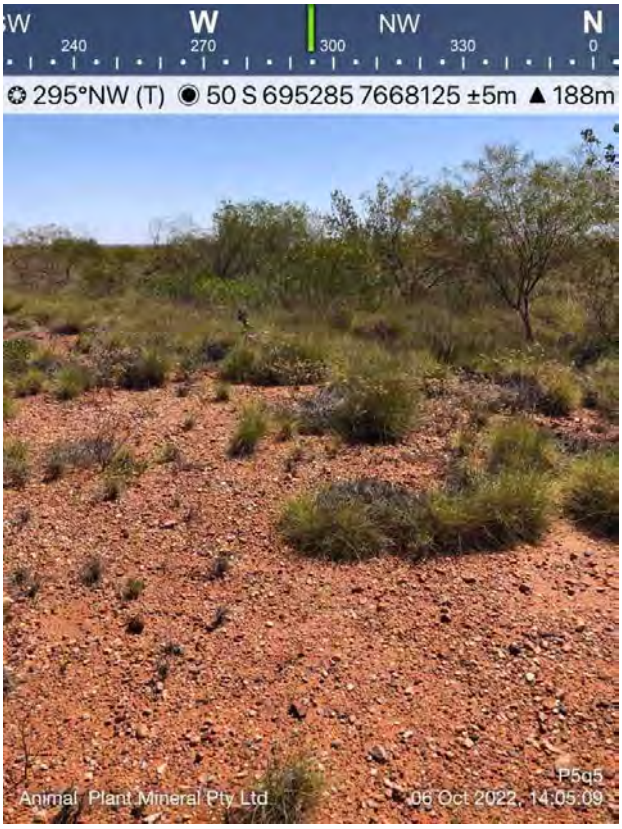


Strata	Cover (%)	Height (m)	Species
Overstorey			
Understorey	2.1	2	*Acacia adsurgens, A. bivenosa, Goodenia lamprosperma*
Groundcover	60	0.8	*Triodia brizoides, T. angusta, T. epactia*
Notes	Quadrat, 50 x 50 m		

Job	PIL002
Site	P5 - Q4
Date	6/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Dry, warm
Rock Type	Granite, quartzite
Soil Type	Sandy loam
Soil Colour	Red
Landform	Ephemeral creek no riparian banks
Surface Rocks Size	0.1 - 1 cm, rounded
Surface Rocks Cover	5%
Slope aspect	-
Vegetation Description	Eucalyptus low open woodland; tall sparse Acacia shrubland, open hummock/tussock grassland.
Condition/Disturbances	Good, Extensive cattle grazing on banks, causing erosions on those banks. Cenchrus and Kapok.

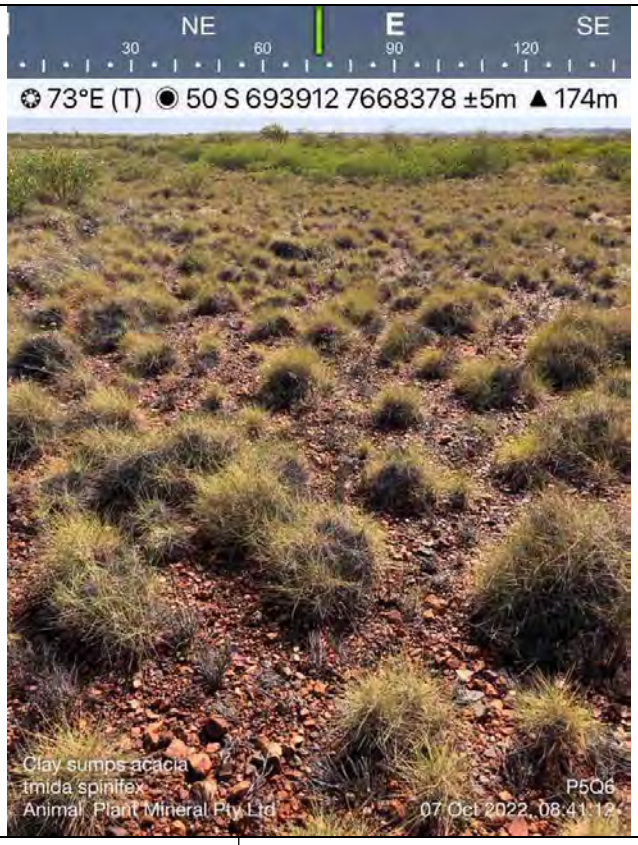
Strata	Cover (%)	Height (m)	Species
Overstorey	5	5	*Eucalyptus camaldulensis, Corymbia hamersleyana*
Understorey	4	2	*Acacia tumida, Acacia adsurgens, Acacia inaequilatera*
Groundcover	18.2	0.8	*Cenchrus setiger, C. ciliaris, Triodia epactia*
Notes	Quadrat, 25 x 100 m		

Job	PIL002
Site	P5 - Q5
Date	6/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Dry, warm
Rock Type	Granite, quartzite
Soil Type	Loamy sand
Soil Colour	Red
Landform	Drainage depression in broad flat plain, no channel
Surface Rocks Size	0.1 - 10 cm, angular
Surface Rocks Cover	30%
Slope aspect	Slight west slope
Vegetation Description	Triodia hummock grassland with sparse tall Acacia shrubland
Condition	Good. Low level cattle grazing



Strata	Cover (%)	Height (m)	Species
Overstorey			
Understorey	8.5	3	*Acacia adsurges, A. tumida, Grevillea wickhamii*
Groundcover	49	0.8	*Triodia angusta, T. epactia, T. lanigera*
Notes	Quadrat, 50 x 50 m		

Job	PIL002
Site	P5 - Q6
Date	7/10/2022
Botanist:	Neil Pettit / Danah Blache
Age since fire	> 5 years
Seasonal Conditions	Dry, warm
Rock Type	Granite, quartzite
Soil Type	Loamy sand
Soil Colour	Red
Landform	Stony open flat plain
Surface Rocks Size	0.1 - 15 cm, angular
Surface Rocks Cover	75%
Slope aspect	Slight gradient to the North
Vegetation Description	Low Triodia hummock grassland with isolated tall Acacia shrubs
Condition	Very good



Strata	Cover (%)	Height (m)	Species
Overstorey			
Understorey	6	2.5	*Acacia tumida, A. adsurgens, Grevillea wickhamii*
Groundcover	45	0.4	*- Triodia wiseana, T. angusta*
Notes	Quadrat, 50 x 50 m		

Job	PIL002		
Site	P5 - R1		
Date	6/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Dry, warm		
Rock Type	Calcrite		
Soil Type	Sandy loam		
Soil Colour	Red		
Landform	Ephemeral creekline and riparian area on		
Surface Rocks Size	1 - 20 cm, angular		
Surface Rocks Cover	20%		
Slope aspect	Very slow, no channel, invert flowing west		
Vegetation Description	Open low woodland of Corymbia hamersleyana sparse tall Acacia shrubs with Triodia/Cenchrus open tussock grassland		
Condition	Good. Moderate Grazing, weedy cenchrus and kapok		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	10	4.5	*Corymbia hamersleyana*
Understorey	2.3	2.5	*Acacia tumida, A. inaequilatera, Petalostylis cassioides*
Groundcover	21	1	*Triodia epactia, Cenchrus ciliaris, Cenchrus setiger*
Notes	Releve, 25 x 100 m		

