

Mulga Downs

Consolidated Terrestrial Fauna Report Hub and Rail Spur Option 8B

Prepared for:

Hancock Prospecting Pty Ltd (HPPL)

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Executive Summary

Roy Hill Infrastructure Pty Ltd (RHI) (the Proponent) is proposing to develop the Mulga Downs Hub and Rail Spur (the Proposal) located approximately 210 km south of Port Hedland and approximately 180 km north-west of Newman, in the Pilbara region of Western Australia. The Proposal is to facilitate the transportation of ore from the Mulga Downs Iron Ore Project (MDIOP) to Port Hedland.

There are two options for the rail alignment – option 1B and option 8B. This report consolidates the findings from the previous surveys undertaken for the Hub, and both Option1B and Option 8B alignments. This area is collectively called the 'Survey area' throughout this report. Only one of these proposed rail corridors will be selected to connect the Mulga Downs Hub to the existing Roy Hill rail line.

Desktop Studies

Standalone desktop assessments were undertaken as part of the *ecologia* (2021a), Biologic (2022) and Spectrum (2022) reports. These reports address different sections of the Proposal area. The detailed field survey results from each of these reports relevant to these three desktop assessments have been consolidated into this report.

Terrestrial vertebrate fauna, and short-range endemic (SRE) invertebrate surveys were undertaken for the preparation of each respective fauna survey reports. The initial phase of this report involved compilation of the mapped habitat data collected for each report, so as to create a compilation map for the Proposal area. The surveys included basic, detailed and targeted surveys across both wet and dry seasons from 2019 through to 2022. The findings of this report are focused on the Proposal which includes mine infrastructure within the Hub and the Option 8B rail spur together with a 1 km buffer either side of the rail spur. This area is referred to as the Proposal area throughout this report.

Desktop Study Results

The desktop and literature assessments by *ecologia* (2021a), Biologic (2022) and Spectrum (2022) identified 384 species of vertebrate fauna, which have previously been recorded or have the potential to occur within the Survey area. This comprises 49 mammals, 188 birds, 134 reptiles and 13 amphibians.

Habitats in the Survey area

Various fauna habitats were identified during each of the previous surveys. This resulted in individual habitat maps for each respective report. This habitat data was then consolidated to create a habitat map representative of the Survey area for this report. The resultant mapping identified 12 terrestrial fauna habitat types including Cleared/disturbed. The habitats within the Proposal area are:

- Drainage Area/Floodplain;
- Drainage Lines;
- Cracking Clay;
- Gibber Cracking Clay;
- Rocky Hills;
- Hilltops, Mesas and Outcrops;
- Mulga Woodland;
- Rocky Plains and Footslopes;
- Stony Spinifex Plains and Hillslopes;



- Boulder Piles;
- Snakewood; and
- Cleared/Disturbed.

Fauna Survey

Combining the data from the various field surveys resulted in a total of 153 vertebrate fauna species being recorded within the combined Hub and Rail Survey area. These included 24 mammals, 78 birds, 50 reptiles and one amphibian species. Analysis of the recorded species indicated that the surveys were effective in detecting the majority of predicted fauna likely to be present in the Survey area. The species accumulation curve had commenced to plateau indicating the maximum number of terrestrial vertebrate fauna species likely to occur was achieved.

In the Proposal area, a total of 147 terrestrial fauna species were detected consisting of 23 mammals, 73 birds, 50 reptile and one amphibian species were recorded. All the terrestrial fauna surveys completed for the Survey area were prepared and undertaken in accordance with the Environmental Protection Authority technical guidance for terrestrial fauna (EPA, 2016b; 2020).

Conservation Significant Species

The surveys undertaken by *ecologia* (2021a), Biologic (2022) and Spectrum (2022) identified the following conservation significant species in the Survey area:

- Dasyurus hallucatus (Northern Quoll) Endangered (EN) Biodiversity Conservation Act 2016 (BC Act) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).
- Anilios ganei (Gane's Blind Snake) DBCA Priority (P)1.
- Leggadina lakedownensis (Short-tailed Mouse) Department of Biodiversity, Conservation and Attractions (DBCA) P4;
- Rhinonicteris aurantia (Pilbara Leaf-nosed Bat) Vulnerable (VU) BC Act and EPBC Act; and
- Pseudomys chapmani (Western Pebble-mound Mouse) a P4.

The following conservation significant fauna, while not recorded in the Survey area, have been recorded within 10 km, and were also assessed as being likely to occur within the Survey area. These species include:

- Dasycercus blythi (Brush-tailed Mulgara) a DBCA P4;
- Macroderma gigas (Ghost Bat) VU BC Act the EPBC Act;
- Falco peregrinus (Peregrine Falcon) (Other Special fauna (OS) BC Act);
- Falco hypoleucos (Grey Falcon) VU BC Act,
- Tringia glareola (Sandpiper) Migratory (MI) EPBC Act,
- Calidiris rufiocollis (Red-necked Stint) MI EPBC Act;
- Tringia nebularia (Common Greenshank) MI EPBC Act;
- Liasis olivaceus (Pilbara Olive Python) VU BC Act and EPBC Act; and
- Ctenotus uber johnstonei (Spotted Ctenotus) DBCA P2.



Short-range Endemic (SRE) Invertebrate Assessment

Within the Proposal area, the Drainage Line habitat was found to provide important microhabitat for many SRE invertebrates with 86% of the SRE species (Potential and Confirmed) identified within this habitat.

From the desktop assessment, 15 Confirmed SRE invertebrate taxa have been identified for the region and 91 Potential SRE species have been previously recorded from within 40 km of the Survey area. Surveys in adjacent areas (*ecologia*, 2020) yielded one Confirmed SRE, *Buddelundia* sp. 56, 30 were identified as Potential.

Biologic (2022) found a total of 140 invertebrate specimens, representing 28 morphological and molecular taxa, 10 were considered to represent Potential SRE species, 17 were considered to be Widespread species. One Confirmed SRE species was collected in the Biologic (2022) survey, *Buddelundia* `56` (including *Buddelundia* `sp. SJ_56_DNA`). Four of the eight Potential SRE taxa were olpiid pseudoscorpions. Olpiidae require extensive phylogenetic review and hence it is not unusual to produce sequences without regional references. However, the habitat within which all four taxa were collected was widespread through the Survey area and it is unlikely that these taxa will be restricted in their range. The remaining four Potential SRE taxa were represented by armadillid isopods, also collected in widespread habitats and not restricted to the Survey area.

ecologia (2020) found a total of 496 invertebrate specimens across both phases of their SRE invertebrate fauna survey program from seven target SRE groups including 152 isopods, 129 spiders, one harvestman, 75 pseudoscorpions, 58 scorpions, 33 millipedes and 48 land snails. Of the specimens recorded, a single isopod species collected within the Survey area during Phase 2 was considered an SRE species. Another 23 species were considered Potential SRE species including eight isopods, one spider, one harvestman, five pseudoscorpions, one millipede and one terrestrial snail.

Spectrum (2022) collected a total of 226 invertebrate specimens, representing 31 taxa from the Survey area. Of these 22 were considered to represent Potential SRE species, and nine were considered to be Widespread. One species was considered to represent an SRE, this being *Buddelundia* `sp. SJ_56_DNA. Four of the 22 Potential SRE taxa recorded were olpiid pseudoscorpions. As previously discussed, Olpiidae require extensive phylogenetic review. However, the Drainage Line habitat within which all four taxa were collected is widespread throughout the Survey area and it is unlikely that these taxa will be restricted in range. The remaining Potential SRE taxa were represented by various groups that were collected widely, in widespread habitats through the Mulga Downs locality.

Twenty nine SRE species identified as Potential SRE were found to occur within the Proposal area by *ecologia* (2021b), Biologic (2022) and Spectrum (2022). These species were most often collected within Drainage Line habitats but were also collected in Rocky Plains and Footslopes, Rocky Hills, Drainage Area/Floodplain, Mulga Woodlands, and Snakewood habitats. The confirmed SRE species *Buddelundia* 56 was identified in Drainage Line habitat within the Proposal area.



Abbreviations

ALA	Atlas of Living Australia
ARU	Acoustic Recording Units
BAM Act	Biosecurity Agriculture Management Act 2007
BC Act	Biodiversity Conservation Act 2016
ВоМ	Bureau of Meteorology
САМВА	China-Australia Migratory Bird Agreement
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEWHA	Department of Environment, Water, Heritage and Arts
DIWA	Directory of Important Wetlands in Australia
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DSEWPaC	Department of Sustainability, Water, Population, and Communities
DSO	Direct Ship Ore
DPaW	Department of Parks and Wildlife
EIA	Environmental Impact Assessment
EN	Endangered
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
HPPL	Handcock Prospecting Pty Ltd
IBRA	Interim Biogeographic Regionalisation of Australia
JAMBA	Japan-Australia Migratory Bird Agreement
MNES	Matter of National Environmental Significance
MDIOM	Mulga Downs Iron Ore Mine
MDIOP	Mulga Downs Iron Ore Project
NVIS	National Vegetation Information System



Р	Priority
PEC	Priority Ecological Community
PRI	Pilbara Regional Inventory
RHI	Roy Hill Infrastructure Pty Ltd
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SRE	Short-range Endemic
Т	Threatened
TEC	Threatened Ecological Community
TSSC	Threatened Species Scientific Committee
VU	Vulnerable
WA	Western Australia
WAM	Western Australian Museum

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1.0 Introduction

1.1 Background

Hancock Prospecting Pty Ltd (HPPL) is developing the Mulga Downs Iron Ore Project (MDIOP) which is located approximately 210 km south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia. The MDIOP comprises two-three standalone projects:

- Mulga Downs Iron Ore Mine (MDIOM) including Murray's Hill Project;
- Mulga Downs Hub and Rail Spur; and
- Murray's Hill above water table direct ship ore (DSO).

To facilitate the transportation of ore from the MDIOP and other third party iron ore mines in the region to Port Headland, Roy Hill Infrastructure Pty Ltd (RHI) are proposing to develop the Mulga Downs Hub and Rail Spur (the Proposal) which will connect the Proposal and MDIOM to RHI existing rail infrastructure located to the north-east. There are currently two rail spur options under consideration (i.e., Option 1B and Option 8B), however only one of the two options (1B and 8B) will be constructed and operational. This report is focused on the Hub and Rail Option 8B alignment and a 1 km wide buffer area either side of the Rail alignment, referred to as the 'Proposal area' within this report.

Numerous surveys for the Proposal and MDIOM were undertaken in the Mulga Downs area since 2008 and include reconnaissance, detailed and targeted surveys. Detailed fauna surveys have been prepared for sections of the Hub and Rail corridor options by ecologia (2021a), Biologic (2022) and Spectrum (2022). These combined areas are collectively referred to as the 'Survey area' throughout this report. For some of these surveys there is an overlap between the MDIOM and the Proposal area (**Figure 1-1**). The tenements relevant to the Proposal area are listed in **Table 1-1**.

Tenement	Pastoral Station	Status	Area (ha)
E 45/2497-I	Mulga Downs	LIVE	21,162
E 45/3593-I	Mulga Downs	LIVE	7,301
E 45/4231-I	Mulga Downs	LIVE	3,810
E 45/4501-I	Mulga Downs	LIVE	2,859
E 45/4389-I	Mulga Downs	LIVE	1,589
E 45/4417-I	Mulga Downs	LIVE	2,540
E 45/4990	Mulga Downs	LIVE	12,381
E 45/5940	Mulga Downs	PENDING	23,178
E 45/6072	Mulga Downs	PENDING	636
E 45/6133	Mulga Downs	PENDING	11,445
E 47/2044-I	Mulga Downs	LIVE	6,983
L 1SA	Mulga Downs	LIVE	43,735

Table 1-1 Description of the Hub & Rail Option 8B Tenements

Tenement	Pastoral Station	Status	Area (ha)
L 45/340	Mulga Downs	LIVE	604
L 45/383	Mulga Downs	LIVE	1,092
L 45/380	Mulga Downs	LIVE	1,786
L 45/381	Mulga Downs	PENDING	1,978
L 45/382	Mulga Downs	PENDING	811
L 45/457	Mulga Downs	LIVE	363
L 45/384	Mulga Downs	LIVE	397
L 45/447	Mulga Downs	PENDING	163
L 45/463	Mulga Downs	LIVE	253
L 45/513	Mulga Downs	LIVE	260
L 45/621	Mulga Downs	PENDING	816
L 4SA	Mulga Downs	LIVE	6,148
R 47/12-I	Mulga Downs	LIVE	22,187
M 45/1094-I	Mulga Downs	LIVE	940
M 47/1621	Mulga Downs	PENDING	22,183

The Proposal area is located within Mulga Downs, a pastoral station area (**Figure 1-1**), with native pasture being the dominant land use in the surrounding region. The nearest key landscape features include the Fortescue Marsh (located to the south), the Wittenoom Asbestos Management Area (WAMA) (located to the south-west) and the Karijini National Park which is located approximately 15 km to the south.



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1.2 Purpose of this Report

Since 2018, several terrestrial vertebrate and invertebrate fauna assessments have been conducted across the Survey area to characterise the terrestrial fauna values. These surveys were completed for the Mulga Downs Iron Ore Project (MDIOP) which comprises the Mulga Downs Iron Ore Mine (MDIOM) and the Mulga Downs Hub and Rail Spur. These are two separate projects which work independently of each other.

The objective of this report is to consolidate all the terrestrial fauna information collected from the terrestrial fauna surveys undertaken for the proposed Hub and Rail Spur alignment option 8B. The main fauna assessments reviewed for this report include:

- *ecologia* Environment (2021a) Mulga East Baseline Terrestrial Vertebrate Fauna Assessment. Hancock Prospecting Pty Ltd, Version 2 (Blue Diagonal Cross Hatching in Hub Component of Hub and Rail Alignment on **Figure 1-1**).
- Biologic (2022) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey. Prepared for Strategen - JBS&G on behalf of Handcock Prospecting Pty Ltd. Version 2 (Green Horizontal Line Hatching on Figure 1-1).
- Spectrum Ecology & Spatial (2022) RHIL Mulga Downs Hub and Rail Spur Eastern Portion of Alignments 8B and 1B: Basic & Targeted Terrestrial Fauna Assessment. Version 2 (Red Vertical Line Hatching on Figure 1-1).

1.3 Policy and Guidance

All the terrestrial vertebrate and SRE invertebrate assessments were undertaken in a manner consistent with the following documents developed by the EPA, the Department of Biodiversity, Conservation and Attractions (DBCA), and the Commonwealth (the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and its former departments):

- (DEWHA (2010a) Survey Guidelines for Australia's threatened bats;
- DEWHA (2010b) Survey Guidelines for Australia's threatened birds;
- DoE (2013) Significant impact guidelines 1.1: Matters of National Environmental Significance;
- DoE (2016) EPBC Act referral guideline for the endangered Northern Quoll (*Dasyurus hallucatus*);
- DPaW (2017) Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporus occidentalis*) in Western Australia;
- DSEWPaC (2011a) Survey guidelines for Australia's threatened mammals;
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles;
- EPA (2016a) Environmental Factor Guideline: Terrestrial fauna;
- EPA (2016b) Technical Guidance: Sampling of short-range endemic invertebrate fauna; and
- EPA (2020) Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment.

1.4 Background to the Protection of Fauna in Western Australia

All native fauna in Western Australia (WA) is protected at a State level under the *Biodiversity Conservation Act 2016* (BC Act) and species of conservation concern at a national level are protected under the Commonwealth *Environment Protection Biodiversity and Conservation Act 1999* (EPBC Act). Any action that has the potential to impact native fauna



requires approval by relevant State and/or Commonwealth department in accordance with the EP Act and the Commonwealth EPBC Act, respectively. Terrestrial fauna may be significant for a range of reasons, including:

- being identified as a threatened or priority species;
- being a species with restricted distribution;
- enduring a degree of historical impact from threatening processes; or
- providing an important function required to maintain the ecological integrity of a significant ecosystem (EPA, 2016a).

While all native fauna are protected under the BC Act, some species are afforded extra protection due to species decline in their distribution, abundance or loss of their habitat. These include species that are considered Threatened (T) under the EPBC Act and/or BC Act, or migratory bird species which are protected under international agreements and subsequently listed as Migratory (MI) under the EPBC Act and/or BC Act. Furthermore, any species which may be at risk but there is insufficient information to support a status allocation can be listed as Priority species by the WA DBCA. A summary of definitions and terms used to define significant species has been provided below in **Table 1-2**.

Table 1-2 Definitions and terms for significant species

ACT, AGREEMENT OR LIST	STATUS CODES	
Federal		
EPBC Act In Australia, native fauna is protected under the EPBC Act. This Act makes provisions for an independent committee (the Threatened Species Scientific Committee [TSSC]), which is charged with maintaining a list of threatened species. Threatened species are listed under one of six categories, depending on their specific conservation status. Migratory bird species are those listed under international agreements and protected under the EPBC Act as a Matter of National Environmental Significance (MNES). Relevant international agreements include the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).	Extinct: • EX – Extinct • EW – Extinct in the Wild Threatened: • CR – Critically Endangered • EN – Endangered • VU – Vulnerable • CD – Conservation Dependent Other • MI – Migratory • MA - Marine	
State		
BC Act In WA, native fauna is protected under the BC Act. Species in special need of protection are listed as being Extinct, Threatened or Specially Protected. Within these groups, species are listed under one of eight categories, depending on their specific conservation status. Migratory bird species are those listed under the Bonn Convention and/or CAMBA, JAMBA and ROKAMBA agreements.	Extinct: • EX – Extinct Threatened: • CR – Critically Endangered • EN – Endangered • VU – Vulnerable • CD – Conservation Dependent Other • MI – Migratory • CD – Conservation Dependent	



ACT, AGREEMENT OR LIST	STATUS CODES
	 OS – Other specially protected fauna
DBCA Priority List	Poorly Known:
The DBCA maintains a list of Priority species that are considered to be possibly	 P1 – Priority 1 P2 – Priority 2
threatened but have not been assigned statutory protection under the BC Act, as not enough information is available for an accurate determination of conservation	• P3 – Priority 3
status. These species are generally in urgent need of survey to determine their	Rare, Near Threatened and
distribution and abundance.	Other Species in need of
	 P4 – Priority 4

For the purposes of this assessment, species considered to be of conservation significance are those that are afforded protection under the EPBC Act, BC Act or listed as Priority species by DBCA.

1.5 Short-range Endemic (SRE) Invertebrates

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national, or local scale (Allen *et al.*, 2002). Endemism at a local scale is referred to as short-range endemism (Harvey, 2002). Short-range endemism of a species is influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions and historical conditions which not only influence the distribution of a species, but also the tendency for differentiation and speciation (Ponder & Colgan, 2002).

Harvey (2002) proposed a range criterion for terrestrial short-range endemic invertebrate species (SREs) at less than 10,000 km² (or 100 km x 100 km), which has been adopted by regulatory authorities in Western Australia (EPA, 2016b). SRE species often share similar biological, behavioral and life history characteristics that influence their restricted distributions and limit their wider dispersal (Harvey, 2002). For example, burrowing taxa such as mygalomorph spiders and Urodacus scorpions may only leave their burrows (or a narrow home territory near the burrow) as juveniles during dispersal from the maternal burrow, or when males search for a mate (Rix *et al.*, 2017). Taxa such as terrestrial isopods, millipedes and snails are dispersal-limited because of their slow movement and cryptic habitat (Car *et al.*, 2019), while other taxa may be limited by highly specific habitat requirements, such as selenopid spiders within fractured rocky outcrops (Crews, 2013).

