REPORT

WODGINA PROJECT: LEVEL 1 FAUNA SURVEY, TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEY & DESKTOP ASSESSMENT

PREPARED FOR **MINERAL RESOURCES LIMITED**

September 2018

Stantec

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Executive Summary

Mineral Resources Limited (MRL) is proposing to undertake expansion of the Wodgina Project (the Project). Mining has occurred at the Project since 1905 for tin, tantalum and beryl. More recently, Atlas Iron Limited (Atlas) operated the Project as a direct shipping ore project (DSO Project) between 2010 and 2017. MRL acquired the lithium rights to the Project in 2016 and has since been operating as a lithium DSO project. As part of the development, a pit expansion within the Eastern Range, construction of a lithium hydroxide processing plant and construction of a borefield and water pipeline will be required. The Project is located approximately 95 km south of Port Hedland in the Pilbara region of Western Australia.

As a result of the proposed expansion, a Level 1 vertebrate fauna survey (Level 1 fauna survey) was required to inform the environmental impact assessment (EIA) for the Project. Stantec Australia Pty Ltd (Stantec) was appointed by MRL to undertake the additional fauna survey work to assess two broad areas, collectively referred to as the Survey Area:

- Eastern Range and lithium hydroxide plant; and
- tenement L45/443.

Previous survey work has been undertaken within the proposed pit expansion area within the Eastern Range. To provide local context, Stantec undertook additional survey work of:

- the adjacent Eastern Range, which extends to the northeast of the proposed pit expansion;
- the lithium hydroxide plant, to inform potential impacts associated with native vegetation clearing; and
- tenement L45/443, which is proposed to be used for the construction of a borefield and water pipeline and has not been subject to any previous survey work.

In addition to the survey work, Stantec undertook a desktop assessment to collate and consolidate all previous fauna survey work that has been completed in the vicinity of the Project (including this current survey). This work involved consolidating the habitat mapping from surveys conducted over multiple years. Additionally, it involved a reassessment of the likelihood of occurrence of conservation significant fauna, taking into account all previous records and the consolidated habitat mapping. The areas considered during the desktop assessment are referred to as the:

- Mine Study Area (which encompasses the current Survey Area); and
- Gas Pipeline and Aerodrome Study Area ("Study Areas").

The objectives of the Level 1 fauna survey and desktop assessment were to define the environmental values of the Survey Area, the Mine Study Area and the Gas Pipeline and Aerodrome Study Area, and to assess the conservation significance of these areas in relation to the Project. The objectives were addressed by undertaking a field survey and desktop assessment, to consolidate all previous fauna work conducted within, and adjacent, to the Project. The desktop assessment was divided into the Mine Study Area and the Gas Pipeline and Aerodrome Study Area, with the Survey Area included within the Mine Study Area. Two Study Areas were delineated due to the differences in habitats occurring within each, and therefore the differences in the potential occurrence of conservation significant fauna.

Based on the desktop assessment, a total of 382 fauna species have potential to be recorded within the Study Areas. Of these, a total of 57 species of vertebrate fauna were recorded during the Level 1 fauna survey, comprising 20 mammals, 33 birds and four reptiles. This diversity is similar to that recorded during surveys of similar intensity, adjacent to the Project. Of the vertebrate fauna identified during the desktop assessment, 42 species are listed as being of conservation significance, comprising nine mammals, 31 birds and two reptiles. During the Level 1 fauna survey, the following conservation significant species were recorded and therefore confirmed to occur:

- the northern quoll (*Dasyurus hallucatus*, EN; EN);
- the ghost bat (*Macroderma gigas*, VU; VU);
- the Pilbara leaf-nosed bat (*Rhinonicteris aurantius* (Pilbara form), VU; VU); and

- the western pebble-mound mouse (*Pseudomys chapmani*, P4).

The Gas Pipeline and Aerodrome Study Area is comprised of different habitats, and consequently substantially different conservation significant fauna records, to the Mine Study Area. Conservation significant fauna confirmed in the Gas Pipeline and Aerodrome Study Area from the desktop assessment comprised:

- the greater bilby (*Macrotis lagotis*, VU; VU)
- the spectacled hare-wallaby (*Lagorchestes conspicillatus leichardti*, P3)
- the brush-tailed mulgara (*Mulgara Dasycercus blythi*, P4)
- the western pebble-mound mouse (*Pseudomys chapmani*, P4)
- the fork-tailed swift (*Apus pacificus*, MI; IA)

Six broad habitats were identified, delineated and described within the Survey Area. These habitats comprised ironstone ridge top, rocky ridge and gorge, rocky foothills, stony rise, spinifex stony plain and drainage line. Based on the desktop assessment, these habitats were found to be well represented within the Mine Study Area. Additionally, three habitats were delineated exclusively within the Gas Pipeline and Aerodrome Study Area; shrubland over spinifex, spinifex sandplain and low vegetation with ephemeral areas.

Within these habitats, two significant microhabitats were identified; semi-permanent pools and diurnal bat roosts. The semi-permanent pools were predominantly located along a rocky drainage line in the southern portion of the Survey Area. These pools are important for supporting a range of fauna assemblages as well as providing habitat and resources for specific conservation significant fauna, including the Pilbara leaf-nosed bat, ghost bat, northern quoll and the Pilbara olive python. One diurnal Pilbara leaf-nosed bat roost, classified as a 'transitory diurnal roost', and five diurnal ghost bat roosts were identified in the Mine Study Area.

Of the broad habitats that occur across the Study Areas, rocky ridge and gorge was considered to provide particularly high value for conservation significant fauna, as it comprised breeding and denning sites for the northern quoll, and roost sites for the Pilbara leaf-nosed bat and ghost bat. This habitat is also of limited extent and is not widespread outside of the Project area. Other habitats which supported a number of conservation significant fauna included spinifex sandplain and shrubland over spinifex sandplain. These were dominated by sandy substrates, which have potential to support the bilby and brush-tailed mulgara; however, this habitat was assessed as widespread in the region. Both Study Areas are known to provide habitat for the western pebble-mound mouse; however, the species records were primarily associated with spinifex stony plains, which are widespread in the landscape. A number of other conservation significant fauna were found to occur in the Study Areas in either sparse numbers, or were considered likely to occur based on records in the surrounds. The habitats within the Study Areas may be of importance to these species, but to a lesser degree than those discussed above.

Mineral Resources Limited

Wodgina Project: Level 1 Fauna Survey, Targeted Conservation Significant Fauna Survey & Desktop Assessment

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1. Introduction

1.1 Project Background, Location and Scope

Mineral Resources Limited (MRL) is proposing to undertake expansion of the Wodgina Project (the Project). Mining has occurred at the Project since 1905 for tin, tantalum and beryl (Global Advanced Metals 2018). More recently, Atlas Iron Limited (Atlas) operated the Project as a direct shipping ore project (DSO Project) between 2010 and 2017. MRL acquired the lithium rights to the Project in 2016 and has since been operating as a lithium DSO project. As part of the development, a pit expansion within the Eastern Range, construction of a lithium hydroxide plant and construction of a borefield and water pipeline will be required. The Project is located approximately 95 km south of Port Hedland in the Pilbara region of Western Australia (**Figure 1-1**).

As a result of the proposed expansion, a Level 1 vertebrate fauna survey (Level 1 fauna survey) was required to inform the environmental impact assessment (EIA) for the Project. Stantec Australia Pty Ltd (Stantec) was appointed by MRL to undertake the additional fauna survey work to assess two broad areas, collectively referred to as the Survey Area (**Figure 1-2**):

- Eastern Range and lithium hydroxide plant; and
- tenement L45/443.

Previous survey work has been undertaken within the proposed pit expansion area within the Eastern Range (360 Environmental 2018d). To provide local context, Stantec undertook additional survey work of:

- the adjacent Eastern Range, which extends to the northeast of the proposed pit expansion;
- the lithium hydroxide plant, to inform potential impacts associated with native vegetation clearing; and
- tenement L45/443, which is proposed to be used for the construction of a borefield and water pipeline and has not been subject to any previous survey work.

In addition to the survey work, Stantec undertook a desktop assessment to collate and consolidate all previous fauna survey work that has been completed in the vicinity of the Project (including this current survey). This work involved consolidating the habitat mapping from surveys conducted over multiple years. Additionally, it involved a reassessment of the likelihood of occurrence of conservation significant fauna, taking into account all previous records and the consolidated habitat mapping. The areas considered during the desktop assessment are referred to as the:

- Mine Study Area (which encompasses the current Survey Area) (**Figure 1-2**); and
- Gas Pipeline and Aerodrome Study Area ("Study Areas") (**Figure 1-2**).

1.2 Objectives

The objectives of the Level 1 fauna survey and desktop assessment were to define the environmental values of the Survey Area, the Mine Study Area and the Gas Pipeline and Aerodrome Study Area, and to assess the conservation significance of these areas in relation to the Project. Specific tasks undertaken to address the objectives included:

- completion of a desktop assessment to summarises all previous fauna survey work, including the consolidation of existing habitat mapping and the conservation significant fauna records;
- completion of a Level 1 fauna survey to assess the Eastern Range, lithium hydroxide plant and tenement L45/443;
- discussion of findings in a local (current survey) and regional (historic data) context by comparing available data from other localities within the region; and
- presentation of revised likelihood of occurrence of conservation significant fauna.

The objectives and methods adopted for the Level 1 fauna survey and desktop assessment are aligned with the following guidelines:

- EPA Factor Guideline (EPA 2016a), Environmental Factor Guideline: Terrestrial Fauna;
- EPA Factor Guideline (DPaW 2016), Sampling Methods for Terrestrial Vertebrate Fauna;
- EPA Technical Guide (EPA 2016b), Technical Guidance – Terrestrial Fauna Surveys;
- Department of Water Heritage and the Arts (DEWHA) (2010), Survey Guidelines for Australia's Threatened Bats;
- Department of Environment (DoE) (2016b), Conservation Advice: *Rhinonicteris aurantia* (Pilbara form) Pilbara Leaf-nosed Bat;
- DoE (2016a), Conservation Advice: *Macroderma gigas* Ghost Bat;
- DoE (DoE 2016c), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral guideline for the endangered Northern Quoll *Dasyurus hallucatus*; EPBC Act Policy Statement;
- Department of Parks and Wildlife (DPaW) (2017), The conservation and management of the Bilby (*Macrostis lagotis*) in the Pilbara;
- DoE (2013), Matters of National Environmental Significance - significant impact guidelines 1.1 EPBC Act.

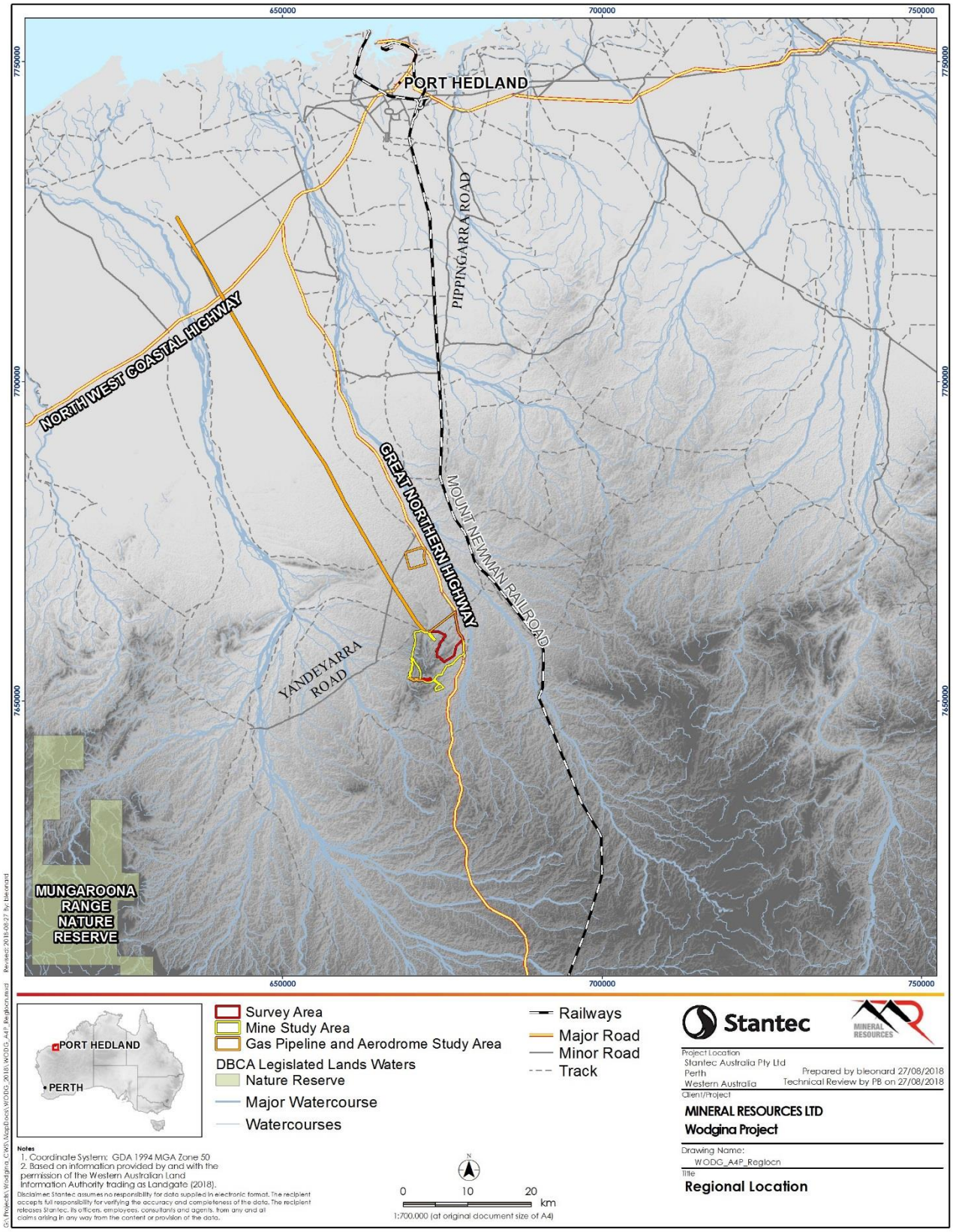


Figure 1-1: Regional location of the Project within the Pilbara region of Western Australia.

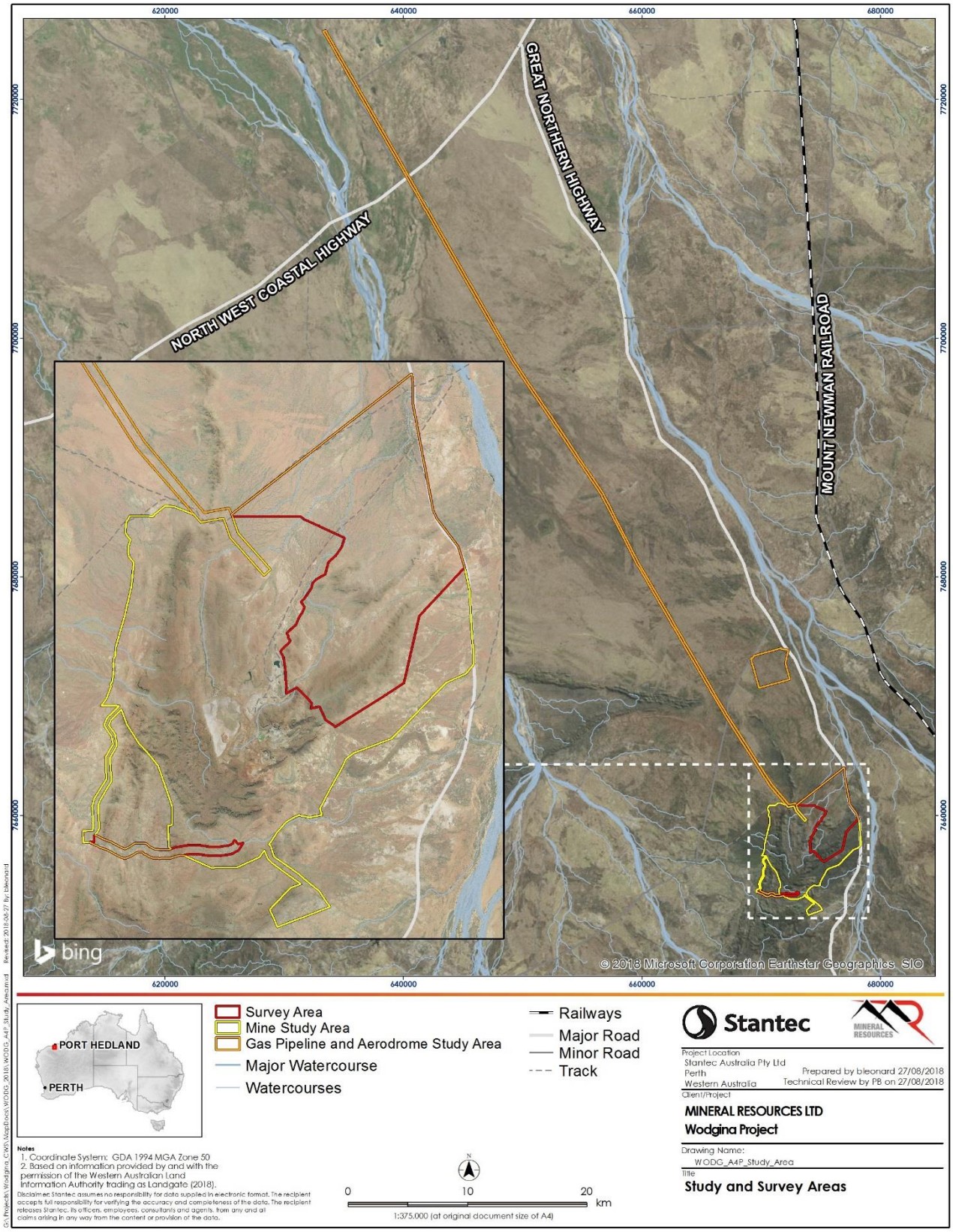


Figure 1-2: Location of the Survey Area, Mine Study Area and Gas Pipeline and Aerodrome Study Area.

2. Existing Environment

2.1 Biogeographic Region

The Interim Biogeographic Regionalisation for Australia (IBRA) is a bioregional framework that divides Australia into 89 bioregions and 419 subregions on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell 1995). It was developed through collaboration between state and territory conservation agencies with coordination by the Commonwealth Department of the Environment, Water, Heritage and the Arts (now the Commonwealth Department of the Environment and Energy; DoEE).

The Survey Area and Study Areas are located within the Chichester subregion of the Pilbara bioregion. The Chichester subregion is the largest of four Pilbara subregions, encompassing 47% (83,700 km^2) of the Pilbara bioregion (McKenzie *et al.* 2009). The Chichester subregion is characterised by undulating Archaean granite and basalt plains with substantial areas of basalt ranges (Kendrick and McKenzie 2001b). The basalt plains host a shrub steppe of *Acacia inaequilatera* over *Triodia* spp. hummock grasslands, while tree steppes of *Eucalyptus leucophloia* occur on the ranges (Kendrick and McKenzie 2001b).

2.2 Land Systems

A regional land survey was undertaken in the Pilbara region between 1995 and 1999, by the Department of Agriculture (now the Department of Primary Industries and Regional Development) and the Department of Land Administration (now the Western Australian Land Information Authority). The objective of the survey was to develop a comprehensive description of biophysical resources and assess the vegetation composition and soil condition within the region. This information was used by van Vreeswyk *et al.* (2004) to classify and map the land systems of the Pilbara region according to landform, soil, vegetation, geology and geomorphology.

Nine land systems occur within the Mine Study Area and the Gas Pipeline and Aerodrome Study Area (**Table 2-1**, **Figure 2-1**; **Figure 2-2**). The Mine Study Area is predominantly comprised of the Capricorn land system (48.5%), while the Uaroo land system occupies the 15.3% of the Gas Pipeline and Aerodrome Study Area.

Table 2-1: Extent of land systems occurring within the Study Areas.