Job	PIL002		
Site	P5 - R2		
Date	7/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Dry, warm		
Rock Type	Granite, quartzite		
Soil Type	Sand / sandy loam		
Soil Colour	Red		
Landform	1st order ephemeral creek + riparian area		
Surface Rocks Size	0.1 - 15 cm, angular		
Surface Rocks Cover	Creekline - 60%; Riparian - 30%		
Slope aspect	Creek flows to the West		
Vegetation Description	Low open woodland of Corymbia hamersleyana, mid isolated Acacia shrubs , Triodia hummock grassland		
Condition	Good. Moderate grazing, Cenchrus weeds.		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	2	3.5	*Corymbia hamersleyana*
Understorey	1.5	1.3	*Acacia bivenosa, A. adsurgens, Petalostylis cassioides*
Groundcover	53	0.7	*Triodia angusta, Triodia epactia. Cenchrus ciliaris*
Notes	Releve, 25 x 100 m		

Job	PIL002		
Site	P5 - R3		
Date	7/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	1 year		
Seasonal Conditions	Warm, dry		
Rock Type	Granite, quartzite		
Soil Type	Loam		
Soil Colour	Red		
Landform	Stony flat open plain with 1st order drainage line		
Surface Rocks Size	0.1 - 10 cm, angular		
Surface Rocks Cover	30%		
Slope aspect	Very gently towards East		
Vegetation Description	Corymbia hamersleyana low open woodland with low sparse forbland (Degraded hummock grassland)		
Condition	Poor, high impact grazing, erosion, lacking a midstory, weedy grasses.		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	2	3.5	*Corymbia hamersleyana*
Understorey			
Groundcover	6	0.1	*Streptoglossa odora Goodenia lamprosperma, Solanum diversiflorum.*
Notes	Releve, 25 x 100 m		

Job	PIL002		
Site	P5- R4		
Date	7/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Dusty		
Rock Type	Granite/cacrete		
Soil Type	Fine loamy sand		
Soil Colour	Red		
Landform	Stony undulating plain		
Surface Rocks Size	0.5 - 30 cm, angular		
Surface Rocks Cover	80%		
Slope aspect	Slight slope to the east		
Vegetation Description	Triodia hummock grassland with sparse tall acacia shrubland		
Condition	Very good		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey			
Understorey	6.5	3	*Acacia tumida, A. adsurgens, A. inaequilatera*
Groundcover	50	0.6	*Triodia wiseana, T. epactia*
Notes	Releve, 50 x 50 m		

Job	PIL002		
Site	P5 - R5		
Date	7/10/2022		
Botanist:	Neil Pettit / Danah Blache		
Age since fire	> 5 years		
Seasonal Conditions	Dry, warm		
Rock Type	Granite		
Soil Type	Sandy loam		
Soil Colour	Red		
Landform	1st order ephemeral creek + riparian area		
Surface Rocks Size	0.1 - 2 cm		
Surface Rocks Cover	5%		
Slope aspect	West flowing stream		
Vegetation Description	Corymbia hamersleyana low open woodland, tall isolated Acacia shrubs, Cenchrus tussock grassland		
Condition	Good. Heavy cattle grazing, invasion by exotic grasses		
Strata	**Cover (%)**	**Height (m)**	**Species**
Overstorey	5	4	*Corymbia hamersleyana*
Understorey	1.5	2	*Acacia tumida, A. bivenosa, A. inaequilatera*
Groundcover	40.2	0.5	*Cenchrus setiger, C. ciliaris, Triodia lanigera.*
Notes	Releve, 25 x 100 m		

APPENDIX D: FAUNA HABITAT PHOTOS


N NE E
330 0 30 60 90
36°NE (T) 50 S 695864 7672232 ±5m 173m
Creek line
Animal Plant Mineral Pty Ltd
As622904
04 Oct 2022, 14:27:25


NW N NE
300 330 0 30
349°N (T) 50 S 695421 7669235 ±5m 179m
Animal Plant Mineral Pty Ltd
Msc006
04 Oct 2022, 15:42:40

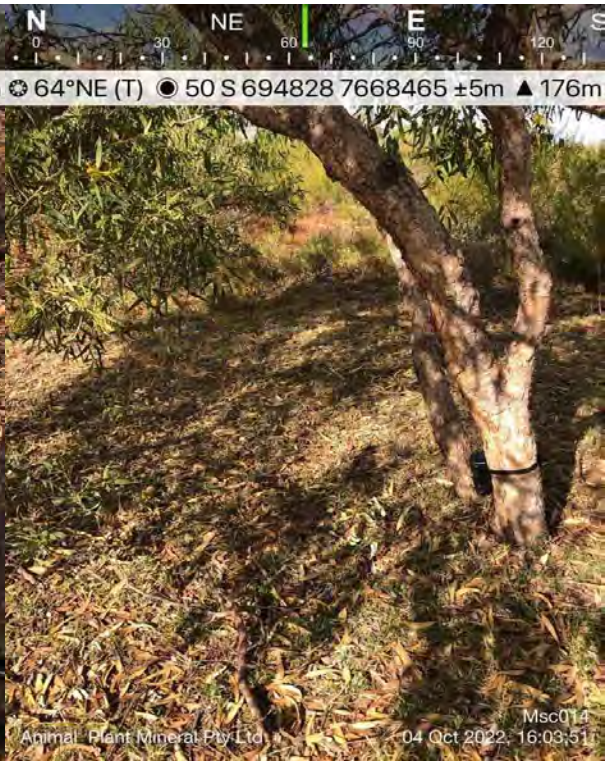

S SW W
180 210 240 270
223°SW (T) 50 S 695423 7668139 ±5m 187m
Animal Plant Mineral Pty Ltd
Msc007
05 Oct 2022, 15:51:14


NW N NE E
330 0 30 60 90
24°NE (T) 50 S 697421 7672050 ±5m 177m
DANGER
ACTIVE MINING AREA
NO UNAUTHORISED ENTRY
HEAVY EQUIPMENT OPERATING
Animal Plant Mineral Pty Ltd
Msc010
06 Oct 2022, 07:40:44


NE E SE
30 60 90 120 150
99°E (T) 50 S 696915 7671812 ±5m 178m
Move to rank creek
Animal Plant Mineral Pty Ltd
As660654
05 Oct 2022, 16:42:24


NE E SE
30 60 90 120 150
98°E (T) 50 S 697059 7673519 ±5m 188m
Low spinifex, some dense shrub. Stony soil
Animal Plant Mineral Pty Ltd
Msc011
05 Oct 2022, 10:20:43