Several invertebrate taxonomic groups are currently understood to have a high proportion of species with restricted ranges and as such are given additional consideration in fauna assessments. The EPA considers the existence of SRE invertebrate fauna to be a significant biodiversity issue and that SRE fauna "may be at a greater risk of changes in conservation status as a result of habitat loss or other threatening processes" (EPA, 2016b). In the Pilbara and nearby regions of Western Australia, invertebrate groups with many known SRE species that are targeted during SRE invertebrate fauna surveys include mygalomorph spiders (Castalanelli *et al.*, 2014), selenopid spiders (Crews, 2013), scorpions (Volschenk *et al.*, 2010), pseudoscorpions (Harvey *et al.*, 2016), millipedes (Car *et al.*, 2019), land snails (Johnson *et al.*, 2004), and terrestrial isopods (Wilson & Keable, 2002). As taxonomic knowledge of Pilbara invertebrates increases many more groups may be found to include SRE fauna.

Most SRE invertebrate species and communities are not currently listed under state or federal legislation, due largely to incomplete taxonomic and ecological knowledge. As such, the assessment of conservation significance for SRE invertebrates is guided primarily by advice provided by the Western Australian Museum (WAM) and other taxonomic experts, and under technical guidance from the EPA (2016b).



1.5.1 SRE Categorization

The SRE categorization used in this report follows the WAM's revised classification system for SREs, based upon the 10,000 km² range criterion proposed by Harvey (2002). It uses three categories (Confirmed SRE, Potential SRE, and Widespread) to describe the degree of certainty with which a species can be considered to be SRE or not (**Table 1-3**). This categorization has been used consistently in all previous reports prepared for the Survey area.

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
Species range <10,000 km²	 Confirmed SRE A known distribution of <10,000 km² The taxonomy is well known The group is well represented in collections and/or has been comprehensively sampled 	 Potential SRE Patchy sampling has resulted in incomplete knowledge of geographic distribution
Species range >10,000 km²	 Widespread A known distribution of >10,000 km² The taxonomy is well known The group is well represented in collections and/or has been comprehensively sampled 	 Incomplete taxonomic knowledge The group is not well represented in collections Any other significant knowledge gaps occur.

 Table 1-3
 SRE categorization used by WAM, adapted from Harvey (2002)

Confirmed SRE species are those for which sufficient evidence exists, from both taxonomic certainty and extent of sampling, to confirm that the species is restricted to a range of less than 10,000 km², whereas Widespread species are confirmed to have a range greater than 10,000 km². For taxa belonging to groups known to include SRE species, unless sufficient evidence exists to denote Confirmed SRE or Widespread status, the default categorization is Potential SRE. This is usually due to lack of taxonomic knowledge and extent of sampling.

For the purposes of this consolidated report, only Confirmed and Potential SRE taxa are discussed.



2.0 Existing Environment

2.1 Biogeography

The Proposal area occurs entirely within the Pilbara bioregion as defined by the Interim Biogeographic Regionalization of Australia (IBRA). Within the Pilbara region, the Proposal area intersects two subregions; Chichester and Fortescue Plains (**Figure 2-2**); which are described further in **Table 2-1**. The majority of the Proposal area is located within the Chichester subregion.

Table 2-1 IBRA bioregion and subregions of the Survey area

Bioregion	Subregion	Area (ha) in Proposal area
Pilbara Characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges	Chichester (PIL1) Comprises the northern section of the Pilbara Craton (Kendrick & McKenzie, 2001). Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. The basalt plains host a shrub steppe characterised by <i>Acacia</i> <i>inaequilatera</i> over <i>Triodia</i> spp. hummock grasslands, while <i>Eucalyptus</i> <i>leucophloia</i> tree steppes occur on ranges. The Chichester subregion drains to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock).	8,949
gorges (Thackway & Cresswell, 1995). Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin, 2008).	Fortescue Plains (PIL2) Characterised by alluvial plains and river frontage. The Fortescue Plains contains extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains, and river gum woodlands fringing major drainage lines (Kendrick, 2001). The significant and dominant feature of this subregion is the Fortescue Marsh. This drainage feature, 100 km long, is effectively the terminus of the upper Fortescue River (EPA, 2013). The lower Fortescue River arises from streams draining the Chichester and Hamersley Ranges below the Marsh and west of the Goodiadarrie Hills.	4,844
TOTAL		13,794

2.2 Climate

The Proposal area is located in the Pilbara region of WA and experiences an arid-tropical climate with two distinct seasons: a hot summer from October to April and a mild winter from May to September. Temperatures are generally high, with summer temperatures frequently exceeding 40°C. Light frosts occasionally occur inland during the winter months of July and August.

Rainfall is generally localized, variable and unpredictable, and temperatures are high, resulting in annual evaporation exceeding rainfall by as much as 500 mm per year. Most of the Pilbara has a bimodal rainfall distribution; from December to March rains result from tropical storms producing isolated, sporadic thunderstorms. Tropical cyclones moving south also bring heavy rains. From May to June, extensive cold fronts move eastwards across the state and



occasionally reach the Pilbara. These fronts usually produce only light rains. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses generally flow intermittently due to the short wet season (Beard 1975a).

Climate data is collected by the Bureau of Meteorology and long-term rainfall data is available from the Mulga Downs weather station (Station Number 5015) (Bureau of Meteorology, 2020); however, this station did not provide temperature data and ceased recording rainfall in June 2018. Mean maximum and minimum temperature data was taken from the nearest weather station at Wittenoom (Station number 5026) and 2018-2021 rainfall data was taken from the nearest weather station at Karijini North (Station Number 5098) (Bureau of Meteorology 2020). These stations are located approximately 10 km south-west and 12 km south from the Survey area, respectively. A summary of mean rainfall, mean maximum and minimum temperatures has been provided in **Figure 2-1**.



Figure 2-1 Climate data for the region surrounding the Proposal area

2.3 Geology

The Proposal area occurs across five broad (1:500,000) geographic units (DMIRS, 2021), which have been summarized in **Table 2-2** and shown on **Figure 2-3**.



Geological Unit	Description (DMIRS, 2021)	Area in Proposal area
Sheetwash unit, PIP (W-PIP)	Clay, silt and sand in distal sheetwash fan and slope deposits; local ferruginous pisoliths and gravel.	1,563
Exposed unit, PIP (X-PIP)	Exposed bedrock.	8,637
Residual or relict unit, PIP (Rr-fh- PIP, Rr-kc-PIP, Rt- PIP)	Hematitic duricrust, massive to rubbly; includes iron-cemented reworked products. Calcrete, nodular to massive; includes calcite and reworked carbonate products. Transported duricrust; cemented sand, gravel, cobbles, and boulders in alluvial/ colluvial deposits	1,189
Alluvial/fluvial unit, PIP (A-PIP, Ac-PIP)	Clay, silt, sand, and gravel in fluvial channels, in channels and on floodplains.	1,019
Colluvial unit, PIP (C-PIP)	Colluvium derived from different rock types; includes gravel, sand, silt and clay.	1,386
Total		13,794

Table 2-2 Geology Units within the Survey area (DMIRS, 2021)





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Hub and Rail Spur Broad geology of the survey area (Option 8B) Figure 2-3

Highway/Road - Watercourse 8B Option Hub & Rail Spur



2.4 Land Systems

The Department of Agriculture Western Australia (van Vreeswyk *et al.*, 2004) undertook a regional inventory of the Pilbara rangelands to document the land systems present and their condition. The Pilbara Regional Inventory (PRI) which covers 181,723 km² is bounded by the Indian Ocean and Roebourne Plains to the north and west, extending to Broome in the north-east and the Ashburton River catchment in the south. A total of 11 land systems occur within the Hub and Option 8B alignment, the extent of which is shown on **Figure 2-4**Error! Reference source not found.. A description of these land systems is provided in **Table 2-3**Error! Reference source not found..



Table 2-3 Land Systems within the Survey area (Van Vreeswyk, et al. 2004)

Land System	Geomorphology	Land Management	Area (ha) in Proposal area
Bonney Land System	Erosional surfaces; low hills, undulating rises and gently undulating stony plains; widely spaced tributary drainage patterns of narrow drainage floors with minor channels. Relief up to 30 m.	Young soft spinifex vegetation is moderately attractive to grazing animals but is not generally prone to grazing induced degradation or erosion. Spinifex is high flammable and fires occur fairly regularly.	61
Jamindie Land System	Depositional surfaces; non-saline plains with hardpan at shallow depth and groved vegetation, stony upper plains and low rises on hardpan or rock, very widely spaced tributary drainage tracts and channels; minor stony gilgai plains, sandy banks and low ridges and hills. Relief up to 30 m.	Most vegetation is only moderately preferred by grazing animals but can become degraded by overgrazing. Drainage tracts (unit 6) are moderately susceptible to erosion, some hardpan plains (unit 3) are slightly susceptible and other parts are inherently resistant.	1,821
Newman land System	Erosional surfaces; plateaux and mountains - extensive high plateaux, mountains and strike ridges with vertical escarpments and steep scree slopes and more gently inclined lower slopes; moderately spaced dendritic and rectangular tributary drainage patterns of narrow valleys and gorges with narrow drainage floors and channels. Relief up to 450 m.	Much of the system is inaccessible or poorly accessible and is unsuitable for pastoral purposes. The system contains iron ore deposits which are currently being mined and deposits which are likely to be mined in the future. Spinifex is the dominant vegetation and the system is burnt fairly frequently.	995
Boolgeeda Land System	Predominantly depositional surfaces; very gently inclined stony slopes and plains below hill systems becoming almost level further downslope; closely spaced, dendritic and sub-parallel drainage lines. Relief up to about 20 m.	Hard spinifex grasslands are not preferred by livestock but soft spinifex is moderately preferred for a few years following fire. Vegetation is generally not prone to degradation and the system is not susceptible to erosion. The system is subject to fairly frequent burning.	1,745



Land System	Geomorphology	Land Management	Area (ha) in Proposal area
McKay Land System	Erosional surfaces; hill tracts, ridges, plateaux remnants and breakaways with steep upper slopes and more gently inclined lower footslopes, restricted stony plains and interfluves; moderately spaced tributary drainage patterns incised in narrow valleys in upper parts becoming broader and more widely spaced downstream. Relief up to 100 m.	This system supports predominantly hard spinifex vegetation and is not preferred by livestock. Some areas are poorly accessible and the system is not prone to degradation or soil erosion.	2,895
Wona Land System	Mainly erosional surfaces; basalt uplands and subdued plateaux with gently sloping stony gilgai plains, minor basalt hills and benched slopes; sparse patterns of incised drainage with narrow valleys and steep stony slopes. Relief up to about 30 m.	The system supports tussock grasses and annual grasses and forbs which are highly preferred by livestock and kangaroos. Tussock grasslands degrade to annual grasslands/herbfields if stocking is uncontrolled. The system is not susceptible to erosion except if the stony mantle is removed such as along tracks on sloping plains.	1,465
Rocklea Land System	Erosional surfaces; hills, ridges and plateaux remnants on basalt with steep stony slopes, restricted lower slopes, stony interfluves and minor gilgai plains; moderately spaced tributary drainage patterns of small channels in shallow valleys in upper parts becoming broader floors and channels downslope. Relief up to 110 m.	Spinifex hummock grasslands are poorly accessible and are generally not preferred by livestock. The system is subject to fairly regular burning. The system has very low erosion hazard.	1,973
Granitic Land System	Erosional surfaces; hill tracts and domes on granitic rocks with rough crests, associated rocky hill slopes, restricted lower stony plains; narrow, widely spaced tributary drainage floors and channels. Relief up to 100 m.	Much of the system is poorly accessible; hard spinifex vegetation is not preferred by livestock, soft spinifex is moderately preferred. The system is subject to fairly frequent burning and is not susceptible to erosion.	950



Land System	Geomorphology	Land Management	Area (ha) in Proposal area
Macroy Land System	Erosional surfaces; gently undulating stony plains and interfluves with quartz surface mantles, sandy surfaced plains, minor calcrete plains, closely spaced tributary drainage lines in upper parts of system becoming much wider downslope; minor granite hills, tor fields and quartz ridges. Relief is up to 25 m.	Mature spinifex vegetation is not preferred by grazing animals but younger stands after burning are moderately preferred. Vegetation is generally not prone to grazing induced changes but fairly regular fires change botanical composition and vegetation structure in the short term. The system has low or very low erosion hazard.	1,474
River Land System	Flood plains and river terraces subject to fairly regular overbank flooding from major channels and watercourses, sandy banks and poorly defined levees and cobble plains. Banks, levees and slightly higher upper terraces receive less regular flooding than lower terraces and flood plains.	Buffel grass and soft spinifex on this system are highly and moderately preferred respectively by livestock. The system is largely stabilised by buffel and spinifex and accelerated erosion is uncommon. However, susceptibility to erosion is high or very high if vegetative cover is removed.	92
White Springs Land System	Mostly depositional surfaces; residual plains with a mosaic of stony non-gilgaied and stony gilgaied surfaces, minor gilgai plains without stone mantles, low rises and short slopes on outer margins of the system. Drainage is internal or as short, dendritic, tributary patterns confined to the outer margins of the system. Relief up to 10 m.	Tussock grasslands on gilgai plains (unit 2) are preferentially grazed by livestock and other animals, and are prone to degrade if stocking is uncontrolled. Hard spinifex may tend to invade degraded tussock grass sites. The system is generally not susceptible to erosion.	323
TOTAL			13,794



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2.5 Soils

Tille (2006) described the soil landscapes of Western Australia's arid rangelands and interior at a broad scale. The Atlas of Australian Soils (Northcote *et al.*, 1960-1968) describes soil units on a finer scale and seven soils units have been identified within the Proposal area, none of which are considered to be restricted. These soil units have been described in greater detail in **Table 2-4** and shown on **Figure 2-5**.

Soil Unit	Description	Area (ha) in Proposal area
Oc63	Pediplains on granite; more dissected than unit Oc62 and usually occurring as a zone flanking the mainstream courses: chief soils are hard alkaline red soils (Dr2.33) and (Dr2.43). There are more areas of (Um5.11) soils on calcrete (kunkar) than in unit Oc62 and some (Uc5.11) and (Uc1.22) soils occur along creeks.	2,145
Gf1	Steep ranges on basic lavas along with dolomites, tuff, banded iron formations, and dolerite dykes, with some narrow valley plains and high-level gently undulating areas of limited extent. The soils are generally shallow and stony and there are large areas without soil cover: chief soils are brown loams (Um6.23) along with significant areas of earthy loams (Um5.51). (Dr2.33) soils occur on lower slopes, with (Uf6.71) and (Ug5.37) on valley floors.	4,644
Oc64	Low stony hills and dissected pediments on granite with occasional basic dykes: the chief soils are hard alkaline red soils (Dr2.33) having shallow stony A horizons. Associated are shallow stony (Uc5.11) soils on steep slopes, (Uc1.22) soils along creek lines, and (Um5.11) soils on patches of calcrete (kunkar).	992
Ja1	Extensive valley plains largely associated with the Fortescue River: chief soils are earthy clays (Uf6.71) along with some (Ug5.38), (Um5.5), and (Dr2.33) soils. Small areas of calcrete (kunkar) with (Um5.11) soils occur also.	1,725
Oc62	Very gently undulating pediplain with low granite outcrops and tors; occasional basic dykes occur as low elongate ridges: chief soils are hard alkaline red soils (Dr2.33) and (Dr2.43) having coarse-textured A horizons up to 18 in. thick. Associated are occasional patches of calcrete (kunkar) with (Um5.11) soils as well as some (Gn2.12) soils.	293
Oc70	Dissected pediments and low stony hills associated with cherts, jaspilites, and iron ore formations; much coarse surface gravel: chief soils are hard alkaline red soils (Dr2 33) along with some (Dr2.32) and (Um5.52) soils.	2,962
MM19	High-level gently undulating plain flanked by areas of basaltic ranges of unit Gfl: chief soils are cracking clays (Ug5.37). Areas of (Uf6.71) and (Dr2.33) soils occur also.	1,033
TOTAL		13,794

Table 2-4	Soil units within the Proposa	l area (Northcote <i>et al</i> .,	1960-1968)
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2.6 Pre-European Vegetation

The major structural vegetation types of WA were broadly (1:1,000,000) mapped by Beard (1975b), before being reinterpreted by Shepherd *et al.*, (2002) who updated the vegetation association mapping to reflect the National Vegetation Information System (NVIS) standards (ESCAVI, 2003) and account for extensive clearing since Beard's original mapping.

Five pre-European vegetation associations have been mapped as occurring within the Proposal area. Descriptions of these communities have been provided below in **Table 2-5** and they have been shown in **Figure 2-6**.

Vegetation Association	Description	Area (ha) in Pilbara Bioregion	Area (ha) in Proposal area	% of Broad Vegetation Type of Pilbara Bioregion in Proposal area
29	Structure: Low woodland, open low woodland or sparse woodland. Flora: Annual grasses <i>Enneapogon</i> spp. <i>Aristida</i> spp. etc on dry plains and saltwater grasses <i>Sporobolus virginicus</i> on the coast	7,782,264	1,901	0.02
562	Structure: Low tree-steppe. Flora: Hummock grassland with scattered bloodwoods & snappy gum <i>Triodia</i> spp., <i>Corymbia dichromophloia</i> and <i>Eucalyptus leucophloia</i>	112,469	3,085	2.74
175	Structure: Grasslands, short bunch-grass savanna. Flora: Annual grasses <i>Enneapogon</i> spp. <i>Aristida</i> spp. etc on dry plains and saltwater grasses <i>Sporobolus virginicus</i> on the coast	558,002	989	0.18
173	Structure: Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee <i>Triodia</i> spp. <i>Acacia</i> spp., <i>Grevillea</i> spp. <i>Eucalyptus</i> spp	1,856,728	4,722	0.25
93	Grevillea pyramidalis, Hakea lorea, Senna sp., Grevillea wickhamii sparse shrubland	3,376,354	3,097	0.09
TOTAL			13,794	

Table 2-5 Vegetation associations within the Proposal area



2.7 Threatened and Priority Ecological Communities

While no Threatened Ecological Communities (TEC) were identified, one PEC has been mapped within the Proposal area, namely; the Four plant assemblages of the Wona Land System (previously 'Cracking clays of the Chichester and Mungaroona Range') (P1 PEC) (**Figure 2-6**). This PEC is a stony gibber community occurring on the tablelands. It lacks shrubs and has very little vegetative cover during the dry season. During the wet season an array of ephemerals/annuals and short-lived perennials had emerged, many of which are poorly known and range-end taxa (DBCA, 2021b).

Another PEC, the Freshwater claypans of the Fortescue Valley (P1 PEC), occurs approximately 10 km to the south of the Survey area. It should be noted that this PEC has a buffer applied to it by (DBCA, 2021a). It is located downstream of the Fortescue Marsh – Goodiadarrie Hills on Mulga Downs Station and is considered important for waterbirds and invertebrates (DBCA, 2021b). It is outside of the Proposal area.

2.8 Ground and Surface Water Values

The Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool and the DBCA managed lands and waters database were queried for Ramsar Wetlands, Nationally Important Wetlands, and DBCA managed waters occurring near the Survey area. No Ramsar wetlands occur near the Survey area.

The Fortescue Marsh (WA066), which is a Nationally Important Wetland, is defined by the DBCA's Draft Fortescue Marsh Management Strategy 2018-2024 and located to the south-east of the Survey area. A section of the lower Fortescue River forms part of the Directory of Important Wetlands in Australia (DIWA) and continues through the MDIOM tenement areas, however it does not lie within the Proposal area (**Figure 2-7**).

The Proposed Hub is located above the Fortescue River Valley (**Figure 2-7**). The Priority 1 PEC Freshwater Claypans of the Fortescue occur within this stretch of the Fortescue Valley, outside of the Proposal area. These wetlands have very diverse aquatic invertebrate communities and most of the restricted elements of the Pilbara riparian flora (Pinder *et al.*, 2017).