Land System	Brief Description	Mine		Pipeline/Aerodrome	
		ha	%	ha	%
Capricorn	Hills and ridges of sandstone and dolomite supporting low shrublands or shrubby spinifex grasslands	3,396	48.5%	22	0.3%
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands	1,088	15.5%	59	0.8%
Uaroo	Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs	-	0.0%	1,070	15.3%
Platform	Dissected slopes and raised plains supporting shrubby hard spinifex grasslands.	639	9.1%	-	0.0%
Mallina	Sandy surfaced alluvial plains supporting soft spinifex grasslands and minor hard spinifex and tussock grasslands.	-	0.0%	355	5.1%
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard (and occasionally soft spinifex) grasslands	170	2.4%	-	0.0%
Macroy	Sandy/Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands	108	1.5%	-	0.0%
Ruth	Hills and ridges of volcanic and other rocks supporting shrubby hard spinifex and occasionally soft spinifex grasslands.	-	0.0%	67	1.0%
Talga	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands	27	0.4%	-	0.0%

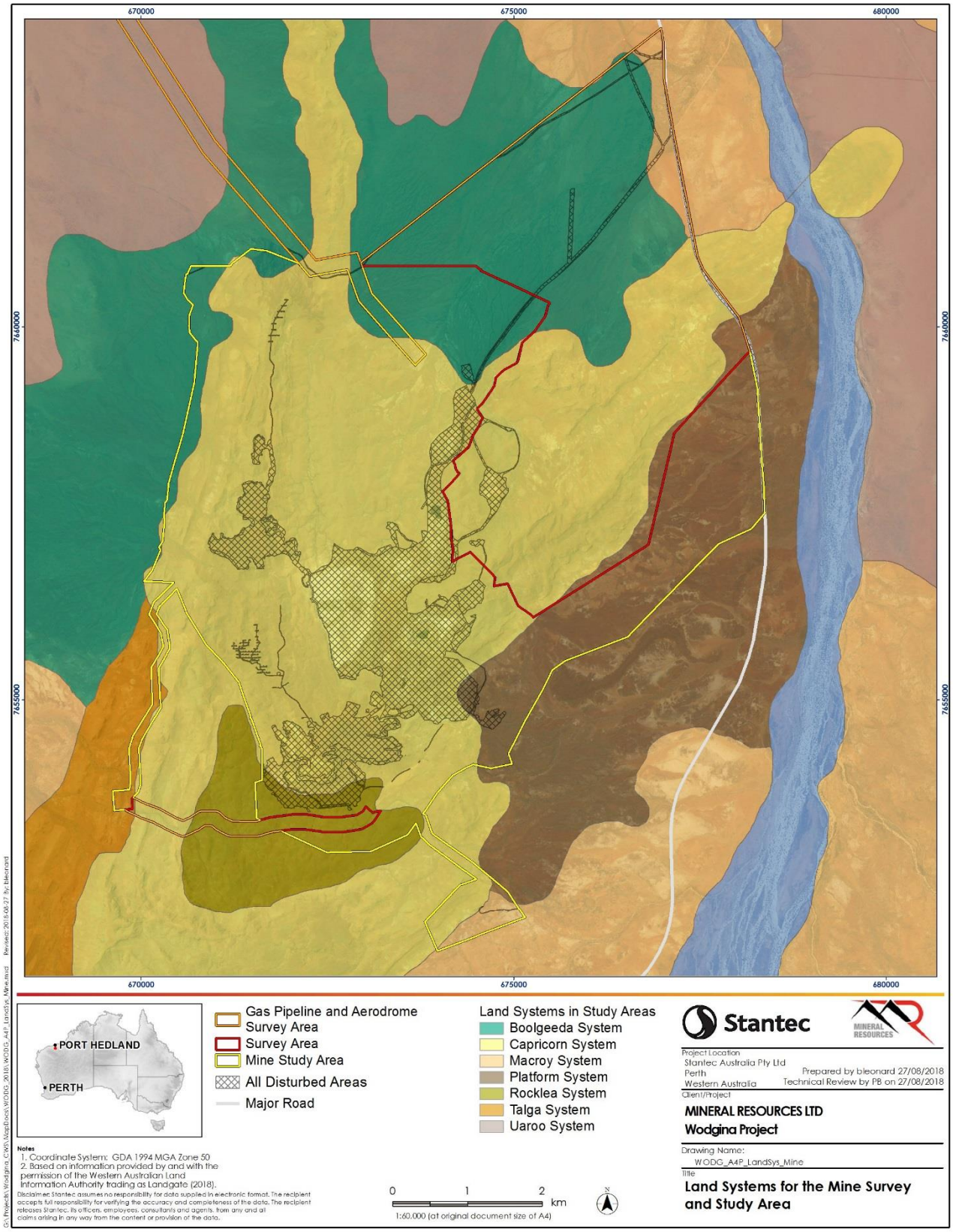


Figure 2-1: Land systems of the Mine Study Area.

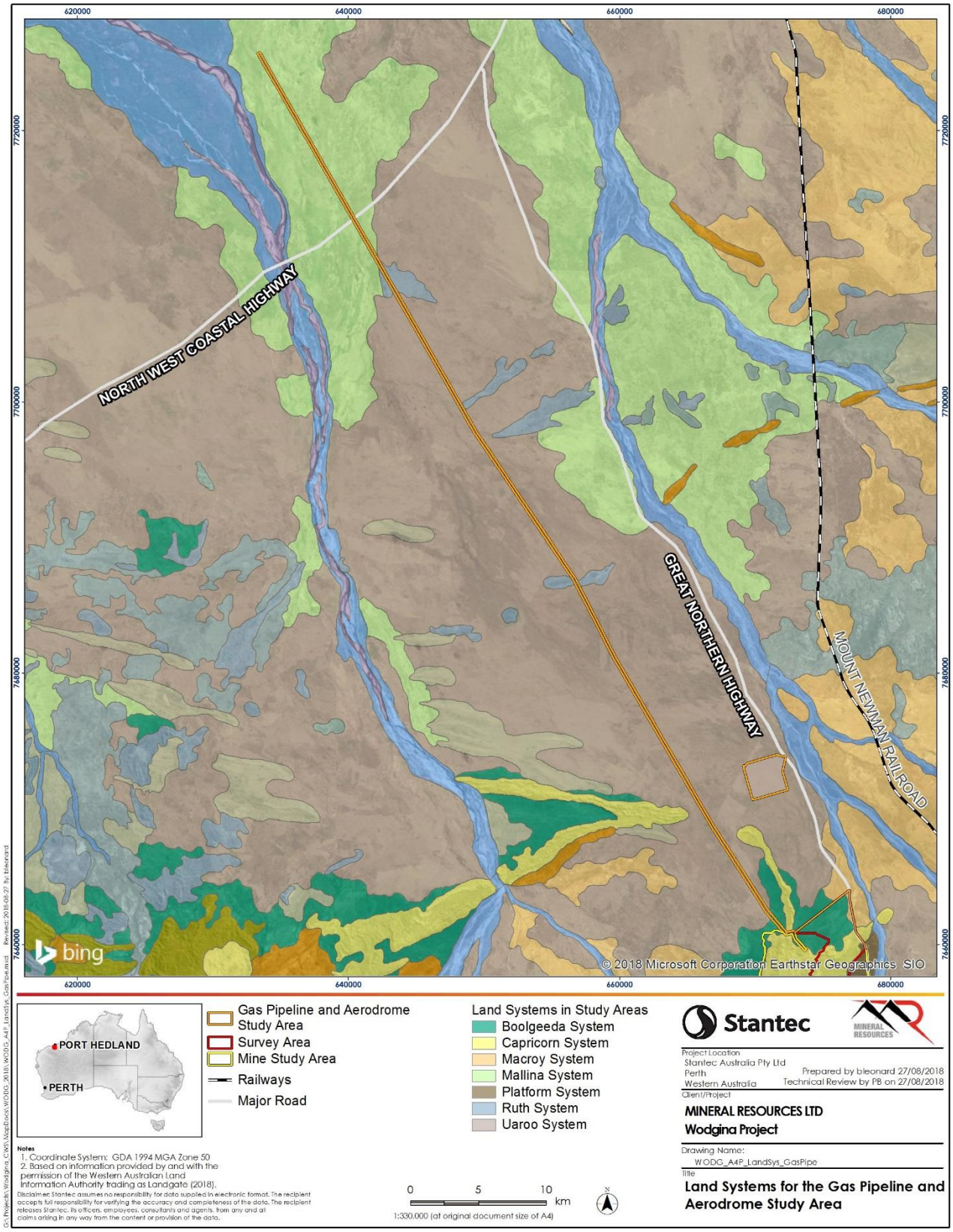


Figure 2-2: Land systems of the Gas Pipeline and Aerodrome Study Area.

2.3 Land Use

Land tenure in the Pilbara consists primarily of pastoral leases and, to a lesser extent, Aboriginal reserves and leasehold reserves. National parks, reserves and unallocated crown land (UCL) are the other major land uses in the region. Mining activity in the Pilbara commenced in the early 1800s and the area currently provides the majority of Western Australia's petroleum, gas and iron ore exports, while gold mining is also important (ANRA: Australian Natural Resources Atlas 2007).

In the Chichester subregion, land tenure is dominated by pastoral leases (i.e. cattle grazing of native pasture), Aboriginal lands and reserves, UCL, crown reserves, conservation, and mining (Kendrick and McKenzie 2001a). A total of 6.5% of the Chichester subregion has land surface reserved under some form of conservation, including Western Australia's second-largest conservation area, Karijini National Park, which covers approximately 620,000 ha.

2.3.1 Reserves

The Mungaroona Range Nature Reserve is located approximately 65 km south southwest of the Project, and is the only substantial portion of conservation estate within 100 km of the Study Areas. Knowledge of the fauna present in this Reserve is limited (Department of Environment and Conservation 2007) and the Department of Biodiversity, Conservation and Attractions (DBCA) proposes to gazette the Reserve as 'wilderness' under the *Conservation and Land Management Act 1984*, based on the following characteristics:

- the Reserve exceeds the minimum size criterion of 20,000 ha;
- there is currently no vehicle access into the Reserve, no built infrastructure and visitation to the Reserve is exceptionally low; and
- given the Reserve's considerable remoteness and lack of anthropogenic impacts, much of the Reserve's biodiversity and natural systems are likely to be intact.

2.4 Climate

The Survey Area and Study Areas are located in the northern part of the Pilbara bioregion, which has a semi-arid to arid-tropical climate characterised by hot summers and relatively warm, dry winters (BoM 2018). Tropical cyclones can occur between January and April, bringing sporadic drenching rainfall (How *et al.* 1991b). The Bureau of Meteorology (BoM) weather station located closest to the Project that records both temperature and rainfall is at Marble Bar (#4106), approximately 113 km to the east. Historic data collated between 2000 and 2018 from this station was used to provide contextual climate data for the Survey Area.

Summer in the Pilbara occurs from November to February when the mean maximum temperature for Marble Bar is 40.6°C (**Figure 2-3**) and the mean minimum temperature is 25.6°C. Marble Bar averages 98 days above 40°C per year (Leighton 2004). Winter occurs from June to August when the mean maximum temperature for Marble Bar is 28.2°C and the mean minimum temperature is 12.8°C (**Figure 2-3**).

The mean annual rainfall recorded at Marble Bar is 392.3 mm, with the majority falling between January and March (mean of 261 mm) in association with tropical lows(BoM 2018). Rainfall within the region can be highly localised and unpredictable (Leighton 2004), with substantial fluctuations occurring from year to year (BoM 2018).

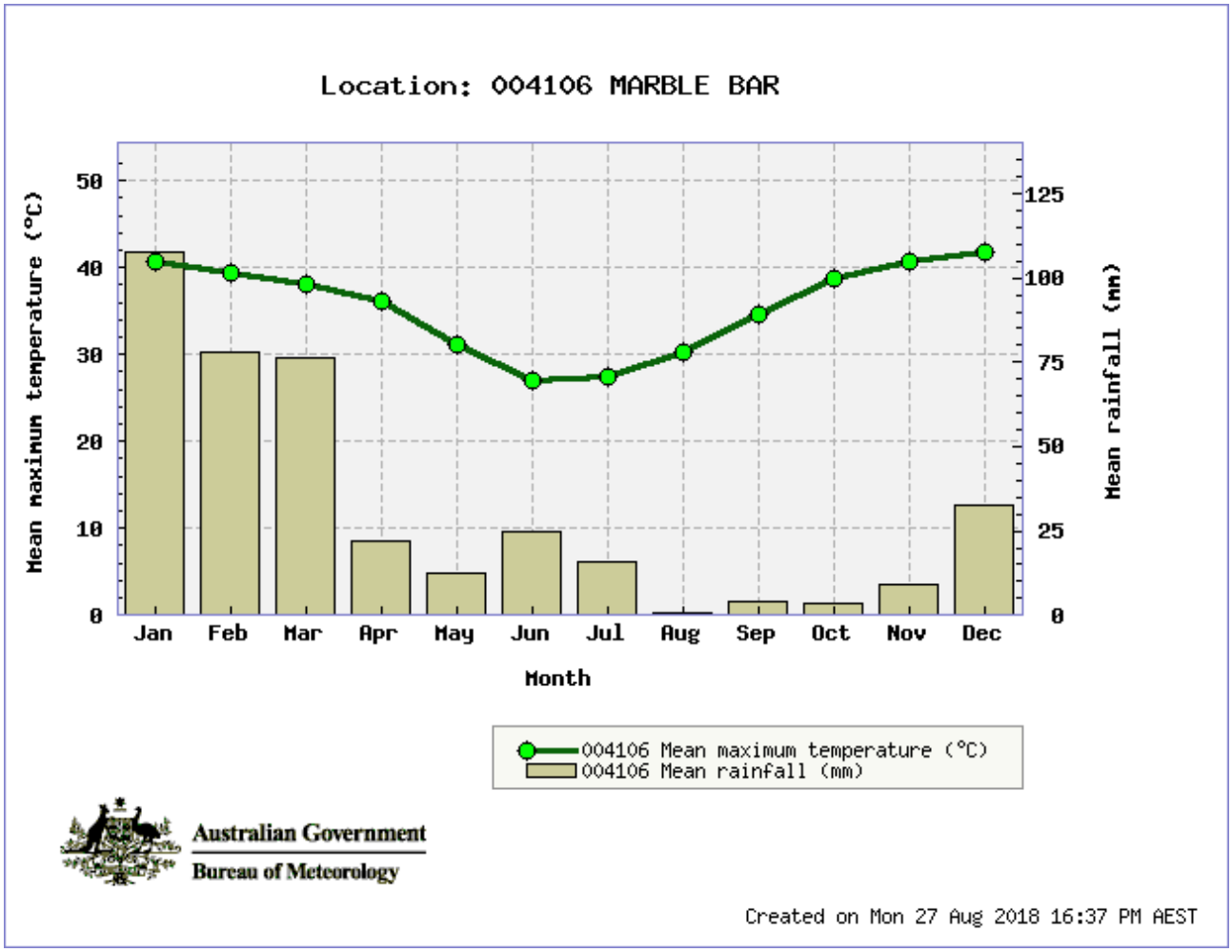


Figure 2-3: Long-term mean monthly rainfall and mean maximum temperature from the Marble Bar weather station (4106)between 2000 and 2018.

3. Methods

3.1 Desktop Assessment

A desktop assessment, comprising database searches and a literature review, was undertaken to: (a) identify fauna of conservation significance with the potential to occur in the Study Areas; (b) to inform targeted searches during the Level 1 field survey; (c) to provide contextual information (local and regional) for the EIA associated with each of the Study Areas. Fauna of conservation significance and conservation rankings used under the EPBC Act and *Wildlife Conservation Act 1950*(WC Act), as well as the DBCA Priority Fauna list, are defined in **Appendix A**.

3.1.1 Database Searches

Database searches were completed to generate a list of vertebrate fauna previously recorded within, and in the vicinity of the Study Areas, with an emphasis on species of conservation significance. Three databases were searched using central coordinates. Appropriate search buffers were selected for each database based on their technical capabilities as well as ecological features of the Study Areas (**Table 3-1**).

Table 3-1: Database searches conducted for the desktop assessment.

Authority	Database	Reference	Buffer (km)	Northwest Point	Southeast Point
DoEE	Protected Matters Search Tool (PMST)	(DoEE 2018a)	50	50K 650727 7695189	50 K 671112 7661747
DBCA	NatureMap	(DBCA 2018a)	40	50K 650727 7695189	50 K 671112 7661747
DBCA	Threatened and Priority Fauna	(DBCA 2018b)	15	15 km buffer of the Mine and Gas Pipeline & Aerodrome Study Areas*	

** Database search undertaken by 360 Environmental (2018d).*

3.1.2 Literature Review

A literature search of publicly-available information relating to vertebrate fauna within and adjacent to the Project was completed, to investigate the occurrence of conservation significant species and to consolidate habitat mapping. Information from the broader bioregion was also incorporated, where available. Information was compiled from reports, books, journals, and relevant government, university or regulatory publications. In addition, internal Stantec reports were also reviewed, due to the extensive body of work completed within the Project area in the past.

3.1.3 Fauna Habitat

The habitat types across the Study Areas were assessed on their extents and levels of significance according to the following criteria:

- Distribution: those habitats widespread and common within the surrounding regions were categorised as widespread; otherwise were categorised as being of limited extent.
- Significance: those habitats considered important to species of conservation significance or distinct fauna assemblages are deemed significant; otherwise they were categorised as being of limited significance.

3.1.4 Likelihood of Occurrence of Conservation Significant Fauna

Prior to conducting the Level 1 fauna survey, the likelihood of occurrence of conservation significant species within the Study Areas, identified from the desktop assessment, were assessed. The likelihood rankings were assigned using the following criteria:

Confirmed – the presence of the species in the Study Areas have been recorded unambiguously during the last ten years (i.e. during recent surveys of the Study Areas or from reliable records obtained via database searches).

Very Likely – the Study Areas lie within the known distribution of the species, is likely to contain suitable habitat(s), and has been recorded nearby within the last 20 years.

Likely – the Study Areas lie within the known distribution of the species and the species has been recorded nearby within the last 20 years; however, either:

- the Study Area is likely to contain only a small area of suitable habitat, or habitat that is only marginally suitable; or
- the species is generally rare and patchily distributed in suitable habitat.

Possible – there is limited likelihood of occurrence, because:

- the Study Area is outside the known distribution of the species, but is likely to contain suitable and sufficient habitat (the species may be common, rare, or patchily distributed); or
- the Study Area lies within the known distribution of the species, but the species is very rare and/or patchily distributed; or
- the Study Area lies on the edge of, or within, the known distribution and is likely to contain suitable habitat, but the species has not been recorded in the area for over 20 years.

Unlikely – the Study Area lies outside the known distribution of the species, is unlikely to contain suitable habitat, and the species has not been recorded in the area for over 20 years.

3.2 Level 1 Fauna Survey

3.2.1 Survey Timing

The Level 1 fauna survey was conducted from the 2nd to the 8th of July, 2018. This timing coincides with the Pilbara 'winter' months, preceding heavy rainfall and high temperatures of summer, and aligns with the period of greatest activity for the Pilbara leaf-nosed bat (Armstrong 2001).

A total of 408.2 mm of rainfall was received at Marble Bar in the six months preceding the field survey, 87.6 mm above the long-term average for the same time period. The majority of this rainfall (314 mm, 77%) was received in January 2018 and no rainfall was recorded for the duration of the field survey. Mean monthly maximum temperatures in the three months preceding the field survey were slightly below the average for the same time period.

3.2.2 Survey Team and Licensing

The field survey comprised of two teams lead by experienced Stantec zoologists Paul Bolton and Samantha Lostrom. Both have experience in working within the Pilbara bioregion, in particular, monitoring conservation significant bat and quoll species within the Project area. In addition, Paul and Samantha are experienced in undertaking biological assessments more generally throughout Western Australia. Stantec zoologists Emma Dobinson and Tom de Silva provided support to each team.

3.2.3 Field Survey

The fauna and habitat assessment techniques summarised in subsequent sections were undertaken across two broad areas, with the focus of each outlined below:

- Eastern Range and lithium hydroxide plant
    - Targeted survey to provide regional context on the distribution of conservation significant fauna within the Eastern Range (specifically northern quoll, Pilbara leaf-nosed bat and ghost bat), and habitat assessment to document the extent and description of habitat outside proposed impact areas.
    - Targeted survey to provide regional context on the distribution of conservation significant fauna within the area proposed for the lithium hydroxide plant (specifically greater bilby and mulgara), and habitat mapping and descriptions of the plains to the north of the Project to inform environmental approvals and provide options for its location.
- Tenement L45/443

- Level 1 fauna survey, comprising habitat descriptions and mapping, and targeted searches to inform environmental approvals for the clearing and construction of a water pipeline and borefield. This will complete the assessment for L45/443, which previously consisted of disconnected surveyed areas.

3.2.3.1 Habitat Assessments

A total of 54 fauna habitat assessments were undertaken within the Survey Area (**Figure 3-1**). At each location, the following key habitat parameters were recorded:

- description of broad vegetation community;
- hollow-bearing trees and dead stag trees (average size and abundance);
- presence of fauna refuges such as burrows;
- substrate (description of composition, presence of algal crust and percentage cover of leaf litter); and
- wetland habitats and water courses including drainage lines, sumplands, floodplains, etc.

3.2.3.2 Targeted Searches

Targeted searches included methods appropriate for the detection of all conservation significant fauna with potential to occur, but with a focus on detection of fauna considered to be a matter of national environmental significance (MNES; i.e. those listed under the EPBC Act). Key MNES species targeted during the survey included the following:

- bilby (*Macrotis lagotis*);
- northern quoll (*Dasyurus hallucatus*);
- ghost bat (*Macroderma gigas*);
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* (Pilbara form));
- Pilbara olive python (*Liasis olivaceus barroni*).

Targeted searches were conducted on foot with a focus on habitat suitable to support MNES species (**Figure 3-1**). Evidence of conservation significant species, including direct visual records, mounds, burrows, tracks, scat, carcasses and bones were recorded using the Fulcrum™ in-field data collection application. GPS track logs (GDA94) of the survey teams were recorded to demonstrate targeted survey effort.

3.2.3.3 SM2 Echolocation Recorders

A total of six SM2 echolocation bat recorders were deployed to detect Pilbara leaf-nosed bat and ghost bat activity in suitable habitat (e.g. caves, overhangs) within the Survey Area (**Figure 3-1**). Each deployment consisted of one preconfigured 384 kHz mono SM2 fitted with an external, omnidirectional SMX-US ultrasonic microphone. The location of each SM2 was selected to provide shelter from direct sun or rain, whilst retaining an unobstructed 'line of sight' between the microphone and the likely bat flyway. Each SM2 was preconfigured to activate at astronomical sunset each day and deactivate at astronomical sunrise the following morning.