W NW N
240 270 300 330 0
307°NW (T) 50 S 695614 7668304 ±5m 189m
Animal Plant Mineral Pty Ltd
Msc012
05 Oct 2022, 16:07:59


N NE E
0 30 60 90 120
64°NE (T) 50 S 694828 7668465 ±5m 176m
Animal Plant Mineral Pty Ltd
Msc014
04 Oct 2022, 16:03:51

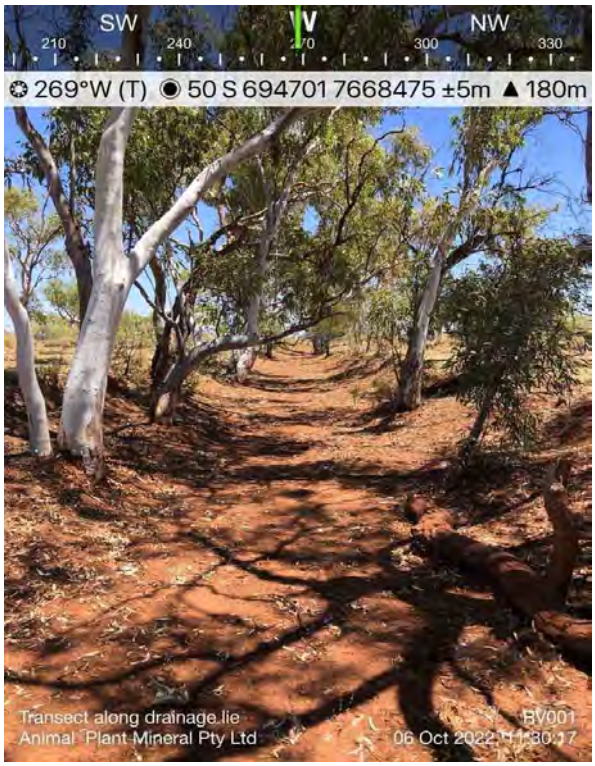

SW 240 W 270 NW 300 330
289°W (T) 50 S 695653 7673140 ±5m 168m
Msc016
Animal Plant Mineral Pty Ltd
05 Oct 2022, 07:13:59


150 S 180 210 SW 240 W 270
213°SW (T) 50 S 695424 7669227 ±5m 177m
Np001
Animal Plant Mineral Pty Ltd
04 Oct 2022, 15:46:35


30 NE 60 E 90 120 SE
81°E (T) 50 S 697352 7672088 ±5m 170m
NP002
Animal Plant Mineral Pty Ltd
04 Oct 2022, 14:55:00


270 W 300 NW 0 N 30
330°NW (T) 50 S 693852 7668141 ±5m 162m
Np003
Animal Plant Mineral Pty Ltd
04 Oct 2022, 15:57:52

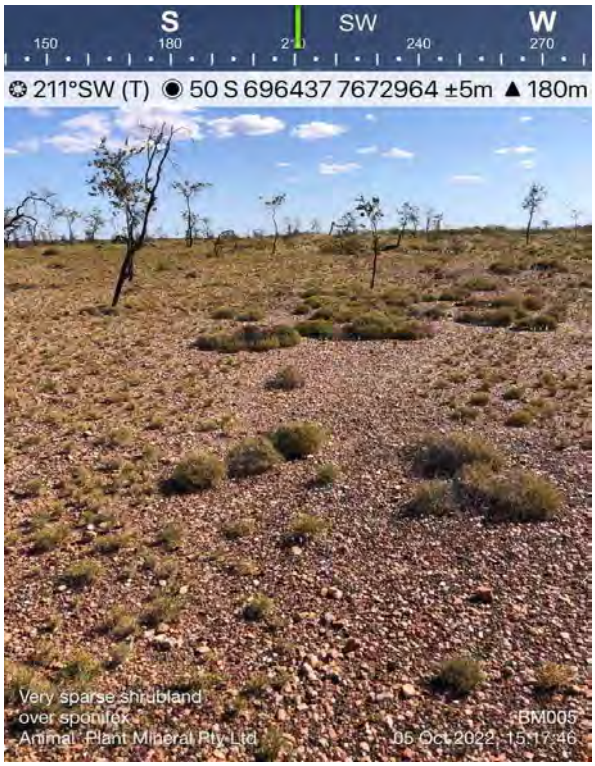

SE S SW
150 180 210 240
196°S (T) 50 S 695694 7673128 ±5m 167m
NP004
Animal Plant Mineral Pty Ltd
04 Oct 2022 15:05:44


SW W NW
210 240 270 300 330
269°W (T) 50 S 694701 7668475 ±5m 180m
Transect along drainage.lie
BV001
Animal Plant Mineral Pty Ltd
06 Oct 2022 11:30:17


NE E SE S
60 90 120 150
111°E (T) 50 S 696343 7672339 ±5m 171m
Low spinifex, some dense shrub. Stony soil
BM001
Animal Plant Mineral Pty Ltd
05 Oct 2022 09:21:38


E SE S
90 120 150 180 210
144°SE (T) 50 S 697161 7673637 ±5m 177m
Mix sand loam gravel loam
extreme small rock expressions
In a run on plain
BM002
Animal Plant Mineral Pty Ltd
05 Oct 2022 10:41:47


NE
30
60
SE
120
150
90°E (T) 50 S 695966 7673465 ±5m ▲173m
BM003
Animal Plant Mineral Pty Ltd
05 Oct 2022, 13:09:26


S
150
180
SW
240
W
270
211°SW (T) 50 S 696437 7672964 ±5m ▲180m
Very sparse shrubland
over spinifex
BM005
Animal Plant Mineral Pty Ltd
06 Oct 2022, 15:17:46


SE
150
S
180
SW
210
240
198°S (T) 50 S 695359 7669273 ±5m ▲176m
Not suitable. Crack clay low
lying. Flood prone
BM006
Animal Plant Mineral Pty Ltd
06 Oct 2022, 07:40:12


N
0
30
60
E
90
48°NE (T) 50 S 694639 7668965 ±5m ▲176m
Not suitable. Crack clay low
lying. Flood prone
BM007
Animal Plant Mineral Pty Ltd
06 Oct 2022, 08:04:26


S SW W
180 210 240 270 300
235°SW (T) 50 S 694448 7667899 ±5m 167m
Identical to BM006+7. Low lying cracking clay pan spinifex and timida
Animal Plant Mineral Pty Ltd
BM008
06 Oct 2022, 10:18:53


NE E SE
30 60 90 120
78°E (T) 50 S 693887 7668874 ±5m 174m
More elevated rolling Stoney hills interspersed with first order streams
Animal Plant Mineral Pty Ltd
BM009
06 Oct 2022, 11:51:02


W NW N
240 270 300 330 0
304°NW (T) 50 S 695031 7668085 ±5m 183m
Elevated slightly. Appears no clay sumps but very stony ground. Not suitable burrowing
Animal Plant Mineral Pty Ltd
BM010
06 Oct 2022, 14:09:19


NW N NE
300 330 0 30 60
354°N (T) 50 S 693860 7668195 ±5m 174m
Same clay sumps dense spinifex
Animal Plant Mineral Pty Ltd
Bm012
06 Oct 2022, 15:48:53

APPENDIX E: SPECIALISED ZOOLOGICAL TECHNICAL REPORT

Acoustic analysis and bat call identification from Lynas Find, Western Australia

Prepared for **Animal Plant Mineral Pty Ltd**

Version **23 November 2022**

SZ project reference **SZ637**

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

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Tel +61 (0)404 423 264
kyle.n.armstrong@gmail.com

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

Specialised Zoological (2022). Acoustic analysis and bat call identification from Lynas Find, Western Australia. Unpublished report by Specialised Zoological for Animal Plant Mineral Pty Ltd, 23 November 2022, project reference SZ637.