Aerial imagery was also inspected for any groundwater and surface water values (i.e., wetlands) within the Survey area. Excluding bores and watering points for cattle, no permanent water bodies have been identified as persisting within the Survey area. Similarly, no wetlands have been mapped or identified within the Survey area.



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Hub and Rail Spur Priority Ecological Communities Figure 2-7

- Highway/Road
- Watercourse

Nationall Important Wetlands - Fortescue Valley (DWIA WA066)

Threatened Ecological

Communities (DBCA-038)

- Priority
- Threatened

8B Option

Hub & Rail Spur



3.0 Implemented Methodologies

3.1 Desktop Assessment

The methodologies adopted for the previously prepared fauna assessments were consistent with EPA guidance (EPA, 2020). A review of all available survey reports within the vicinity of the Survey area was undertaken as part of the design of the surveys (**Section 3.1.2**). Additionally, searches of mapping resources and databases (**Table 3-1**) to identify conservation significant species recorded within, or in the vicinity of the Survey area, were also completed. All results were reviewed based on the likelihood of relevant conservation significant species occurring within the Survey area. In this assessment, consideration was given to the proximity of previous records, habitats present, habitat condition, species habitat requirements, and landforms.

Table 3-1	Databases review	ed as part of	f desktop assessment
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Database	Search Details
EPBC Act Protected Matters Database	Records of MNES under the EPBC Act within 40 km of the Survey area
DBCA Threatened and Priority Fauna Database	Records of significant fauna species within 40 km of the Survey area
DBCA NatureMap	All fauna records within 40 km of the Survey area
BirdLife Birdata	Bird records within 40 km of the Survey area
Atlas of Living Australia	All fauna within 40 km of the Survey area

3.1.1 Likelihood of Occurrence Criteria

Conservation significant fauna species identified as occurring within 40 km of the Survey area were assigned a likelihood of occurrence rating according to the criteria in Error! Not a valid bookmark self-reference.. For relevant species, the likelihood of occurrence was determined by investigating the following:

- Fauna habitats likely to exist within the Survey area based on the desktop study;
- Distance of previously recorded conservation significant species based on publicly available records;
- Frequency of occurrence of conservation significant species records; and
- Time passed since conservation significant species were recorded.

Table 3-2 Criteria used to assess the likelihood of occurrence for significant fauna species

Rating	Criterion
Recorded	The species has been recorded within the Survey area previously or during the current survey
Likely	The species may occur within the Survey area as suitable habitat is known to be present and there are existing records within 10 km of the Survey area



Rating	Criterion
Possible	The species may occur within the Survey area as there are existing records in the vicinity of the Survey area, and suitable habitat is likely to be present, OR the species may occur within the Survey area as there is insufficient information available to exclude the possibility of occurrence.
Unlikely	The species is unlikely to occur within the Survey area as suitable habitat is not present or is not likely to be present, OR suitable habitat is present within the Survey area, but the taxon/community has not been recorded despite reasonable survey effort

3.1.2 Literature Review

A review was undertaken of the desktop searches from the three terrestrial fauna reports covering the Survey area. Included were reviews of the results of other ecological assessments from the Survey area or within 40 km. A total of 19 terrestrial vertebrate studies and five targeted SRE invertebrate studies were reviewed, comprising detailed (formerly Level 2) and basic (formerly Level 1) surveys of which several had a targeted survey component. A summary of literature sources reviewed is provided in **Table 3-3**.

Table 3-3	Literature sources	reviewed as	part of the	overall desktop	o assessment
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Database	Survey Type
Vertebrate Fauna	
Bell <i>et al.</i> (2014). Winter bird assemblages of the Fortescue Marshes and surrounding vegetation, Pilbara Region, Western Australia.	Targeted
Biota, 2004. Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor. Fortescue Metals Group.	Detailed
Coffey (2008) Level 2 terrestrial vertebrate fauna assessment for the Solomon Project.	Detailed
Coffey (2010) Level 1 vertebrate fauna assessment - Solomon Rail Project	Basic
Coffey (2011) Targeted surveys - Northern Quolls, Mulgara and Pilbara Olive Pythons. Solomon Rail Project.	Targeted
ecologia (2009). Brockman Resources Ltd Marillana Iron Ore Porject Vertebrate Fauna Assessment	Detailed
ecologia (2009). Murray's Hill level 1 fauna survey.	Detailed
ecologia (2010). Solomon Project: Kings Area vertebrate fauna assessment.	Detailed
ecologia (2011). Brockman Resources Limited Rail Proposal Area Level 2 vertebrate Fauna Survey	Detailed
<i>ecologia</i> (2014). Investigator Project terrestrial vertebrate fauna assessment. Unpublished report for Fortescue Metals Group	Detailed
<i>ecologia</i> (2019). Mulga East Level 1, Level 2 terrestrial fauna survey and targeted conservation significant fauna surveys.	Detailed & Targeted
<i>ecologia</i> (2020). Mulga East baseline terrestrial fauna assessment. Unpublished report for Fortescue Metals Group.	Detailed & Targeted


Database	Survey Type				
Ecoscape (2010a). Solomon Project - Rail camp sites 1, 2 and 3, fauna assessment.	Basic & Targeted				
Ecoscape (2010b). Solomon Project - Rail realignment fauna assessment.	Basic & Targeted				
Ecoscape (2010c). Vertebrate fauna and fauna habitat assessment for the Firetail Project.	Detailed				
ENV Australia (2012). Christmas Creek Terrestrial Vertebrate Fauna and Fauna Habitat Assessment. Unpublished report for Fortescue Metals Group.	Detailed				
Terrestrial Ecosystems (2013). Level 2 fauna assessment for the Mulga Downs Survey area. Unpublished Report prepared for Hancock Prospecting Pty Ltd (HPPL).	Detailed & Targeted				
Thompson et al. (2010). Spatial and temporal variations in the trapped terrestrial vertebrate fauna of the Hamersley Range, Western Australia.	Detailed				
Trainor et al. (2016). New bird records from the Fortescue Marsh and nearby claypans, Pilbara bioregion, Western Australia.	Targeted				
SRE Invertebrate Fauna					
ecologia (2009b) Murray Hills short range endemic pilot survey.	Detailed				
ecologia (2020a) Mulga East baseline terrestrial fauna assessment.	Detailed				
ecologia (2020b) Mulga East short-range endemic invertebrate fauna assessment.	Detailed				
Phoenix (2010) Short-range endemic invertebrate fauna survey at Murray's Hill Transport Corridor final report.	Detailed				
Wilson and Harvey (2020) Molecular identification of terrestrial arthropods from Mulga Downs Station, Western Australia	N/A				

3.2 Survey Timeframes

The fauna assessments included in this consolidated fauna report include both basic and detailed surveys, conducted between October 2018 and March 2022. A summary of the individual surveys is provided in **Table 3-4**. The detailed surveys were conducted in Autumn following the period of maximum rainfall for the Pilbara region as per the EPA technical guidance (EPA, 2016a and 2020). All survey methods employed were undertaken in accordance with EPA guidelines (EPA, 2016a; 2020).

Table 3-4 Timeframes and types of surveys conducted within the Survey area

Document	Survey Level	Survey Timing		
	Level 1 – Fauna habitat assessment	8-12 Oct 2018		
	Phase 1 – Level 2 Vertebrate fauna survey	4-16 Apr 2019		
ecologia, 2021a	Phase 1 – Targeted conservation significant fauna survey	22-30 Jul 2019		
	Targeted Pilbara Leaf-nosed Bat Survey	25-2 Dec 2019		
	Long-term Pilbara Leaf-nosed Bat Survey	Dec 2019 - Mar 2020		



Document	Survey Level	Survey Timing	
	Phase 2 – Level 2 vertebrate fauna assessment	14-27 Apr 2020	
	Phase 2 – Targeted conservation significant fauna survey	29-6 Jul 2020	
	Targeted Pilbara Leaf-nosed Bat Survey	5-9 Oct 2020	
D: / : 2022	Dry Season (Basic) Survey	5-10 Nov 2021	
Blologic, 2022	Wet Season (Detailed) Survey	15-25 Mar 2022	
	Dry Season (Basic) Survey	15-19 Nov 2021	
Spectrum, 2022	Wet Season (Detailed) Survey	9-14 Mar 2022	
	Wet Season (Detailed) Survey	26 – 29 April 2022	

3.2.1 Level 1 (Basic) Fauna Habitat Assessments

Basic fauna habitat assessment was conducted throughout the Survey area to broadly describe areas of habitat that were distinguishable by vegetation, soil characteristics and land features. The identified habitats were considered to likely host different fauna assemblages to those found in adjoining habitat types. The habitat assessment of the Survey area paid particular attention to the likelihood that conservation significant fauna may be present in particular habitat types. Extensive ground truthing of habitat types during subsequent surveys allowed fauna habitat mapping within the Survey area to be further refined.

3.2.2 Level 2 (Detailed) Terrestrial Vertebrate Fauna Assessments

As previously described, habitat mapping based on the results of the basic surveys identified the presence of 12 distinct fauna habitat types occurring within the survey area (**Section 4.2.1**). Trapping sites were established within the most widespread of the fauna habitats present within the Survey area. The remaining habitat types were either too sparse, too difficult to access or too at risk from severe environmental conditions (i.e., flooding), making them unsuitable trapping locations. Where sites were established within areas with hard substrates that prevented the installation of pitfall traps, a combination of funnel traps, Elliott traps, cage traps and drift fences were used instead. This survey design and effort is considered to be comparable to that of a pitfall trap line (EPA 2016a; 2020).

3.3 Vertebrate Survey Methodologies

Numerous survey methodologies were implemented by *ecologia* (2021a), Biologic (2022) and Spectrum (2022) to sample the available fauna assemblages present within the Survey area. These methods are detailed below.

3.3.1 Systematic Trapping

Systematic trapping involved a variety of trapping methods established across each Systematic Trapping Site including:

• **Pitfall Traps:** 20 L bucket and/or 50 cm x 15 cm diameter PVC pipe traps. Each site was designed to have multiple trap lines established along drift fence with a total of 10 bucket or PVC pipe traps installed. Bucket and or PVC



traps were interchanged with additional Funnel traps at sites where installation was not possible (i.e. too rocky). Drift fences were 7.5 m long and were places approximately 10-20 m apart.

- **Funnel Traps:** Funnel traps were placed at both ends of each drift fence, resulting in a total of 20 funnel traps being deployed at each systematic trapping site. All funnel traps were covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- Elliott Traps: 20 medium (Type B) Elliott style box traps were placed at each systematic trapping site. Traps were baited with a 'universal bait' (oats, peanut butter, sardines) to attract and capture smaller mammals and re-baited as necessary. All Elliott traps were covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- **Cage Traps:** Two larger wire-frame box traps were deployed at each systematic trapping site. These traps were baited with the same 'universal bait' as the Elliott traps to capture medium sized mammals. Cage traps were covered by hessian shades to reduce the likelihood of animals suffering from overheating, excess stress from being out in the open and protection from predators.

All traps were cleared within three hours of sunrise, closed during the day, and then reopened in the late afternoon to minimise potential heat stress to captured animals. All traps were removed, and holes were filled following the completion of each systematic trapping program. Systematic survey locations are shown on **Figure 3-1**.

3.3.2 Avifauna Surveys

Avifauna surveys involved 20-30 minute timed searches undertaken at each systematic trapping site by experienced ecologists. During each timed survey, the number of individuals of each species observed was recorded while actively searching similar habitat within a two-hectare area around the survey site. Avifauna surveys were conducted within three hours of dawn and dusk, which is deemed to be optimal for recording majority of bird species.

Timed avifauna surveys were conducted at each systematic trapping site between 6:30 am and 10:30 am while clearing traps. Avifauna were recorded from either direct observation, call and/or secondary evidence (e.g., nests, feathers and/or tracks). The order of site visitation was staggered to reduce arrival time bias (Lindenmayer *et al.,* 2009). Opportunistic surveys were also conducted at sites considered to potentially support a different avifauna assemblage, with a specific focus on areas containing surface water. Avifauna survey locations are shown on **Figure 3-1**.

3.3.3 Acoustic Recording Units

SongMeter ultrasonic bat recorders were deployed at several within the Survey area, including all the systematic sampling sites. At each location, Acoustic Recording Units (ARUs) were placed in or in the vicinity of areas of prospective foraging and/or roosting habitats and features most likely to be utilised by bats, such as caves and waterbodies. These ARUs have a high sampling frequency, enabling the full spectrum of bat calls to be recorded without being transformed, allowing greater accuracy and sensitivity. Bat calls were analyzed by suitability qualified ecologists to determine which species were present within the Survey area.

SongMeter acoustic recorders were also deployed at several locations within the Survey area in an effort to target the Night Parrot (*Pezoporus occidentalis*). These ARUs were deployed in potential habitat for this species, which according to DPaW (2017) includes "stands of large, old clumps of spinifex (*Triodia*), especially so if the identified area is part of a paleo-drainage system or contains healthy stands of samphire." Owing to technical issues, the recorder in one of the locations only captured five nights of data, as opposed to the recommended six. Acoustic survey locations have been shown on **Figure 3-1**.



Opportunistic observations of other species were also captured using these ARUs.

3.3.4 Nocturnal Spotlighting

Spotlighting surveys were undertaken across a portion of the Mulga Downs Rail Corridor to detect the presence of any nocturnal fauna species. Spotlighting surveys consisted of searches using head torches and, where possible, road spotting to detect fauna from movement, eye shine and other evidence of species' presence. Nocturnal survey locations are shown on **Figure 3-1**.

3.3.5 Camera Trap Sites

Individual motion sensor camera traps were deployed at numerous locations around the Survey area to survey for larger and/or cryptic species (i.e. significant and introduced species) that may not be recorded using other sampling methods. The chosen locations prioritized suitable habitat for significant fauna species. Cameras established around water features required no baiting, whereas other sites were baited with 'universal bait' in a non-reward receptacle (i.e. perforated and capped PVC pipe). Nocturnal survey locations have been shown on **Figure 3-1**.

3.3.6 Targeted Searches and Active Foraging

The following conservation significant fauna were identified as either previously recorded in the Survey area or likely to occur within the Survey area from the previous terrestrial fauna reports. Targeted searches were undertaken in an effort to confirm their presence:

- Bilby (Macrotis lagotis) Drainage lines;
- Ghost Bat (*Macroderma gigas*) Breakaways, gorge and gully habitat within the Rocky Hill areas. These areas were expected to contain potential roosting sites include caves in rocky outcrops and boulder fields;
- Night Parrot (*Pezoporus occidentalis*) Cracking clay floodplains dominated by spinifex;
- Northern Quoll (*Dasyurus hallucatus*) Rocky areas such as ranges, escarpments, mesas, gorges, breakaways, and boulder fields. Drainage lines are considered important for dispersal;
- Western Pebble-Mound Mouse (*Pseudomys chapmani*) Rocky ranges and hills where suitably sized pebbles are available for mound construction. Most common on the lower slopes of ridges vegetated with spinifex hummock grassland;
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) Gullies, rocky outcrops, and open grassland and woodland foraging habitat. Drainage lines provide potential foraging habitat;
- Pilbara Olive Python (*Liasis olivaceus*) Rocky hills (rocky outcrops, breakaways and small gorges), although it is also known to inhabit spinifex grasslands; and
- Migratory species including Common Green Shank (*Tringa nebularia*), Wood Sandpiper (*Tringa glarecola*), Rednecked Stint (*Calidris ruficollis*), Glossy Ibis (*Plegadis falcinellus*) – Drainage lines where water may pool following rainfall.

The targeted searches focused on collecting records from direct observation, secondary evidence (i.e., tracks, scats, shed skins and pebble-mounds) and/or habitat features of importance (i.e. den sites, roost caves and/or water features) likely to be utilized by these species.



Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included raking leaf litter and spoil heaps, overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence.

3.3.7 Opportunistic Records

At all times while surveying, all records pertaining to vertebrate fauna species not previously recorded during each respective survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g. burrows, scratching, diggings, tracks and/or scats) evidence.

3.4 SRE Invertebrate Sampling Methodologies

SRE invertebrate sampling was undertaken as part of the Biologic (2022) and Spectrum (2022) fauna reports within. *ecologia* (2021a) did not undertake SRE invertebrate sampling within the Survey area. Biologic undertook habitat assessment, dry pitfall trapping leaf litter searches and foraging surveys within the Mulga East sections of the Hub while Spectrum (2022) undertook habitat assessment, wet pitfall trapping, leaf litter searches and foraging surveys during their field surveys of the Rail components of the Survey area. SRE sampling locations are shown on **Figure 3-1**.

3.4.1 Site Selection

Habitats considered suitable for SRE terrestrial invertebrates in the Pilbara were targeted for the baseline SRE invertebrate fauna surveys by Biologic (2022) and Spectrum (2022), namely gorges/deep gullies, shallow/open gullies, rocky hills and ridges, and drainage lines. Sampling was also undertaken in less suitable habitat types including sandy or stony plains, and on minor rocky outcrops.

The sampling methods adopted as detailed below, were carried out in accordance with EPA (2016b) guidelines.

3.4.2 Targeted and Active Foraging

Targeted SRE foraging involved various techniques depending on the characteristics of the site including:

- Presence of rocky outcropping and loose rocks: suitably sized rocks were overturned, and rocky microhabitats (cracks, crevices, and boulders) were actively searched for rock-dwelling species.
- Presence of woody debris: larger logs and woody debris were overturned and actively searched for detritivore species.
- Presence of trees and larger vegetation: trees such as *Ficus*, *Acacia* and *Eucalyptus* species were actively searched, including underneath bark and in tree hollows.
- Presence of large *Triodia* hummocks were turned over to expose accumulated soil and litter that could be searched and / or sifted.
- Presence of burrows of mygalomorph spider and scorpion was undertaken. A leaf blower was utilised in some areas to blow away leaf litter to observe burrow lids more readily. Burrow searching was also conducted continuously while traversing the Survey area.



3.4.3 Leaf Litter and Soil Sifting

Leaf litter, humus, and soil (to approximately 15 cm below surface where possible) was placed in a sieve at each site and agitated to divide the sample into two grades (10 mm, and 3 mm). This technique was used by both Biologic (2022) and Spectrum (2022) within survey locations shown in **Figure 3-1**. The numbers of samples collected are summarized in **Table 3-9**. Each grade was thoroughly searched for target SRE species such as pseudoscorpions, millipedes, snails, and small scorpions. Up to six sifts (~ 3 L of material) were conducted at each site, providing enough leaf litter and humus was available.

3.4.4 Burrow Searching

Active searches were undertaken by *ecologia* (2021), Biologic (2022) and Spectrum (2022) in their respective sections of the Survey area. This technique targeted mygalomorph spider and scorpion burrows at SRE sites. A leaf blower was utilised in some areas to blow away leaf litter to observe burrow lids more readily. Burrow searching was also conducted continuously while traversing the Survey area.

3.4.5 Opportunistic Collections

Opportunistic collection of SRE invertebrate fauna was also undertaken by Biologic (2022) at four of their vertebrate systematic trapping sites and Spectrum (2022) at their respective vertebrate systematic sites. These samples represent the main potential SRE habitat types present in the Survey area.

Invertebrate fauna representing target groups were collected when present during the checking and clearing of the pit-traps. Some invertebrate specimens were also collected during active foraging for vertebrate fauna.

3.4.6 SRE Invertebrate Specimen Preservation and Identification

All specimens were euthanized in 100% ethanol on site. Specimen vials were put on ice as soon as possible and once returned to the lab, stored at -21°C to preserve DNA for sequencing. Specimen identification was performed in-house ecologists and taxonomists using available keys and expertise.

3.5 Consolidated Survey Effort

Considering the survey methodologies outlined in **Section 3.3** and **Section 3.4**, the following summary has been prepared to outline the consolidated survey effort undertaken as part of the *ecologia* (2021a), Biologic (2022) and Spectrum (2022) survey programs across the Survey area.