When activated, SM2s passively listen for calls within a specified range of volume and frequency. On encountering a call within the set volume and frequency ranges, SM2s are triggered to record until the call ceases. Jumper settings, audio settings, selectable filters and selectable triggers used to preconfigure each SM2, and hence define the volume and frequency ranges sought, followed the manufacturer's recommendations for bat detection (Wildlife Acoustics 2011) (**Appendix B**).

3.2.3.4 Motion Sensor Camera

A total of 32 Reconyx HC600 motion-sensor cameras were deployed to record fauna species unlikely to be sighted opportunistically during the field survey, including conservation significant species such as the northern quoll and bilby (**Figure 3-1**; **Appendix C**). Cameras were placed in habitats likely to support fauna of conservation significance and in areas displaying fauna activity (e.g. burrows, foraging evidence, etc.). Cameras were deployed to ensure adequate coverage of habitats and also to achieve appropriate geographical coverage of the Survey Area.

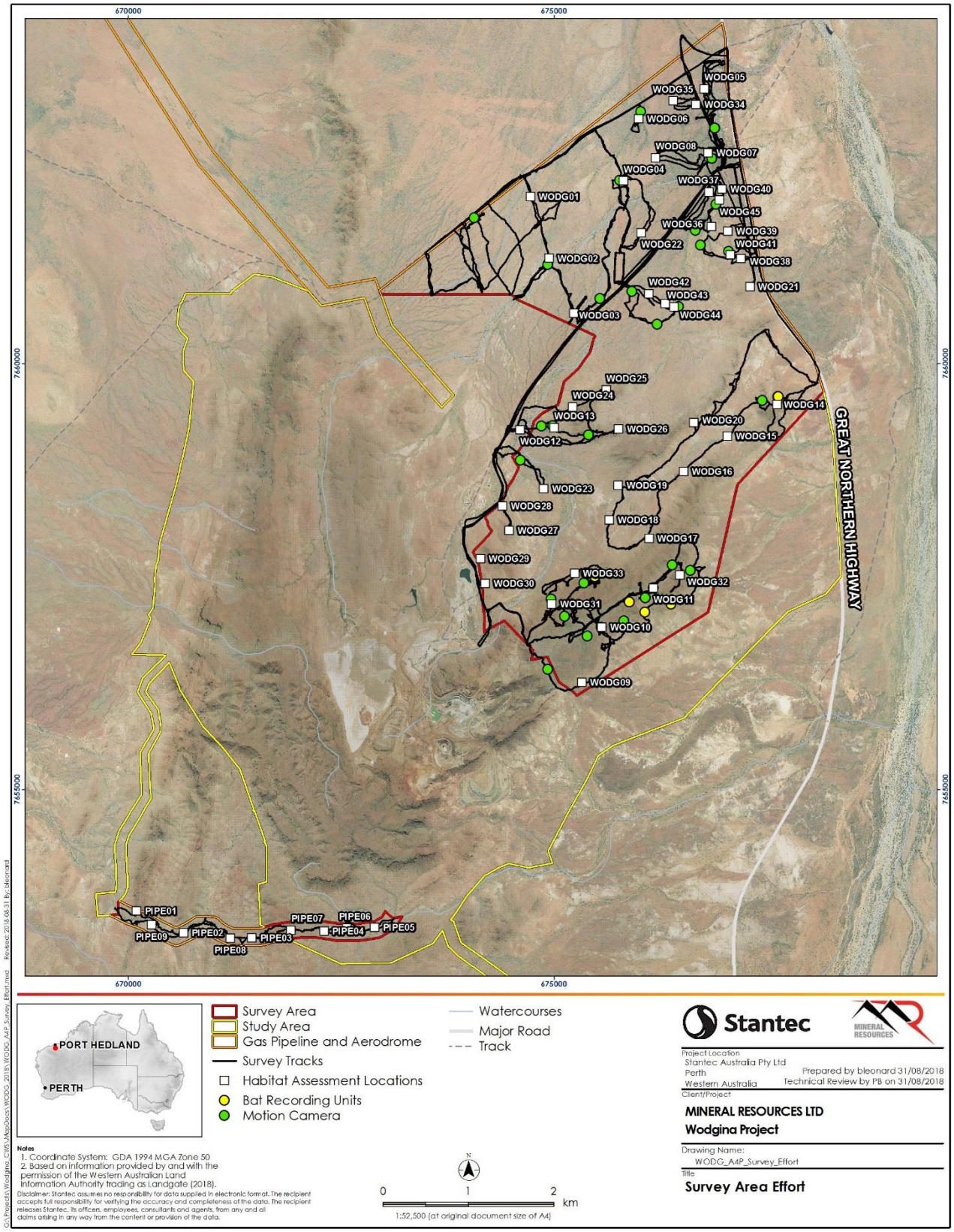


Figure 3-1: Habitat assessment sites, targeted search tracks, and locations of SM2 bat recording units and motion camera sites within the Survey Area.

3.3 Data Management

3.3.1 Echolocation Data Treatment

Individual bat calls were identified from echolocation recordings using COOL EDIT 2000 (now available as AUDITION from Adobe Systems Inc.). Once calls were identified, an experienced observer compared calls to a database of reference calls. Only good quality call sequences were used for ghost bat identification, as this species can be confused with the common sheath-tailed bat (*Taphozous georgianus*) if counts are based on poor quality calls (McKenzie and Bullen 2009).

When quantified, calls are referred to as 'passes'. For Pilbara leaf-nosed bats, the number of passes is an approximate reflection of the species activity at the location as individuals emit navigation calls in the vicinity of the microphone. Often one individual is responsible for multiple passes if it is active in close proximity to the SM2 for a period of time; therefore, the number of calls recorded is not necessarily related to the number of individuals inhabiting or visiting a cave. Estimates of activity based on passes should be considered as minimum measures, as an unknown percentage of the call sequence counted may have two or more bats present.

Ghost Bats are discussed in presence-absence terms only, as individuals of this species are capable of hunting and navigating entirely visually without calling, and are known to hang from cave walls for many minutes calling both socially and ultrasonically (Armstrong and Anstee 2000). Additionally, ghost bats may depart important day roost caves on dusk and not return until dawn (Armstrong and Anstee 2000), meaning that activity levels quantified using passes do not necessarily have any relationship with the significance of the cave to the species.

3.4 Survey Limitations and Constraints

The follow factors were assessed in terms of determining any limitations and constrains related to the Level 1 fauna survey (**Table 3-2**).

Table 3-2: Summary of limitations and constrains related to the Level 1 fauna survey.

Factor	Limitation / Constraint	Comments
Competency and experience of consultants	No	Field personnel are qualified Stantec zoologists, with the field team leads having extensive experience conducting fauna surveys, particularly surveys for conservation significant fauna of this nature within the Pilbara region. Field support personnel provided assistance during the field survey, and were trained in the identification of conservation significant fauna signs. All records were confirmed in the field.
Scope	No	The scope was well-defined. Fauna and their habitats were surveyed using standardised and well-established techniques involving targeted searches, motion camera trapping and echolocation recordings. Relevant databases and previous studies surrounding the Survey Area were reviewed.
Proportion of species identified	No	A total of 57 species were recorded during the survey which is comparable to the number of species recorded in the surrounding area. It should be noted that some of the surveys were Level 2 surveys and consequently had a higher representation of mammals and reptiles due to different techniques including trapping.
Information sources (e.g. historic or recent)	No	Stantec had access to all of the previous surveys conducted for Atlas which included approximately 10 years of baseline, targeted and monitoring surveys. Stantec conducted a detailed collation and consolidation of these survey reports, which included the Project area and adjacent areas.
Completeness and Intensity	No	Adequate survey coverage was achieved to describe and delineate the habitats within the Survey Area. Additionally, survey coverage specifically focused on obtaining adequate coverage of fauna habitats with potential to support fauna of conservation significance. Survey methods comprised: • 54 habitat assessments;

Factor	Limitation / Constraint	Comments
		• 6 echolocation recorder deployments; and • 32 motion camera deployments.
Timing / weather / season / cycle	No	The timing of the Level 1 fauna survey was adequate, and weather was appropriate for conducting survey work. No rainfall was recorded during the survey and conditions were appropriate for the activity of the conservation significant fauna considered to have potential to occur in the Survey Area (i.e. greater bilby, northern quoll, Pilbara leaf-nosed bat and ghost bat). Survey timing was outside the optimal time for detecting the Pilbara olive python; however, this species is unlikely to be present in high numbers within the Survey Area due to the limited proportion of drainage line habitat present.
Disturbances	No	Although the Project area has been subject to disturbance since 1905, the Survey Area showed very little disturbance. There were very few tracks that intersected the Survey Area and most access was required on foot.
Resources	No	Resources were adequate to complete the survey and the survey participants were physically fit and capable of achieving adequate coverage of the Survey Area. The survey leads were zoologists experienced at identifying secondary signs of conservation significant fauna and experienced in deploying scientific survey equipment, including motion cameras and echolocation recorders. DBCA database searches and data from previous survey reports were all used to prepare for the survey.
Remoteness / access problems	No	Limited vehicle access was available for majority of the Survey Area; however, this was not a constraint of the survey. Adequate survey coverage was achieved on foot as evidenced by the targeted search tracks.

4. Results and Discussion

4.1 Desktop Assessment

The literature review identified 29 previous surveys that have been undertaken in the vicinity of the Project. For the purposes of the desktop assessment, the surveys have been summarised into those that occurred within 15 km of the Project, to provide local context (**Table 4-1, Figure 4-1** and **Figure 4-2**), and those that occurred up to 75 km from the Project, to provide regional context (**Table 4-2**, **Figure 4-2**). Additionally, the species records from surveys within 15 km of the Project have been collated to generate a detailed inventory of the vertebrate fauna known to occur in the immediate vicinity of the Project (**Appendix E**).

Table 4-1: Summary of findings from fauna surveys conducted within 15 km of the Project.

Reference(s)	Survey Details	Proximity to Study Area	Methods	Habitats	Fauna Recorded	Species of Conservation Significance*
(360 Environmental 2018d)	Project: Wodgina Mine and Additional Gas Pipeline Client: Mineral Resources Limited Survey type: • Reconnaissance Flora and Vegetation Survey • Level 1 Vertebrate Fauna Survey with a Targeted Northern Quoll (*Dasyurus hallucatus*) Survey Survey date: Jan-Feb 2018	Adjacent and within portions of the Study Area	• fauna habitat assessments, • systematic bird searches, • opportunistic observations • remote camera trapping • targeted northern quoll survey comprising of searches and motion cameras	• Grassland - Hills, midslopes, upperslopes and ridges over rock; • Grassland - Foot slopes, low rises, undulating plain over rock; • Grassland - Flat plain on sand with isolated Eucalypts and shrubs; • Low Woodland / Shrubland - Eucalyptus and Acacia over Triodia Grassland; • Low-lying Habitat with ephemeral wet areas; • Major Drainage Lines; and • Rocky Ironstone Ridge / Rocky Ironstone Valley.	64 terrestrial vertebrate fauna: • 14 mammals • 36 birds • 13 reptiles • 1 amphibian	Threatened: • Northern Quoll, • Greater Bilby Priority: • Western Pebble-mound Mouse Migratory: • Fork-tailed Swift
(360 Environmental 2018c)	Project: Wodgina Mine Site and Proposed Airstrip Client: Mineral Resources Limited Survey type: • Reconnaissance Flora and Vegetation Survey • Level 1 Vertebrate Fauna Survey with a Targeted Northern Quoll (*Dasyurus hallucatus*) Survey Survey date: Dec 2017	Adjacent and within portions of the Study Area	• fauna habitat assessments, • systematic bird searches, • opportunistic observations • remote camera trapping • targeted northern quoll survey comprising of searches and motion cameras	• Grassland - Hills, midslopes, upperslopes and ridges over rock; • Grassland - Foot slopes, low rises, undulating plain over rock; • Grassland – Flat plain on sand with low Eucalyptus Woodland; • Major Drainage Line; and • Rocky Ironstone Ridge / Rocky Ironstone Valley.	57 terrestrial vertebrate fauna: • 11 mammals • 38 birds • 8 reptiles	Threatened: • Northern Quoll, Priority: • Western Pebble-mound Mouse
(360 Environmental 2018b)	Project: Wodgina Gas Pipeline Targeted Fauna Survey Client: Mineral Resources Limited Survey type: Targeted survey: • Bilby • Brush-tailed Mulgara • Ghost Bat • Pilbara Leaf-nosed Bat • Western Pebble-mound Mouse Survey date: June 2018	Adjacent to the Study Area	• 46xBilby monitoring quadrats • 36xMotion cameras • 13xBat echolocation recorders (SM2) • 9x SRE sites	• See 360 Environmental (2018d)	Bilby: • Scats and diggings limited to a portion of the SA north of North West Coastal Highway. • No Burrows. Brush-tailed Mulgara: • Scats and diggings limited to a portion of the SA north of North West Coastal Highway. Ghost Bat • No records Pilbara Leaf-nosed Bat • 2 records demonstrating limited foraging Western Pebble-mound Mouse • No records	Threatened: • Bilby (30 records) • Pilbara Leaf-nosed Bat (2 records) Priority: • Brush-tailed Mulgara (30 records)
(360 Environmental 2018b)	Project: Wodgina Aerodrome Targeted Fauna Survey Client: Mineral Resources Limited Survey type: Targeted survey: • Bilby; • Brush-tailed Mulgara; • Western Pebble-mound Mouse; and • Ghost and Pilbara Leaf-nosed Bat; and • Short-range Endemics. Survey date: June 2018	Approx 10 km north	• 46xBilby monitoring quadrats • 12xMotion cameras • Active searching • Opportunistic collection	Broad habitat • Grassland – on sand with low Eucalyptus Woodland Microhabitats: • Quartz Outcrop • Low-lying habitat	Vertebrate taxon: • 3 species	Threatened: • Bilby (2 records) • Pilbara-leaf Nosed Bat (1 call) Priority: • Brush-tailed Mulgara (4 records) SRE: • Scutigeridomorpha Scutigeridae (SRE status pending)
(MWH 2014d;2015d;2016b; Outback Ecology 2010c;2011f;2012h;2013f; Stantec 2017b)	Project: Wodgina DSO project Client: Atlas Iron Limited Survey type:	Approx. 4 km south	• Elliott trapping • Targeted searching • Motion sensor cameras • Opportunistic recording	See Outback Ecology (2009b)	1 vertebrate taxon: • 1 mammal	Threatened: • Northern Quoll

Reference(s)	Survey Details	Proximity to Study Area	Methods	Habitats	Fauna Recorded	Species of Conservation Significance*
	Targeted Northern Quoll monitoring Survey date: 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017					
MWH (2014e;2015e;2016c); Outback Ecology (2011b;2011g;2011h;2011i;2012c;2013g); Stantec (2017a)	Project: Wodgina DSO Project Client: Atlas Iron Limited Survey type: Targeted bat monitoring Survey date: 2011, 2012, 2013, 2014, 2015, 2016, 2017	Approx. 4 km south	• Targeted searching • AnaBat • Opportunistic recording	See Outback Ecology (2009b)	7 vertebrate taxa: • 7 mammal	Threatened: • Pilbara Leaf-nosed Bat • Ghost Bat
(Outback Ecology 2012f)	Project: Hercules Direct Shipping Ore (DSO) Project Client: Atlas Iron Limited Survey type: One-phase, Level 2 survey Survey date: March 2011	Within 5 km	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	• Rocky Ridge; • Spinifex Stony Plain; • Scree Slope; • Drainage Line; and • Rocky Foothills.	85 vertebrate taxa: • 12 mammal • 39 bird • 31 reptile • 3 frog	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat Priority: • Western Pebble-mound Mouse
(Outback Ecology 2012e)	Project: Hercules Direct Shipping Ore (DSO) Project Client: Atlas Iron Limited Survey type: Terrestrial Short-range Endemic Invertebrate Fauna Baseline Survey Survey date: March –April 2011	Within 5 km	• Targeted searching • Wet pitfall trapping • Leaf litter processing (Tullgren funnels) • Soil sieving	• Rocky ridge and gorge • Drainage line • Ironstone ridge top • Rocky foothill • Scree slope • Stony plain	1,688 invertebrate specimens from 36 species. • Slaters: 1,206 individuals from 12 species • Pseudoscorpions: 245 specimens from 11 species • Snails: 186 specimens from 6 species • Scorpions: 35 specimens from 4 species • Millipedes: 15 specimens from 2 species • araneomorph spiders 1 specimen	Potential SREs: • selenopid spider Karaops SEL003.; • pseudoscorpion Synsphyronus 'sp. PSE012'; • slater Buddelundia sp. nov. 21; • slater Buddelundia sp. nov. 31; • slater Buddelundia sp. nov. 36; • slater Gen. nov. sp. nov. 5; • slater Unknown genus sp. nov; and • camaenid Gen. nov. sp. nov.
(Outback Ecology 2010b)	Project: Wodgina DSO Project Stage 2 Targeted Terrestrial Snail Survey Client: Atlas Iron Limited Survey type: Targeted snail survey Survey date: July 2010	Survey area overlaps portions of the Study Areas	• Targeted searches of 25 sites	• Ficus trees were specifically targeted during this survey.	433 specimens of an undescribed camaenid species.	The undescribed species is considered a potential SRE species.

Reference(s)	Survey Details	Proximity to Study Area	Methods	Habitats	Fauna Recorded	Species of Conservation Significance*
(Outback Ecology 2010a)	Project: Turner River Hub Terrestrial Vertebrate Fauna Baseline Survey Client: Atlas Iron Limited Survey type: Two phase Level 2 survey Survey date: April-May 2010 and Sept-Oct 2010.	Large scale survey: The Turner River Hub portion of the Study Area partially overlaps the Study Area	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	Within Turner River Hub portion of the Study Area • Acacia, spinifex on sandplain • Drainage line • Riverine • Rocky foothills • Spinifex sandplain • Spinifex stony plain • Stony rise	Within Turner River Hub portion of the Study Area 95 vertebrate fauna: • 20 mammal • 41 bird • 33 reptile • 1 frog	Within Turner River Hub portion of the Study Area Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat Priority: • Western Pebble-mound Mouse
(Outback Ecology 2011e)	Project: Turner River Hub Project Terrestrial Short-range Endemic Invertebrate Fauna Baseline Survey Client: Atlas Iron Limited Survey type: Single phase Level 2 survey Survey date: March – May 2010.	Large scale survey: The Turner River Hub portion of the Study Area partially overlaps the Study Area	• wet pitfall trapping, • leaf litter collection, • soil sieving, • ultraviolet (UV) spotlighting • targeted searching.	Within Turner River Hub portion of the Study Area. SRE habitats comprised: • Drainage depression • Riverine • Drainage line	Within Turner River Hub portion of the Study Area 1004 specimens: • Mygalomorph spiders 8 specimens from 2 species • Scorpions 18 specimens from 6 species • Pseudoscorpions 533 specimens from 2 species • Slaters 445 specimens from 5 species	Within Turner River Hub portion of the Study Area • None of the specimens collected were found to represent known or potential SRE species
Outback Ecology (2011d)	Project: Mount Dove DSO Project Client: Atlas Iron Limited Survey type: Two-phase, Level 2 survey Survey date: May and September 2010	Approx. 34 km north-west	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	• Acacia, Spinifex on Sandplain • Acacia Shrubland on Footslopes • Rocky Ridge • Stony Rises	92 vertebrate taxa: • 23 mammal • 40 bird • 29 reptile	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat Priority: • Western Pebble-mound Mouse
(MWH 2014b;2015c); Outback Ecology (2011c); (Outback Ecology 2012g;2013c)	Project: Mt Dove DSO project Client: Atlas Iron Limited Survey type: Targeted Northern Quoll monitoring Survey date: 2011, 2012, 2013, 2014, 2015,	34 km north-west	• Elliott trapping • Targeted searching • Motion sensor cameras • Opportunistic recording	See Outback Ecology (2011d)	1 vertebrate taxon: • 1 mammal	Threatened: • Northern Quoll
(MWH 2014c; Outback Ecology 2013d;2014b)	Project: Mt Dove DSO project Client: Atlas Iron Limited Survey type: Targeted bat monitoring Survey date: 2012, 2013, 2014	34 km north-west	• Targeted searching • AnaBat • Opportunistic recording	See Outback Ecology (2011d)	7 vertebrate taxa: • 7 mammal	Threatened: • Pilbara Leaf-nosed Bat • Ghost Bat
Outback Ecology (2009b)	Project: Wodgina Direct Shipping Ore (DSO) Project Client: Atlas Iron Limited Survey type: One-phase, Level 2 survey Survey date: April-May and July-August 2009	Within 5 km	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	• Ridge • Hill Crest • Scree Slope • Minor Drainage Line • Gully • Open Mixed Shrubland • Low Stony Rise/Hills • Minor Gorge	90 vertebrate taxa: • 18 mammal • 45 bird • 25 reptile • 2 frog	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat Priority: • Long-tailed Dunnart • Western Pebble-mound Mouse