Summary

The outcome is provided of the analysis of acoustic (bat detector) recordings made at Lynas Find, 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.

The scope of the analysis was limited to the detection of the Threatened-listed Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae). Attention was also given to determining if the Northern Leaf-nosed Bat *Doryrhina* (=*Hipposideros*) *stenotis* (Hipposideridae) was present based on an acoustics-based record as part of a previous biological survey (report and further details unavailable).

Acoustic processing of the bat detector recordings was conducted separately for each of these three species using methods optimised for the detection of their unique echolocation call types. The recording dataset comprised a total of 59 recording nights from four bat detector units (**Table 1**).

No calls of the Ghost Bat were observed in the recordings. There were many examples of insect stridulations that had some similarity to the structure of the echolocation call of the Ghost Bat (**Figure 1**), but the repetitive nature of these and the lack of any associated social calls of the Ghost Bat is evidence that the source is from an insect.

No calls of the Pilbara Leaf-nosed Bat were observed in the recordings. Five sequences of the Pilbara Leaf-nosed Bat were recorded in a recent survey in the same study area (Specialised Zoological 2022).

No calls of the Northern Leaf-nosed Bat were detected. The accepted distribution of this species does not include in the Pilbara region (Churchill 2008; Australasian Bat Society, Inc[1]). While I have not seen the bat detector recording associated with a past record of detection, I suggest that this identification is more likely the result of an over-enthusiastic attribution.

Further details are available should verification be required.

[1] https://www.ausbats.org.au/batmap.html

Methods

The data provided were recorded in full spectrum WAV format with Titley Scientific Anabat Swift bat detectors (sampling rate 500 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 et al. 2021a,b) 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 application that performed three tasks:

1. undertook a Discriminant Function Analysis on training datasets from representative echolocation calls of Pilbara cave-roosting bat species, the Pilbara Leaf-nosed Bat and other northern Australian bat species;

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 ellipses representing one standard deviation of the variation 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 version 22.

Species were identified based on information in Armstrong and Coles (2007) and the author's own unpublished material. The occurrence of the Northern Leaf-nosed Bat was checked against distribution information in Churchill (2008) and the BatMap resource hosted by the Australasian Bat Society, Inc[2].

[2] https://www.ausbats.org.au/batmap.html

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 three target 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 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.

References

Armstrong, K.N. and Coles, R.B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonicteris aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* 88: 94–104. http://dx.doi.org/10.1644/06-MAMM-A-115R1.1

Armstrong K.N., Broken-Brow J., Hoye G., Ford G., Thomas M. and Corben C. (2021a). Effective detection and identification of sheath-tailed bats of Australian forests and woodlands. *Australian Journal of Zoology* 68: 346–363. https://doi.org/10.1071/ZO20044

Armstrong K.N., Clarke S., Linke A., Scanlon A., Roetman P., Hitch, A.T. and Donnellan S.C. (2021b). Citizen science implements the first intensive acoustics-based survey of insectivorous bat species across the Murray-Darling Basin of South Australia. *Australian Journal of Zoology* 68: 364–381. https://doi.org/10.1071/ZO20051

Churchill, S.K. (2008). *Australian bats.* 2nd ed. Allen and Unwin, Crows Nest, NSW.

Specialised Zoological (2022). Acoustic analysis and bat call identification from Lynas Find, Western Australia. Unpublished report by Specialised Zoological for Animal Plant Mineral Pty Ltd, 20 October 2022, project reference SZ627.

Table 1. Summary of bat detector recordings analysed.

Serial	Night	Coordinates
622904	4/10/2022	21.040270 S, 118.884913 E
622904	5/10/2022	21.040285 S, 118.885012 E, 159 m
622904	6/10/2022	21.040412 S, 118.884940 E, 160 m
622904	7/10/2022	21.040223 S, 118.885180 E, 211 m
622904	8/10/2022	21.040365 S, 118.885098 E, 190 m
622904	9/10/2022	21.040332 S, 118.884955 E, 178 m
622904	10/10/2022	21.040448 S, 118.885117 E, 168 m
622904	11/10/2022	21.040368 S, 118.885002 E, 184 m
622904	12/10/2022	21.040173 S, 118.885027 E, 168 m
622904	13/10/2022	21.040375 S, 118.884973 E, 176 m
622904	14/10/2022	21.040203 S, 118.885565 E, 185 m
622904	15/10/2022	21.040393 S, 118.884940 E, 165 m
622904	16/10/2022	21.040393 S, 118.884893 E, 161 m
622904	17/10/2022	21.040288 S, 118.884968 E, 124 m
622904	18/10/2022	21.040425 S, 118.884837 E, 151 m
622904	19/10/2022	21.040382 S, 118.884923 E, 159 m
642029	5/10/2022	21.075802 S, 118.882870 E
642029	6/10/2022	21.075845 S, 118.882947 E, 170 m
642029	7/10/2022	21.075825 S, 118.882932 E, 184 m
642029	8/10/2022	21.075828 S, 118.882923 E, 180 m
642029	9/10/2022	21.075425 S, 118.883522 E, 334 m
642029	10/10/2022	21.075822 S, 118.882870 E, 210 m
642029	11/10/2022	21.075272 S, 118.882767 E, 242 m
642029	12/10/2022	21.075763 S, 118.882850 E, 170 m
642029	13/10/2022	21.075893 S, 118.882923 E, 185 m
642029	14/10/2022	21.074850 S, 118.883212 E, 164 m
642029	15/10/2022	21.075717 S, 118.882853 E, 173 m
660630	4/10/2022	21.074392 S, 118.875240 E, 161 m
660630	5/10/2022	21.074278 S, 118.875868 E, 224 m
660630	6/10/2022	21.074415 S, 118.875243 E, 171 m
660630	7/10/2022	21.074437 S, 118.875250 E, 169 m
660630	8/10/2022	21.074425 S, 118.875265 E, 175 m
660630	9/10/2022	21.074418 S, 118.875267 E, 166 m
660630	10/10/2022	21.074453 S, 118.875292 E, 168 m
660630	11/10/2022	21.074402 S, 118.875257 E, 173 m
660630	12/10/2022	21.074398 S, 118.875240 E, 179 m
660630	13/10/2022	21.074430 S, 118.875240 E, 179 m
660630	14/10/2022	21.074257 S, 118.875652 E, 197 m
660630	15/10/2022	21.074362 S, 118.875233 E, 174 m
660630	16/10/2022	21.074502 S, 118.875272 E, 186 m
660630	17/10/2022	21.074332 S, 118.875245 E, 167 m
660630	18/10/2022	21.074427 S, 118.875240 E, 175 m
660630	19/10/2022	21.074445 S, 118.875340 E, 188 m
660630	20/10/2022	21.074282 S, 118.875203 E, 164 m