As the Northern Quoll and Pilbara Olive Python share similar habitat preferences, surveys techniques were applied to both species simultaneously. This was also the case with the Pilbara Leaf-nosed Bat the Ghost Bat, who were targeted in the same surveys.

This summary includes the following:

- Baseline vertebrate fauna survey effort (Table 3-5);
- Total survey effort for the Northern Quoll and Pilbara Olive Python (Table 3-6);
- Total survey effort for the Pilbara Leaf-nosed Bat and Ghost Bat (Table 3-7);
- Total survey effort for the Night Parrot (**Table 3-8**); and



• Total survey effort for SRE invertebrate species (Table 3-9).

Spectrum (2022) focused their terrestrial fauna surveys on the 1B and 8B Options while the survey efforts undertaken by *ecologia* (2021a) and Biologic (2022) were focused on the Mulga East tenement and the transport corridor, addressing the Hub components of the Survey area.





Mulga Downs Mine Fauna survey sites

Figure 3-1

•	Avian Acoustic Recording Site
	Avifauna Survey
	Cage Trap
0	Camera Trap
	Cave Assessment site
	Invertebrate Dry Pitfall Trapping
0	Invertebrate Foraging Site
\bigcirc	Invertebrate Habitat Survey Site
	Systematic Survey Sites
0	Targeted Survey Site
•	Ultrasonic Bat Detectors
>	Vertebrate Habitat Survey Site

____ Hub & Rail Spur 8B

Date: 24/10/2022 Author: TOD Reviewed: MW Project: STR-001



Data Source(s): IBRA Subregions - Department of Climate Change, Energy, Environment and Water 2022 Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS, Esri, CGIAR, Esri, Geoscience Australia, NASA, NGA, USGS, Maxar





Mulga Downs Mine Fauna survey sites

Figure 3-1

•	Avian Acoustic Recording Site		
	Avifauna Survey		
0	Camera Trap		
\bigcirc	Invertebrate Habitat Survey Site		
	Invertebrate Leaf Litter Sampling Site		
	Systematic Survey Sites		
0	Targeted Survey Site		
•	Ultrasonic Bat Detectors		
>	Vertebrate Habitat Survey Site		
	Hub & Rail Spur 8B		
	Highway/Road		

Date: 24/10/2022 Author: TOD

Reviewed: MW Project: STR-001





Altexó

Mulga Downs Mine Fauna survey sites

Figure 3-1

0	Camera Trap
	Invertebrate Leaf Litter Sampling Site
>	Invertebrate Wet Pitfall Trapping
0	Targeted Survey Site
•	Ultrasonic Bat Detectors
>	Vertebrate Habitat Survey Site
	Hub & Rail Spur 8B

Highway/Road



Data Source(s): IBRA Subregions - Department of Climate Change, Energy, Environment and Water 2022 Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS, Esri, CGIAR, Esri, Geoscience Australia, NASA, NGA, USGS, Maxar



Altexó

Mulga Downs Mine Fauna survey sites

Figure 3-1

0	Camera Trap
	Invertebrate Leaf Litter Sampling Site
>	Invertebrate Wet Pitfall Trapping
0	Targeted Survey Site
•	Ultrasonic Bat Detectors

Hub & Rail Spur 8B



Date: 24/10/2022 Author: TOD





Table 3-5 Baseline vertebrate fauna survey effort

Reference Document	Type of Survey	Habitat Assessments	Systematic Trap Sites	Avifauna Surveys	Ultrasonic Bat Detector Surveys ¹	Camera Trap Survey	Acoustic Surveys (Birds)	Spotlight Surveys	Active Forages
Biologic	Basic Survey (Nov, 2021)	45 sites	-	-	-	1 site 4 nights	-	-	2 sites 2 hrs surveyed
(2022)	Detailed Survey (Mar, 2022)	14 sites	6 sites 2,184 trap nights	9 sites 8.7 hrs surveyed	27 sites 43 recording nights	10 sites 99 nights	3 sites 17 nights	Undertaken along access tracks in Hub area	9 sites 7.6 hrs surveyed
ecologia (2021a)	Detailed Survey (April, 2019- Oct 2020)	-	7 sites 2,364 trap nights	1 Transect	24 sites 29 recording nights	13 sites 354 nights	-	_	-
Cue e etamore	Basic Survey (Nov 2021)	22 sites	-	-	-	-	-	-	-
(2022)	Detailed Survey (Mar, 2022) and April 2022	-	-	-	8 Sites 32 recording nights	8 sites 1,680 nights	-	-	6 sites 3.5 hours
Total baseline survey effort		81 sites	13 sites 4,548 trap nights	10 sites 8.7 hrs surveyed	59 sites 104 recording nights	32 sites 2,137 recording nights	3 sites 17 nights	Along existing tracks in Hub	17 sites 13.1 hrs surveyed

¹ Includes SongMeter ultrasonic bat recorders and acoustic recorders. "-" indicates survey method not undertaken



Table 3-6 Total survey effort for the Northern Quoll (Dasyurus hallucatus) and the Pilbara Olive Python (Liasis olivaceus) (same habitat?)

Reference Document	Type of Survey	Camera Trap Sites	Cage Traps	Targeted Searches
ecologia (2021a)	Phase 1 – Targeted significant fauna survey (Jul, 2019)	2 sites 14 trap nights	-	-
Biologic (2022)	Basic Survey (Nov, 2021)	1 site 4 trap nights	-	-
	Detailed Survey (Mar, 2022)	8 sites 71 trap nights	6 sites 84 trap nights	5 sites 3.5 hrs
Spectrum (2022)	Basic Survey (Nov, 2021)	-	-	_
	Detailed Survey (Mar, 2022) and (Apr 2022)	8 sites 1,638 trap nights from	-	6 sites not quantified in report.
Total survey effort for the Nort Olive Python	hern Quoll and the Pilbara	19 sites 1,723 trap nights	4 sites 46 trap nights	11 sites 3.5 hrs

¹ There was additional targeted survey effort undertaken as part of ecologia (2021a), however this could not be quantified. "-" indicates survey method not undertaken

Table 3-7	Total survey effort for the Pilbara Leaf-nosed Bat (Rhinonicteris aurantia) and the Ghost Bat
(Macrodern	na gigas)

Reference Document	Type of Survey	Targeted Survey	Ultrasonic Recording Surveys	Cave Habitat Assessments
	Basic Survey (Nov, 2021)		-	
Biologic (2022)	Detailed Survey (Mar, 2022)	5 Sites 3.5 hours	18 sites 52 recording nights	-
	Baseline Mulga East (July, 2020)		3 sites 5 nights	5 Sites, 5 nights
	Mulga East (November 2019)		6 sites 6 nights	
ecologia (2021a)	Mulga East (April, 2019)		2 sites 2 nights	
	Mulga East (April 2020)		4 sites 4 nights	
	Mulga East (June 2020)		6 sites, 6 nights	
	Basic Survey (Nov, 2021)		-	-
Spectrum (2022)	Detailed Survey (Mar, 2022) and (Apr 2022)		8 Sites 1,638 recording nights	-
Total survey effort for the Pilbara Leaf-nosed Bat and Ghost Bat		5 Sites 3.5 hours	57 sites 1,713 recording nights	5 Sites 5nights

"-" indicates survey method not undertaken

Table 3-8 Total survey effort for the Night Parrot (*Pezoporus occidentalis*)

Reference Document	Type of Survey	Acoustic Recording Surveys
Biologic (2022)	Detailed Survey (Mar, 2022)	2 sites 11 recording nights
Total survey eff	ort for the Night Parrot	2 sites 11 recording nights

Table 3-9 Total SRE invertebrate survey effort

Reference Document	Type of Survey	Pitfall Traps	Active Foraging	Leaf litter and Soil Sampling
Biologic	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	-	8 sites 12 hrs searched	8 sites
(2022)	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	-	39 sites 58.5 hrs searched	39 sites



Reference Document	Type of Survey	Pitfall Traps	Active Foraging	Leaf litter and Soil Sampling
ecologia	Phase 1 – Level 2 (April 2019)	1340 traps nights at 18 locations	18 locations 74 hours	-
(2021b)	Phase 2 – Level 2 (March 2020)	700 trap nights at 10 locations	22 sites 44 hours	-
	Basic Survey (Nov, 2021)	Not done	-	-
Spectrum (2022)	Detailed Survey (Mar, 2022) and (Apr 2022)	7 Wet Pitfall Site 2,688 trap night	6	13 Sites
Total survey effort for SRE invertebrate taxa		7 Wet Pitfall Site 2,688 trap night	47 sites 70.5 hrs searched	47 sites
"-" indicates su	rvey method not undertaken			



4.0 Results

4.1 Desktop Results

4.1.1 Vertebrate Fauna Desktop Results

The consolidated desktop and literature assessments undertaken as part of the *ecologia* (2021a), Biologic (2022) and Spectrum (2022) faunal assessments identified 384 species of vertebrate fauna, which have previously been recorded in or within 40 km of the Survey area (**Table 4-1**). This comprises 49 mammals, 188 birds, 134 reptiles and 13 amphibians. Of the species previously recorded within 40 km of the Survey area, 39 species are considered conservation significant species and are identified in **Table 4-2**.

Source	Mammals	Birds	Reptiles	Amphibians	Total
Literature Sources					
Bell at al. (2014)	0	122	0	0	122
Coffey (2008)	21	68	62	3	154
Coffey (2010)	1	2	0	0	3
Coffey (2011)	7	3	1	0	11
ecologia (2009)	13	64	21	0	98
ecologia (2010)	29	79	73	4	185
ecologia (2014)	21	65	25	1	112
ecologia (2019)	22	85	46	1	154
ecologia (2020)	22	85	44	0	151
Ecoscape (2010a)	3	14	6	0	23
Ecoscape (2010b)	3	17	2	0	22
Ecoscape (2010c)	17	52	38	0	107
Terrestrial Ecosytems (2013)	16	76	37	1	130
Thompson <i>et al.</i> (2010)	8	0	65	0	73
Trainor <i>et al.</i> (2016)	0	99	0	0	99
Database Searches					
ecologia (2021a)	49	188	134	13	384
Biologic (2022)	44	184	111	11	350

169

109

10

Table 4-1 Summary of fauna species recorded in desktop and literature assessments

46

Spectrum (2022)

335



Source	Mammals	Birds	Reptiles	Amphibians	Total
Average of Fauna Literature Reviews	46	180	118	11	356
Significant Species recorded from all sources combined	10	23	6	0	39

Table 4-2Conservation Significant fauna identified from desktop and literature assessments (potential to occur)

Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	ecologia (2021a)	Biologic (2022)	Spectrum (2022)
Bird Species							
Australian Painted Snipe	Rostratula australis	EN	EN			\checkmark	
Barn Swallow	Hirundo rustica	MI	MI			\checkmark	
Caspian Tern	Hydroprogne caspia	MI	MI			\checkmark	~
Common Greenshank	Tringa nebularia	MI	MI		✓	✓	~
Common Sandpiper	Actitis hypoleucos	MI	MI			✓	~
Curlew Sandpiper	Calidris ferruginea	CE, MI	CE, MI			✓	\checkmark
Eastern Osprey	Pandion haliaetus cristatus	MI	MI			~	
Fork-tailed Swift	Apus pacificus	MI	MI		√	~	~
Glossy Ibis	Plegadis falcinellus	MI	MI			\checkmark	\checkmark
Grey Falcon	Falco hypoleucos		VU		✓	✓	\checkmark
Grey Wagtail	Motacilla cinerea	MI	MI			✓	\checkmark
Gull-billed Tern	Gelochelidon nilotica	MI	MI			✓	
Letter-winged Kite	Elanus scriptus			P4		\checkmark	\checkmark
Little Tern	Sternula albifrons	MI	MI			\checkmark	
Night Parrot	Pezoporus occidentalis	EN	CE		~	~	~
Oriental Plover	Charadrius veredus	MI	MI			~	
Oriental Pratincole	Glareola maldivarum	MI	MI			~	
Pectoral Sandpiper	Calidris melanotos	MI	MI			~	
Peregrine Falcon	Falco peregrinus		OS		~	~	√
Grey Falcon	Falco hypoleucos	VU	VU				~

Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	ecologia (2021a)	Biologic (2022)	Spectrum (2022)
Red-necked Stint	Calidris ruficollis	MI	MI		~	~	✓
Sharp-tailed Sandpiper	Calidris acuminata	MI	MI			~	✓
Wood Sandpiper	Tringa glareola	MI	MI		~	~	✓
Yellow Wagtail	Motacilla flava	MI	MI			✓	
Mammal Species							
Bilby	Macrotis lagotis		VU		\checkmark	\checkmark	~
Brush-tailed Mulgara	Dasycercus blythi			P4	~	✓	~
Ghost Bat	Macroderma gigas	VU	VU		~	✓	~
Long-tailed Dunnart	Sminthopsis longicaudata			P4	~	\checkmark	
Northern Brushtail Possum	Trichosurus vulpecula arnhemensis		VU			~	
Northern Quoll	Dasyurus hallucatus	EN	EN		\checkmark	\checkmark	✓
Pilbara Leaf-nosed Bat	Rhinonicteris aurantia			P4	~	✓	~
Short-tailed Mouse	Leggadina lakedownensis			P4		✓	~
Western Pebble-mound Mouse	Pseudomys chapmani			P4	~	~	~
Reptile Species							
Gane's Blind Snake	Anilios ganei			P1	\checkmark	✓	✓
Lined Soil-Crevice Skink	Notoscincus butleri			P4		✓	
Pilbara Barking Gecko	Underwoodisaurus seorsus			P2		✓	
Pilbara Olive Python	Liasis olivaceus	VU	VU		~	✓	~
Pin-striped Finesnout Ctenotus	Ctenotus nigrilineatus			P1	~	~	
Spotted Ctenotus	Ctenotus uber johnstonei			P2		~	

¹CE = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory, OS = Other Specially Protected Fauna

4.1.2 SRE Invertebrate Desktop Results

SRE invertebrate desktop assessment undertaken as part of the Biologic (2022) faunal assessment yielded 888 records of specimens collected in 144 taxa. Comparing these records and those found in the literature review, a total of 15 Confirmed and 10 Potential SRE invertebrate taxa occur within a 40 km search area around the Survey area. Of the potentially occurring taxa, only one has been previously recorded within the Survey area.



The desktop assessment undertaken by Spectrum (2022) revealed a total of 17 spiders, 11 scorpions, eight pseudoscorpions and one snail from the WAM database search. A total of six species of crustacean were also returned; however, these species are freshwater shrimp and were not included in their assessment.

4.2 Field Results

4.2.1 Terrestrial Fauna Habitat Types Identified within the Proposal area

Fauna habitat surveys undertaken as part of the *ecologia* (2021a), Biologic (2022), and Spectrum (2022) assessments identified 12 distinct habitat types within the Proposal area (**Figure 4-1**). Descriptions of vegetation and habitat characteristics within these habitat types are provided in **Table 4-3** and are adapted from the original reports. Identified habitats were generally classified as being in 'Good', 'Very Good' or 'Excellent' condition, however several threatening process were acknowledged from the surrounding area, including:

- Grazing by introduced herbivores;
- Clearing of native vegetation;
- Fires;
- Impacts of introduced predators; and Weed invasion.



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Drainage Line	Scattered Eucalyptus victrix or Corymbia hamersleyana over an open shrubland of Acacia tumida and A. pyrifolia over hummock and tussock grasses.	The banks provide quality burrowing substrates for monitors while trees and shrub species provide habitat for birds such as honeyeaters and corellas. Drainage lines are of low to moderate conservation value as they provide foraging and dispersal habitat for fauna. Conservation significant species known to utilize drainage lines to forage include Pilbara Leaf- nosed Bats (VU) and Ghost Bats (VU), while Northern Quolls (VU) utilise drainage lines for dispersal and foraging. This habitat is considered widespread in the Pilbara	Acanthodillo sp. indet. Buddelundia 14fm Buddelundia 56 Buddelundia 56 Buddelundia sp. Biologic-ISOP084' Buddelundia sp. SJ13 Buddelundia sp. Indet. Gastropoda sp. Laevophiloscia 'sp. Biologic-ISOP089' Laevophiloscia sp. indet. Olpiidae 'sp. Biologic- PSEU097' Indolpium PSE175 Indolpium sp. Lychas 'hairy tail complex' Lychas 'SCO024' Lychas 'SCO046'		•	*	✓	456

Table 4-3 Fauna habitat types identified within the Proposal area



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Rocky Hills	Isolated Eucalyptus leucophloia and/or Corymbia hamersleyana over sparse shrubland of mixed Acacia spp., Grevillea wickhamii, Hakea lorea and over open Triodia sp. Hummock grassland.	The Rocky Hills provides quality refugia, shelter and caves for conservation significant species. Ridgelines, boulders, crevices and caves provide shelter, denning and roosting habitat for species including Northern Quolls (VU), Pilbara Leaf-nosed bats (VU), Ghost Bats (VU), Pilbara olive pythons (VU), Rothschild's rock wallaby, rock rats, monitor lizards and <i>Pseudantichinus</i> sp. Rocky Hills are considered common and widespread throughout the Pilbara.	Austrostrophus sp. Buddelundia 14fm Buddelundia indet. 1 Dampetrus OPI001 Indolpium PSE174 Indolpium PSE175 Indolpium `sp. MD1` Lychas 'SCO024'		✓	✓	-	826



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Mulga Woodland	Open woodland of Acacia aneura, A. xiphophylla with isolated A. pruinocarpa over Acacia spp., Eremophila spp., Dodonaea petiolaris and Hakea sp. over sparse soft grasses or Triodia hummock grasslands.	Compacted alluvial loamy clay soils with occasional surface stones are generally not favourable for burrowing species with few burrows recorded during the surveys. Dead wood, peeling bark, stumps and leaf litter provide shelter for marsupials, monitors, geckos and skinks. The Mulga Woodland has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Regionally this habitat type is generally well represented although it is of low value to conservation significant fauna except for the Gane's blind snake (Priority 1).	Indolpium `sp. MD1`		✓	✓	_	1,816



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Rocky Plains and Footslopes	Vegetation is dominated by <i>Triodia</i> hummock grasses of various life stages with scattered eucalypts and patches of various small to medium shrub species on gravelly clay loam substrates. In some low-lying areas, isolated patches of sandy substrate occur.	Comprises flat to low undulating areas and low hills. Within Survey area, much of the Rocky Plain and Footslope habitat occurs within the lower lying plain which can ne soften subjected to sheet flow following large rainfall events.	<i>Lychas</i> `sp. SCO052` <i>Olpiidae</i> `sp. Biologic- PSEU099 <i>Olpiidae</i> sp. indet.		*	*	*	4,547
Stony Spinifex Plains and Hillslopes	Isolated <i>Eucalyptus</i> <i>leucophloia</i> over sparse shrubland of mixed <i>Acacia</i> spp. over open spinifex hummock grassland. The <i>Triodia</i> hummocks found are generally small and few isolated long unburnt patches are present.	Coarse stony red clay soils provide habitat for the western pebble-mound mouse (Priority 4) which has been recorded multiple times during surveys conducted within the Survey area. The substrates and vegetation present support termitaria which are a known refuge for vertebrate fauna. Stony Spinifex Plains and Hillslopes are considered as low value offering minimal refugia to species of conservation significance. However, the northern quoll, Pilbara leaf-	Buddelundia `10MA` Buddelundia `sp. SJ_10MA_DNA` Buddelundia `sp. SJ_14FMc`_DNA		*	*	-	4,329



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
		nosed bat and ghost bat are known to forage in these areas. Stony Spinifex Plains and Hillslopes are widespread in the Pilbara.						