Reference(s)	Survey Details	Proximity to Study Area	Methods	Habitats	Fauna Recorded	Species of Conservation Significance*
(Outback Ecology 2009a)	Project: Wodgina Direct Shipping Ore (DSO) Project Client: Atlas Iron Limited Survey type: Two-phase, SRE survey Survey date: May & July 2009	Within 5 km	• Dry pitfall trapping • Targeted searching • Litter collection • Soil sieving • UV night searching	Potential SRE habitats comprised: • South facing ridges and outcropping • Minor gorges • Gullies and minor drainage lines	two mygalomorph spider specimens, • 19 scorpions, • 10 pseudoscorpions, • six millipedes, • seven slaters and • 21 snail specimens	None of the specimens collected were found to represent known or potential SRE species
Bamford (2008)	Project: Wodgina Tailings Storage Facility 3 Client: Sons of Gwalia Survey type: Level 1 survey Survey date: April-May 2008	Within 1 km	• Microhabitat searching • Avifauna census • Spotlighting • Targeted searching • Opportunistic recording	• Low stony rises • Narrow drainage systems • Minor drainage tracts • Rocky ridges • Gullies and minor gorges • Previously disturbed areas	73 vertebrate taxa: • 11 mammal • 49 bird • 11 reptile • 2 frog	Threatened: • Northern Quoll • Pilbara Olive Python (anecdotal evidence) • Ghost Bat Priority: • Western Pebble-mound Mouse
Mattiske Consulting (2000)	Project: Wodgina Expansion Project Client: Sons of Gwalia Survey type: Desktop study Survey date: November 2000	Within 1 km	• Database searches • Field survey for vegetation communities • No field observations for fauna	• *Eucalyptus* woodlands (four types) • *Acacia* shrublands (two types) • Hummock grasslands (12 types)	254 vertebrate taxa: • 32 mammal • 109 bird • 102 reptile • 11 frog	Threatened: • Northern Quoll • Pilbara Olive Python • Pilbara Leaf-nosed Bat • Ghost Bat • Peregrine Falcon Priority: • Grey Falcon • Western Pebble-mound Mouse Migratory: • Several species of waterbird

** Conservation listings have been updated and may not match those presented in each of the original reports; the Turner River Hub (TRH) survey covered a large linear Study Area comprising 62,381 ha and crossing a large number of habitats. The results presented here are for the portion of the TRH that occurred in close proximity to the Project.*

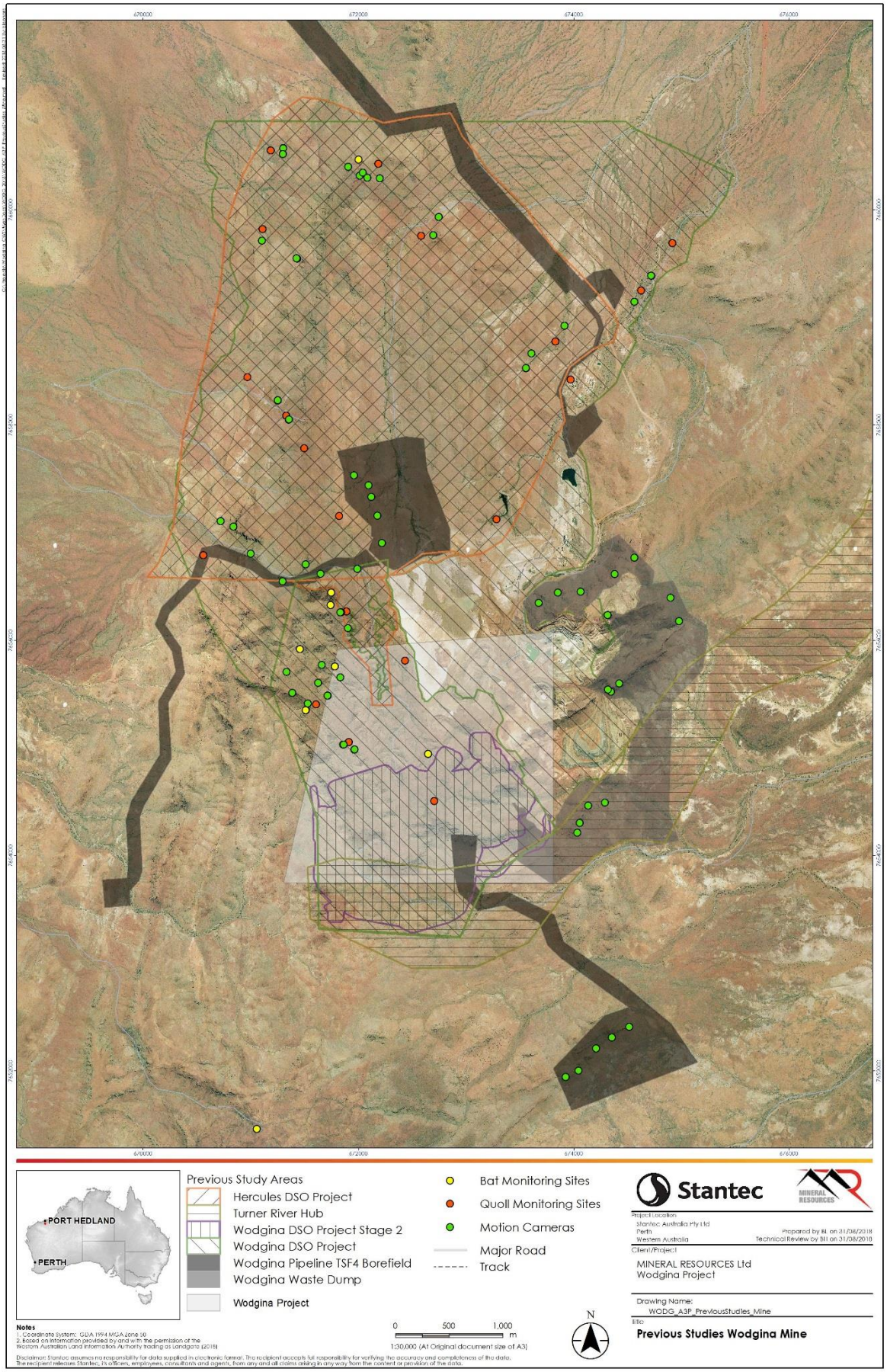


Figure 4-1: Previous fauna survey and monitoring around the mine study area.

Table 4-2: Summary of findings from fauna surveys conducted up to 75 km of the Project.

Reference(s)	Survey Details	Proximity to Study Area	Methods	Habitats	Fauna Recorded	Species of Conservation Significance*
(Outback Ecology 2011b)	Project: Abydos DSO Project Client: Atlas Iron Limited Survey type: Two-phase, Level 2 survey Survey date: April/May and September 2010	Approx. 45km east	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	• Rocky Ridges and Gorges • Rocky Foothills • Drainage Lines • Stony Rises	104 vertebrate taxa: • 18 mammal • 39 bird • 41 reptile • 3 amphibians • 3 fish	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Pilbara Olive Python • Ghost Bat
(MWH 2014b;2015a; Outback Ecology 2011a;2012b;2013b)	Project: Abydos DSO Project Client: Atlas Iron Limited Survey type: Northern Quoll Survey Survey date: 2011, 2012,	Approx. 45km east	• Elliott trapping • Cage trapping	• Major Sandstone Gorge • Major Ironstone Gorge • Ironstone Ridge • Major Drainage Line • Low Rounded Hills		Threatened: • Northern Quoll
(MWH 2014a;2015b; Outback Ecology 2012a;2013a)	Project: Abydos DSO Project Client: Atlas Iron Limited Survey type: Conservation Significant Bat Annual Monitoring Survey date: 2012	Approx. 45km east	• Echolocation recording	• Major Sandstone Gorge • Major Ironstone Gorge • Ironstone Ridge • Major Drainage Line • Low Rounded Hills		Threatened: • Pilbara Leaf-nosed Bat • Ghost Bat
Bamford Consulting Ecologists (2009)	Project: Abydos DSO Project Client: Atlas Iron Limited Survey type: Two-phase, Level 2 survey Survey date: October 2008 and April 2009	Approx. 45 km east	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	• Ironstone Ridges • Sandstone Ridges • Major Gorges • Cliff Faces • Major Drainage Lines • Permanent Water Holes and Springs • Caves • Stony Lower Slopes and Undulating Stony Plains • Spinifex Plains on Sand/loam Soil • Low Rounded Hills • Minor Gorges and Gullies • Cracking Clay Drainage	125 vertebrate taxa: • 17 mammal • 72 bird • 30 reptile • 4 frog • 2 fish	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat • Pilbara Olive Python Priority: • Western Pebble-mound Mouse
Outback Ecology (2010a)	Project: Turner River Hub Project Client: Atlas Iron Limited Survey type: Two-phase, Level 2 Survey date: April-May and September-October 2010	Between 5 km east, 90km north and 75km SE.	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Motion sensor cameras • Opportunistic recording	• Spinifex Sandplain • Spinifex Stony Plain • Stony Rise • Rocky Foothills • Rocky Ridges and Gorges • Acacia, Spinifex on Sandplain • Low Acacia Heath with Spinifex • Riverine • Hard Spinifex on Calcrete • Granite Uplands • Granite Outcrop • Drainage Line • Channel Iron Deposit • Mangrove Forest	228 vertebrate taxa: • 32 mammal • 105 bird • 80 reptile • 7 frog • 4 fish	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Pilbara Olive Python • Ghost Bat Priority: • Ramphotyphlops ganei • Spectacled Hare-wallaby • Brush-tailed Mulgara • Western Pebble-mound Mouse Migratory: • Whimbrel
(ecologia Environment 2012)	Project: North Star Client: Fortescue Metals Group	Approx 38 km east	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping	• Rocky spinifex hills; • Rocky plains with spinifex; • Rocky ridges/breakaway/gorges; • Sandy plains with spinifex and scattered granites;	184 vertebrate taxa: • 22 mammal • 81 bird • 75 reptile	Threatened: • Pilbara Olive Python • Ghost Bat • Pilbara Leaf-nosed Bat

Reference(s)	Survey Details	Proximity to Study Area	Methods	Habitats	Fauna Recorded	Species of Conservation Significance*
	Survey type: Level 2 terrestrial vertebrate fauna assessment		• Avifauna census • Systematic searching • Targeted searching • Spotlighting • SM2 bat recording • Motion sensor cameras • Opportunistic recording	• Acacia shrubland on hard soil; • Creek lines; and • Granite outcrops.	• 6 amphibian	• Northern Quoll Priority: • Star Finch (Western) • Fork-tailed Swift • Grey Falcon • Western Pebble-mound Mouse • Long-tailed Dunnart
How *et al* (1991b)	Project: Abydos-Woodstock Reserve Client: Western Australian Museum Survey type: Major biodiversity survey Survey date: Nine sessions, from 1988 to 1990	Approx. 58 km north-west	• Pitfall trapping • Elliott trapping • Mist nets • Avifauna census • Systematic searching • Opportunistic recording	• Rocky Slope • Ridge • Plateau • Rockpiles • Thickets • Woodlands • Scrublands/Shrublands • Herbaceous Formations and Communities	179 vertebrate taxa: • 14 mammal • 92 bird • 68 reptile • 5 frog	Threatened: • Northern Quoll • Mulgara • Pilbara Olive Python • Ghost Bat Priority: • Pin-stripe Finesnout Ctenotus • Spectacled Hare-wallaby • Western Pebble-mound Mouse
Bamford Consulting Ecologists (2001)	Project: Panorama Project Client: Astron Environmental Survey type: Two-phase, Level 2 survey Survey date: June and September 2001	Approx. 44 km east (at closest point)	• Pitfall trapping • Elliott trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Harp trapping • Mist netting • Opportunistic recording	• Rocky Hills • Gorges • Cliff Lines • Undulating Plains	137 vertebrate taxa: • 22 mammal • 80 bird • 29 reptile • 2 frog • 4 fish	Threatened: • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat Priority: • Mulgara (burrows only) • Spectacled Hare-wallaby • Western Pebble-mound Mouse
Biota (2007)	Project: Panorama Project Haul Road Client: CBH Resources Survey type: One-phase, Level 2 Survey date: August-September 2006	Approx. 44 km east (at closest point)	• Pitfall trapping • Elliott trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Harp trapping • Opportunistic recording	• Narrowly Incised Valley supporting mid-dense to dense riparian vegetation and small to medium sized pools of water • Low Stony Hills, vegetated with Triodia hummock grasslands	73 vertebrate taxa: • 12 mammal • 41 bird • 18 reptile • 2 frog	Threatened: • Northern Quoll • Ghost Bat • Pilbara Leaf-nosed Bat Priority: • Brush-tailed Mulgara • Spectacled Hare-wallaby • Western Pebble-mound Mouse
Biota (2002)	Project: Hope Downs Rail Corridor Client: Hope Downs Management Services Survey type: Two-phase, Level 2 survey Survey date: April-May and June-July 2001	Approx. 15 km east (at closest point	• Pitfall trapping • Elliott trapping • Funnel & cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Harp trapping • Opportunistic recording	• Sand Dune • Fortescue Basin Flats • Cracking Clay • Major Drainage Lines • Granite Rock Piles • Mangrove and Mudflats	201 vertebrate taxa: • 31 mammal • 116 bird • 48 reptile • 6 frog	Threatened: • Northern Quoll • Greater Bilby • Ghost Bat • Peregrine Falcon Priority: • Mulgara • Pin-stripe Finesnout Ctenotus • Lakeland Downs Mouse • Western Pebble-mound Mouse
Biota (2004)	Project: Stage A Rail Corridor Client: Fortescue Metals Group Survey type: One-phase, Level 2 survey Survey date: March-April 2004	Approx. 10 km north-east (at closest point)	• Pitfall trapping • Elliott trapping • Funnel trapping • Cage trapping • Avifauna census • Systematic searching • Targeted searching • Spotlighting • AnaBat • Opportunistic recording	• Littoral– shrub dominated • Sandy Plain– Spinifex dominated • Sandy Plain– Tree/shrub dominated • Stony Plain and Hill– Spinifex dominated • Drainage and Sandy Plain– Tree/shrub dominated • Drainage Areas and Floodplains • Granite Outcrop • Granite Ridge & Quartz Ridge • Dolerite Dyke • Cracking Clay • Clayey/Sandy Plains • Sand Dune	176 vertebrate taxa: • 25 mammal • 84 bird • 58 reptile • 6 frog • 3 fish	Threatened: • Peregrine Falcon • Grey Falcon Priority: • Mulgara • Lakeland Downs Mouse

** Conservation listings have been updated and may not match those presented in each of the original reports.*

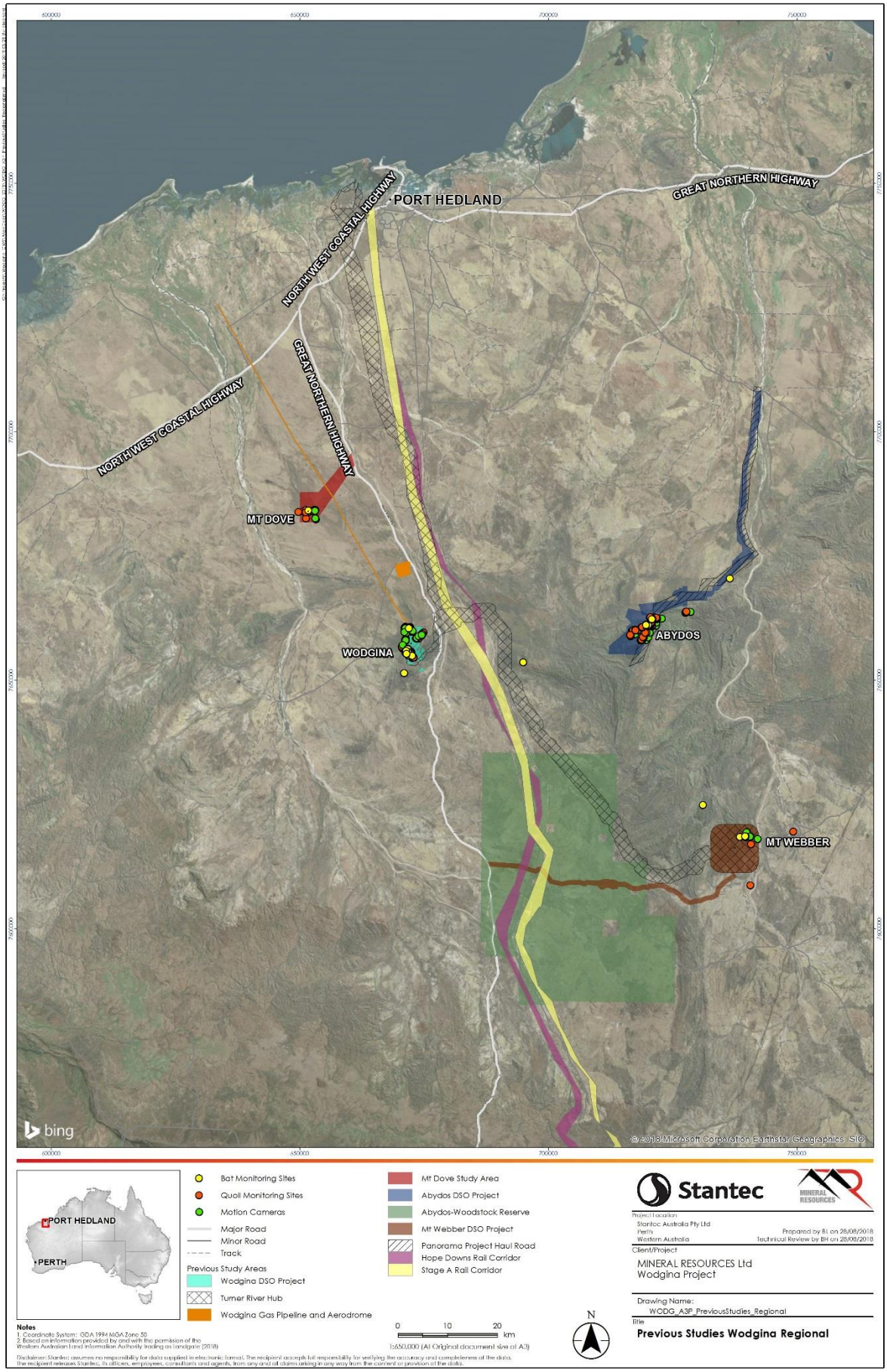


Figure 4-2: Summary of findings from fauna surveys conducted up to 75 km from the Project.

4.1.1 Conservation Significant Species

The desktop assessment identified a total of 382 species of vertebrate fauna, which have been recorded and/or have the potential to occur within the Study Area (**Appendix E**). This total comprises 38 native mammal, 11 introduced mammal, 197 native bird, two introduced bird, 122 native reptile, one introduced reptile, and 11 amphibian species. Many of these species are unlikely to occur in the Study Areas as these records have been collected from a large area encompassing a wide range of habitats, many of which do not occur within the Project. Furthermore, some small, common, ground-dwelling reptile and mammal species tend to be patchily distributed even where appropriate habitats are present, and many species of bird can occur as regular migrants, occasional visitors or vagrants.

Based on previous surveys and database search results, of the 382 species of vertebrate fauna identified as part of the desktop assessment, 42 species are listed as being of conservation significance, comprising nine mammals, 31 birds and two reptiles (**Table 4-3**).

Table 4-3: Fauna of conservation significance identified during the desktop assessment.

Scientific Name	Common Name	EPBC Act	WA Act
Mammals			
Dasyurus hallucatus	Northern quoll	EN	EN
Macrotis lagotis	Bilby	VU	VU
Dasycercus cristicauda	Crest-tailed mulgara	VU	P4
Rhinonicteris aurantius (Pilbara form)	Pilbara leaf-nosed bat	VU	VU
Macroderma gigas	Ghost bat	VU	VU
Sminthopsis longicaudata	Long-tailed dunnart		P4
Dasycercus blythi	Brush-tailed mulgara		P4
Lagorchestes conspicillatus leichardti	Spectacled hare-wallaby		P3
Pseudomys chapmani	Western pebble-mound mouse		P4
Birds			
Calidris ferruginea	Curlew sandpiper	CR; MI	VU; IA
Numenius madagascariensis	Eastern curlew	CR; MI	VU; IA
Calidris canutus	Red knot	EN; MI	IA
Limosa lapponica menzbieri	Bar-tailed godwit (northern Siberian)	CR; MI	VU
Pezoporus occidentalis	Night parrot	EN	CR
Limosa lapponica baueri	Bar-tailed godwit (western Alaskan)	VU	VU
Plegadis falcinellus	Glossy ibis	MI	IA
Pandion haliaetus	Osprey	MI	IA
Charadrius veredus	Oriental plover	MI	IA
Rostratula australis	Australian painted snipe	EN	EN
Calidris acuminata	Sharp-tailed sandpiper	MI	IA
Calidris melanotos	Pectoral sandpiper	MI	IA
Calidris ruficollis	Red-necked stint	MI	IA
Calidris subminuta	Long-toed stint	MI	IA
Numenius phaeopus	Whimbrel	MI	IA
Tringa glareola	Wood sandpiper	MI	IA
Tringa hypoleucos	Common sandpiper	MI	IA

Scientific Name	Common Name	EPBC Act	WA Act
Tringa nebularia	Common greenshank	MI	IA
Tringa stagnatilis	Marsh sandpiper	MI	IA
Limosa lapponica	Bar-tailed godwit	MI	IA
Glareola maldivarum	Oriental pratincole	MI	IA
Sterna caspia	Caspian tern	MI	IA
Sterna leucoptera	White-winged black tern	MI	IA
Sterna nilotica	Gull-billed tern	MI	IA
Apus pacificus	Fork-tailed swift	MI	IA
Hirundo rustica	Barn swallow	MI	IA
Motacilla cinerea	Grey wagtail	MI	IA
Motacilla flava	Yellow wagtail	MI	IA
Falco hypoleucos	Grey falcon		VU
Falco peregrinus	Peregrine falcon		OS
Amytornis striatus	Striated grasswren		P4
Reptiles			
Liasis olivaceus barroni	Pilbara olive python	VU	VU
Anilios ganei	Gane's blind snake		P1

4.1.2 Habitats And Habitat Mapping Of The Study Areas

Habitat mapping has previously been undertaken within, and adjacent to, the Survey Area (i.e. the Study Areas by Outback Ecology, MWH, Stantec and 360 Environmental). The mapping scales and delineating characteristics were largely consistent between Outback Ecology, MWH and Stantec; however, the mapping undertaken by 360 Environmental utilised different scales and different delineating characteristic (i.e. landforms and vegetation).