Serial	Night	Coordinates
660654	5/10/2022	21.041485 S, 118.899255 E
660654	6/10/2022	21.044085 S, 118.895025 E, 184 m
660654	7/10/2022	21.044080 S, 118.894970 E, 172 m
660654	8/10/2022	21.044070 S, 118.894972 E, 172 m
660654	9/10/2022	21.044035 S, 118.894972 E, 187 m
660654	10/10/2022	21.044042 S, 118.894988 E, 174 m
660654	11/10/2022	21.044078 S, 118.894970 E, 191 m
660654	12/10/2022	21.044085 S, 118.894963 E, 188 m
660654	13/10/2022	21.044030 S, 118.894960 E, 176 m
660654	14/10/2022	21.044083 S, 118.894997 E, 183 m
660654	15/10/2022	21.043912 S, 118.895568 E, 200 m
660654	16/10/2022	21.044023 S, 118.894975 E, 189 m
660654	17/10/2022	21.044023 S, 118.894962 E, 175 m
660654	18/10/2022	21.044028 S, 118.894957 E, 171 m
660654	19/10/2022	21.044025 S, 118.894975 E, 177 m

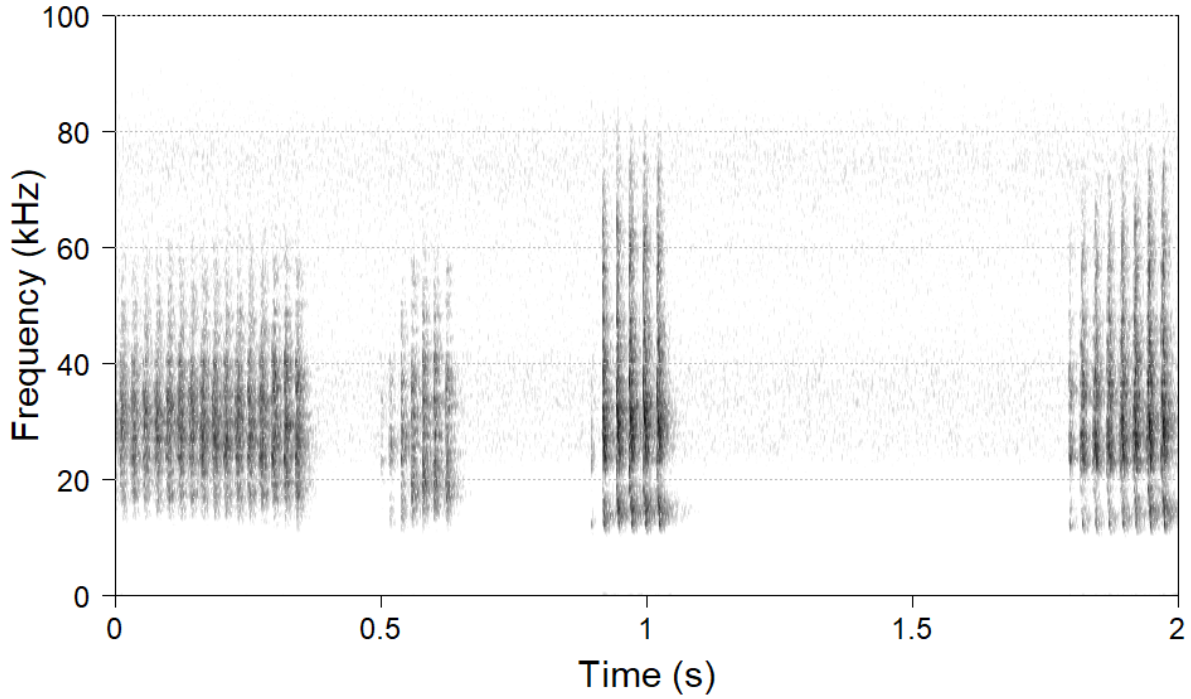

Figure 1. Example of an insect with a call stridulation pattern that has some similarity to the structure of echolocation calls of the Ghost Bat.

APPENDIX F: SPECIES BY SITE MATRIX - FLORA

Species	Status	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P2R1	P2R2	P2R3	P2R4	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P5R1	P5R2	P5R3	P5R4	P5R5
Amaranthaceae																						
Aerva javanaica	*Int.*				1										0.1			1				
Alternanthera nodiflora															0.1							
Ptilotus aervoides														0.1								
Ptilotus astrolasis		0.1		0.1		0.1	0.1	0.1	0.1			0.1	0.1		0.1	0.1	0.5				0.1	
Ptilotus auriculifolius									0.1				0.1		0.1							
Ptilotus axillaris						0.1	0.1		0.1		0.1											
Ptilotus calostachyus		0.5	0.1	0.1		0.1	1		0.1			0.1	0.1		0.1	0.1	1				0.1	
Ptilotus clementii			0.1			0.1															0.1	
Ptilotus exaltatus																					0.1	
Ptilotus helipteroides									0.1				0.1			0.2					0.1	
Asteraceae																						
Flaveria trinervia	*Int.*									0.1		0.1	0.1									
Pluchea rubelliflora										0.1												
Pluchea tetranthera					0.1																	0.1
Pterocaulon sphacelatum															0.2							
Streptoglossa ?decurrens															0.1			0.1				
Streptoglossa odora													0.1							2		
Boraginaceae																						
Euploca chrysocarpa			0.5	0.1																		
Euploca ovalifolia						0.1																
Chenopodiaceae																						
Dysphania rhadinostachya						0.1	0.1						0.1									
Cleomaceae																						
Arivela uncifera						0.1	0.1	0.1									0.1				0.1	
Convolvulaceae																						
Bonamia ?rosea					0.1								0.1			0.1			0.1	0.1		0.1
Bonamia erecta				0.5	0.1	0.1	1	0.1	0.5	0.1	0.1	0.1		0.1		0.1	0.1	0.1	0.1		0.1	
Bonamia media						0.1	0.1															
Bonamia pilbarensis																						
Bonamia rosea																						
Polymeria ambigua															0.1							