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Drainage Area/Floodp Iain	Vegetation and substrates of this habitat was variable, often comprising scattered <i>Eucalyptus</i> over <i>Acacia</i> and/or <i>Grevillea</i> shrubs with an understory dominated by <i>Triodia</i> hummock grasses and/or mixed tussock grasses on alluvial substrates. Tussock grasses were dominant within Drainage Area/Floodplain habitat as a result of high rainfall in the months preceding the survey.	Lower lying plain often subjected to sheet flow following large rainfall events. Often comprising heavy clays and gravel. Occurs throughout a large portion of the Survey area, often occurring as the intervening area between other habitats. This fauna habitat is common throughout the Pilbara bioregion. Across the region its structure and condition are variable as a result of rainfall events and disturbance (i.e., fire and cattle grazing).	<i>Buddelundia</i> `sp. SJ_10MA_DNA` Idiosoma `sp. MD1` <i>Olpiidae</i> `sp. PSE176`			~	_	211



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Hilltops, Mesas and Outcrops	Vegetation is characterised by <i>Corymbia</i> <i>hamersleyana</i> over <i>Acacia inaequilatera</i> , with sparse <i>Hakea</i> <i>cordophylla</i> over <i>Eremophila</i> sp., over mixed <i>Triodia</i> sp.	Both Survey Areas contain rolling, rocky hills, with the summits supporting different faunal assemblage than the slopes. Leaf and wood litter was sparse and restricted to shrubs. The substrate was loamy clay with abundant and sometimes continuous rock cover.			✓		✓	254
Cracking Clay	Sparse chenopod shrubland of <i>Sclerolaena trigona, S.</i> <i>bicornis, S. densiflora</i> over low tussock grasses of <i>Eragrostis</i> <i>xerophila</i> on a substrate of cracking clays.	This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. This habitat type is not considered widespread in the Pilbara.	Buddelundia 'sp.SJ_56 DNA' Buddelundiinae sp. Biologic-ISOP090' Buddelundiinae 'NYI01' Lychas jonesae Luchas 'sp. SCO024' Olpiidae sp. Indet.		✓	*	✓	242



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Snakewood	Vegetation dominated by discrete patches of Snakewood (<i>Acacia</i> <i>xiphophylla</i>)	The Snakewood (<i>Acacia</i> <i>xiphophylla</i>) habitat was recorded from the southern section of both Survey Areas. This habitat is restricted to scattered patches on cracking clay. Other vegetation recorded in this habitat type included <i>Acacia inaequilatera</i> and scattered Mulga and Mesquite over Buffel grass. Leaf and wood litter was very sparse and basalt rock cover was abundant.	<i>Olpiidae</i> sp. indet.				✓	145
Gibber Cracking Clay	It lacks shrubs and has very little vegetative cover during the dry season. During the wet season an array of ephemerals/annuals and short-lived perennials emerge, many of which are poorly known and range-end taxa.	Previously 'Cracking clays of the Chichester and Mungaroona Range' (P1 PEC). This PEC is a stony gibber community occurring on the tablelands.	Indolpium sp. PSEU075 Idiosoma`sp. MD1`			✓	-	873



Habitat Type	Vegetation Description	Habitat Description	Recorded SREs	Habitat Photograph	ecologia (2021a)	Biologic (2022)	Spectrum (2022)	Area (ha) in Proposal area
Boulder Piles	Little to no vegetation present.	Isolated and distinct rock or bolder piles that lack bedrock outcropping associated with other rock landforms and are often different geologies like granites, basalts, and quartz. These areas can provide critical denning, foraging and dispersal habitat for Northern Quoll populations.	<i>Indolpium</i> `sp. Biologic-PSEU075` <i>Indolpium</i> `sp. MD1`			✓	-	1
Disturbed / Cleared	Disturbed/Cleared	Areas cleared for Roads and other infrastructure and historic seismic lines.	No SREs		~	✓	✓	94





Fauna habitat mapping (Option 8B) Figure 4-1

Lege	nd
	Boulder Piles
	Cleared/Disturbed
	Cracking Clay
	Drainage Area/ Floodplain
	Drainage Lines
	Gibber Cracking Clay
	Hilltops, Mesas & Outcrops
	Mulga Woodland
	Rocky Hills
	Rocky Plains & Footslopes
	Snakewood
	Stony Spinifex Plains and Hillslopes
	Hub & Rail Spur
	Highway/Road
-	- Watercourse
Micro	-habitat feature
\triangle	Cave Site
\$	Water Feature
Date:	25/10/2022 Reviewed: MW
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4.2.2 Fauna Microhabitat Values Recorded

4.2.2.1 Microbat Caves

Five caves were found during field surveys of the Proposal area. These caves are shown in **Figure 3-1**. These caves may represent roosting habitat for various microbat species including Pilbara Leaf-nosed Bat and the Ghost Bat. These caves were targeted during detailed fauna surveys to determine usage by conservation significant species. No bat activity was identified within these caves during these surveys.

4.2.2.2 Water Feature

Surveys in the hub section of the Proposal area identified a temporary pool of water. This pool appeared to persist for weeks, and, as such, is an important water feature in the Survey area. All other drainage lines appear to dry up rapidly after rain. The presence of temporary water pools may therefore be significant for a variety of conservation significant species including the Pilbara Lead-nosed Bat, which was recorded at this site (**Figure 3-1**).

4.2.3 Vertebrate Fauna Records

The cumulative survey effort undertaken by *ecologia* (2021a), Biologic (2022) and Spectrum (2022) recorded a total of 153 vertebrate fauna species within the Survey area, including 24 mammals, 78 birds, 50 reptiles and one amphibian species. Of these, eight species are identified as species of 'conservation significance' under the EPBC Act, BC Act or the DBCA. The species found during field surveys within the Proposal area are shown in the following sections.

4.2.3.1 Mammals

Native Ground Dwelling Mammals

The desktop assessment found 49 native ground dwelling mammals as potentially occurring on or adjacent to the Survey area. In total, the surveys undertaken throughout the Survey area identified 24 terrestrial vertebrate mammal species. For the purposes of this report, these have been separated into ground dwelling species (ten species recorded), bat species (nine species recorded). Of the ground dwelling terrestrial fauna recorded, four are introduced species.

The ground native ground dwelling mammal species recorded within the Survey area and the Proposal area are outlined in **Table 4-4**.

Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Dasykaluta rosamondae	Little Red Kaluta		✓
Ningaui timealeyi	Pilbara ningaui		✓
Planigale sp.	Pilbara Planigale		✓
Dasyurus hallucatus	Northern Quoll	EN – BC Act and EPBC Act	✓
Osphranter robustus	Common Wallaroo		✓
Osphranter rufus	Red Kangaroo		✓

Table 4-4	Native Ground Dwelling	ı Mammals	recorded in th	e Survey	varea and Prov	nosal area
	Native Ground Dwennig	, iviaiiiiiai3	recorded in th	e Suive	y area anu Froj	Jusai alea



Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Leggadina lakedownensis	Short-tailed Mouse	DBCA Priority 4	✓
Pseudomys chapmani	Western Pebble-mound Mouse	DBCA Priority 4	✓
Zyzomys argurus	Common Rock-rat		\checkmark
Sminthopsis macroura	Stripe-faced dunnart		✓
Tachyglossus aculeatus	Short-beaked Echidna		



Altexó

Hub and Rail Spur Conservation significant Fauna Species (Option 8B)

Figure 4-2

	Highway/Road
	Watercourse
	Hub & Rail Spur
222	10km Buffer
Conse	rvation Significant Fauna
\bigtriangleup	Anilios ganei
0	Calidris ruficollis
☆	Dasycercus blythi
\bigcirc	Dasyurus hallucatus
★	Falco hypoleucos
\bigstar	Falco peregrinus
\diamond	Leggadina lakedownensis
	Liasis olivaceus barroni
•	Macroderma gigas
÷	Pseudomys chapmani
\bigcirc	Rhinonicteris aurantia (Pilbara)
	Tringa glareola

Tringa nebularia

Date: 26/10/2022 Reviewed: MW Project: STR-001

Scale: 1:200,000@A3 Data Source(s): IBRA Subregions - Department of Climate Change, Energy, Environment and Water 2022 Earthstar Geographics, Esri, CGIAR, Esri, HERE, Garmin, FAO, NOAA, USGS, Esri, USGS

5

0

10 Km



Dasyurus hallucatus (Northern Quoll) is identified as an Endangered species under both the BC Act and the EPBC Act. *Pseudomys chapmani* (Western Pebble-mound Mouse) and *Leggadina lakedownensis* (Short-tailed Mouse) are Priority 4 species. No other conservation significant mammal species were identified within the Proposal area. These species are discussed in more detailed in **Section 4.2.3.7** of this report.

Bats

The literature review identified the potential occurrence of 12 bat species on or in the vicinity of the Proposal area. In total, nine bat species were identified during the field surveys of the Survey area and nine species were recorded within the Proposal area. **Table 4-5** identifies the bat species recorded in the Survey area and the Proposal area.

Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat		✓
Taphozous georgianus	Common Sheath-tailed Bat		\checkmark
Taphozous hilli	Hills Sheath-tailed Bat		✓
Chaerephon jobensis	Greater Northern Freetail Bat		✓
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU– BC Act and EPBC Act	✓
Nyctophylis sp.	A Nyctophylis species of bat		✓
Chalinolobus gouldii	Goulds Wattle Bat		✓
Scotorepens greyii	Little Broad-nosed Bat		✓
Vespadelus finlaysoni	Finlayson's Cave Bat		\checkmark

Table 4-5 Bat species identified within the Survey area and Proposal area

Of these species the only conservation significant species identified during surveys of Proposal area was *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat).

The Pilbara Leaf-nosed Bat is known to use caves as roost sites. Five cave sites were found within the Proposal area, however none showed any evidence of activity or use. A potential transitory roost cave was identified by *ecologia* (2020) within the Mulga East tenement. This cave, while not in the Proposal area, does occur within a 900 m boundary.

Rhinonicteris aurantia (Pilbara Leaf-nosed Bat) is discussed further in Section 4.2.3.7 of this report.

Introduced Fauna

In total, four introduced terrestrial fauna species were detected during the field surveys. These species are further discussed in **Section 4.3.2.5** of this report. They are:

- Bos taurus (cattle);
- Felix cattus (Domestic Cat);
- Equus ferus caballus (Horse); and
- Canis familiaris (Domestic Dog/Dingo).



4.2.3.2 Avifauna

The literature review identified the potential occurrence of 189 bird species. **Table 4-6** lists the 78 avian species identified during the field surveys of the Survey area. Those species recorded in the Proposal area are identified in **Table 4-6**. Species have been divided into woodland/shrubland canopy species, ground dwelling species, nocturnal birds of prey, raptors and wading species. In total, 73 avian species were recorded within the Proposal area.

Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Woodland Species			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		\checkmark
Acanthiza robustirostris	Slaty-backed Thornbill		✓
Acanthiza uropygialis	Chestnut-rumped Thornbill		~
Artamus cinereus	Black-faced Woodswallow		~
Artamus minor	Little Woodswallow		~
Barnardius zonarius	Australian Ring-neck		~
Cacatua roseicapilla	Galah		\checkmark
Cacatua sanguinea	Little Corella		~
Centropus phasianinus	Pheasant Coucal		\checkmark
Chalcites basalis	Horsfield's Bronze-cuckoo		~
Chalcites osculans	Black-eared Cuckoo		\checkmark
Chlamydera guttata	Western Bowerbird		\checkmark
Cincloramphus mathewsi	Rufous Song-lark		√
Colluricincla harmonica	Grey Shrikethrush		~
Coracina novaehollandiae	Black-faced Cuckoo Shrike		√
Corvus bennetti	Little Crow		✓
Corvus orru	Torresian Crow		~
Cracticus nigrogularis	Pied Butcherbird		~
Cracticus torquatus	Grey Butcherbird		~
Dacelo leachii	Blue-winged Kookaburra		\checkmark
Dicaeum hirundinaceum	Mistletoe Bird		✓

 Table 4-6
 Bird species identified within the Survey area and Proposal area

Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Emblema pictum	Painted Finch		✓
Eolophus roseicapilla	Galah		✓
Epthianura tricolor	Crimson Chat		✓
Gavicalis virescens	Singing Honeyeater		✓
Geopelia cuneata	Diamond Dove		✓
Geopelia striata	Zebra Dove		\checkmark
Grallina cyanoleuca	Magpie-lark		\checkmark
Gymnorhina tibicen	Australian Magppie Lark		~
Lalage tricolor	White-winged Triller		\checkmark
Lichmera indistincta	Brown Honeyeater		\checkmark
Malurus assimilis	Purple-backed Fairywren		
Malurus lamberti	Variagated Fairy-wren		\checkmark
Malurus leucopterus	White-winged Fairywren		\checkmark
Manorina flavigula	Yellow-throated Miner		\checkmark
Melanodryas cucullata	Hooded Robin		\checkmark
Melithreptus gularis	Black-chinned Honeyeater		\checkmark
Melopsittacus undulatus	Budgerigars		\checkmark
Merops ornatus	Rainbow Bee-eater		\checkmark
Mirafra javanica	Horsfield's Bush-lark		\checkmark
Nymphicus hollandicus	Cockateil		\checkmark
Ocyphaps lophotes	Crested Pigeon		\checkmark
Oreoica gutturalis	Crested Bellbird		\checkmark
Pachycephala rufiventris	Rufous Whistler		\checkmark
Pardalotus rubricatus	Red-browed Pardelote		✓
Petrochelidon ariel	Fairy Martin		
Phaps chalcoptera	Common Bronzewing		✓
Platycercus zonarius	Port Lincoln Parrot		✓
Pomatostomus superciliosus	White-browed Babbler		✓

Scientific Name	Common Name	Conservation Status	Recorded in Proposal area	
Pomatostomus temporalis	Grey-crowned Babbler		✓	
Ptilonorhynchus nuchalis	Great Bowerbird		✓	
Ptilotula keartlandi	Grey-headed Honeyeater		✓	
Ptilotula penicillata	White-plumed Honeyeater		~	
Purnella albifrons	White-fronted Honeyeater		\checkmark	
Rhipidura leucophrys	Willie Wagtail		\checkmark	
Smicrornis brevirostris	Weebil		✓	
Taeniopygia guttata	Zebra Finch		✓	
Todiramphus pyrrhopygius	Red-backed Kingfisher		√	
Todiramphus sanctus	Sacred Kingfisher			
Ground Dwelling Species				
Amytornis striatus	Striated grasswren		✓	
Anthus australis	Australasian Pippit		✓	
Ardeotis australis	Australian Bastard		✓	
Burhinus grallarius	Bush stone-curlew		✓	
Coracina maxima	Ground Coockoo Shrike		✓	
Dromaius novaehollandiae	Emu		√	
Geophaps plumifera	spinifex pigeon		\checkmark	
Poodytes carteri	Spinifexbird		✓	
Synoicus ypsilophora	Brown Quail		✓	
Turnix velox	Little Button Quail		✓	
Nocturnal Birds of Prey				
Aegotheles cristatus	Australian owlet-nightjar		✓	
Eurostopodus argus	Spotted Nightjar		✓	
Ninox boobook	Boobook Owl			
Raptors				
Accipiter fasciatus	Brown Goshawk		✓	


Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Falco berigora	Brown Falcon		✓
Falco cenchroides	nankeen kestrel		✓
Falco longipennis	Australian hobby		\checkmark
Waders			
Dendrocygna eytoni	Plumed whistling duck		✓

No conservation significant avian species were recorded within the Survey area during the surveys. Two introduced avian species were detected during the field survey, namely the Diamond Dove and Zebra Dove.

4.2.3.3 Reptiles

The literature review identified the potential occurrence of 134 species of reptile on or within 40 km of the Survey area. In total, 50 reptile species were identified during the field surveys of the Survey area. Within the Proposal area, 50 reptile species were recorded including the Priority 1 species, Gane's Blind-snake.

The reptile species found during the field surveys of the Survey area and Proposal area are identified in Table 4-7.

Table 4-7 Reptile species identified within the Survey area and Proposal
--

Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Anilios ammodytes	Sand-diving blind snake		✓
Anilios ganei	Gane's Blind-snake	Priority 1	✓
Anilios grypus	Long-beaked Blind-snake		✓
Anilios hamatus	Pale-headed Blind-snake		\checkmark
Antaresia perthensis	Pygmy Python		✓
Brachyurophis approximans	North-western Shovel-nosed Snake		\checkmark
Carlia munda	Shaded-litter Rainbow-skink		✓
Carlia triacantha	Desert Rainbow-skink		\checkmark
Ctenophorus caudicinctus	Ring-tailed Dragon		\checkmark
Ctenotus grandis	Grand Ctenotus		✓
Ctenotus inornatus	Bar-shouldered Ctenotus		\checkmark
Ctenotus pallasotus	Western Pilbara Lined Ctenotus		\checkmark
Ctenotus pantherinus	Leopard Ctenotus		\checkmark



Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Ctenotus saxatilis	Stony-soil Ctenotus		V
Delma tincta	Excitable Delma		✓
Demansia psammophis	Yellow-faced Whip-snake		✓
Demansia rufescens	Rufous Whip-snake		√
Diplodactylus galaxias	Northern Pilbara Beak-faced Gecko		✓
Diplodactylus pulcher	Fine-faced Gecko		✓
Diplodactylus savagei	Yellow-spotted Pilbara Gecko		✓
Egernia cygnitos	Western Pilbara Spiny-tailed skink		✓
Egernia epsisolus	Eastern Pilbara Spiny-tailed Skink		
Egernia formosa	Goldfield's Crevice-skink		✓
Egernia pilbarensis	Pilbara Crevice-skink		√
Gehyra crypta	Western Cryptic Gehyra		√
Gehyra micra	Small Pilbara Spotted Rock Gehyra		√
Gehyra variegata	Tree Dtella		✓
Gowidon longirostris	Gowidon		✓
Heteronotia binoei	Binoes Gecko		✓
Heteroscenes pallidus	Pallid Cuckoo		✓
Lerista amicorum	Fortescue Three-toed Slider		✓
Lerista jacksoni	Jackson's Three-toed Slider		✓
Lerista verhmens	Powerful three-toed slider		✓
Lialis burtonis	Burtons Legless Lizard		✓
Lucasium wombeyi	Pilbara ground gecko		✓
Lucasium woodwardi	Pilbara ground gecko		✓
Menetia greyii	Common Dwarf Skink		✓
Morethia ruficauda exquisita	lined firetail skink		✓
Parasuta monachus	Common Hooded Snake		\checkmark
Pseudechis australis	King Brown Snake		\checkmark
Pygopus nigriceps	Hooded scaly-foot		✓
Rhynchoedura ornata	Western beaked gecko		√
Tympanocryptis fortescuensis	Agama		✓



Scientific Name	Common Name	Conservation Status	Recorded in Proposal area
Varanus acanthurus	Spiny-tailed monitor		√
Varanus giganteus	Perentie		\checkmark
Varanus gouldii	Sand goanna		✓
Varanus panoptes	Yellow-spotted Monitor		✓
Varanus panoptes panoptes	Yellow-spotted Monitor		✓
Varanus sp.	Monitor		✓
Varanus tristis	Black-headed Monitor		✓
Vermicella snelli	Pilbara bandy bandy		✓

The only conservation significant species detected during the field surveys of the Survey area was Ganes Blind-snake. Gane's Blind Snake is identified as a Priority 1 species. Gane's Blind-snake was recorded in the Proposal area. This species is further discussed in **Section 4.2.3.7** of this report.

4.2.3.4 Amphibians

The desktop assessments undertaken by *ecologia* (2021), Biologic (2022) and Spectrum (2022) for the combined Survey area found 13 amphibian species as occurring within 40 km of the Survey area. The field survey results identified 1 amphibian species within the Proposal area, this being *Cyclorana australis* (Giant Frog).