A review was undertaken of the mapping scales and delineating characteristics of each habitat identified across all surveys to consolidate habitat mapping within the Mine Study Area and Gas Pipeline and Aerodrome Study Area. This involved reviewing habitat descriptions, habitat photographs and habitat assessments undertaken in the field for each habitat identified, and delineated, in each survey.

Although the habitat names, delineating characteristics and scale did not align well between all surveys, the names were broadly aligned to assist with the process of remapping both Study Areas. The broad alignment of habitat types is presented in **Table 4-4**.

Table 4-4: Broad alignment of habitat types in the Study Areas.

Wodgina Direct Shipping Ore (DSO) Project Outback Ecology (2009b)	Turner River Hub: Terrestrial Vertebrate Fauna Baseline Survey (Outback Ecology 2010a)	Hercules Direct Shipping Ore (DSO) Project (Outback Ecology 2012f)	Wodgina Mine Site and Proposed Airstrip (360 Environmental 2018c)	Wodgina Mine and Additional Gas Pipeline (360 Environmental 2018d)	Wodgina Fauna Survey 2018 (This Survey)
Hill crest	-	Ridge top	Rocky ironstone ridge / Rocky ironstone valley.	Rocky ironstone ridge / Rocky ironstone valley.	Ironstone ridge top
Ironstone ridge Gully Minor gorge	Rocky ridge/gorge	Rocky ridge			Rocky ridge and gorge
Low Stony Rise/Hills	Rocky foothills	Rocky foothills	Grassland - Hills, midslopes, upperslopes and ridges over rock;	Grassland - Hills, midslopes, upperslopes and ridges over rock;	Rocky foothills
Scree slope	Stony rise	Scree slope	Grassland - Foot slopes, low rises, undulating plain over rock;	Grassland - Foot slopes, low rises, undulating plain over rock;	Stony rise
-	Spinifex stony plain	Spinifex stony plain			Spinifex stony plain
-	Spinifex sandplain	-	Grassland – Flat plain on sand with low Eucalyptus Woodland;	Grassland - Flat plain on sand with isolated Eucalypts and shrubs;	Spinifex sandplain
-	*Acacia*, spinifex on sandplain	-	-	Low woodland / shrubland - *Eucalyptus* and *Acacia* over *Triodia* Grassland;	Shrubland over spinifex
Minor Drainage Line	Drainage Line	Drainage Line	Major Drainage Line	Major drainage lines;	Drainage line
				Low-lying habitat with ephemeral wet areas;	Low vegetation with ephemeral areas

4.2 Level 1 Fauna Survey

4.2.1 Fauna Assemblages

The Level 1 fauna survey recorded a total of 57 species of vertebrate fauna, of which 20 were mammals, 33 were birds and four were reptiles (**Table 4-5**). Four species of conservation significance were recorded; the northern quoll (En; CR), Pilbara leaf-nosed bat (Vu; VU), ghost bat (Vu; VU) and pebble-mound mouse (P4) (both old and active mounds). Four introduced species were recorded; European cattle, dog, red fox and cat.

Table 4-5: Vertebrate fauna species recorded from the Survey Area during the Level 1 fauna survey.

Species Name	Common Name	EPBC Act	WC Act
Mammals			
Bos taurus *	European cattle		
Canis lupus *	Dog		
Vulpes *	Fox		
Dasykaluta rosamondae	Kaluta		
Dasyurus hallucatus	Northern quoll	EN	EN
Sminthopsis macroura	Stripe-faced dunnart		
Taphozous georgianus	Common sheathtail-bat		
Felis catus *	Cat		
Rhinonicteris aurantius (Pilbara form)	Pilbara leaf-nosed bat	VU	VU
Macropus robustus	Common wallaroo		
Petrogale rothschildi	Rothschild's rock-wallaby		
Macroderma gigas	Ghost bat	VU	VU
Austronomus australis	White-striped freetail-bat		
Notomys alexis	Spinifex hopping-mouse		
Pseudomys chapmani	Western pebble-mound mouse		P4
Zyzomys argurus	Common rock-rat		
Tachyglossus aculeatus	Short-beaked echidna		
Chalinolobus gouldii	Gould's wattled bat		
Scotorepens greyii	Little broad-nosed bat		
Vespadelus finlaysoni	Inland cave bat		
Birds			
Aquila audax	Wedge-tailed eagle		
Haliastur sphenurus	Whistling kite		
Hamirostra melanosternon	Black-breasted buzzard		
Milvus migrans	Black kite		
Ardea pacifica	White-necked heron		
Artamus cinereus	Black-faced woodswallow		
Cacatua sanguinea	Little corella		
Cacatua roseicapilla	Galah		
Coracina novaehollandiae	Black-faced cuckoo-shrike		

Species Name	Common Name	EPBC Act	WC Act
Geopelia cuneata	Diamond dove		
Geophaps plumifera	Spinifex pigeon		
Ocyphaps lophotes	Crested pigeon		
Corvus orru	Torresian crow		
Emblema pictum	Painted finch		
Taeniopygia guttata	Zebra finch		
Eurostopodus argus	Spotted nightjar		
Falco cenchroides	Nankeen kestrel		
Dacelo leachii	Blue-winged kookaburra		
Todiramphus pyrrhopygius	Red-backed kingfisher		
Cincloramphus mathewsi	Rufous songlark		
Eremiornis carteri	Spinifexbird		
Lichenostomus keartlandi	Grey-headed honeyeater		
Lichenostomus penicillatus	White-plumed honeyeater		
Lichenostomus virescens	Singing honeyeater		
Lichmera indistincta	Brown honeyeater		
Manorina flavigula	Yellow-throated miner		
Merops ornatus	Rainbow bee-eater		
Grallina cyanoleuca	Magpie-lark		
Pomatostomus temporalis	Grey-crowned babbler		
Melopsittacus undulatus	Budgerigar		
Rhipidura leucophrys	Willie wagtail		
Ninox novaeseelandiae	Southern boobook owl		
Turnix velox	Little button-quail		
Reptiles			
Ctenophorus caudicinctus	Ring-tailed dragon		
Ctenophorus isolepis	Central military dragon		
Morethia ruficauda	Lined firetail skink		
Varanus giganteus	Perentie		

** Introduced species.*

4.2.2 Fauna Habitat

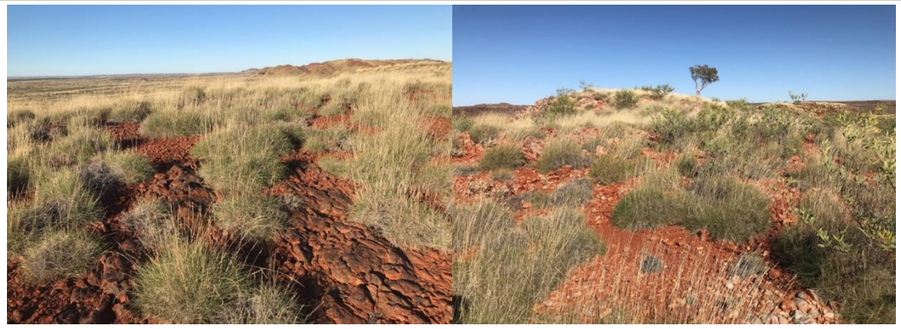
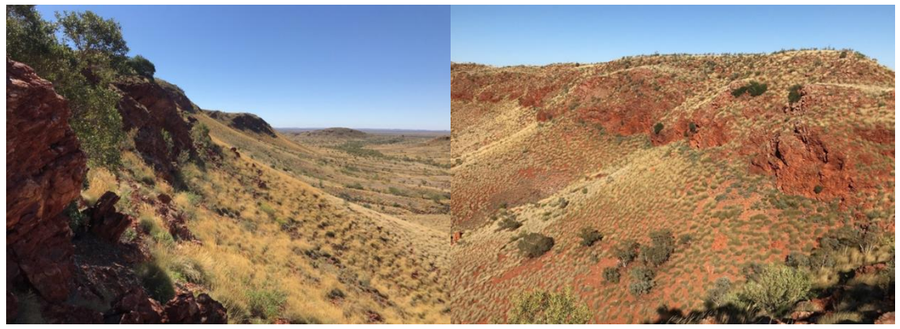
Six broad fauna habitats were identified and delineated from fauna habitat assessments conducted across the Survey Area (**Table 4-6**). These habitats comprised ironstone ridge top, rocky ridge and gorge, rocky foothills, stony rise, spinifex stony plain and drainage line. Following the consolidation of habitat mapping exercise, nine broad habitat types were identified as occurring within the Study Areas (**Table 4-6**, **Figure 4-3** to **Figure 4-5**). These habitats differed primarily in landform (i.e. ridge, plain, drainage line), the presence of structure or substrate and the composition of the vegetation which would influence the presence of fauna. According to the criteria presented in **Section 3.1.3**, the ironstone ridge top, rocky ridge and gorge, and low vegetation with ephemeral areas were all habitats that were considered to be of limited distribution, while the rocky ridge and gorge, spinifex stony plain and spinifex sandplain habitats were considered significant.

Within the Mine Study Area (which encompasses the Survey Area), two area calculations are presented for each habitat type. One calculation represents the habitat types prior to disturbance as part of the Atlas DSO Project (Stage 1 and Stage 2) presented in the original baseline survey reports. The second calculation is based on post-Atlas DSO Project and is presented to display cumulative impacts to each habitat so this can be taken into consideration for the proposed expansion of the Project.

Table 4-6: Fauna habitats recorded within the Study Areas and Survey Area.

Fauna Habitat	Mine Study Area	Gas Pipeline / Aerodrome Study Area	Survey Area
Ironstone ridge top	X		X
Rocky ridge and gorge	X		X
Rocky foothills	X	X	X
Stony rise	X	X	X
Spinifex stony plain	X	X	X
Shrubland over spinifex		X	
Spinifex sandplain		X	
Drainage line	X	X	X
Low vegetation with ephemeral areas		X	

Table 4-7: Fauna habitats recorded within the Study Areas.

Habitat type	Proportion of Mine Study Area – Pre-Atlas DSO Project		Proportion of Mine Study Area – Post-Atlas DSO Project		Proportion of Gas Pipeline and Aerodrome Study Area		Description and value to fauna	Reference Photographs
	ha	%	ha	%	ha	%		
Ironstone ridge top • Limited Extent • Limited significance	339.4	6.2%	208.2	3.8%	n/a	n/a	The ridge top habitat formed the most elevated habitat in the Study Areas. Broadly, this habitat corresponded with the Capricorn land system. The ridge top was characterised by flat or gently sloping spinifex hummock grasslands over a stony, ferruginous duricrust with occasional minor drainage features. This habitat type was elevated and exposed with limited shelter, and consequently its ability to support diverse fauna assemblages is variable.	
Rocky ridge and gorge • Limited Extent • Significant	401.9	7.3%	371.3	6.7%	n/a	n/a	Rocky ridge and gorge habitat was located predominantly, on the margins of the ironstone ridge top habitat. The habitat was characterised by features including outcropping ironstone, fallen boulders, caves, overhangs and crevices. Many of these features are considered significant microhabitat features important for supporting distinct vertebrate fauna assemblages and fauna of conservation significance. Rocky Ridge and Gorge habitat was associated with the Capricorn land system. The specific features that characterise this habitat type, and provide its value for fauna (e.g. deep caves), are unevenly distributed within this habitat type. This habitat is important for conservation significant species which are known to reside within this habitat and the Study Areas. These include the northern quoll, Pilbara leaf-nosed bat and ghost bat.	
Rocky foothills • Widespread • Limited significance	1,412.8	25.8%	1329.2	24.2%	2.6	0.1%	Rocky foothills habitat occurred as a transition between the pronounced rocky ridge and gorge habitat and the lower stony rise and spinifex stony plain habitat. Rocky foothills corresponded broadly with the Rocklea land system, which is widespread throughout the Pilbara bioregion (van Vreeswyk *et al.* 2004). Rocky foothills were characterised by low hills of *Triodia* hummock grasslands, small rocky outcrops and may contain water sources such as relatively minor drainage lines. This habitat differed from the rocky ridge and gorge habitat by the lack of ridges, caves or gorges. Overall this habitat does not tend to possess microhabitats and features that support resident populations of fauna of conservation significance or faunal assemblages substantially different to those found elsewhere in the local surrounds.	

Habitat type	Proportion of Mine Study Area – Pre-Atlas DSO Project		Proportion of Mine Study Area – Post-Atlas DSO Project		Proportion of Gas Pipeline and Aerodrome Study Area		Description and value to fauna	Reference Photographs
	ha	%	ha	%	ha	%		
Stony rise • Widespread • Limited significance	172.5	3.1%	172.5	3.1%	2.7	0.1%	Stony rise habitat corresponded with the Rocklea land system, which is widespread throughout the Pilbara bioregion (van Vreeswyk *et al.* 2004). This habitat was characterised by rolling hills supporting *Triodia* hummock grasslands and small rocky outcrops. It contained very little woody debris and leaf litter and had poor burrowing suitability. This habitat is not typically utilised for pastoralism (van Vreeswyk *et al.* 2004), and it therefore remains in relatively good condition. The Stony rise habitat represented a transition between the spinifex stony plains and the more rugged rocky foothills.	
Spinifex stony plain • Widespread • Significant	2,297.9	42.0%	2,297.9	42.0%	44.3	1.9%	The Spinifex stony plain habitat was predominantly located in the northern portions of the Mine Study Area and at the base of the ranges to the east and west. Much of this habitat was intersected by small drainage features that were dominated by dense thickets of *Acacia*. Spinifex stony plains are well represented in the Pilbara bioregion and this habitat type aligns closely with the Boolgeeda land systems. This habitat type is characterised by extensive spinifex cover over a stony substrate with occasional patches of interspersed sandier substrate. The value of Spinifex stony plain habitat to native fauna assemblages is closely related to its fire history, with areas that retain a mosaic of fire ages often providing the best habitat (Kelly *et al.* 2016; Parr and Andersen 2006). Newly burnt habitat present in the Study Areas may be used for foraging, while long unburnt areas may be used for shelter and breeding. It is common for large swathes of this habitat type to be burnt for pastoralism to promote new palatable growth and prevent regrowth of non-palatable *Acacia* species (van Vreeswyk *et al.* 2004). Much of this habitat within the Study Areas appeared to be long unburned. The western pebble-mound mouse is likely to occur throughout this habitat due to the ubiquitous presence of small stones required for mound building (Anstee 1996).	 
Shrubland over spinifex • Widespread • Significant	n/a	n/a	n/a	n/a	206.9	8.9%	The shrubland over spinifex habitat occurred along the Gas Pipeline and Aerodrome Study Area. The habitat differed from the spinifex stony plain and the spinifex sandplain in having a dominant mid story of *Acacia* species. However the density of the *Acacias* varied considerably across this habitat. The presence of *Acacia* provided greater habitat diversity, providing foraging opportunities for bird species and small reptiles while also supporting the variety of Spinifex dwelling species present in the broad spinifex sandplain habitat. The substrate was predominantly sandy and potentially provided burrowing opportunities for conservation significant fauna including the brush-tailed mulgara and bilby.	 

Habitat type	Proportion of Mine Study Area – Pre-Atlas DSO Project		Proportion of Mine Study Area – Post-Atlas DSO Project		Proportion of Gas Pipeline and Aerodrome Study Area		Description and value to fauna	Reference Photographs
	ha	%	ha	%	ha	%		
Spinifex sandplain • Widespread • Significant	n/a	n/a	n/a	n/a	1,947.5	83.5%	Spinifex sandplain habitat was located in the Gas Pipeline and Aerodrome Study Area. This habitat type loosely aligns with the Uaroo land system. The sands varied in depth, with some areas being relatively shallow while others had deep sands suitable for deep burrowing species. These include the bilby and brush-tailed mulgara. Like spinifex stony plain habitat, the value of Spinifex sandplain habitat to native fauna assemblages is closely related to its fire history; areas that retain a mosaic of fire ages often provide the best habitat (Kelly *et al.* 2016; Parr and Andersen 2006). Newly burnt habitat present in the Study Areas may be used for foraging, while long unburnt areas may be used for shelter and breeding. It is common for large swathes of this habitat type to be burnt for pastoralism to promote new palatable growth and prevent regrowth of non-palatable *Acacia* species (van Vreeswyk *et al.* 2004). This habitat can be resistant to extensive degradation by livestock, as the mature spinifex is not preferred by grazing animals (van Vreeswyk *et al.* 2004).	
Drainage line • Widespread • Limited significance	331.6	6.1%	328.1	6.1%	21.9	1.0%	The drainage line habitat type was characterised by minor watercourses, as opposed to the broad sandy water channels of the riverine habitat. The drainage line habitat was recorded throughout the Study Areas and often supported a thin band of *Eucalypts victrix* and a dense shrubland of Acacia species (e.g. *Acacia tumida*). This was often over soft spinifex and Buffel Grass on sandy or loamy alluvial soils. The understorey vegetation of these systems is usually palatable to livestock and often results in this habitat becoming degraded from over grazing (van Vreeswyk *et al.* 2004). The drainage line habitat function as linear corridors connecting multiple habitat types and is one of few habitat types that may contain temporary and permanent water sources. For these reasons it provides transit corridors through the landscape for many species. Drainage line habitat itself is also likely to provide temporary sources of food (e.g. seeds for granivorous birds) and is likely to retain water longer than the surrounding plains (How *et al.* 1991a). Drainage lines are well represented in the Pilbara in the Rocklea and Talga land systems. Despite their wide distribution, they cover only a small area and are therefore not dominant in the landscape. Due to the widespread availability of microhabitats (leaf litter accumulations, large trees, hollows, and semi-permanent / permanent water sources), a number of fauna of conservation significance are likely to forage widely in this habitat type. These include, but are not limited to, the northern quoll, Pilbara leaf-nosed bat, ghost bat and potentially the Pilbara olive python.	

Habitat type	Proportion of Mine Study Area – Pre-Atlas DSO Project		Proportion of Mine Study Area – Post-Atlas DSO Project		Proportion of Gas Pipeline and Aerodrome Study Area		Description and value to fauna	Reference Photographs
	ha	%	ha	%	ha	%		
Low vegetation with ephemeral areas • Limited extent • Significant	n/a	n/a	n/a	n/a	84.4	3.6%	The Low vegetation with ephemeral areas habitat occurs exclusively within the northern portion of the Gas Pipeline and Aerodrome Study Area. The habitat is low lying in the landscape and therefore has areas that become temporarily inundated after substantial rainfall events. Vegetation was dominated by *Triodia* spp. on red sands. The habitat aligns broadly with the Mallina land system. The bilby was recorded from this habitat by 360 Environmental during the gas pipeline survey (360 Environmental 2018d).	
No Fauna Habitat Available	523.1	9.5%	722.0	14.1%	21.4	0.9%	Areas disturbed prior to habitat mapping within the study areas.	
Total	**5,479.2**	**100**	**5,479.2**	**100**	**2,331.7**	**100**		

4.2.3 Significant Microhabitat Features

A number of significant microhabitat features have been recorded within the Mine Study Area including caves, and semi-permanent water sources (**Plate 4-1**). These features were highlighted because they provide important sources of shelter, food and water for species of conservation significance. Many of these features were located within the rocky ridge and gorge habitat and were not commonly recorded in other broad habitat types of the Study Areas. For this reason rocky ridge and gorge habitat should be considered the most important broad fauna habitat type in the Study Areas.

4.2.3.1 Significant Bat Roosts

The Pilbara leaf-nosed bat is heavily reliant on warm (28 to 32°C), humid (85 to 100%) sites for roosting (Armstrong 2001), which enables individuals to reduce water loss and energy expenditure (Baudinette *et al.* 2000). Sites with relevance to the Pilbara leaf-nosed bat are defined by DoE (2016b) as follows:

- Permanent diurnal roost: "occupied year-round and likely the focus for some part of the 9-month breeding cycle; considered as critical habitat that is essential for the daily survival of the Pilbara leaf-nosed bat";
- Non-permanent breeding roost: "evidence of usage during some part of the 9-month breeding cycle (July–March), but not occupied year-round; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara leaf-nosed bat";
- Transitory diurnal roost: "occupied for part of the year only, outside the breeding season (i.e. April–June), and which could facilitate long distance dispersal in the region; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara leaf-nosed bat"; and
- Nocturnal refuge: "occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. Excludes overhangs. Not considered critical habitat, but are important for persistence in a local area"

There are no known permanent diurnal roosts for the Pilbara leaf-nosed bat within the Mine Study Area, and none are expected to occur based on the extensive amount of survey conducted (**Appendix D**). However, previous survey work by Stantec (2017a) and MWH (2016c) have identified some degree of diurnal roosting by Pilbara leaf-nosed bats at a cave identified as C2, which was monitored as part of the Atlas significant species monitoring program (Stantec 2018). On each survey that diurnal roosting was recorded, the number of calls was low, suggesting that only a small number of individuals remained in the cave during the day. As diurnal roosting at C2 was only recorded for a night during each survey period, the cave is likely represent a 'transitory diurnal roost' as defined by DoE (2016b), and serve as a satellite roost for a small number of bats from the Yule River roost (**Figure 4-6**). The Yule River roost is one of three known permanent diurnal Pilbara leaf-nosed bat roosts in the area with the other two being the Glacier Valley roost and the East Turner River roost, all approximately 25 km from the Project (**Appendix D**). The Yule River roost is the closest permanent diurnal roost to C2; however, the exact location of the roost has never been confirmed, with all records based on the triangulation of first calls after dark from other surveys in the region.