Species	Status	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P2R1	P2R2	P2R3	P2R4	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P5R1	P5R2	P5R3	P5R4	P5R5
Cucurbitaceae																						
Cucumis argenteus												0.1										
Cucumis variabilis					0.1																	
Cyperaceae																						
Cyperus bifax								0.1														
Euphorbiaceae																						
Euphorbia careyi															0.1							
Euphorbia coghlanii																				0.1		
Euphorbia mitchelliana					0.1								0.1		0.1							
Fabaceae																						
Acacia adsurgens		2		1		0.1			2	2		5	2	2	1	5	0.5		0.5		0.5	
Acacia bivenosa			0.5					2		2	0.5	1	2	0.1					0.5			0.5
Acacia inaequilatera		1		1	0.5	0.5	0.5	0.1	0.1						0.5	0.5		0.1			0.5	0.5
Acacia orthocarpa			0.5																			
Acacia stellaticeps			1		2			0.5		5	0.5											
Acacia synchronicia													0.6									
Acacia trachycarpa																						0.5
Acacia tumida		0.1	1	15	5	10	0.5	2	5	5	1				2	2	5	2			5	0.5
Cajanus cinereus					0.5						0.5				0.1			1	0.1			0.5
Crotalaria cunninghamii					0.5			0.5														
Crotalaria medicaginea				0.1											1							
Cullen leucanthum					0.1																	
Cullen stipulaceum					0.1																	0.1
Indigofera hirsuta		0.1																				
Indigofera monophylla		0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1	0.5	1	1	0.5	0.5	0.1	0.1	0.5
Indigofera rugosa			0.1			0.1					0.1											
Neptunia dimorphantha													0.1									
Neptunia monosperma														0.2								
Petalostylis labicheoides												0.5	1		0.5			0.2	0.5		0.5	
Rhynchosia minima								0.1		0.1	0.1		0.1					0.1	0.1			0.1
Senna artemisioides subsp. *helmsii*			0.1																			
Senna artemisioides subsp. *oligophylla*					0.1					0.1												

Species	Status	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P2R1	P2R2	P2R3	P2R4	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P5R1	P5R2	P5R3	P5R4	P5R5
Senna ferraria												0.1	0.1							0.1		
Senna glutinosa																						
Senna glutinosa subsp. *glutinosa*																		0.1				
Senna notabilis						0.1			0.5				0.1		0.1					0.1		0.1
Tephrosia arenicola				0.1	0.5	1	0.2	0.1	0.5													
Tephrosia clementii							0.1					0.1					0.1					
Tephrosia rosea					0.1				0.1						0.1			0.1	0.1			
Goodeniaceae																						
Goodenia lamprosperma								0.1	0.1		0.1	0.1	0.1	2	0.1	0.1	0.1	0.1		2	0.1	0.1
Goodenia microptera						0.1	0.1		0.1													
Goodenia muelleriana																			0.1			
Goodenia scaevolina		1		1			0.2		0.5								0.1				0.1	0.1
Scaevola amblyanthera			0.1	0.1						0.1	0.1				0.1	0.1			0.1			
Haloragaceae																						
Gonocarpus ephemerus			0.1																			
Haloragis maierae			0.1																			
Lauraceae																						
Cassytha filiformis			0.1	1	0.5					0.1	0.5	0.1						0.1				
Malvaceae																						
Abutilon lepidum																		0.2				0.1
Corchorus incanus		1	0.1	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.1	1	1	0.1	0.5	0.1	0.1	1	0.1	0.1	0.1	0.1
Gossypium australe								0.5			0.5				0.1							0.1
Gossypium sturtianum					0.1																	
Hibiscus burtonii																						0.1
Hibiscus leptocladus						0.1																
Malvastrum americanum	*Int.*																					0.1
Melhania oblongefolia											0.1		0.1									0.1
Nellica maderaspatensis											0.1								0.1			
Sida arenicola			0.2		0.5			0.1			0.1				0.1	0.1						
Sida fibulifera													0.1									
Sida rohlenae																				0.1		
Triumfetta pentandra	*Int.*														0.2			0.1				0.1

Species	Status	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P2R1	P2R2	P2R3	P2R4	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P5R1	P5R2	P5R3	P5R4	P5R5
Molluginaceae																						
Trigastrotheca molluginea		0.1		0.1		0.1	0.5		0.1	0.1		0.1		0.1		0.1	0.1	0.1			0.1	
Myrtaceae																						
Corymbia hamersleyana		2	2		2	0.1		1.5		0.5					1			10	2	2		5
Eucalyptus camaldulensis					5			5			10				4							
Eucalyptus victrix										1												
Nyctaginaceae																						
Boerhavia gardneri						0.1																
Phyllanthaceae																						
Notoleptopus decaisnei													0.1									
Poaceae																						
?Sorghum plumosum											0.5											
Aristida holathera											0.1											
Cenchrus ciliaris	*Int.*				10			15		15	5				2			5	5	0.1		10
Cenchrus setiger	*Int.*				5			5		2					10			5	5			15
Chrysopogon fallax				0.1	0.1						0.5				0.2				2			0.1
Cymbopogon obtectus					0.1			0.1		0.1	0.1											
Dichanthium sericeum																			2			
Enneapogon lindleyanus													0.1					0.5				
Eragrostis eriopoda			0.5			0.5			0.5													
Eriachne mucronata						1							0.5	2	0.5							
Eriachne pulchella																				0.1		
Eulalia aurea															0.5							
Heteropogon contortus								0.1						2	0.5							
Paraneurachne muelleri			0.1								0.1											
Themeda avenacea								0.1										0.5	2			
Themeda triandra					1			0.1			0.5				0.5			0.5	2	0.1		0.1
Triodia angusta												60	30	15		25	10		20			
Triodia brizoides				5			5							40		5						
Triodia epactia		5	2	10	15	5		10	20	10	10	10	5	5	3	15		5	15	0.1	5	5
Triodia lanigera		5	35	25	10	1	15		5	5			5		2	2		5				10
Triodia wiseana		35	10			10											30				40	

Species	Status	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P2R1	P2R2	P2R3	P2R4	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P5R1	P5R2	P5R3	P5R4	P5R5
Portulacaceae																						
Portulaca oleracea	mixed														0.1							
Proteaceae																						
Grevillea pyramidis																		0.1				
Grevillea wickhamii		1		1		0.1		0.1	0.1							1	0.5					
Hakea loreus											0.1					0.1			0.1			0.1
Santalaceae																						
Santalum lanceolatum					1																	
Dodonaea coriacea						0.1																
Scrophulariaceae																						
Eremophila forrestii subsp. *forrestii*		0.1																				
Solanaceae																						
Solanum ?horridum																0.1						
Solanum diversiflorum													0.1							0.5		
Solanum phlomoides															0.1					0.1		
Typhaceae																						
Typha domingensis										1												
Violaceae																						
Afrohybanthus aurantiacus				0.1		0.1										0.1		0.1	0.1			
Zygophyllaceae																						
Tribulus hirsutus							0.1						0.1									
Not previously recorded for the Pilgangoora project																						
Int: Introduced species. Mixed: native to part of the range, introduced to part of the range.																						