No conservation significant amphibian species were recorded during the field surveys of the Survey area or during the literature undertaken by *ecologia* (2021a), Biologic (2022) and Spectrum (2022).

4.2.3.5 Introduced Species

Four introduced mammal species were recorded within the Survey area including the cat, wild dog/dingo, cattle and horses. Cats are classed as declared pests under the *Biosecurity Agriculture Management Act 2007* (BAM Act) and appear to have an affinity for Rocky Hills habitat, occupying the same niches as the threatened Northern Quoll. As the Survey area is located on an active pastoral lease where cattle and horses area regularly observed.

In addition to the mammal species, two introduced avian species were also detected during the field surveys in the Survey area. These being the Diamond Dove and Zebra Dove.

4.2.3.6 Data Analysis

To allow some validation of the survey effort undertaken across the Survey area, all data records were combined into a dataset so that a Species Accumulation curve could be developed. The desktop analysis of the Survey area indicated that 384 vertebrate fauna taxa have previously been recorded from within 40 km of the Survey area.

The combined field surveys for the Survey area identified a total of 153 vertebrate fauna species including 24 mammal, 78 bird, 50 reptile and one amphibian species. As shown below, the asymptote on the species curve indicates that the maximum number of species to be detected was found to be 211. As the combined field surveys for terrestrial vertebrate fauna identified a total of 153 taxa, the Species Accumulation Curve (**Figure 4-3**) for the



combined surveys indicates that 73% of the apparent maximum number of species in the locality were recorded. However, the slope of the curve visually appears to be approaching its plateau, suggesting that the maximum number of species of vertebrate fauna recorded during the survey of the Proposal area has predominantly been achieved.



Species Accumulation Curve

Figure 4-3 Species accumulation curve

4.3 Likelihood of Occurrence Assessment

To refine the list of Conservation Significant terrestrial fauna species for later assessment, **Table 4-8**Error! Reference source not found. has been prepared to summarise the desktop and field survey findings from *ecologia* (2021a), Biologic (2022) and Spectrum (2022). Species that are known to occur within the Proposal area, together with those species who have recent, reliable records from within 10 km of the Survey area, and that have habitats present in the Proposal area are assessed further in **Section 5** of this Report. Due to the levels of survey on and adjacent to the Proposal area, only those species that are rated as Recorded or Likely to occur have been assessed further. **Table 3-2** from **Section 3** of this report outlines the standardised assessment criteria used to identify those species that are considered likely to occur within the Proposal area.

Table 4-8	Occurrence of Conservation	Significant Spec	cies within the Proposal are	а

Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	<i>ecologia</i> (2021a)	Biologic (2022)	Spectrum (2022)	Assessment of Occurrence in Proposal area	Likelihood of Occurrence in Proposal area
Gane's Blind Snake	Anilios ganei	-	-	P1	Recorded	-	Recorded	Recorded within the Proposal area within the Rocky Hills (1) and Mulga Woodland (1) habitat types.	Recorded
Ghost Bat	Macroderma gigas	VU	VU	-	Recorded	Recorded	Medium	Recorded within 10 km of the Proposal area. Suitable habitats occurs along Drainage Lines where pools may form after rainfall periods.	Likely
Northern Quoll	Dasyurus hallucatus	EN	EN	-	Likely	Likely	Recorded	Recorded within the Proposal area the Rocky Hills (1) habitat type.	Recorded
Spectacled Hare-wallaby	Lagorchestes conspicillatus leichardt			Ρ4			Medium	Recorded approximately 26 km to the north of the Proposal area. Further to this, this species has not been recorded in surveys on or adjacent to the Proposal area.	Unlikely
Bilby	Macrotis lagotis	VU	VU	-	-	-	Medium	1 historic record approximately 4.6 km to the north of the Proposal area. Considered unlikely to occur due to historic grazing activities throughout the Proposal area. The lack of sandy habitats also suggests species is unlikely to occur in Proposal area as its reliant on burrowing in suitable sandy soils.	Unlikely



Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	<i>ecologia</i> (2021a)	Biologic (2022)	Spectrum (2022)	Assessment of Occurrence in Proposal area	Likelihood of Occurrence in Proposal area
Pilbara Leaf-nosed Bat	Rhinonicteris aurantia			Ρ4	Likely	Recorded	Recorded	Recorded within the Proposal area in Stony Spinifex Plains and Hilltops (5), Drainage Line (3), and Mulga Woodland (1) and Rocky Hills (1).	Recorded
Pilbara Olive Python	Liasis olivaceus	VU	VU	-	Likely	-	Recorded	Recorded within 10 km of the Proposal area. Suitable habitats occurs along Drainage Lines where pools may form after rainfall periods.	Likely
Red-necked Stint	Calidris ruficollis	MI	MI	-	Likely	-	Low	Recorded within 10 km of the Project area. Suitable habitats occur along Drainage Line habitat.	Likely
Short-tailed Mouse	Leggadina lakedownensis	-	-	Ρ4	-	Recorded	High	Recorded within the Proposal area. This species was recorded in Snakewood (2) habitat.	Recorded
Western Pebble-mound Mouse	Pseudomys chapmani	-	-	Ρ4	Likely	Recorded	Recorded	Recorded within the Proposal area. This species was recorded in Rocky Hill (7), Stony Plains and Hillslopes (5), Rocky Plains and Footslopes (3) and within Cleared Disturbed (1) habitats.	Recorded
Night Parrot	Pezoporus occidentalis	EN	CE	-	Likely	Likely	Medium	Considered unlikely to occur due to historic grazing activities throughout the Proposal area.	Unlikely



Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	<i>ecologia</i> (2021a)	Biologic (2022)	Spectrum (2022)	Assessment of Occurrence in Proposal area	Likelihood of Occurrence in Proposal area
Common Greenshank	Tringa nebularia	MI	MI	-	Recorded	-	Low	Species recorded within 10 km of the Proposal area. Suitable habitat exists within pools along the Drainage Line habitat areas.	Likely
Wood Sandpiper	Tringa glareola	MI	MI	-	Likely	-	Recorded	Recorded within 10 km of the Project area. Suitable habitats occurs along drainage lines where pools may form after rainfall periods.	Likely
Peregrine Falcon	Falco peregrinus		OS		Likely	Likely	Recorded	Recorded within 10 km of the Project area. Suitable habitats occur along drainage lines and within Mulga Woodland Habitat	Likely
Grey Falcon	Falco hypoleucos	VU	VU		Likely	Likely	Recorded	Recorded within 10 km of the Project area. Suitable habitats occur along drainage lines and within Mulga Woodland Habitat	Likely
Letter-winged Kite	Elanus scriptus			Ρ4			Database Record	Recorded within 10 km of the Project area in 2000 via a public entry to a public database. No details are available on the qualification of the person who recorded this species. This species not generally known to occur in the pllbara. Suitable habitats occur along Drainage Lines and within Mulga Woodland, and Rocky Plains and Footslopes habitat types.	Possible



Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	<i>ecologia</i> (2021a)	Biologic (2022)	Spectrum (2022)	Assessment of Occurrence in Proposal area	Likelihood of Occurrence in Proposal area
Brush-tailed Mulgara	Dasycercus blythi	-	-	Ρ4	Likely	-	Recorded	Two recent database records (2016) within Proposal area. Not recorded during field surveys of the Proposal area. According to Spectrum (2022) marginal habitat is present within the Survey area.	Likely
Glossy Ibis	Plegadis falcinellus	MI	MI	-	Likely	-	Low	Recorded within 40 km of the Proposal area. Some suitable habitat may be present within the Drainage Line habitats present within the Proposal area.	Possible
Fork-tailed Swift	Apus pacificus	MI	MI	-	-	-	Medium	Not recorded within 10 km of the Project area. Suitable habitats occur along the Drainage Line habitat and within Mulga Woodland habitat.	Possible
Spotted Ctenotus	Ctenotus uber johnstonei	-	-	P2	-	Likely	Likely	Closely related <i>Ctenotus uber uber</i> was identified within 10 km of Proposal area. This species is undergoing taxonomic revision, so this record may actually be that of the conservation significant sub species.	Possible



As identified within **Table 4-8**, the following conservation significant fauna species are considered with known to occur or are likely to occur within the Proposal area. These species are discussed further in **Section 5** of this report including:

Commonwealth Significant Species

- Pilbara Leaf-nosed Bat (Rhinonicteris aurantia) (VU EPBC Act and BC Act); and
- Northern Quoll (Dasyurus hallucatus) (EN EPBC Act and BC Act);
- Ghost Bat (*Macroderma gigas*) (VU EPBC Act and BC Act);
- Pilbara Olive Python (*Liasis olivaceus*) (VU EPBC Act, BC Act).
- Common Greenshank (Tringa nebularia) (MI EPBC Act and BC Act);
- Wood Sandpiper (*Tringa glareola*) (MI EPBC Act, BC Act);
- Red-necked Stint (Calidris ruficollis) (MI EPBC Act, BC Act); and

State Significant Species

- Short-tailed Mouse (Leggadina lakedownensis) (DBCA Priority 4 species);
- Brush-tailed Mulgara (Dasycercus blythi) (DBCA Priority 4 species);
- Gane's Blind Snake (Anilios ganei) (DBCA Priority 1 species); and
- Grey Falcon (Falco hypoleucos) (VU BC Act);
- Peregrine Falcon (Falco peregrinus) (OS Protected Fauna BC Act); and
- Western Pebble-mound Mouse (Pseudomys chapmani) (DBCA Priority 4 species).

4.4 SRE Invertebrate Records

Biologic (2022) found a total of 140 invertebrate specimens, identified as representing 28 morphological and molecular taxa, collected from sites within the MDIOP. The specimens collected were comprised of mygalomorph spiders, pseudoscorpions, scorpions, a polyxenid millipede, aquatic and land snails, and terrestrial isopods. Fifty specimens were sequenced for further elucidation of their identification by Biologic (2022).

Ecologia (2020) found a total of 496 invertebrate specimens across both phases of SRE invertebrate fauna survey from seven target SRE groups including 152 isopods, 129 spiders, one harvestman, 75 pseudoscorpions, 58 scorpions, 33 millipedes and 48 land snails. Of the specimens recorded, a single isopod species collected within the Survey area during Phase 2 was considered an SRE species, while 23 species were considered potential SRE species including eight isopods, one spider, one harvestman, five pseudoscorpions, one millipede and one terrestrial snail.

Nine specimens which were unidentifiable down to species level due to a lack of morphological features and were from confirmed or potential SRE groups were sent for molecular investigation at the Western Australian Museum (WAM) to determine identity. Single specimens of *Dampetrus* 'OPI001', *Conothele* 'MYG716', *Beierolpium* 'PSE173', *Indolpium* 'PSE175', *Indolpium* 'PSE174' and Genus 7/4 'PSE176' were selected for molecular analysis. In addition, specimens from each of the scorpion species complexes *Lychas* 'SCO024', *Lychas* 'hairy tail complex' and *Lychas* 'SCO046'.

The results of molecular investigations were cross referenced against WAM databases to confirm SRE status. *Dampetrus* 'OPI001', *Conothele* 'MYG716', *Beierolpium* 'PSE173', *Indolpium* 'PSE175', *Indolpium* 'PSE174' represent newly discovered species and are all considered potential SREs due to data deficiencies regarding their distributions.



Genus 7/4 'PSE176', *Lychas* 'SCO046' and *Lychas* 'SCO024' do not represent newly discovered species; however, they are considered Potential SRE species due to data deficiencies relating to their distribution. *Lychas* 'hairy tail complex' was unable to be identified using molecular analysis due to sample contamination.

Spectrum (2022) collected a total of 226 invertebrate specimens, representing 31 taxa. Of these 22 were considered to represent Potential SRE species, and 9 were considered to be Widespread. One species was considered to represent an SRE, this being *Buddelundia* `sp. SJ_56_DNA. Four of the 22 Potential SRE taxa recorded were olpiid pseudoscorpions. As previously discussed, Olpiidae require extensive phylogenetic review. However, the habitat within which all four taxa were collected was widespread through the Survey area and hence, it is unlikely that these taxa will be restricted in range. The remaining Potential SRE taxa were represented by various groups that were collected widely, in widespread habitats through the Mulga Downs locality.

Based on the field surveys undertaken by *ecologia* (2021b), Biologic (2022) and Spectrum (2022) 1 confirmed SRE, *Buddelundia* `sp. SJ_56_DNA was confirmed in the Proposal area and a further a total of 29 Potential SRE species were recorded. These species were recorded in following habitat types:

- Drainage Lines;
- Drainage Area/Floodplain;
- Rocky Hills;
- Mulga Woodland
- Rocky Plains and Footslopes;
- Boulder Piles; and
- Snakewood (1 Potential SRE species).

4.4.1 SRE Field Survey Results

A summary of Biologic (2022) and Spectrum (2022) Confirmed and Potential SRE invertebrate taxa recorded within the Proposal area are provided in **Table 4-9**.

Table 4-9 Confirmed and Potential SRE invertebrate taxa recorded in the Proposal area

Higher Taxon	Taxon	Habitat	SRE Status
Araneae			
Assamiidae	Dampetrus OPI001	Rocky Hills	Potential
Idiopidae	Idiosoma `sp. MD1`	Drainage Area/Floodplain	Potential
	Olpiidae sp. indet.	Rocky Plains and Footslopes Snakewood	Potential
Olpiidae	Olpiidae `sp. PSE176`	Drainage Area/Floodplain	Potential
	Olpiidae `sp. Biologic-PSEU097`	Drainage Lines	Potential



Higher Taxon	Taxon	Habitat	SRE Status
	Olpiidae `sp. Biologic-PSEU099`	Rocky Plains and Footslopes	Potential
	Indolpium PSE174	Drainage Area/Floodplain	Potential
	Indolpium PSE175	Drainage Lines Rocky Hills	Potential
	Indolpium `sp. Biologic-PSEU075`	Boulder Piles	Potential
	Indolpium`sp. MD1`	Boulder Piles Drainage Area/Floodplain Mulga Woodland Rocky Hills	Potential
	Indolpium sp.	Drainage Lines	Potential
Diplopoda			
	Austrostrophus sp.	Rocky Hills	Potential
Philosciidae	Laevophiloscia `sp. Biologic-ISOP089`	Drainage Lines	Potential
	Laevophiloscia sp. indet.	Drainage Lines	Potential
Isopoda			
Armadilloidea	Acanthodillo sp. indet.	Drainage Lines	Potential
	Scorpiones		
Buthidae	Lychas `sp. SCO052`	Rocky Plains & Footslopes	Potential
	Lychas 'hairy tail complex'	Drainage Lines	Potential
	Lychas 'SCO024'	Drainage Lines Rocky Hills	Potential
	Lychas 'SCO046'	Drainage Lines	Potential
	Buddelundia `10MA`	Stony Spinifex Plains and Hillslopes	Potential
	Buddelundia `sp. Biologic-ISOP084`	Drainage Area/Floodplain	Potential
	Buddelundia `sp. SJ_10MA_DNA`	Drainage Area/Floodplain Stony Spinifex Plains and Hillslopes	Potential
Armadillidae	Buddelundia `sp. SJ_14FMa`_DNA	Drainage Lines	Potential
	Buddelundia `sp. SJ_14FMc`_DNA	Stony Spinifex Plains and Hillslopes	Potential
	Buddelundia 14fm	Drainage Lines Rocky Hills	Potential
	Buddelundia 56	Drainage Lines	Confirmed



Higher Taxon	Taxon	Habitat	SRE Status
	<i>Buddelundia</i> indet.	Drainage Lines	Potential
	<i>Buddelundia</i> indet. 1	Rocky Hills	Potential
	Buddelundia sp. SJ13	Drainage Lines	Potential
	Buddelundiinae `sp. Biologic-ISOP086`	Drainage Lines	Potential
Gastropoda			
Camaenidae	Gastropoda sp.	Drainage Lines	Potential



5.0 Discussion

The EPA's objective for the terrestrial fauna is to protect biological diversity and maintain ecological integrity (EPA, 2020). The aim of this assessment was characterise the vertebrate fauna assemblages in the Proposal area, identify those species recorded in the Proposal area, and those likely to occur. The information gathered is to inform environmental impact assessment. The following sections describe the fauna habitats and condition. Brief profiles of conservation significant species and potential impacts on their habitat from the Proposal are provided.

5.1 Fauna Habitat Assessment

5.1.1 Fauna Habitats

Within the Proposal area, 12 broad fauna habitat types were identified including two patches of the 'Four plant assemblages of the Wona Land System' (Priority 1 Priority Ecological Community (PEC)). This PEC occurs within the 1B and 8B rail spur alignments and include the Gibber Cracking Clay fauna habitat type.

The Drainage Area/Floodplain habitat occurs sporadically throughout the Proposal area. It often occurs as the intervening area between other habitat types. This habitat type is relatively common throughout the Pilbara bioregion. It is considered suitable habitat for a variety of fauna species and is subject to partial inundation after significant rainfall events.

Drainage Line habitat within the Survey area is generally considered small and common at a local and regional scale. Database searches indicate that these areas could potentially provide foraging and dispersal habitat for conservation significant species including the Pilbara leaf-nosed Bat, Ghost Bat and the Northern Quoll. This habitat is considered widespread in the Pilbara.

The Rocky Hills habitat was assessed to be of high conservation value to species of conservation significance. Critical habitat relating to MNES are outlined in detail in **Section 5.3** below. Breakaways, gorges and gullies within the Rocky Hills habitat type provide potential caves, denning and foraging habitat considered to be critical habitat for the survival of Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat. The occurrence of breakaways and caves in the Rocky Hills habitat type is relatively common at a regional level, particularly within the Chichester and Hamersley Ranges bioregions.

The Stony Spinifex Plains and Hillslopes habitat type provides stones of a suitable size for the Western Pebble-mound Mouse to construct mounds and this species was recorded within the Proposal area. This habitat type is considered common and widespread at a local and regional scale.

The Mulga Woodland habitat provides critical foraging habitat for the Ghost Bat in the vicinity of suitable roosts. It also provides suitable habitat for the Short-tailed Mouse and non-critical foraging habitat (Priority 5) for the Pilbara Leaf-nosed Bat.

With the exception of the Gibber Cracking Clay fauna habitat type, the remaining 11 fauna habitats, according to *ecologia* (2021a), Biologic (2022) and Spectrum (2022) are broadly distributed and well represented across the Pilbara Region and are likely to support fauna assemblages which are generally common and widespread.



5.1.2 Fauna Habitat Condition

Fauna habitat assessments undertaken across the Survey area indicated that habitat condition ratings varied from 'Excellent' to 'Degraded'. Generally, the steeper parts of the Survey area were in best condition as these areas are not conducive to cattle grazing. Areas rated as 'Degraded' typically occur where long term cattle grazing activities take place. The Mulga Downs Station has been an operational pastoral lease for over 100 years. Fauna habitats within the Survey area, particularly those in the vicinity of cattle holding yards and the station homestead, have been heavily grazed. The condition of fauna habitats is shown in **Figure 5-1**.

5.2 Terrestrial Vertebrate Fauna

The cumulative survey effort undertaken across the Survey area recorded a total of 153 vertebrate fauna species, including 24 mammal, 78 bird, 50 reptile and one amphibian species. The statistically determined maximum number of taxa was 211, based upon the results of vertebrate fauna recorded by *ecologia* (2021), Biologic (2022) and Spectrum (2022) occurring in the Survey area. The average number of mammal taxa from the literature reviews undertaken in *ecologia* (2021), Biologic (2022) and Spectrum (2022) are compared in **Table 5-2**.