The ghost bat has less stringent roost microclimate requirements than the Pilbara leaf-nosed bat and the population at the Project has been known to diurnally roost at a number of monitoring caves in the area (C1, C2, PC3, C7a and C7b)(**Figure 4-6**). While evidence of relatively high roosting activity at PC3 and C2 has been recorded during annual monitoring surveys, this level of activity was temporary (Stantec 2017a). Overall, ghost bat roosting behaviour tends to be low and temporary in terms of location; however, roosting at PC3, C7a and C7b has been recorded during 2016 and 2017 (Stantec 2017a).

4.2.3.2 Semi-permanent Water Sources

Water sources are a limiting factor and an important habitat feature within the Pilbara region (James *et al.* 1995), and more broadly within arid-zone ecosystems (Burbidge *et al.* 2010; Doughty *et al.* 2011). While temporary water sources may be abundant during, and following, the wet season, important features are those which can provide resources for ecosystems for the majority, if not all, of the year. Generally areas containing permanent or semi-permanent water sources are comparatively more productive ecosystems due to the direct and indirect benefit to fauna and flora (Murray *et al.* 2003).

Specifically, birds and mammals will use these areas for drinking, amphibians will use these areas to breed, and many vertebrate fauna species benefit from the increased invertebrate abundance as food. Many of the conservation significant fauna likely to occur within the Study Areas have occurrences that are strongly associated with such features. For example, the Pilbara leaf-nosed bat forages on invertebrates common at such features and require drinking water regularly due to its high metabolic expenditure (Churchill 1994). As such, gorges with pools, gullies and major watercourses are identified as three of the highest priority foraging habitats for the species (DoE 2016b). Presence of the northern quoll is often associated with gorges containing pools, as these habitat are generally more productive ecosystems (Oakwood 2002), and the Pilbara olive python, an ambush predator, is also heavily reliant on such features for hunting.

For the purposes of this report, semi-permanent water sources were defined as bodies of water that were large or permanent enough to contain water for at least a number of months (**Plate 4-1**). Semi-permanent water sources were distinguished from permanent water sources by the absence of a groundwater seep, and the absence of groundwater-dependent vegetation. Such features included pools in rocky drainage systems and along drainage lines, with importance varying on the ability to capture and store water (**Plate 4-1**). The majority of semi-permanent water sources were recorded in a rocky drainage system in the southern portion of the Survey Area (**Plate 4-1**). However, there was one other semi-permanent pool located in the central portion of the Survey Area. Aside from these pools, anecdotal evidence suggests that a permanent pool known as the 'Wodgina rock hole' occurs outside the Survey Area, but within the Mine Study Area (MRL pers comm).

Plate 4-1: Example of two semi-permanent water sources.

4.2.4 Likelihood of Fauna of Conservation Significance

Of the 382 species of vertebrate fauna identified during the desktop assessment, 42 species are listed as being of conservation significance, comprising nine mammals, 31 birds and two reptiles (**Table 4-9**). Of the 42 vertebrate species in the desktop assessment:

- 14 are listed under the EPBC Act and/or the WC Act;
- seven are recognised as being of conservation concern under the WC Act (Priority fauna);
- one is recognised under the WC Act to be in need of special protection; and
- 25 species are listed under the EPBC Act and/or WC Act as Migratory, in alignment with applicable international agreements.

Evidence of four species of conservation significant vertebrate fauna were recorded within the Survey Area, and nine were confirmed within the Mine Study Area and/or the Gas Pipeline and Aerodrome Study Area (**Table 4-8**). Additional to these, three species were considered likely to occur in the Mine Study Area or the Gas Pipeline and Aerodrome Study Area; the grey falcon (VU), peregrine falcon (OS) and Pilbara olive python (VU; VU). In addition, 21 species were considered possible to occur, all of which are migratory waterbirds (terns, sandpipers, knots etc.) and are unlikely to occur in the Mine Study Area due to a lack of suitable habitat but may occur in low vegetation with ephemeral areas in the Gas Pipeline and Aerodrome Study Area. All remaining species were considered unlikely to occur.

Two erroneous conservation significant species were recorded in the database search, and were not included in the likelihood assessment;

- Crest-tailed mulgara (VU): Although two species of mulgara are known to occur in Australia, it is now recognised that only the brush-tailed mulgara (*Dasycercus blythi*) (P4) occurs within Western Australia (DoEE 2018b; van Dyck and Strahan 2008). The crest-tailed mulgara (*Dasycercus cristicauda*) (VU) is restricted in its distribution to the eastern portion of the Northern Territory, South Australia and potentially Queensland (DoEE 2018b; van Dyck and Strahan 2008); and
- Striated grasswren (P4): This subspecies of grasswren (*Amytornis striatus striatus*) occurs in the eastern deserts of Western Australia (Simpson and Day 2010; WAM 2018). The subspecies that occurs within the Pilbara region (*Amytornis striatus whitei*) is not a threatened or priority species (Simpson and Day 2010; WAM 2018).

Separate likelihood assessments were conducted for the Mine Study Area and for the Gas Pipeline and Aerodrome Study Area. These two Study Areas were separated due to the differences in habitats and therefore in the potential occurrence of conservation significant fauna.

Table 4-8: Conservation significant species confirmed within the Study Areas.

Scientific Name	Common Name	EPBC Act	WC Act	Survey Area	Mine Study Area	Gas Pipeline & Aerodrome Study Area
Dasyurus hallucatus	Northern quoll	EN	EN	X	X	
Macrotis lagotis	Bilby	VU	VU			X
Rhinonicteris aurantius (Pilbara form)	Pilbara leaf-nosed bat	VU	VU	X	X	X
Macroderma gigas	Ghost bat	VU	VU	X	X	
Apus pacificus	Fork-tailed swift	MI	IA			X
Lagorchestes conspicillatus leichardti	Spectacled hare-wallaby		P3			X
Sminthopsis longicaudata	Long-tailed dunnart		P4		X	
Dasycercus blythi	Brush-tailed mulgara		P4			X
Pseudomys chapmani	Western pebble-mound mouse		P4	X	X	X

Table 4-9: Fauna of conservation significance with the potential to occur within the Study Areas.

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Mammals						
Northern quoll *Dasyurus hallucatus*	EN	EN	The species is threatened by several, interacting factors. The largest, Cane Toads (Bufo marinus), currently threatens outside of the Pilbara although this is likely to become an issue in the coming decades (Tingley *et al.* 2013). Within the Pilbara the current largest threats to the species are: inappropriate fire regimes; predation by feral Cats, wild dogs and foxes; habitat loss and fragmentation (mostly associated with mining ventures); and habitat degradation due to invasive pasture grasses (Woinarski *et al.* 2014).	In the Pilbara, ironstone ridges, scree slopes of sandstone or ironstone and granite boulders and outcrops (Cramer *et al.* 2016; Molloy *et al.* 2016).	**Possible** The Gas Pipeline and Aerodrome Study Area lacks suitable refuge habitat for the northern quoll as it is dominated by spinifex sandplain habitat (Cramer *et al.* 2016; Molloy *et al.* 2016). However, this species has been recorded recently in close proximity to the Study Areas, where there is an occurrence of rocky ridge and gorge or riverine habitat (DBCA 2018b). This includes recent northern quoll records from the Mine Study Area near the southern portion of the Gas Pipeline and Aerodrome Study Area (e.g. 25 capture records ranging from 2011 – 2017 within 500 m south) and numerous records at Mt Dove, located less than 5 km west of the Gas Pipeline and Aerodrome Study Area from 2011 – 2015 (DBCA 2018b; MWH 2015c; Stantec 2017b). As such, northern quolls possibly pass through the Gas Pipeline and Aerodrome Study Area, however are unlikely to rely upon habitats within.	**Confirmed** The species was confirmed to occur within the current Survey Area (which is located within the Mine Study Area) through records of scats at 13 locations and on motion cameras at 6 locations (**Figure 4-5**). All of these records occurred within rocky ridge and gorge habitat, which contained numerous crevices, alcoves and outcrops known to provide optimal habitat for the species. Additionally, the species is known to be abundant throughout the Mine Study Area, and has been recorded in a number of previous surveys. This includes on 24 occasions (motion camera and scat records) across both 360 Environmental (2018) surveys and from numerous scat, motion camera and trapping records throughout baseline and annual significant species monitoring surveys between 2009 and 2017 (360 Environmental 2018a;c; Outback Ecology 2009b;2011f; Stantec 2017b). Northern quolls were confirmed via annual significant species trapping between 2010 and 2017 every year aside from 2015, where the species was confirmed via motion camera (four occasions) and scat records (seven locations) (MWH 2015d; Stantec 2017b). Northern quoll captures from 2010 – 2014 ranged from nine to 43 individuals (from seven and nine sites respectively) (Stantec 2017b). Following on from no captures during 2015, capture success remained low (two and one captures in 2016 and 2017 respectively) (Stantec 2017b). The decrease in captures following 2015 may be a result of a large scale fire during 2014, which potentially affected the species resources and shelter (Stantec 2017b). The annual monitoring and recent surveys, including this survey, demonstrate that the Mine Study Area, particularly the areas containing Rocky Ridge and Gorge habitat, provides a valuable resource to the species. The Project pre-fire capture success is similar to that at the Abydos Project (~42km east), where between 10 and 17 individuals were captured during annual monitoring between 2011 – 2017 (Stantec 2018b). Similarly, initial capture success at Mt Dove mine site (~4 km north west) are similar to the Project (19 during 2011, 10 during 2012), however this decreased to levels similar to post-fire the Project capture rates after mining commenced (four in 2013 and two in 2014) (MWH 2014b). In contrast, one capture and five scat locations were recorded during a baseline survey at Mt Webber Project (Outback Ecology 2013e) and a baseline survey at Corunna Downs Project site only recorded three northern quoll scats and one motion camera record despite conducting targeted trapping (Outback Ecology 2014a). However subsequent survey efforts captured eight individuals, recorded eight scat occurrences and 18 motion camera records (MWH 2016a). These surveys at Abydos, Mt Dove, Mt Webber and Corunna Downs indicate that northern quolls appear to occur at similar densities at the Project than at other projects in the region, and would be expected to occur at higher densities than some regional sites if recovery to levels prior to the 2014 fire occurs.

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Ghost bat *Macroderma gigas*	Vu	VU	Five moderate-severe threats have been identified for the species (Woinarski *et al.* 2014). The most severe being (human) disturbance to maternity roost sites, followed by habitat loss caused by mining, collision with fences, contamination of roost sites within old mines and collapse of roost sites within old mines (Woinarski *et al.* 2014).	The species roosts within deep humid caves, rock crevice and abandoned mines (Armstrong and Anstee 2000). The species will forage in most habitat types and will travel 2 km from a roost to hunt (Churchill 2008).	**Possible** The Gas Pipeline and Aerodrome Study Area lacks suitable roosting habitat (Armstrong and Anstee 2000). However, this species is known to occur nearby within suitable rocky ridge and gorge habitat with annual monitoring records displaying roosting and nocturnal refuge at caves from 2011 – 2017 within the Mine Study Area (1.8 – 6.2km south), and a record from Mt Dove baseline survey in 2010 (~5.3k m west) (DBCA 2018b; Outback Ecology 2010a; Stantec 2017a). As such, while the species is unlikely to depend upon the habitats within the areas, the species possibly overfly while foraging.	**Confirmed** Ghost bat scats were recorded at four locations within the Survey Area (located within the Mine study Area) within the rocky ridge and gorge (2) and Rocky Foothills (3) habitat (**Figure 4-5**). However all three records in the Rocky Foothills habitat were within 15 m of the rocky ridge and gorge habitat. The species has been observed or recorded in previous studies within similar habitat in the Mine Study Area. Ghost bats have been consistently recorded at all the Project annual monitoring caves from 2012 – 2017, and activity and fresh feeding evidence was recorded during the 2012 Hercules survey within six caves (Outback Ecology 2012i; Stantec 2017a). This suggests a population persists and forages in the local area, using caves for nocturnal refuge. The population at the Project has been known to diurnally roost at a number of monitoring caves in the area (C1, C2, PC3, C7a and C7b), however all recorded roosting behaviour of ghost bats within the Mine Study Area, aside from C2 and PC3, tends to be relatively low, and roosting at all monitored sites has been temporary (Stantec 2017a). The most significant evidence of roosting was recorded at cave C2 during 2012, where ≤75 and ~65 individuals were observed roosting with young during the Hercules and Wodgina Surveys, respectively (Outback Ecology 2012d;i). Although annual monitoring of this cave has been conducted between 2012 and 2017, only low numbers of individuals have been recorded (Stantec 2017a). Relatively high call counts, indicating roosting, were recorded at PC3 during 2016, however this decreased to low levels in 2017 (when three individuals were observed roosting in the cave) (MWH 2016c; Stantec 2017a). Individuals are capable of hunting and navigating entirely visually without recourse to calling, and are known to hang from cave walls for many minutes calling socially and ultrasonically (Armstrong and Anstee 2000; MWH 2016c). Due to this calls cannot be used to estimate individuals, however the variation in calls indicated PC3 was potentially used as a significant roost only during 2016. Recent roosting at the Project was also recorded at caves C7a and C7b during 2016 and 2017 (MWH 2016c; Stantec 2017a), where low numbers (14) of individuals were observed roosting in the two entrances (Stantec 2017a). Recent ghost bat roosting within the Mine Study Area is relatively minimal in comparison to the significance of regional sites. Two abandoned mine adits serve as major well-known permanent diurnal roosts in the surrounding area; Lalla Rookh (~17 km north east of Abydos mine site) and Comet mine (~11 km north east of Corunna Downs mine site) (DoE 2016a; Stantec 2018a; Stantec 2018d). Dusk counts conducted during 2017 recorded 204 and 90 individuals roosting at Lalla Rookh and Comet respectively, and records of a 2017 video census at Comet reported 125 roosting individuals (Stantec 2018a; Stantec 2018d). This represents a significant portion of the current population of ghost bats within the Pilbara, which is estimated to be between 1,300 to 2,000 individuals (DoE 2016a). While historical roosting has been recorded within the Mine Study Area in significant numbers at C2 and potentially at PC3, monitoring since 2012 suggests that roosting generally tends to be in relatively low numbers and not at permanent locations as detected at regionally significant roosts.

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Pilbara leaf-nosed bat *Rhinonicteris aurantia* (Pilbara form)	Vu	VU	Three major threats identified for the species with the most severe being the potential loss of roosting habitat due to mining (Woinarski *et al.* 2014). This is followed by collapse of roost sites within old mines (Hall *et al.* 1997) and human disturbance causing roost abandonment (Armstrong 2001).	Species roosts within caves and abandoned mines with high humidity (95%) and temperature (32 °C). Species forages in caves and along waterbodies with fringing vegetation (Armstrong 2001; DoE 2016b).	**Confirmed** The Gas Pipeline and Aerodrome Study Area lacks suitable roosting habitat for the species (Armstrong 2001; DoE 2016b). However, the foraging suitability of open grassland and woodland within the areas is assigned the lowest priority (Priority 5) (DoE 2016b). Numerous recent records of the species occur within and near the Gas Pipeline and Aerodrome Study Area, particularly near suitable rocky ridge and gorge roosting and foraging habitat (360 Environmental 2018d; DBCA 2018b) (**Figure 4-3**; **Figure 4-4**). This includes records from caves known to provide roosting and refuge for the species within the Mine Study Area (2011 – 2017) (Stantec 2017a). The species was also recorded in spinifex sandplains (e.g. four records ~1.8km west of the Study Area in 2015 and one record ~4.3km east of the Study Area in 2013), however these occurred near suitable rocky ridge and gorge habitat or riverine foraging habitat (Priority 4) (DBCA 2018b; DoE 2016b). As such, the species has been recorded from the Gas Pipeline and Aerodrome Study Area, however the species is only likely to be foraging and is unlikely to rely on the Study Area for roosting due to the lack of suitable Rocky Ridge and Gorge habitat.	**Confirmed** The species was recorded within the current Survey Area (located within the Mine Study Area) via recording units in two locations (**Figure 4-5**). A low number of calls were detected, averaging 11 and 14 calls per night over the sample period and timing indicated the species was foraging within the area and using sites as a nocturnal refuge (**Appendix D**). The Mine Study Area is known to contain suitable foraging and roosting habitat for the species. Roosting and nocturnal refuge habitat may occur within the rocky ridge and gorge habitat, which is known to provide caves and alcoves. These areas may also contain gorges with pools, which are considered the highest priority foraging habitat for the species (Priority 1) (DoE 2016b). Five semi-permanent pools within a drainage line surrounded by rocky foothills in the L45/443 Survey Area were identified in the current survey. This habitat aligns with Priority 2 foraging habitat for the species (DoE 2016b). Drainage line habitat comprises 4 ha of the Mine Study Area and is considered Priority 4 foraging habitat, particularly in the north portion of the Survey Area where remnant pools were recorded during the current survey (DoE 2016b) (**Section 4.2.3.2**). The species has been recorded from previous surveys within the Mine Study Area (**Table 4-1**). These include baseline (Outback Ecology 2009b;2012i) and 2012 – 2017 annual monitoring surveys conducted at the Project (Stantec 2017a). The species has been consistently recorded at all five monitoring caves within the Mine Study Area since 2013. Most activity was recorded at caves PC3 and C2, which averaged 325 and 162 nightly passes in 2017 respectively (Stantec 2017b). Activity within the Survey Area was lower than most call rates recorded at caves within the Project mine site, and had similar values to the least active cave (C4, average of 14 nightly passes) in the annual monitoring during 2017 (Stantec 2017a). All other annual caves recorded an average of at least 38 nightly passes in 2017 (Stantec 2017a). No 'permanent diurnal roosts' for the species have been recorded in the Mine Study Area and none are expected to occur (**Appendix D**). One cave, C2, has been recorded as a 'transient diurnal roost' over two nights during 2016 and in a small number of individuals over one night during 2017 (MWH 2016c; Stantec 2017a) (**Appendix D**). Cave C2 is also a satellite roost of the closest permanent diurnal roost located at the Yule River ~25km northwest (**Appendix D**). Overall, data indicates the Mine Study Area is used for foraging with some caves used as nocturnal refuges and one cave (C2) used as a transitory diurnal roost. When compared to regionally significant Pilbara leaf-nosed bat sites, the activity at caves within the Mine Study Area is relatively minor. Permanent diurnal roosts in the region that have been monitored previously by Stantec comprise CO-CA-01 (Corunna Downs mine site), MW-CA-02 (Mt Webber mine site), MW-AN-27 (Mt Webber mine site) and LR-MI-01 (Lalla Rookh, ~17 km north east of Abydos mine site) (Stantec 2018c). Unlike caves in the Mine Study Area, these sites have consistently supported roosting individuals over the course of their monitoring, which in the case of CO-CA-01, MW-AN-27 and LR-MI-01 has been since 2014 at least (Stantec 2018c). Average nightly passes varies from 2,432 (±402.5) at LR-MI-01 to 47,619 (±1,432.4) at MW-CA-02 over the course of monitoring (Stantec 2018c). In addition, cave CO-CA-03 (Corunna Downs mine site) serves as a non-permanent breeding roost for the species owing to the temporary nature of the roosting, potentially due to fluctuations in cave humidity (Stantec 2018c). Average nightly calls fluctuate depending on roosting, however activity still averages 1,569 (±200.3) nightly passes. By comparison, the highest average nightly calls since annual monitoring began was 325 at cave PC3 during 2017 (Stantec 2017a). In addition to the major permanent diurnal roosts mentioned above, there are three other recognised permanent diurnal roosts in the surrounding region: Yule River, Glacier Valley and Turner River (~25km north east of the Mine Study Area) roosts (**Appendix D**). The timing of activity within the Mine Study Area indicates individuals originate from two other recognised permanent diurnal roosts: Yule River and Glacier Valley (~25km west and east of the Mine Study Area respectively) (**Appendix D**). Furthermore, a third permanent diurnal roost, East Turner River, is located ~25km north east of the Mine Study Area (**Appendix D**).
Long-tailed dunnart *Sminthopsis longicaudata*		P4	Relatively little is known about the species distribution and biology (van Dyck and Strahan 2008), however potential threats may include inappropriate fire regimes, habitat alteration by non-native herbivores and predation by red foxes and feral cats.	Rocky, hilly areas, occasionally open areas with a stony, rocky mantle (van Dyck and Strahan 2008).	**Likely** The Gas Pipeline and Aerodrome Study Area contains only minimal suitable habitat for the species that is restricted to a small area of rocky foothills in the southern portion of the Study Area (van Dyck and Strahan 2008). However, the species was recorded once ~2.5km south west of the gas pipeline in 2009 within suitable rocky foothill habitat (Outback Ecology 2009b). As such, the species is considered likely to occur within the southern area of the gas pipeline, however is considered unlikely to depend on the habitat within its area.	**Confirmed** The species was recorded within the Mine Study Area during 2009, ~2.5km west of the northern Survey Area boundary within rocky foothill habitat (**Figure 4-5**) (Outback Ecology 2009b). This comprises the only record for the species in the area. The Mine Study Area contains rocky ridge and gorge, ironstone ridge top and rocky foothills habitat, all of which are considered suitable for the species (van Dyck and Strahan 2008).