APPENDIX G: FAUNA LIKELIHOOD OF OCCURRENCE ASSESSMENT - FAUNA

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
-- Birds --					
Actitis hypoleucos	Common Sandpiper	MI	MI	Edge of sheltered waters salt or fresh (*e.g.* estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone and Storr, 1998). Shallow, pebbly, muddy or sandy edges of rivers and streams coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers, waterways in mangroves or saltmarshes; mudflats: rocky or sand beaches; causeways, riverside lawns, drains, street gutters. (Pizzey and Knight, 2012).	Possible. The gilgai areas provide inundated clay soils suitable for waders, however these areas do not provide perching opportunities. Perching opportunities available in the creeks however limited water pooling was observed. Two records 20 km to the west from a semi-permanent pool in a tributary of the Turner River. No Nationally or Internationally Important Congregations occur.
Apus pacificus	Fork-tailed Swift	MI	MI	Broadly distributed aerial species that is not specifically limited to any particular habitat type. Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. (Pizzey and Knight, 2012). Occurs over dry or open habitats comprising of riparian woodland, low scrub, heathland, or saltmarsh, also grasslands and sandplains with spinifex. (Morcombe, 2011).	Possible. No local records but listed by the PMST as Likely to occur. Seven records are reported from 1998 – 2014 over a wide variety of habitats. This species is distributed across Australia. It is an aerial species that rarely comes to land. Individuals would not be specifically dependant on any habitats present in the Study Area.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
Calidris acuminata	Sharp-tailed Sandpiper	MI	MI	Scarce to moderately common (much more plentiful near coasts than in interior). (Johnstone and Storr, 1998). Tidal mudflats, saltmarshes, mangroves; shallow fresh, brackish or saline inland wetlands; floodwaters, irrigated pastures and crops; sewage ponds, saltfields. Widespread summer migrant to coastal and inland Australia. (Pizzey and Knight, 2012).	Possible. The gilgai areas provide seasonally inundated clay soils. Limited pooling of water in the ephemeral drainage lines. No Permanent pools. No records in the local area. PMST considers the species May occur.
Calidris ferruginea	Curlew Sandpiper	CR	CR, MI	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds. (Johnstone and Storr, 1998) Tidal mudflats; saltmarsh, saltfields; fresh, brackish or saline wetlands; sewage ponds. (Pizzey and Knight, 2012)	Possible. The gilgai areas provide seasonally inundated clay soils. Limited pooling of water in the ephemeral drainage lines. No Permanent pools. No records in the local area. PMST considers the species May occur.
Calidris melanotos	Pectoral Sandpiper		MI	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also, samphire flats around estuaries and saltlakes. (Johnstone and Storr, 1998) Shallow fresh waters, often with low grass or other herbage; swamp margins, flooded pastures, sewage ponds, occasionally tidal areas, saltmarshes. (Pizzey and Knight, 2012)	Possible. The gilgai areas provide seasonally inundated clay soils. Limited pooling of water in the ephemeral drainage lines. No Permanent pools. No records in the local area. PMST considers the species May occur.
Charadrius veredus	Oriental Plover	MI	MI	Open plains; bare, rolling country, often far from water; ploughed land; muddy or sandy wastes near inland swamps or tidal mudflats; bare claypans; margins of	Likely. The gilgai areas provide inundated clay soils suitable for Oriental Plover. There is a 1999 record 250 m from Option 2. This area is now part of the active

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
				coastal marshes; grassy fields and lawns. (Pizzey and Knight, 2012).	Pilgangoora operations. Prior to clearing it would have been similar habitat to the gilgai areas.
Erythrotriorchis radiatus	Red Goshawk	VU	VU	Well-wooded country. (Johnstone and Storr, 1998) Open forests, woodlands, especially near rivers, wetlands; rainforest fringes. (Pizzy and Knight, 2012)	Unlikley. No records are known from the Pilbara and not within the range of the species known distribution (BirdLife International 2022, TSSC 2015).
Falco hypoleucos	Grey Falcon	VU	VU	Mainly lightly wooded and coastal riverine flats. (Johnstone and Storr, 1998) Lightly treed and inland plains; gibber deserts, sandridges, pastoral lands, timbered watercourses; seldom in driest deserts (Pizzey and Knight, 2012).	Likely. The Study Areas are potentially suitable foraging habitat. Listed by EPBC as Known to Occur in the search radius and five records since 2012 near the Turner River and larger tributaries. The closest record is 10 km south west of the Study Area. All habitats in the Study Areas are suitable foraging habitat for this species. The red gum is unsuitable for nesting due to the low stature.
Falco peregrinus	Peregrine Falcon	OS	-	Mainly about cliffs along coasts, rivers and ranges, and about wooded watercourses and lakes (Johnstone and Storr, 1998). Cliffs, gorges, timbered watercourses, environs of rivers, wetlands, plains, open woodlands, pylons, spires, buildings. (Pizzey and Knight, 2012)	Likely. All habitats are suitable. One record from 2002 is 250 m from the Study Area. This location is now the site of the Pilgangoora mine.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
Glareola maldivarum	Oriental pratincole	MI	MI	Feeding in air and roosting on bare ground beside water, *e.g.* tidal flats and floodwaters (Johnstone and Storr, 1998). Plains; shallow wet and dry edges of open bare wetlands; tidal mudflats, beaches (Pizzey and Knight, 2012).	Possible. The gilgai areas provide seasonally inundated clay soils. Limited pooling of water in the ephemeral drainage lines. No Permanent pools. No records in the local area. PMST considers the species May occur.
Hirundo rustica	Barn swallow	MI	MI	Mainly towns and wetlands (sewage and saltworks ponds, river pools, swamps, tidal creeks and reservoirs). (Johnstone and Storr, 2004) Open country; agricultural land, especially near water; railyards, towns, overhead wires. (Pizzey and Knight, 2012)	Possible. The gilgai areas provide seasonally inundated clay soils. Limited pooling of water in the ephemeral drainage lines. No Permanent pools. No records in the local area. PMST considers the species May occur.
Motacilla cinerea	Grey Wagtail	MI	MI	Mainly banks and rocks in fast-running fresh water habitats; rivers, creeks, streams and around waterfalls, both in forest and open country; but occurs almost anywhere during migration. Flits from rock to rock, and often enters water after insects (or performs flycatcher sallies after them). (Johnstone and Storr, 2004) In Australia, near running water in disused quarries; sandy, rocky streams in escarpments and rainforests; sewage ponds, ploughed fields, airfields. (Pizzey and Knight, 2012)	Unlikely. The drainage lines in the Study Area are highly ephemeral and would only flow for brief period of time. Drainage lines are in plains habitat where fast running channel flow is limited. There are no previous records in the local area and the species is uncommonly recorded in Australia. No records in the local area. PMST considers the species May occur.
Motacilla flava	Yellow Wagtail	MI	MI	Damp short-grass flats: rice stubbles and edge of swamps, sewage ponds, bore overflows, grazed or	Possible. Suitable habitat occurs in the gilgai during seasonal inundation.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
				mowed grass and irrigated areas. (Johnstone and Storr, 2004)	No records in the local area. PMST considers the species Likely to occur.
Numenius madagascariensis	Eastern Curlew	CR	CR, MI	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds). (Johnstone and Storr, 1998) Estuaries, tidal mudflats, sandspits, saltmarshes, mangroves; occasionally fresh or brackish lakes; bare grasslands near water. (Pizzey and Knight, 2012)	Possible, but prefers saline habitats.
Pezoporus occidentalis	Night Parrot	CR	EN	Treeless or sparsely wooded spinifex *Triodia* spp. near water (including artesian bores) (Johnstone and Storr, 1998). Seeding spinifex on stony rises, breakaway country, sandy lowlands; shrubby glasswort, chenopods; succulents on flats around salt lakes; flooded claypans saltbush, bluebush, bassia associations (Pizzey and Knight, 2012).	Possible. No local records. Habitat modelling includes the Study Area at the extremity of the species potential extent. Foraging resources are limited.
Rostratula australis	Australian Painted-Snipe	EN	EN	Common in south and north-east Kimberley swampy plains before their degradation by cattle, but only five records since 1909. Rare summer visitor to North-west, single birds recorded at man-made ponds in the Hamersley and Ophthalmia Ranges in December and January and a male collected at Carnarvon in November. In arid interior a female about to lay collected at	Unlikely. No habitat occurs in the Study Area. Vegetation too open to provide well vegetated shallows. No records in the local area. PMST considers the species May occur.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
				Brockman Creek in August 1896 (Johnstone and Storr, 1998). Well-vegetated shallows and margins of wetlands, dams, sewage ponds; wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, open timber. (Pizzey and Knight, 2012)	
				-- Mammals --	
Dasycercus blythi	Brush-tailed Mulgara	P4	-	Inhabits spinifex grasslands and burrows on the flats between low sand dunes (Van Dyck and Strahan, 2008).	Possible. Sandy rises in the undulating plains habitat is suitable.
Dasyurus hallucatus	Northern Quoll	EN	EN	The Northern Quoll will usually den in hollow tree trunks (Hill and Ward, 2010) or in small caves and crevices in rocky outcrops.	Likely. Foraging habitat available in the creek lines, however is likely to be poor quality as lacking in litter and vegetation cover due to heavy grazing. Trees too small to provide hollows suitable for denning. Confirmed to occur in the rocky range 4 km to the east. One record 1.2 km to the northeast of Option 2.
Hipposideros stenotis	Northern Leaf-nosed Bat	P2		It is found near the entrance of shallow caves and abandoned mines where they are usually very sensitive to the approach of an observer (Duncan *et al*. 1999). It forages in forest, woodlands and grasslands in close proximity to rocky outcrops and escarpments (Churchill 2008).	Unlikely. Very few records in the Pilbara. Database records from 2012 are a cluster of acoustic recordings, however the location is stated as 'Great Sandy Desert' therefore have low spatial accuracy. The accepted distribution of this species does not include in the Pilbara region (*e.g.*, Churchill 2008). Records may be a result of misidentification of echolocation records (Appendix E).