Vertebrate Group	Average of Literature Reviews	Survey Results	% of Average
Mammal	46	24	52%
Avian	180	78	43%
Reptile	118	50	42%
Amphibian	11	1	9%

Table 5-1	Summary of Surv	ey Results Against	Literature Review	Average for	Vertebrate Group

The results shown in **Table 5-1** indicate that the habitats present within the Survey area are consistent with dry habitat types found within the Pilbara region. This data demonstrates the dominance of reptile species, and highly mobile avian species. Highly specialised mammal groups were also found, however wet habitat specialists such as amphibian species were comparatively rare within the Survey area.

The total number of terrestrial vertebrate fauna recorded within the Proposal area was 147 species consisting of 73 birds, 23 mammals, 50 reptiles and one amphibian species. The proportion of fauna groups found within the Proposal area is consistent with the numbers expected within the dry habitat types of the Pilbara region.





Mulga Downs Mine Habitat condition (Option 8B) Figure 5-1

- Highway/Road
 Watercourse
 Habitat Condition
 Excellent
 Very Good
 Good
 Poor
 - Degraded
- Completely Degraded





5.3 Matters of National Environmental Significance

Species listed as threatened or migratory under the EPBC Act are known as Matters of National Environmental Significance (MNES). In accordance with DoE (2013) guidelines, significant impacts to MNES are described as impacts which are important, notable or are of consequence having regard to their context or intensity.

For MNES, habitat critical to the survival of a species and important populations is considered important. According to DoE (2013), critical habitat to the survival of a species refers to areas that are necessary:

- for activities such as foraging, breeding, roosting or dispersal;
- for the long-term maintenance of the species;
- to maintain genetic diversity and long-term evolutionary development; or
- for the reintroduction of populations or recovery of the species.
- Similarly, DoE (2013) outlines important populations necessary for a species' long-term survival and recovery, which may include:
- key source populations either for breeding or dispersal;
- populations necessary for maintaining genetic diversity; and/or
- populations near the limit of the species range.

More specific critical habitat criteria and definitions surrounding important populations of MNES have been outlined for many species in government documents such as conservation plans, recovery plans and Threatened Species Scientific Committee listing advice documentation.

A profile summary has been provided below for the MNES fauna species listed under the EPBC Act that were recorded within the Proposal area, namely:

- Pilbara Leaf-nosed Bat (Rhinonicteris aurantia) (VU EPBC Act and BC Act); and
- Northern Quoll (Dasyurus hallucatus) (EN EPBC Act and BC Act);

Profile summaries have also been provided for several other MNES species which were considered likely to occur in the Proposal area. These species were recorded within 10 km of the Proposal area and are known to utilize habitats similar to those within the Proposal area. These species include:

- Ghost Bat (Macroderma gigas) (VU EPBC Act and BC Act);
- Pilbara Olive Python (Liasis olivaceus) (VU EPBC Act, BC Act).
- Common Greenshank (Tringa nebularia) (Migratory EPBC Act and BC Act);
- Wood Sandpiper (Tringa glareola) (Migratory EPBC Act, BC Act);
- Red-necked Stint (Calidris ruficollis) (Migratory EPBC Act, BC Act);

5.3.1 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

This small insectivorous bat occurs throughout the Pilbara and adjacent upper Gascoyne regions of Western Australia (DoEE, 2016b). The species was listed as VU in April 2001 because it had undergone a substantial reduction in numbers, its geographic distribution is precarious for its survival (being limited to the Pilbara), and the estimated total number of mature individuals is limited, and the number is likely to continue to decline.



The Pilbara Leaf-nosed Bat has very restrictive habitat requirements, including caves and disused mines with hot to very hot and humid roost sites at 28° to 32° C with 96% to 100% relative humidity (Armstrong 2001; Churchill 2008). During the Pilbara winter dry months, preceding the heavy rains of summer, Pilbara Leaf-nosed Bat colonies are thought to contract to the deepest mines and caves that maintain microclimates suitable for roosting (Armstrong 2001; van Dyck and Strahan 2008a; Bullen and McKenzie 2011). During the hotter wetter and more humid summer months, the species has a greater ability to disperse through the landscape. The Pilbara Leaf-nosed Bat has been observed foraging in a variety of habitats such as *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (DoE, 2020). This species is most commonly encountered over small pools of water in rocky gullies and gorges.

Given the deficiency of information around what habitats are required to sustain a roosting colony, it is often difficult to define critical foraging habitat of the Pilbara leaf-nosed bat (DoEE 2016b). Foraging habitats, as outlined by DoEE (2016b), that are considered to be important for sustaining a nearby Pilbara leaf-nosed bat colony include five habitat categories (Priority 1-5) including:

- Gorges with pools (Priority 1) watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months, sites of relatively large biomass production, sometimes containing caves.
- Gullies (Priority 2) primary drainage with limited riparian development in upland rocky habitats, sometimes containing small pools that may last for weeks, with less biomass production than Priority 1 gorge habitat.
- Rocky outcrop (Priority 3) areas of exposed rock at the top of rocky outcrop and mesa hills that contain caves and overhangs, and boulder piles in the granite terrains.
- Major watercourses (Priority 4) riparian vegetation on flat land plus the main gravelly or sandy channel of the riverbed, sometimes containing pools that persist for weeks or months, and generally supporting higher productivity of biomass than the surrounding habitats.
- Open grassland and woodland (Priority 5) dominated by *Triodia*, on lowland plains, colluvial slopes and hilltops.

The Proposal area was assessed as supporting Gullies (Priority 2), Rocky Outcrop (Priority 3), and open grassland and woodland (Priority 5) foraging habitat. Rocky Hills and Drainage Lines within the Newman land system supports Priority 2 and Priority 3 foraging habitat while Drainage Lines (not within Newman land system) and Stony Spinifex Plains and Hillslopes support Priority 5 foraging habitat. These habitat types are considered widespread in the Survey area and in a regional context.

Between 2019 and 2021, eight field assessments (one two-phased detailed survey (*ecologia*, 2020a), and six targeted field assessments (*ecologia*, 2021b, 2021c) were conducted immediately south of the Proposal area (within the Mulga East tenement) to determine the extent to which the Pilbara Leaf-nosed Bat was using or occupying the local area. No Permanent Diurnal Roost (Priority 1) or Non-permanent Diurnal Roosts (Priority 2) were recorded during the surveys, however, one cave, potentially, represented a Transitory Diurnal Roost (located 2.2 km south of the Proposal area). Furthermore, ultrasonic results indicated that a Permanent Diurnal Roost likely exists in the vicinity given the year-round presence of Pilbara Leaf-nosed Bats (*ecologia*, 2020a). Numerous caves have been recorded within the vicinity of the Proposal area (*ecologia*, 2021b, 2021c), the nearest of which is located 958 m south of the Proposal area (*ecologia*, 2021b).

During the current survey, the Pilbara Leaf-nosed Bat was recorded from secondary evidence (ultrasonic recorder) on two occasions at an ephemeral water feature (**Figure 4-1**) in the Proposal area. Three calls belonging to the species were recorded on the 22 March 2022 and 10 calls were recorded on the 23 March 2022. The timing of the calls was indicative of foraging individuals.

The water features at which this species was recorded occurs within Drainage Line habitat adjacent to the Stony Spinifex Plains and Hillslopes and Rocky Hills habitats. Based on DoEE (2016b) categories of foraging habitat for the



species, this water feature is considered to provide potential Priority 2 foraging habitat. Furthermore, instances where outcropping occurs within Rocky Hills habitat provides potential Priority 3 foraging habitat, Drainage Line generally provide potential Priority 4 habitat and Mulga Woodland as well as Drainage Area/Floodplain provide potential Priority 5 foraging habitat.

Given the fact that the species has been recorded from numerous locations on and in the vicinity of the Proposal area, the Pilbara Leaf-nosed Bat is likely to be an occasional to regular visitor during foraging and/or dispersal movements, particularly within the Rocky Hills, Mulga Woodland, Boulder Piles, Drainage Line, and Drainage Area/Floodplain habitats.

Within the Proposal area footprint **Table 5-2** summarises the potential habitats of Pilbara Leaf-nosed Bat compared to the total habitat type mapped throughout the broader Survey area.

PLnB Habitat	Priority Rating	Area in Development Footprint of Proposal area	Area within Survey area	% of Impact to Survey Area Habitat Type
Drainage Line	Priority 2	63	875	7%
Rocky Hills	Priority 3	52	826	6%
Hilltops, Mesas & Outcrops	Priority 3	14	923	2%
Drainage Area/Floodplain	Priority 4	71	211	34%
Mulga Woodland	Priority 5	1,064	1,816	59%
Boulder Piles	Priority 3	0	1	0
Open Grasslands and Woodlands	Priority 5	2,084	14,919	14%

Table 5-2 Pilbara Leaf-nosed Bat: Habitat Impact for the Hub and Option 8B alignment

The Proposal will impact upon 7% of the Priority 2 habitat and 8% of the Priority 3 habitat, 34% of the Priority 4 habitat and 14% of the Priority 5 habitat of Pilbara Leaf-nosed Bat in the Survey area.

5.3.2 Northern Quoll (Dasyurus hallucatus)

The Northern Quoll's range once extended contiguously across the north of Australia but is now restricted to six separate land units including the Pilbara (DoE, 2019). The Pilbara is regarded as the stronghold population for the species given that the cane toad is not expected to make its way across the desert into parts of the Pilbara (Woinarski *et al.*, 2014). Preferred habitat for the Northern Quoll is rocky escarpments, but it also inhabits riverine habitats. Rocky habitats with rock crevices and caves support higher densities of northern quoll (van Dyck and Strahan, 2008a). Predominantly inhabiting dissected rocky escarpments, a male quoll can have a home range of more than 100 ha while a female occupies territories of up to 35 ha (van Dyck and Strahan, 2008b).

This species is predominantly nocturnal but may be observed during the day, during the breeding season and on overcast days (Oakwood, 2008). Northern Quolls are opportunistic omnivores and feed primarily on small vertebrates (mammals, amphibians and reptiles), invertebrates and soft fruits. Breeding occurs once per year, with juveniles deposited in dens once they reach eight to nine weeks of age and can no longer fit in the maternal pouch. Northern Quolls are the smallest of the Australian quolls but are the largest mammal species in the world to undergo male die-



off events following the breeding season. The lifespan of females in the wild is typically less than three years, with most females only surviving a single breeding season.

According to the referral guidelines for the Northern Quoll (Commonwealth of Australia, 2016), a low-density population is characterised by infrequent captures of one or two individuals confined to one or two traps or where no trapping has identified a Northern Quoll, but latrine evidence remains. A high-density population may be characterised by numerous camera triggers by multiple individuals across multiple cameras and/or traps on the site.

There are 321 previous records in the vicinity (within 40 km) of the Survey area (DBCA, 2021a; *ecologia*, 2021a; Ecoscape, 2010; Terrestrial Ecosystems, 2013). The Northern Quoll was recorded in Rocky Hills habitat in the central sections of the Hub during the detailed survey undertaken by Spectrum (2022). The population was identified as potentially low-density (one to two individuals). During *ecologia* (2021a) survey, two scats were collected from Rocky Hill habitat south-western of the Survey area. The scats potentially belonged to Northern Quoll and were subsequently sent to Georgeanna Story (Scats About NSW) for identification. The scats could not be definitively confirmed; however, they were deemed likely to represent that of Northern Quoll.

Northern Quoll populations considered important for the long-term survival of the species occur in habitats that are free of cane toads and unlikely to support cane toads upon arrival eg. granite habitats in WA, populations surrounded by desert and without permanent water (Commonwealth of Australia (CoA), 2016). The habitats identified within the Survey area are currently free of cane toads and are unlikely to support any future cane toad invasion due to a lack of water sources. No natural permanent water sources were recorded within the Survey area and therefore, any residential population recorded is considered important for the long-term survival of this species.

Rocky habitats (i.e. ranges, gorges, escarpments, breakaways, mesas and boulder field) are considered habitat critical to the survival of Northern Quoll (DoE, 2016). Therefore, the Boulder Pile habitat occurring within the Survey area may provide critical denning or shelter habitat for the species. Potential denning and shelter opportunities are provided by breakaways occurring within the Rocky Hills. Therefore, the Rocky Hills habitat is considered to provide critical denning and shelter habitat for the species and provides connectivity to other areas of similar habitat beyond the Survey area boundary. Instances of breakaways occurring within the Rocky Hills may provide critical denning habitat for the species, however, the extent of its occurrence within the Survey area is limited to small areas. The Northern Quoll may occasionally occur within the Drainage Line habitat of the Survey area to forage or during dispersal movements, particularly in areas adjacent to or near areas of suitable habitat outside of the Survey area. Given the recorded sightings in the Proposal area together with nearby records from the Spectrum (2022) and *ecologia* (2021a) surveys, and the presence of suitable habitat, the species is known and expected to be resident in the Proposal area.

The most common cause of adult mortality (excluding post-reproduction die-off) is predation by dingoes, foxes, feral cats, snakes, owls and kites (Maxwell *et al.* 1996; Oakwood, 2008). The main threats to the Northern Nuoll as outlined in the national recovery plan (Hill and Ward, 2010) include cane toads, feral predators, inappropriate fire regimes, habitat degradation, weeds, disease, hunting and persecution, and population isolation. The main threats to the northern Quoll applicable to the Survey area are feral predators (cat, and wild dog/dingo) and loss of habitat. Feral predators were recorded occupying the same Rocky Hills habitat as where Northern Quoll was recorded from. The Northern Quoll national recovery plan (Hill and Ward, 2010) recommends implementing best-practice techniques for feral predator control at sites with remnant Northern Quoll populations and potential refuge habitats. There is some evidence to suggest that the presence of a healthy dingo population in an area has positive impacts on the local native mammal populations through suppression of feral predator numbers (Hill and Ward, 2010).

Table 5-3Error! Reference source not found. outlines the potential direct impacts of the proposed development of the Hub and Option 8B rail alignment on the habitat of the Northern Quoll.



Habitat	Habitat Value	Area to be Cleared in Hub and Option 8B alignment	Area in Survey area	% of Impact to Survey area Habitat Type
Rocky Hills	Critical	52	826	6%
Drainage Area/Floodplain	Foraging/Dispersal	71	211	34%
Drainage Line	Foraging/Dispersal	63	875	7%

Table 5-3 Northern Quoll: Habitat Impacts for the Hub and Option 8B alignment

5.3.3 Ghost Bat (*Macroderma gigas*)

The Ghost Bat is the largest Microchiroptera bat in Australia, is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (van Dyck and Strahan 2008b). The Ghost Bat has a patchy but widespread distribution across northern Australia. Preferred roosting habitat in the Pilbara includes caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles (Woinarski *et al.*, 2012). Ghost Bats have also been known to roost in large colonies within sandstone caves, under boulder piles and in abandoned mines (Churchill, 1998). Ghost bats disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop, 1985). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong and Anstee 2000). During daylight hours, ghost bats roost in large caves, mines or deep rock fissures (van Dyck and Strahan 2008b). In some parts of its range, the ghost bat shares roosts with the Pilbara Leaf-nosed Bat, Finlayson's Cave bat (*Vespadelus finlayson*), Common Heath-tailed bat (*Taphozous georgianus*), and possibly Hill's sheath-tailed bat (*Taphozous hilli*) (DoE, 2020). Ghost Bats are known to move between several caves seasonally or as dictated by weather conditions (Hutson *et al.*, 2001) and disperse widely when not breeding but concentrate in a relatively few roost sites when breeding (DoEE, 2016a).

Ghost Bats are surface foragers ambushing prey either on the ground or in the air (Woinarski *et al.*, 2012). Hunting behavior within foraging areas consisted of observing and locating prey from stationary vantage points with brief flights to catch prey before intermittently changing vantage point (Tidemann *et al.*, 1985). No studies have been undertaken to accurately define foraging habitat within the Pilbara.

The species has previously been recorded on 13 occasions within the vicinity of the Survey area (DBCA, 2021a). Several potential roosts for the species were also identified in the Mulga East tenement component area (*ecologia*, 2021a) in the Survey area. Additional potential roosts have also been recorded within the Solomon Project Kings Area located approximately 57 km west of the Survey area (*ecologia*, 2010).

During the current survey, ultrasonic recorders were deployed for 1,660 sampling nights in 16 locations within the Survey area. No suitable roost caves likely to be used by the species, were recorded. Ghost Bats were detected within the Survey area during the surveys undertaken by Spectrum (2022). Generally, there is a lack of records from ultrasonic recorders, as sampling detectability, particularly of foraging individuals, can be difficult due to the species foraging behaviour (i.e. infrequent and highly variable calling during foraging) and ultrasonic recording devices have limited detection zones.

Foraging habitat occurs within Mulga Woodland and Drainage Area/Floodplain habitats of the Survey area that is associated with caves represent critical foraging habitat for the species. Stony Spinifex Plains and Hillslopes, Gibber Cracking Clay, Drainage Line and Rocky Hills, as well as Drainage Line, Mulga Woodland and Drainage Area/Floodplain habitats that are distanced from caves, are considered non-critical foraging habitat. The suitability of these habitats is however variable, with higher value areas including suitable foraging structures (tree perches) and a relatively open understory.



Critical habitat for this species within the Survey area overlaps with the Northern Quoll and Pilbara Olive Python in the form of breakaway, gorge and gully habitat within the Rocky Hills habitat type. This species has the potential to forage in all habitat types within the Survey area. Armstrong and Anstee (2000) suggested that Ghost Bats occur in small groups within the Hamersley Ranges and may move about in a local area, possibly in response to disturbance, microclimate or social factors.

Based on the recorded occurrence of this species near to the Survey area, presence of previous records and potential roosts in close proximity to the Survey area, and the occurrence of potential foraging habitat (Mulga Woodland, Drainage Area/Floodplain, Drainage Line, and Rocky Hills) in the Proposal area, this species is considered to occur throughout the Survey area during foraging activities and/or dispersal movements from potential roosting habitat. No roost sites were identified within the Proposal area.

Table 5-4 outlines the amount of clearing of habitats within the proposed development footprint of the Hub and Option8B alignment likely to impact Ghost Bat.

Habitat	Habitat Value	Area to be Cleared in Hub and Option 8B alignment	Area in Survey area	% of Impact to Survey area Habitat Type
Rocky Hills	Critical	52	826	6%
Gibber Cracking Clay	Foraging	141	878	16%
Mulga Woodland	Foraging	1,064	1,816	59%
Drainage Area/Floodplain	Foraging	71	211	34%
Stony Spinifex Plains and Hillslopes	Foraging	1,140	4,332	26%
Drainage Line	Foraging	63	875	7%

Table 5-4 Ghost Bat: Habitat Impacts for the Hub and Option 8B alignment

5.3.4 Pilbara Olive Python (*Liasis olivaceus*)

One of Australia's largest snakes, the Pilbara Olive Python is restricted to gorges, rocky habitats and escarpments of the Pilbara (Wilson and Swan, 2017). Bush and Maryan (2011) noted that Pilbara Olive Pythons have been observed from locations some distance from water sources including granite outcrops, elevated mesas and spinifex plains on stony ground, preferring to shelter in caves, crevices and beneath large boulders. They have been known to eat prey as large as rock wallabies and the Pilbara Subspecies is larger and can grow up to 6.5 m in length (Wilson and Swan, 2017). Two distinct populations of the Pilbara Olive Python exist (not including the northern subspecies *L. olivaceus olivaceus*) with one isolated around Mt Augustus in the Gascoyne, and the other occurring across a vast area from the Burrup Peninsula, Ord Ranges and Meentheena south to Nanutarra and Newman (Storr *et al.* 2002).

Population size estimates are difficult due to the cryptic nature of this species and lack of reliable trapping or census techniques (DoEE, 2008). The main threats to this subspecies come from predation by feral cats and foxes, particularly of juveniles, competition with foxes for food, and destruction of habitat (Pearson, 2006).