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Western pebble-mound mouse *Pseudomys chapmani*		P4	Four minor-catastrophic threats have been identified; the most severe is habitat loss and fragmentation due to mining (Woinarski *et al.* 2014). Others listed are predation by red foxes and feral cats, and habitat degradation and resource loss due to non-native herbivores (Woinarski *et al.* 2014).	Gentle rocky spinifex slopes (van Dyck and Strahan 2008).	**Confirmed** The majority of the Gas Pipeline and Aerodrome Study Area is unlikely to contain suitable stony plain habitat with pebbles of appropriate size to construct mounds. This is with the exception of a small area within the southern portion of the Gas Pipeline and Aerodrome Study Area (van Dyck and Strahan 2008). The species was recorded on the edge of the proposed aerodrome portion twice in 2015 (DBCA 2018b), and is therefore confirmed in the Gas Pipeline and Aerodrome Study Area. However, a subsequent survey targeting conservation significant species at the aerodrome did not detect the species (360 Environmental 2018b). The species has also been recorded on numerous occasions where suitable spinifex stony plains habitat occurs near the gas pipeline, including from at least four studies conducted in the area (DBCA 2018b). These include eight mound records within 1.3km of the Gas Pipeline and Aerodrome Study Area in the Mine Study Area and a 2015 record ~0.4km north of the southern portion of the pipeline (DBCA 2018b). While the species occurs in the area, the species is unlikely to depend on most of the habitats within the areas due to unsuitability of habitats.	**Confirmed** The species was recorded within the Survey Area on 14 occasions via mounds within the Survey Area (**Figure 4-5**). Furthermore, mounds have been recorded on numerous occasions in the other portions of the Mine Study Area, including from 10 studies within 15 km (**Table 4-1**). This includes on 11 occasions by 360 Environmental during 2018 and on 25 occasions through the DBCA database search conducted for these reports (360 Environmental 2018a;c; DBCA 2017).
Greater bilby *Macrotis lagotis*	Vu	VU	Largest threat to the species is posed by predation from the Red Fox and feral Cats (Woinarski *et al.* 2014). Also inappropriate fire regimes, although to a lesser extent (van Dyck and Strahan 2008).	Variety of habitats including spinifex hummock grassland and *Acacia* shrubland, on soft soils (Burrows *et al.* 2012). In the Pilbara often associated with major drainage line sandy terraces (How *et al.* 1991a).	**Confirmed** The Gas Pipeline and Aerodrome Study Area contains suitable spinifex sandplain habitat (Burrows *et al.* 2012). Within the aerodrome portion of this Study Area, the species was recorded once in 2015 and twice during 2018, and on 32 occasions (12 scats, 16 diggings and four tracks) within the gas pipeline portion of the Study Area during 2018 (360 Environmental 2018b;c;d; DBCA 2018b) (**Figure 4-3**; **Figure 4-4**). Furthermore, four records of the species from 2013 and 2015 occur within 8km of the gas pipeline boundary in similar habitat (DBCA 2018b). No Bilby burrows were recorded from within the Gas Pipeline and Aerodrome Study Area.	**Unlikely** The species has been recorded on eight occasions within 7km of the Survey Area, with records varying from 2013 to 2015 (DBCA 2018b). However the Mine Study Area largely consists of stony substrates, which does not provide suitable habitat for the species (van Dyck and Strahan 2008). As such the species is considered unlikely to occur, and is more likely to rely upon spinifex sandplain habitat in the surrounding region.
Brush-tailed mulgara *Dasycercus blythi*		P4	Eight minor to severe threats to the Brush-tailed Mulgara are recognised (Woinarski *et al.* 2014). The most severe are habitat loss and fragmentation due to clearing, mining and tourism developments and climate change, however other threats comprise weeds, altering of habitat by non-native herbivores, predation by feral cats and red foxes, inappropriate fire regimes and poisoning from baits used for predators (Woinarski *et al.* 2014).	Inhabit spinifex grass plains within the arid zone (van Dyck and Strahan 2008).	**Confirmed** The Gas Pipeline and Aerodrome Study Area contains suitable spinifex sandplain habitat (**Figure 4-3**; **Figure 4-4**) (van Dyck and Strahan 2008), and the species has been recorded at the aerodrome portion of the Study Area on five occasions (one record in 2015, four in 2018) and was recorded 30 times (four scat, 21 burrow and five track records) in the gas pipeline portion of the Study Area in 2018 (360 Environmental 2018b;d) (**Figure 4-3**; **Figure 4-4**). Furthermore, the species has been recorded on nine occasions during 2013 within 8km of the pipeline boundary within similar habitat (DBCA 2018b).	**Unlikely** The Mine Study Area occurs within the species range (van Dyck and Strahan 2008), however the area is dominated by stony substrates with minimal foraging and burrowing suitability. The species has only been recorded recently nearby on two occasions; 10km and 6.5km north of the Mine Study Area in suitable sandy areas during 2015 and 2013 respectively (DBCA 2018b). Due to the lack of suitable habitat and lack of records despite extensive surveys, the species is considered unlikely to occur.

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Spectacled hare-wallaby *Lagorchestes conspicillatus leichardti*		P3	The species has declined drastically in the Pilbara (van Dyck and Strahan 2008). The most severe threats to the species comprise habitat loss and fragmentation and predation by red foxes, and possibly inappropriate fire regimes in the Pilbara preventing the formation of large spinifex hummock shelter (van Dyck and Strahan 2008; Woinarski *et al.* 2014). Moderate to minor threats include predation by feral cats and habitat alteration by non-native herbivores (Woinarski *et al.* 2014).	Occurs in a wide variety of grassland and woodland areas (Woinarski *et al.* 2014). Within the Pilbara uses large, unburnt spinifex hummocks for shelter (van Dyck and Strahan 2008).	**Confirmed** The Gas Pipeline and Aerodrome Study Area contains suitable habitat and occurs within the species range. Additionally, the species was recorded once in the aerodrome portion of the Study Area during 2015 (DBCA 2018b; van Dyck and Strahan 2008) (**Figure 4-3**; **Figure 4-4**). However, the species may be sparsely distributed in the area as there is only one other record from the region which occurred in 2010 ~36km south east of the southern portion of the pipeline portion of the Study Area (Outback Ecology 2010a). The species has been in decline in the Pilbara in recent years and there is only one other recent record of the species from 2014 approximately 130km to the southeast (DBCA 2018b).	**Possible** The Survey Area contains suitable habitat, including large spinifex hummocks within spinifex stony plain habitat, and occurs within the species range (van Dyck and Strahan 2008). However, the species has only been recorded twice recently nearby; during 2015 ~10.5km north and during 2010 ~33km south east of the Mine Study Area (DBCA 2018b; Outback Ecology 2010a). Although there are two records near the Study Area, the lack of recent records in the region, suggests the species is only Possible to occur.
Birds						
Fork-tailed swift *Apus pacificus*	Mi	IA	There are no major threats towards the species within Australia, however potential threats include predation by feral animals and habitat destruction (DoEE 2018b).	Aerial species, which forages high above the tree canopy and rarely lower (Johnstone and Storr 1998). Occurs over a range of habitats including islands, open country, coasts, semi-deserts, urban, forests (Pizzey and Knight 2007).	**Confirmed** The Gas Pipeline and Aerodrome Study Area contains suitable habitat (van Dyck and Strahan 2008), and the species was recorded in the northern portion of the pipeline during 2018 (360 Environmental 2018c) (**Figure 4-3**; **Figure 4-4**). The species was also recorded ~8.5km southeast of the southern portion of the pipeline during 2011 and ~5km north east of the gas pipeline during 2014 (DBCA 2018a;b).	**Likely** The Mine Study Area occurs within the species range, contains suitable habitat (Pizzey and Knight 2007) and the species has been recorded twice recently nearby. One 2014 record occurs <1km east of the Mine Study Area, while the second occurs ~5.5km south east of the Mine Study Area during 2011 (DBCA 2018a;b). Given the proximity of recent records, the species is considered likely to occur.
Grey falcon *Falco hypoleucos*		VU	The main threat to the species is clearing and habitat degradation (AWC).	Mainly lightly wooded coastal and riverine plains (Johnstone and Storr 1998).	**Likely** Suitable habitat within wooded areas and drainage lines are restricted to the northern area of the gas pipeline and are absent from the aerodrome (Simpson and Day 2010). Despite the species being sparsely distributed, there are five records from 2000 – 2015 within 8km of the Gas Pipeline and Aerodrome Study Area (DBCA 2018b). Three of these are associated with optimal riverine habitat that does not occur within the Gas Pipeline and Aerodrome Study Area. As such, the species is considered likely to occur.	**Likely** The Mine Study Area contains suitable habitat and occurs within the species range (Simpson and Day 2010). Furthermore, despite the species being sparsely distributed, there are three records of the species from 2012 – 2015 within 5km of the Survey Area (DBCA 2018b). One of these occurs within optimal riverine habitat that does not occur within the Mine Study Area. Due to the close proximity of previous records this species is considered likely to occur.
Peregrine falcon *Falco peregrinus*		OS	The major threat to the species is habitat loss, particularly wooded areas which serve as nesting sites to the species in the absence of cliffs.	The species occurs along cliffs, gorges, wooded rivers, wetlands, plains and open woodlands, as well as in association with pylons and buildings (Pizzey and Knight 2007). Nests on cliffs, in crevices, large tree hollows, in nests of other large birds or on building ledges (Pizzey and Knight 2007).	**Likely** Suitable habitat within wooded areas and drainage lines of the Gas Pipeline and Aerodrome Study Area are restricted to the northern area of the gas pipeline and are absent from the aerodrome (Simpson and Day 2010). The species has been recorded twice during 2013 within 5km of the gas pipeline boundary (DBCA 2018a;b).	**Likely** The Mine Study Area contains suitable habitat and occurs within the species range (Simpson and Day 2010), and the species has been recorded twice during 2013 within 2km of the Survey Area (DBCA 2018b). Due to the close proximity of previous records this species is considered likely to occur.

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Night parrot *Pezoporus occidentalis*	CR	En	While there are no threats with direct evidence, threats proposed to affect the species include predation by feral cats and red foxes, human induced fires removing long unburnt habitat and land and water source degradation by non-native herbivores (DoEE 2016).	Known to inhabit treeless or sparsely wooded long unburnt spinifex hummock plains often interspersed with chenopods (Pyke and Ehrlich 2014).	**Unlikely** The Gas Pipeline and Aerodrome Study Area contains spinifex hummocks within spinifex sandplain and spinifex stony plain habitats, however these were not interspersed with chenopods, which are often present within Night Parrot habitat (Pyke and Ehrlich 2014). Furthermore, the species is incredibly rare and has not been recorded nearby (DBCA 2018b; Pizzey and Knight 2007).	**Unlikely** The Mine Study Area does contain large, long-unburnt spinifex hummocks. However these were not interspersed with chenopods, which are often present within Night Parrot habitat (Pyke and Ehrlich 2014). Furthermore, the species is incredibly rare and has not been recorded nearby (DBCA 2018b; Pizzey and Knight 2007). As such, the species is considered unlikely to occur within the Mine Study Area.
Osprey *Pandion haliaetus*	Mi	IA	The major threat to the species is habitat loss and degradation, mainly due to tourism and urban development (DoEE 2018b). Other threats include consumption of contaminated prey (e.g. pesticides, heavy metals, fishing objects), fisheries depleting food sources and reduced water quality due to run-off (DoEE 2018b).	Coastal areas including beaches, tidal flats, estuaries, forests, estuaries and mangroves as well as major rivers (Pizzey and Knight 2007).	**Unlikely** The Gas Pipeline and Aerodrome Study Area lies on the edge of the species range, and does not contain suitable riverine habitat (Pizzey and Knight 2007). The species has been recorded twice nearby during 2000 within major riverine habitat ~5.8km west of the gas pipeline (DBCA 2018a). Due to the proximity, the species may overfly the gas pipeline, however is unlikely to depend upon the habitat within its boundaries.	**Unlikely** The Mine Study Area does not contain suitable habitat (Pizzey and Knight 2007), and the species has not been recorded recently nearby. Species records are restricted to the coast, occasionally occurring slightly further inland along major river systems (DBCA 2018a). Due to the lack of suitable habitat the species is considered unlikely to occur.
18 sandpiper, stint, whimbrel, snipe, greenshank, curlew, knot, pratincole, ibis and godwit species from the families Scolopacidae; Charadriidae; Rostratulidae; and Glareolidae	Mi, Cr, En	IA, VU, EN		Small to large sized shore/ wetland birds. Inhabit shallow aquatic areas on coasts, mudflats, saltmarshes, estuaries, lake margins and other inland waters and bare or grassy plains (Johnstone and Storr 1998).	**Possible** The Gas Pipeline and Aerodrome Study Area may contain suitable habitat within small areas of the low vegetation with ephemeral areas habitat in the northern portion of the gas pipeline, however the proposed aerodrome area does not contain suitable habitat (Pizzey and Knight 2007). Most recent nearby records of these species occur along the coast or near riverine habitat, which would provide optimal habitat for the species but are absent from areas of the gas pipeline (DBCA 2018a;b). However, some records of these species extend into drainage line habitat near the northern areas of the gas pipeline (DBCA 2018a;b). Furthermore, given major riverine habitat occurs as close as 3km from the gas pipeline boundary, consequently, these species may overfly the Study Area or use the low vegetation within ephemeral area habitats when inundated. As such, these species are considered to possibly occur within the gas pipeline and unlikely to occur within the aerodrome portions of the Gas Pipeline and Aerodrome Study Area.	**Unlikely** The Mine Study Area does not contain suitable habitat (Pizzey and Knight 2007), and these species have not been recorded recently nearby. This group of species are largely restricted to coastal areas or major riverine and drainage habitats slightly further inland (DBCA 2018a).
Caspian tern *Sterna caspia* **White-winged black Tern** *Sterna leucoptera* **Gull-billed tern** *Sterna nilotica*	Mi	IA		Associated with wetlands and coastal areas including estuaries, lakes, airfields, mudflats, ploughed fields, salt swamps and coastal waters (Pizzey and Knight 2007).	**Possible** The majority of the Gas Pipeline and Aerodrome Study Area does not contain suitable habitat, however small areas of the low vegetation with ephemeral areas habitat which is located in the northern portion of the gas pipeline may provide suitable habitat (Pizzey and Knight 2007). Species records are restricted to the coast or suitable habitat within the riverine area ~6km west of the northern portion of the gas pipeline (DBCA 2018a;b). Due to the proximity of riverine records, the species is considered to possibly occur in the vicinity of the gas pipeline and unlikely to occur in the aerodrome.	**Unlikely** The Mine Study Area does not contain suitable habitat (Pizzey and Knight 2007), and the species has not been recorded recently nearby. The species has been recorded north near coastal areas and south in association with Fortescue Marsh (DBCA 2018a;b). These areas serve as suitable habitat, however occur over 70km from the Mine Study Area. Due to the lack of suitable habitat and nearby records, these species are considered unlikely to occur.

Common name (*Scientific name*)	Conservation status		Threats and reasoning for listing	Broad habitat type	Likelihood of occurrence Reason for likelihood	
	EPBC Act	WC Act			Gas Pipeline and Aerodrome Study Area	Mine Study Area
Barn swallow *Hirundo rustica*	Mi	IA	The main threat to the species is habitat loss (DoEE 2018b).	Open areas and coastal lowlands, agricultural land (particularly near water), also in urban areas and rail yards (DoEE 2018b; Pizzey and Knight 2007).	**Unlikely** The species has not been recorded recently nearby, and was only listed as 'species or species habitat known to occur' near the Study Area (DoEE 2018a).	**Unlikely** The species has not been recorded recently nearby, and was only listed as 'species or species habitat may occur' (DoEE 2018a).
Grey wagtail *Motacilla cinerea* **Yellow wagtail** *Motacilla flava*	Mi	IA		Both species inhabit sewage ponds and lawn fields, however the Grey Wagtail also occurs along streams in escarpments, rainforests and unused quarries while the Yellow Wagtail occurs in swamp edges, short grass, bare ground and saltmarshes (Pizzey and Knight 2007).	**Unlikely** The species were not recorded recently nearby, and were included as the species or habitat were listed as 'may occur' and 'likely to occur' near the Gas Pipeline and Aerodrome Study Area for the yellow and grey wagtail respectively (DoEE 2018a). As such, they are considered unlikely to occur.	**Unlikely** The species were not recorded recently nearby, and were included as the species or habitat were listed as 'may occur' near the Study Area (DoEE 2018a). Due to a lack of suitable habitat and a lack of nearby records, they are considered unlikely to occur.
Reptiles						
Pilbara olive python *Liasis olivaceus barroni*	Vu	VU	The main threats identified to the species are predation of juvenile and prey items (such as the Northern Quoll and Rock-wallabies) by the feral Cat and Red Fox, and destruction of habitat from resources development (Pearson 2003). Also major fire events are likely to impact the species (Pearson 2003).	Species commonly recorded along watercourses and areas of permanent water, particularly in rocky gorges, escarpments and gullies (Pearson 1993).	**Possible** The gas pipeline portion of the Gas Pipeline and Aerodrome Study Area only contains minimal areas of relatively minor drainage line habitat, and does not contain suitable rocky ridge and gorge habitat or gullies (Pearson 1993). The aerodrome portion of the Study Area does not contain suitable habitat. The species was recorded 1.9km east of the gas pipeline during 2011 in the DBCA (2018b) database search. However as record location is only accurate to within 3km, the record does not occur in optimal habitat and the site details are listed as 'Roy Hill Railway', the location may be erroneous. Numerous other records occur within suitable rocky habitat ~30 – 40km east of the southern area of the gas pipeline, and one record from 2012 occurs ~19km east of the northern portion of the gas pipeline within riverine habitat (DBCA 2018a). These habitats are both absent from the Gas Pipeline and Aerodrome Study Area. As such, the species is only considered to possibly occur.	**Likely** The Mine Study Area occurs within the species range and contains suitable habitat. The species was recorded within the Survey Area during 2011 in the DBCA (2018b) database search. However as record location is accurate to within 3km, site details are listed as 'Roy Hill Railway', and the record does not occur in optimal habitat, the location may be erroneous. Numerous other recent records of the species occur ~30 – 40km east of the Mine Study Area within similar rocky ridge and gorge habitat (DBCA 2018a). Due to the presence of suitable habitat and the Study Area being within the species range, the species is considered likely to occur within the Mine Study Area.
Anilios ganei		P1		Known to occur between Newman and Pannawonica, possibly within moist gorges and gullies (Wilson and Swan 2013).	**Unlikely** The Gas Pipeline and Aerodrome Study Area does not contain suitable rocky ridge and gorge habitat, and the species has not been recorded recently nearby (Wilson and Swan 2013). The only record of the species was from the Turner River Hub survey (Outback Ecology 2010a), ~73km south east of the gas pipeline.	**Unlikely** While the Mine Study Area contains suitable habitat, the species has not been recorded recently nearby. The only record of the species was from the Turner River Hub survey (Outback Ecology 2010a), at a location ~70km south east of the Mine Study Area. Due to the lack of nearby records, the species is considered unlikely to occur.

Figure 4-3: Locations of conservation significant fauna and habitats across the northern portion of the Gas Pipeline and Aerodrome Study Area.

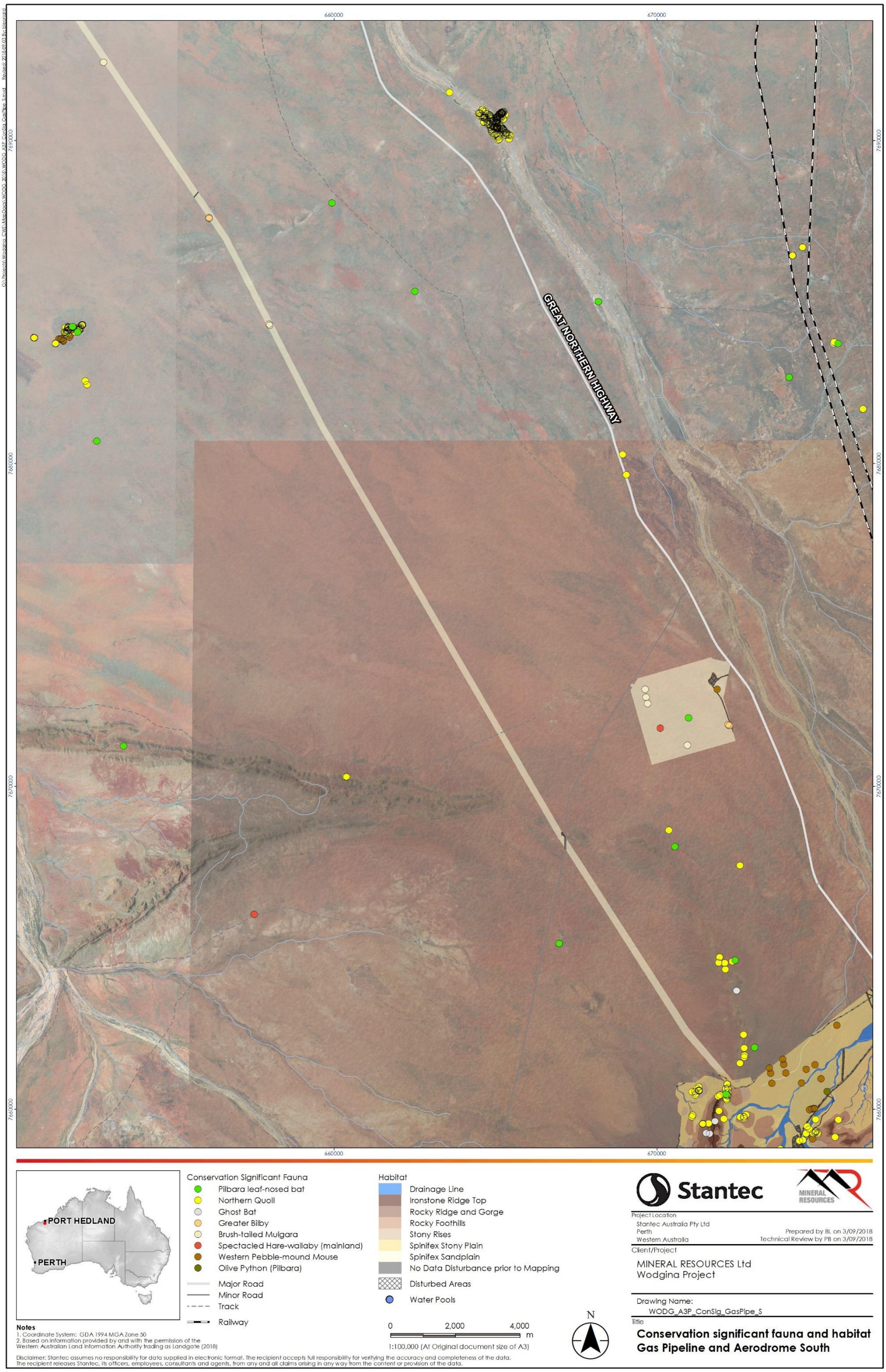


Figure 4-4: Locations of conservation significant fauna and habitats across the southern portion of the Gas Pipeline and Aerodrome Study Area.