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
Lagorchestes conspicillatus leichardti	Spectacled Hare-Wallaby	P4	-	Open *Acacia* forests, open woodlands and tall shrubland over tussock or hummock grasslands (Van Dyck and Strahan, 2008).	Unlikely. Historic records nearby however habitat is too open to be suitable.
Macroderma gigas	Ghost Bat	VU	VU	Their distribution is influenced by the availability of suitable caves and mines for roost sites (Churchill 2008). In the Pilbara, ghost bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (Triodia spp.) on sand or stony ground (Bat Call WA 2021a).	Likely. Foraging habitat available across the Study Area. No roosting habitat available. Study Areas within foraging range of database record locations.
Macrotis lagotis	Bilby	VU	VU	Occupy a variety of inland habitats including grass and stony downs country on cracking clays, desert sandplains and dune fields of laterite with hummock grassland and massive red earths with *Acacia* shrubland (Van Dyck and Strahan, 2008).	Possible. Suitable habitat includes the undulating plains habitats. Historic record nearby, recent records 16 km to the west.
Pseudomys chapmani	Western Pebble-mound Mouse	P4	-	Found on stony hillsides with hummock grassland (Menkhorst and Knight, 2009)	Present. Mounds located in the stony rises of the undulating plains habitats. .
Rhinonicteris aurantia	Pilbara Leaf-Nosed Bat	VU	VU	Dependant on deep and complex cave systems. Roosting and foraging habitats defined by TSSC (2016) and Bat Call WA (2021b)	Likely. No roosting habitat available, foraging quality of habitats in the Study Area is Low. Not recorded in acoustic survey. May fly over the area to reach more productive foraging habitat.
Sminthopsis longicaudata	Long-tailed Dunnart	P4		A specialist rock dwelling species (Freeland *et al.* 1988). It prefers exposed rock and stony soils with hummock	Unlikely. No suitable habitat.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
				grasses and shrubs, on flat-topped hills, lateritic plateaus, sandstone ranges and breakaways.	
				-- Reptiles --	
Anilios ganei	Gane's blind snake (Pilbara)	P1		Known from widely separated areas between Newman and Pannawonica. Possibly associated with moist gorges and gullies (Wilson and Swan 2008).	Unlikely. Suitable habitat unlikely to be present as drainage lines small and highly ephemeral. No termite mounds present for foraging resource.
Liasis olivaceus subsp. *baronni*	Pilbara Olive Python	VU	VU	Recorded in areas with gorges and escarpments in close proximity to water holes (Doughty *et al*. 2011). During the cooler months they will typically hide in caves, crevices and fissures away from water sources. However, in the warmer months they become active and tend to stay near rocky outcrops and water.	Unlikely. No suitable habitat. There are no gorges or significant water filled gullies in the Study Area. No permanent or semi-permanent pools in the creeks. No caves, crevices or fissures.
Liopholis kintorei	Great Desert Skink		VU	A nocturnal burrowing and social lizard, living in family groups and creating extensive burrows that are typically 1 m deep and up to 10 m in diameter with multiple entrances (McAplin 2001). Typically occupy hummock grass sandplains and some adjacent dunefield swales, though they can occur in a variety of habitats (McAplin 2001). Vegetation usually consists of hummock grassland (*Triodia basedowii*, *T. pungens* and *T. schinzii*), with some scattered shrubs and occasional trees (*e.g*. Acacia spp., Eucalyptus spp., Hakea spp., Grevillea spp. and Allocasuarina decaisneana) (McAlpin 2001). Tend to utilise areas of habitat that have	Unlikely. No records in the local area. PMST considers the species May occur. The area where suitable habitat may occur is 10 km to the east of the Study Area and separated by a rocky range.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
				been burnt within the previous 2-15 years (McAplin 2001; Morre *et al*. 2015).	

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