A Pilbara Olive Python was recorded during the recent surveys to the south of the Proposal area. The species has previously been recorded on 30 occasions within 40 km of the Survey area (DBCA, 2021a; *ecologia*, 2021a). The nearest record (a single live individual was opportunistically recorded at the Mulga East Camp) and is approximately 1 km west of the Proposal area. This species has also been detected at the Fortescue's Solomon Mine (40 km to the west), the Malay Well in Wittenoom Gorge (13 km to the south) and in the Chichester Ranges (7 km to the north-west). The



distribution of this species to the south, west, north and north-east of the Proposal area indicates this species occurs widely across the broader landscape and is not restricted to specialized habitats within the Proposal area.

Within the Proposal area, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills habitat type, specifically the rocky outcrops, breakaways and small gorges, although it has also been known to inhabit spinifex grasslands and travel large distances, suggesting the species has a large home range (Tutt *et al.*, 2002). The Survey area does not contain deep gorges or permanent sources of water considered as preferred habitat by DoEE (2008).

Table 5-5 outlines the potential impacts of the Proposal on the habitat of the Pilbara Olive Python.

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Rocky Hills	Foraging/Dispersal	52	826	6%
Drainage Area/Floodplain	Foraging/Dispersal	71	211	34%
Stony Spinifex Plains and Hillslopes	Foraging/Dispersal	1,140	4,332	26%
Drainage Line	Foraging/Dispersal	63	875	7%

Table 5-5 Pilbara Olive Python: Habitat Impacts for the Hub and Option 8B alignment

5.3.5 Common Greenshank (Tringa nebularia)

The Common Greenshank is a large, pale, nervous wader with a medium-long slightly upturned bill growing to between 30 and 34 cm (Pizzey *et al.* 2013). This migratory bird breeds in northern Europe, north Asia and winters in southern areas including Australia where it inhabits shallow freshwaters (river pools, lakes, claypans, lagoons, swamps) and salt water (estuaries, mangroves, lakes, reef flats) (Johnstone and Storr, 1998). This species is highly mobile and tends to be found around any open body of water including pools in drainage lines after rain.

This species was recorded during surveys to the south of the Proposal area. Suitable habitat for this species in the Survey area and in the Proposal area includes all Drainage Line habitats where pools may occur following high rainfall events. It is important to note that this species has been recorded in sporadically throughout the surrounding region. Due to the high mobility of this species, and as it has been recorded within 10 km of the Proposal area, it is considered likely to occur in the Proposal area. The Proposal will therefore impact approximately 63 ha of Drainage Line habitat. This habitat is considered common in the Pilbara bioregion.

5.3.6 Red-necked Stint (Calidris ruficollis)

Breeding in arctic Siberia and northern Alaska, this small (13-16 cm) wading species is an abundant summer migrant to coastal and inland Australia (Pizzey *et al.*, 2013). This species is a common to very common visitor on most coasts, coastal plains and larger west-coast islands and is considered rare to moderately common to the interior usually in small flocks (Johnstone and Storr, 1998). Red-necked stints frequent a variety of habitats including tidal mudflats, saltmarshes, sandy and shelly beaches, and coastal and inland saline or freshwater wetlands (Pizzey *et al.*, 2013).

Whilst this species was not recorded during surveys across the Survey area, suitable habitat has been recorded in the surrounding region which may allow this species to temporally occur within the Survey area whilst dispersing to these habitats. Further to this, this species was recorded during recent surveys by Biological (2022) to the south of the Proposal area.



Table 5-6 outlines the potential impacts of the proposed development of the Hub and Option 8B rail alignment on the habitat of the Red-necked Stint.

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Drainage Area/Floodplain	Foraging/Dispersal	71	211	34%
Drainage Line	Foraging/Dispersal	63	875	7%

Table 5-6	Red-necked Stint: H	labitat Impact	Impacts for the	Hub and Optio	on 8B alignment

5.3.7 Wood Sandpiper (Tringa glareola)

This species is of a similar size and has similar habits to the Common Greenshank. The Wood Sandpiper is migratory bird that breeds in northern Europe, north Asia and winters in southern areas including Australia where it inhabits shallow freshwaters (river pools, lakes, claypans, lagoons, swamps) and is less likely to occur in salty or brackish waters (Johnstone and Storr, 1998). This species is highly mobile and tends to be found around any open body of water including pools in drainage lines after rain.

This species was recorded during recent surveys by Biologic (2022) to the south of the Proposal area, suitable habitat has been recorded in the surrounding region which may allow this species to temporally occur within the Survey area whilst dispersing to these habitats.

Table 5-7 outlines the potential impacts of the Proposal on the habitat of the Wood Sandpiper in the Survey area.

Table 5-7 Wood Sandpiper Habitat Impact for the Hub and Option 8B alignment

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Drainage Area/Floodplain	Foraging/Dispersal	71	211	34%
Drainage Line	Foraging/Dispersal	63	875	7%

5.4 State Significant Fauna Species

In addition to the MNES species discussed above, profile summaries have also been provided for several state significant fauna species (listed under the BC Act or the DBCA) that were observed or considered likely to occur, as determined in **Section 4.3** of this report, within the Proposal area, including:

- Short-tailed Mouse (Leggadina lakedownensis) (DBCA Priority 4 species);
- Brush-tailed Mulgara (Dasycercus blythi) (DBCA Priority 4 species);
- Gane's Blind Snake (Anilios ganei) (DBCA Priority 1 species); and
- Grey Falcon (Falco hypoleucos) (VU BC Act);
- Peregrine Falcon (Falco peregrinus) (OS Protected Fauna BC Act); and



• Western Pebble-mound Mouse (Pseudomys chapmani) (DBCA Priority 4 species).

5.4.1 Short-tailed Mouse (Leggadina lakedownensis)

The Short-tailed Mouse occurs across northern Australia, from Cape York to the Pilbara, with one population on Thevenard Island (Western Australia). It is a nocturnal species found in areas of open tussock and hummock grassland, acacia shrubland, and savanna woodland, on alluvial clay or sandy soils (Lee, 1995; Moro & Kutt, 2008).

Fifty records occur within 40 km of the Survey area (DBCA, 2021d). The nearest previous record is located approximately 18 km east of the Survey area from 2004 (DBCA, 2021a). The Short-tailed Mouse was captured on two occasions by Biologic (2022) during their surveys of the Proposal area at the same location. This species was recorded within the Snakewood habitat (**Figure 4-2**).

Like many rodent species, Short-tailed Mouse populations can be subject to boom-bust or eruptive population dynamics, particularly following fire and rainfall events when resources are less or more abundant (Bennison *et al.*, 2018; van Dyck & Strahan, 2008). This species was recorded within the Snakewood habitat present in the Proposal area. In addition to this habitat, this species can also be expected to occur within Gibber Cracking Clay, Mulga Woodland and Drainage Line habitats. The species is considered to occur as a resident, particularly following rainfall events when resources are most abundant.

Table 5-8 outlines the potential impacts of the proposed development of the Proposal on the habitat of the Short-tailed Mouse.

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Gibber Cracking Clays	Forage and Refuge	141	878	16%
Snakewood	Forage and Refuge	23	145	16%
Drainage Area/Floodplain	Forage and Refuge	71	211	34%
Mulga Woodland	Forage and Refuge	1,064	1,816	59%

Table 5-8 Short-tailed Mouse: Habitat Impacts for the Hub and Option 8B

5.4.2 Brush-tailed Mulgara (Dasycercus blythi)

The Brush-tailed Mulgara is a medium sized carnivorous marsupial belonging to the family Dasyuridae. It occupies the arid and semi-arid interior of Australia with records from Western Australia, the Northern Territory, South Australia, and Queensland (Woolley, Haslem and Westerman, 2013). Preferred habitats for this species include sandy and loamy flats vegetated with hummock and/ or tussock grasses. Brush-tailed Mulgara have also been recorded from stony gibber plains where wind-blown soil or sand has accumulated and allows for burrowing (Pavey *et al.*, 2011).

The Brush-tailed Mulgara was recorded approximately 5km to the northern of Proposal area. The Rocky Plains and Footslopes provides marginal habitat for this species. The Brush-tailed Mulgara prefers spinifex *Triodia* spp. grasslands on sand plains and the swales between low dunes (Pavey *et al.*, 2012; Woolley, 2006). Mature spinifex hummocks appear to be an important protection mechanism from introduced predators (Körtner *et al.*, 2007).



Table 5-9 outlines the potential impacts of the proposed development of the Hub and Option 8B rail alignment on the habitat of the Brush-tailed Mulgara.

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Drainage Area/Floodplain	Forage and Refuge	71	211	34%
Drainage Lines	Foraging/Dispersal	63	875	7%

Table 5-9	Brush-tailed Mul	gara: Habitat Im	pacts for the Hub	and Option	n 8B alignment

5.4.3 Gane's Blind-snake (Anilios ganei)

Little is known about the Gane's Blind-snake; however, it can be assumed that its ecology and behaviour are similar to other blind snake species (Cogger, 2014). Due to its fossorial nature, the species is rarely encountered, and little is known of the species habitat preferences. Records of the species are often associated with moist gorges and gullies (Wilson & Swan, 2014).

This species was recorded twice within the Proposal area, within Mulga Woodland and Rocky Hills habitats. A previous record of the species occurs approximately 3.8 km south of the Proposal area (*ecologia*, 2020a). During the surveys of the Proposal area, the Gane's Blind-snake was recorded at on two occasions, one records from *ecologia* (2020a) and one record from Biologic (2022). The individuals were captured from one pitfall trap located in the Mulga Woodland habitat and one funnel trap located in the Rocky Hills habitat in the Proposal area (Error! Reference source not found.). Therefore, the species can be considered to occur as a resident within Mulga Woodland and Rocky Hills, particularly in areas where leaf litter accumulates, and moisture is retained in leaf litter and substrates.

Table 5-10 outlines the potential impacts of the Proposal on the habitat of the Gane's Blind-snake.

Habitat	Habitat Value	Area to be Cleared in Hub and Option 8B alignment	Area in Survey area	% of Impact to Survey area Habitat Type
Rocky Hills	Foraging/Dispersal	52	826	6%
Mulga Woodland	Forage and Refuge	1,064	1,816	59%

 Table 5-10 Gane's Blind-snake: Habitat Impacts for the Hub and Option 8B alignment



5.4.4 Western Pebble-mound Mouse (Pseudomys chapmani)

The Western Pebble-mound Mouse is a species endemic to the Pilbara region, though was previously distributed through the Gascoyne and Murchison regions (Start *et al.*, 2000). Using a readily available supply of stones, this species builds an above ground mound atop underground tunnels (Anstee & Armstrong, 2001; Dunlop & Pound, 1981). The Western Pebble-mound Mouse appears to inhabit a single primary mound during the day and visit secondary mounds within their home range during the night (Anstee, 1996). Due to the need for mound construction, the species almost exclusively occurs on gentle slopes of rocky ranges and undulating plains, where the ground is covered with a stony mantle and is vegetated by hard spinifex and often sparse overstorey of eucalypts and scattered shrubs (Anstee & Armstrong, 2001; Dunlop & Pound, 1981).

The distinctive pebble mounds created by this species were detected within the Proposal area. The species has also been recorded numerous times within the vicinity of the Proposal area. The nearest previous record occurs 1.9 km to the south (*ecologia*, 2020). The Western Pebble-mound Mouse was recorded from secondary evidence (pebble-mounds) on seven occasions in Rocky Hills habitat. There were also five records of this species within the Stony Spinifex Plains and Hillslopes habitat (Error! Reference source not found.).

The species is considered most likely to occur within the Proposal area as a resident and its occurrence is likely to be common and widespread across Rocky Hills and Stony Spinifex Plains and Hillslopes habitats. The species may also forage more broadly into Drainage Area/Floodplain habitat where this is adjacent to habitat permitting burrowing and mound construction.

Table 5-11 outlines the potential impacts of the proposed development of the Hub and Option 8B rail alignment on the habitat of the Western Pebble-mouse.

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Rocky Hills	Foraging/Dispersal	52	826	6%
Stony Spinifex Plains and Hillslopes	Foraging/Dispersal	1,140	4,332	26%
Drainage Area/Floodplain	Forage and Refuge	71	211	34%

Table 5-11 Western Pebble-Mouse: Habitat Impacts for the Hub and Option 8B

5.4.5 Grey Falcon (Falco hypoleucos)

The Grey Falcon is a widely distributed but infrequently recorded species which appears to have a distribution centered on ephemeral or permanent creek lines (Garnett & Crowley, 2000). The species tends to prefer sparsely-treed, open plains and creek lines for hunting (Olsen & Olsen, 1986), while nesting often occurs in the abandoned nest of a raptor or corvid in trees or tall infrastructure such as power line towers or communications towers (Olsen & Olsen, 1986; Schoenjahn et al., 2019).

The Grey Falcon was recorded on one occasion during the surveys undertaken for the MDIOP to the west of the Proposal area. Further to this, the species was previously recorded (2016) approximately 7.8 km north-east of the Proposal area (DBCA, 2021a). Grey Falcons have the potential to overfly all habitat types within the Proposal area and the Mulga Woodland and the Drainage Area/Floodplain and Drainage Line habitats provide potential nesting locations for this species. Whilst nesting habitat may be present in Eucalypt trees lining the drainage lines, it is not considered optimal nesting habitat due to the low height of the trees. The frequency of occurrence of the species



within the Proposal area is likely to be dependent on the proximity of nesting individuals to the Proposal area. No suitable nesting habitat was recorded within the Proposal area.

Table 5-12 outlines the potential impacts of the proposed development of the Hub and Option 8B rail alignment on the habitat of the Grey Falcon.

Table 5-12	Grey Falcon:	Habitat Impact	s for the Hub	and Optior	n 8B alignment

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Drainage Area/Floodplain	Forage and Refuge	71	211	34%
Mulga Woodland	Forage and Refuge	1,064	1,816	59%
Drainage Line	Foraging/Dispersal	63	875	7%

5.4.6 Peregrine Falcon (Falco peregrinus)

In arid areas of its distribution, the Peregrine Falcon is often recorded along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone & Storr, 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces between 25m to 50 m high (Olsen & Olsen, 1989). It also appears to prefer nesting on ledges a reasonable distance (average of 13 m) from the top of the cliff, possibly to avoid predators. Nesting also occasionally occurs in tall trees along drainage lines, including use of abandoned nests of other large bird species (Olsen & Olsen, 1989).

One Peregrine Falcon was recorded 2 km to the west of the Proposal area by Biologic (2022). This species has previously been recorded on multiple occasions within the surrounding area (DBCA, 2021a). The nearest previous record of the species occurs approximately 2 km north of the Proposal area from 2014 (DBCA, 2021a).

The species is considered likely to forage throughout all broad fauna habitats occurring in the Proposal area. Due to the greater likelihood of prey fauna being associated with the Mulga Woodland and Drainage Line habitats, these are considered the most important habitats for this species in the Proposal area. Due to the species broad foraging range and the widespread occurrence of these habitats in the broader locality, foraging is likely to occur over a much broader area and not confined to the Proposal area. No suitable nesting habitat was recorded within the Proposal area.

Table 5-13 outlines the potential impacts of the proposed development of the Hub and Option 8B rail alignment on the habitat of the Peregrine Falcon.

Habitat	Habitat Value	Area to be Cleared for the Proposal	Area in Survey area	% of Impact to Survey area Habitat Type
Drainage Area/Floodplain	Forage and Refuge	71	211	34%
Mulga Woodland	Forage and Refuge	1,064	1,816	59%
Drainage Line	Foraging/Dispersal	63	875	7%

Table 5-13 Peregrine Falcon: Habitat Impacts for the Hub and Option 8B alignment



5.5 SRE Invertebrate Fauna

Drainage Lines, Drainage Areas/Floodplains, Rocky Hills, Rocky Plains and Footslopes and Mulga Woodlands provide important microhabitat for many SRE invertebrates including mygalomorph spiders, selenopid spiders, polydesmid millipedes, and terrestrial isopods. From the desktop assessment, 15 Confirmed SRE invertebrate taxa have been identified for the region and 91 Potential SRE species have been recorded from within 40 km of the Survey area boundaries. Recent surveys adjacent to the Survey area (Biologic, 2022) have also yielded one additional Confirmed SRE, *Buddelundia* sp. 56. This indicates a high level of regional endemism in comparison to other areas of the Pilbara.

During the current studies, a total of 31 invertebrate SRE specimens were collected from sites within the Proposal area. Thirty were classified as Potential, one was a Confirmed SRE. Within the Proposal area, the habitats within which these specimens were collected is widespread including Drainage Lines, Drainage Areas/Floodplains, Mulga Woodland, Rocky Plains and Footslopes and Rocky Hills. These habitat types are considered unlikely to be restricted to the Proposal area. The one Confirmed SRE isopod species, *Buddelundia* sp. 56, was encountered in the Proposal area (**Figure 5-2**) within the Drainage Line habitat.

Site - SRE07

Acanthodillo sp. indet. Gastropoda sp. Buddelundia sp. SJ13 Buddelundiinae 'sp. Biologic-ISOP086' Buddelundiinae sp. indet. Laevophiloscia 'sp. Biologic-ISOP089' Laevophiloscia sp. indet.

Site - SRE05

Great Northern Highwa

Buddelundia `sp. Biologic-ISOP084` Buddelundiinae `sp. Biologic-ISOP086` Buddelundiinae sp. indet. Olpiidae `sp. Biologic-PSEU097`

Site - AS01 Site - SMUE-100 Lychas 'sp. SCO052' Buddelundia `10MA` SMUL-204 Site - LL08 Buddelundia `sp. SJ_10MA_DNA` Buddelundia `sp. SJ_14FMa`_DNA Olpiidae sp. indet. SMUL-205 Olpiidae `sp. Biologic-PSEU099` Site - VMUE-051 SREPT002 Buddelundia `sp. SJ_14FMc`_DNA Indolpium 'sp. MD1' Buddelundia 56 **SMUL-207** Buddelundia 14fm Buddelundia `sp. SJ_14FMa`_DNA Buddelundia indet. Site - LL11 Indolpium PSE175 Olpiidae sp. indet. Genus 7/4 PSE176 SMUL-218 Indolpium sp. Indolpium 'sp. Biologic-PSEU075' SMUL-221 Lychas hairy tail complex' Indolpium 'sp. MD1' Indolpium 'sp. MD1' Lychas SCO024 SMUL-224 Lychas SCO046 Idiosoma `sp. MD1` Buddelundia `sp. SJ_10MA_DNA` SMUL-22 Indolpium `sp. MD1` Indolpium 'sp. MD1' Olpiidae `sp. PSE176` 2 SREPT007 Buddelundia 14fm Buddelundia indet. 1 Dampetrus OPI001 Indolpium PSE174 Indolpium PSE175 Genus 7/4 PSE176 Lychas SCO024 Austrostrophus sp.

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Short-range endemics in the survey area (Option 8B) Figure 5-2

	Highway/Ro	bad				
	Watercourse					
8B O	ption					
	Hub & Rail	Spur				
Fauna	a Habitat					
	Boulder Piles					
	Cleared/Dis	turbed				
	Cracking Cl	ау				
	Drainage A	rea/ Floodplain				
	Drainage Li	nes				
	Gibber Crac	king Clay				
	Hilltops, Me	esas & Outcrops				
	Mulga Woo	dland				
	Rocky Hills					
	Rocky Plains & Footslopes					
	Snakewood					
	Stony Spinit Hillslopes	fex Plains and				
•	Short-range	e endemics				
	enere enge					
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Author	: TOD	Project: STR-001				
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 Scale: 1:200,000@A3

Data Source(s):
IBRA Subregions - Department of Climate Change, Energy,
Environment and Water 2022
Earthstar Geographics, Esri, CGIAR, Esri, HERE, Garmin, FAO,
NOAA, USGS, Esri, USGS

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