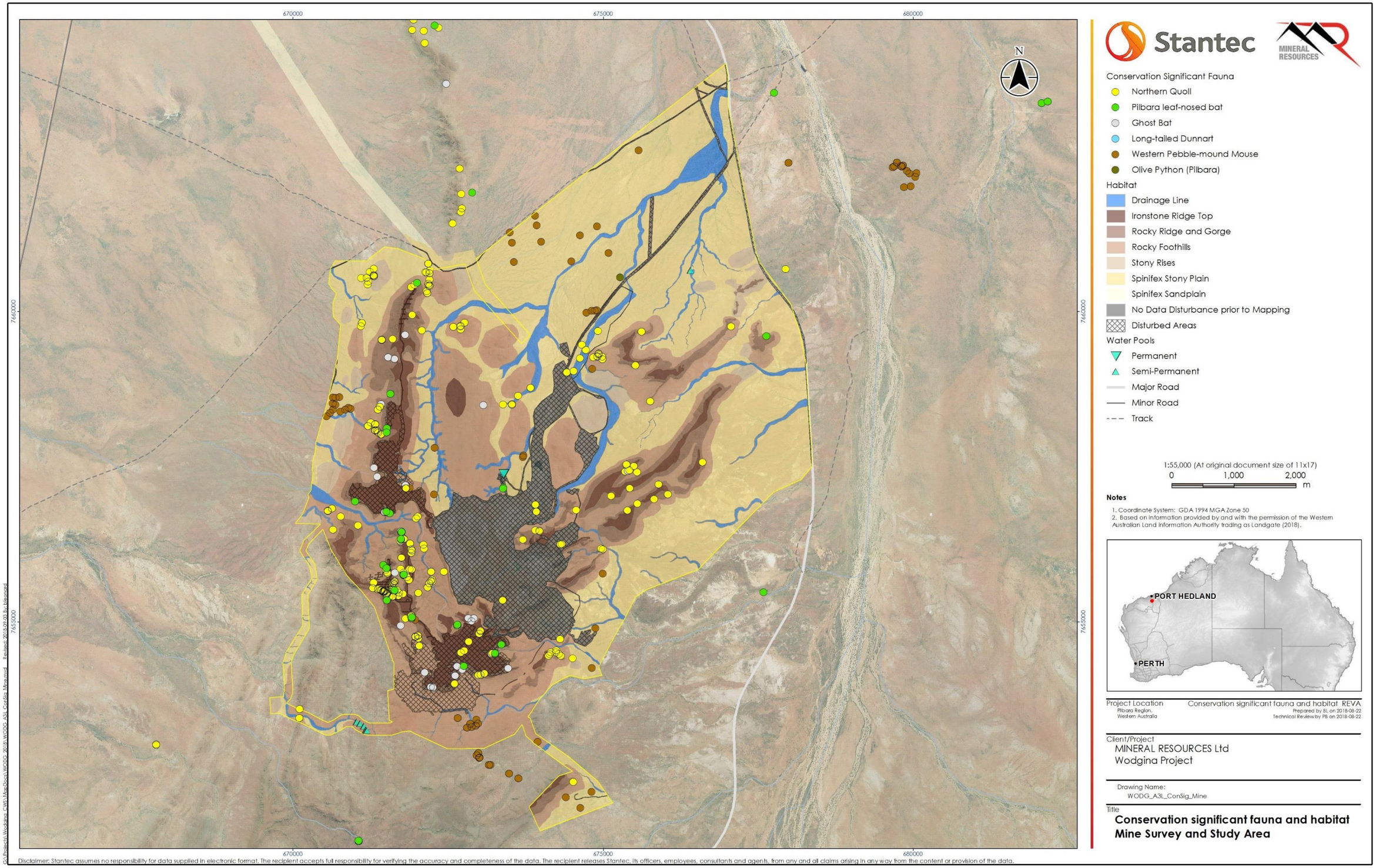


Figure 4-5: Locations of conservation significant fauna and habitats across the Mine Study Area.

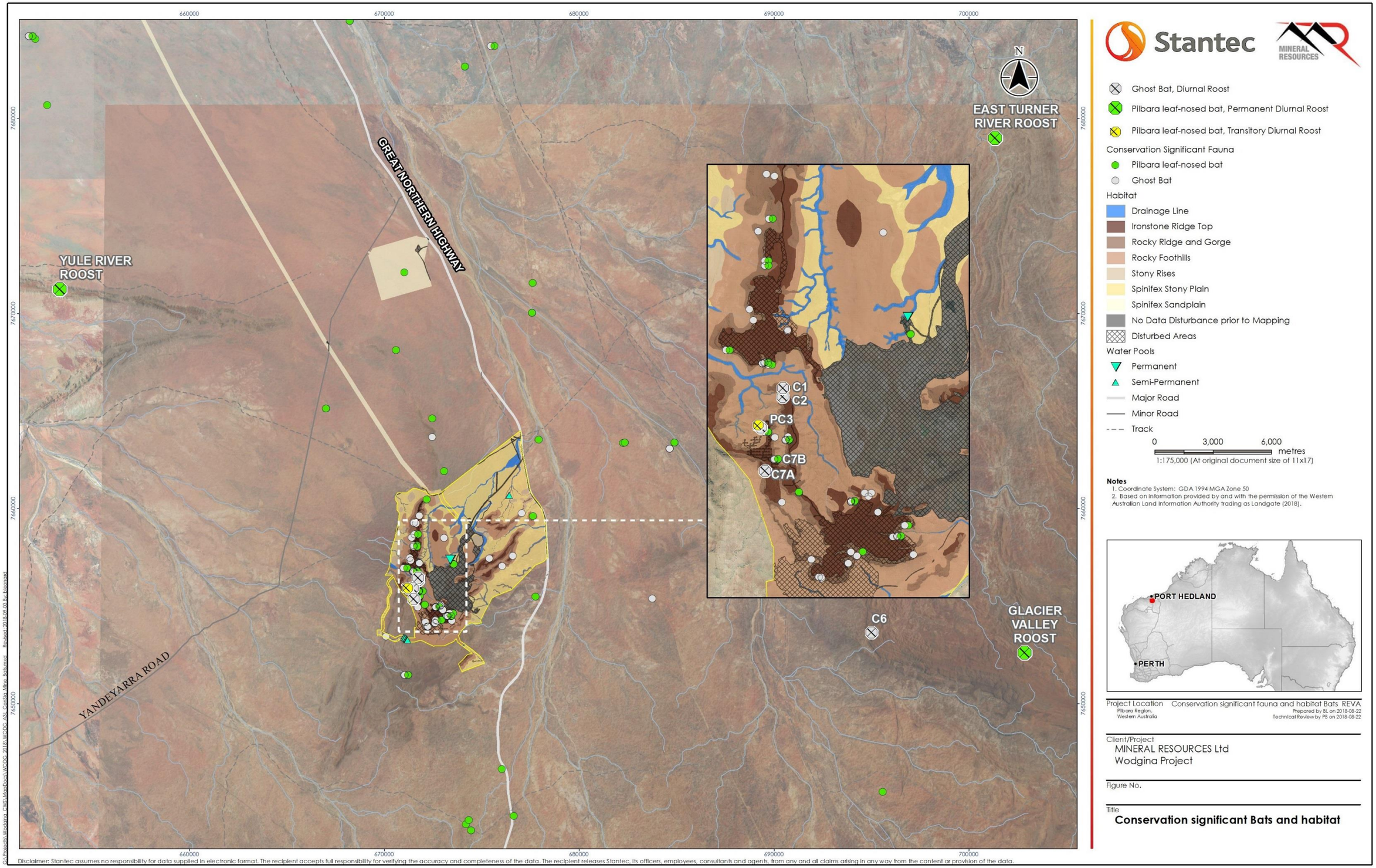


Figure 4-6: Locations of significant bat roosting caves in the Study Areas with respect to regional permanent diurnal roosts.

5. Summary

The objectives of the Level 1 fauna survey and desktop assessment were to define the environmental values of the Survey Area, the Mine Study Area and the Gas Pipeline and Aerodrome Study Area, and to assess the conservation significance of these areas in relation to the Project. The objectives were addressed by undertaking a field survey and desktop assessment, to consolidate all previous fauna work conducted within, and adjacent, to the Project. The desktop assessment was divided into the Mine Study Area and the Gas Pipeline and Aerodrome Study Area, with the Survey Area included within the Mine Study Area. Two Study Areas were delineated due to the differences in habitats occurring within each, and therefore the differences in the potential occurrence of conservation significant fauna.

Based on the desktop assessment, a total of 382 fauna species have potential to be recorded within the Study Areas. Of these, a total of 57 species of vertebrate fauna were recorded during the Level 1 fauna survey, comprising 20 mammals, 33 birds and four reptiles. This diversity is similar to that recorded during surveys of similar intensity, adjacent to the Project. Of the vertebrate fauna identified during the desktop assessment, 42 species are listed as being of conservation significance, comprising nine mammals, 31 birds and two reptiles. During the Level 1 fauna survey, the following conservation significant species were recorded and therefore confirmed to occur:

- the northern quoll (*Dasyurus hallucatus*, EN; EN);
- the ghost bat (*Macroderma gigas*, VU; VU);
- the Pilbara leaf-nosed bat (*Rhinonicteris aurantius* (Pilbara form), VU; VU); and
- the western pebble-mound mouse (*Pseudomys chapmani*, P4).

The Gas Pipeline and Aerodrome Study Area is comprised of different habitats, and consequently substantially different conservation significant fauna records, to the Mine Study Area. Conservation significant fauna confirmed in the Gas Pipeline and Aerodrome Study Area from the desktop assessment comprised:

- the greater bilby (*Macrotis lagotis*, VU; VU)
- the spectacled hare-wallaby (*Lagorchestes conspicillatus leichardti*, P3)
- the brush-tailed mulgara (*Mulgara Dasycercus blythi*, P4)
- the western pebble-mound mouse (*Pseudomys chapmani*, P4)
- the fork-tailed swift (*Apus pacificus*, MI; IA)

Six broad habitats were identified, delineated and described within the Survey Area. These habitats comprised ironstone ridge top, rocky ridge and gorge, rocky foothills, stony rise, spinifex stony plain and drainage line. Based on the desktop assessment, these habitats were found to be well represented within the Mine Study Area. Additionally, three habitats were delineated exclusively within the Gas Pipeline and Aerodrome Study Area; shrubland over spinifex, spinifex sandplain and low vegetation with ephemeral areas.

Within these habitats, two significant microhabitats were identified; semi-permanent pools and diurnal bat roosts. The semi-permanent pools were predominantly located along a rocky drainage line in the southern portion of the Survey Area. These pools are important for supporting a range of fauna assemblages as well as providing habitat and resources for specific conservation significant fauna, including the Pilbara leaf-nosed bat, ghost bat, northern quoll and the Pilbara olive python. One diurnal Pilbara leaf-nosed bat roost, classified as a 'transitory diurnal roost', and five diurnal ghost bat roosts were identified in the Mine Study Area.

Of the broad habitats that occur across the Study Areas, rocky ridge and gorge was considered to provide particularly high value for conservation significant fauna, as it comprised breeding and denning sites for the northern quoll, and roost sites for the Pilbara leaf-nosed bat and ghost bat. This habitat is also of limited extent and is not widespread outside of the Project area. Other habitats which supported a number of

conservation significant fauna included spinifex sandplain and shrubland over spinifex sandplain. These were dominated by sandy substrates, which have potential to support the bilby and brush-tailed mulgara; however, this habitat was assessed as widespread in the region. Both Study Areas are known to provide habitat for the western pebble-mound mouse; however, the species records were primarily associated with spinifex stony plains, which are widespread in the landscape. A number of other conservation significant fauna were found to occur in the Study Areas in either sparse numbers, or were considered likely to occur based on records in the surrounds. The habitats within the Study Areas may be of importance to these species, but to a lesser degree than those discussed above.

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Appendices

Appendix A Codes and Terms Used to Describe Species of Conservation Significance

Fauna may be afforded legislative protection by being listed under the EPBC Act and/or the WC Act, or by being listed on the DBCA Priority Species List. This Appendix presents a summary of the different rankings and listings used to describe conservation status. Some categories, such as 'extinct', 'extinct in the wild' and 'conservation dependent' (EPBC Act) are not presented here, as the table includes only the information needed to fully understand the codes presented in the preceding report. Refer to the relevant legislation for a full description of all codes in use, as well as their associated criteria.

Categories used under the EPBC Act		
Status	Code	Description
Critically Endangered	**CR**	Taxa that is considered to be facing an extremely high risk of extinction in the wild in the immediate future
Endangered	**EN**	Taxa that is considered to be facing a very high risk of extinction in the wild in the near future
Vulnerable	**VU**	Taxa that is considered to be facing a high risk of extinction in the wild in the medium-term future
Migratory	**MI**	Species that migrate to, over and within Australia and its external territories

Conservation Codes used under the WC Act			
Status	Code	Schedule	Description
Critically Endangered	**CR**	**S1**	Taxa that is rare or likely to become extinct, as critically endangered taxa
Endangered	**EN**	**S2**	Taxa that is rare or likely to become extinct, as endangered taxa
Vulnerable	**VU**	**S3**	Taxa that is rare or likely to become extinct, as vulnerable taxa
Presumed Extinct	**EX**	**S4**	Taxa that is presumed to be extinct
Migratory	**IA**	**S5**	Birds that are subject to international agreements relating to the protection of migratory birds
Conservation Dependent	**CD**	**S6**	Taxa that are of special conservation need being species dependent on ongoing conservation intervention
Special Protection	**OS**	**S7**	Taxa that is in need of special protection

Appendix B SM2 Audio Software Parameters & Settings

Table B-1: SM2 audio software parameters and settings.

Parameter	Setting
Sample rate	384,000 KHz
Channel used	Left
Compression protocol	WAC2
Gain (software)	0.00
Gain (hardware)	+ 48 dB
High pass filter (software)	fs/24
High pass filter (hardware)	1000 kHz
Frequency range	12 to 192 kHz
Triggering level	6 SNR (adaptive + 6 dB triggering)
Triggering window	1.0 sec
Recording format	WAC 'full spectrum'

Appendix C Motion Camera Locations

Table C-1: Motion camera locations within the Survey Area.

Camera	Habitat Type	Coordinates (50K)	
		Easting	Northing
REC02	Rocky ridge and gorge	675494	7657506
REC03	Drainage line	675545	7660760
REC05	Spinifex stony plain	675918	7660843
REC06	Rocky foothills	674933	7656408
REC07	Drainage line	676857	7662408
REC10	Rocky ridge and gorge	675357	7657423
REC13	Ironstone ridge top	675131	7657139
REC14	Spinifex stony plain	675777	7662148
REC16	Rocky foothills	676171	7657368
REC17	Drainage line	676667	7661560
REC19	Rocky foothills	674991	7659270
REC20	Spinifex stony plain	676909	7661867
REC21	Rocky ridge and gorge	677632	7659608
REC22	Spinifex stony plain	676218	7660460
REC23	Spinifex stony plain	676024	7662954
REC24	Rocky ridge and gorge	674972	7657235
REC25	Spinifex on stony plain	677057	7661316
REC27	Rocky ridge and gorge	675378	7657528
REC28	Rocky foothills	676392	7657631
REC29	Rocky foothills	674855	7659263
REC30	Rocky ridge and gorge	675410	7659161
REC32	Spinifex stony plain	674064	7661710
REC34	Drainage line	674932	7661158
REC36	Drainage line	676468	7660668
REC37	Drainage line	676893	7662759
REC38	Rocky ridge and gorge	675827	7656976
REC39	Drainage line	674610	7658864
REC40	Spinifex stony plain	676726	7661387
REC42	Rocky ridge and gorge	677448	7659566
REC43	Rocky ridge and gorge	675557	7656904
REC44	Rocky foothills	676076	7657245
REC45	Ironstone ridge top	675396	7656798

Appendix D Historic Northern Quoll and Pilbara Leaf-nosed Bat Records

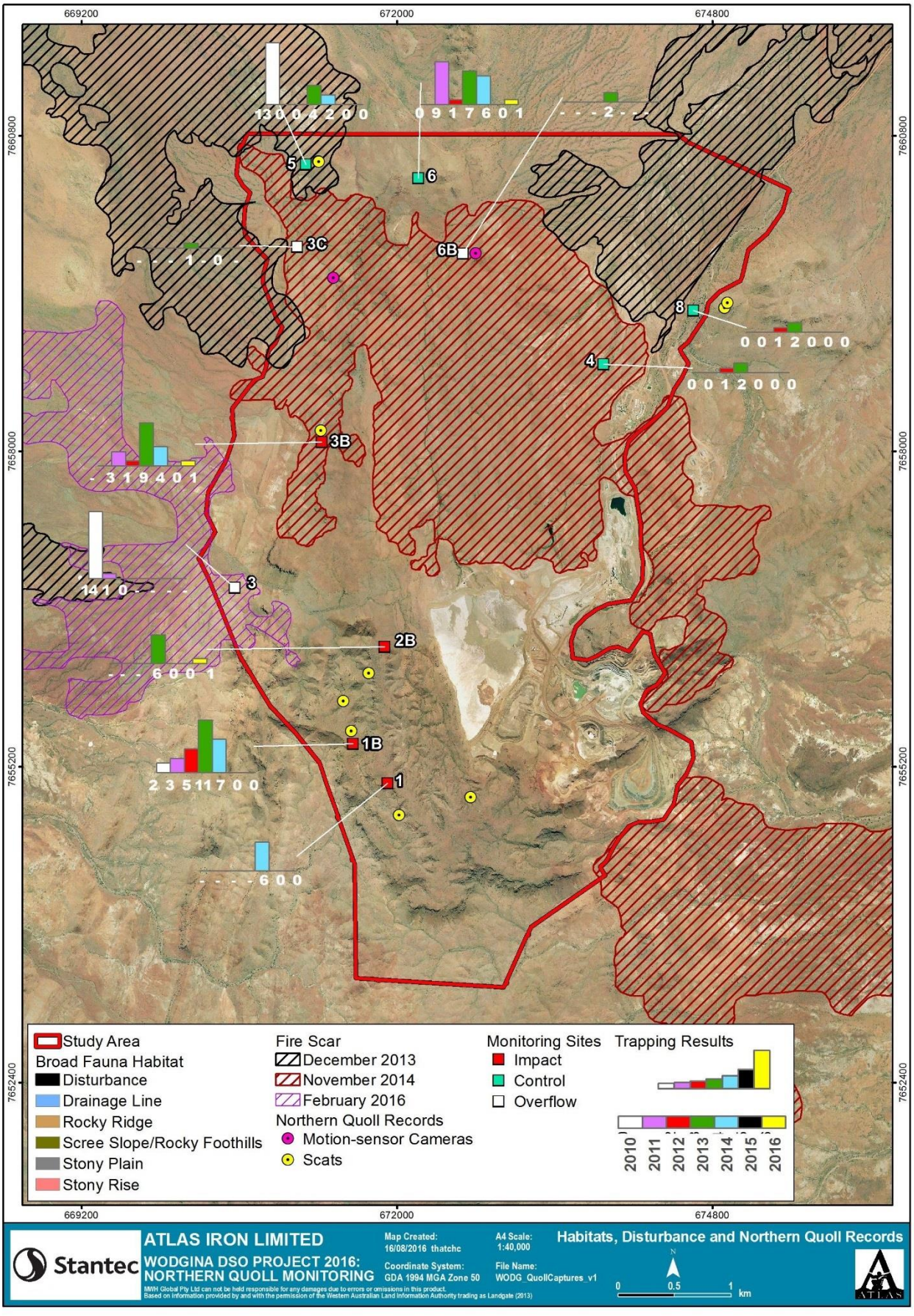


Figure D-1: Atlas Wodgina DSO Project northern quoll monitoring records, 2010 – 2017 Stantec (2017b).

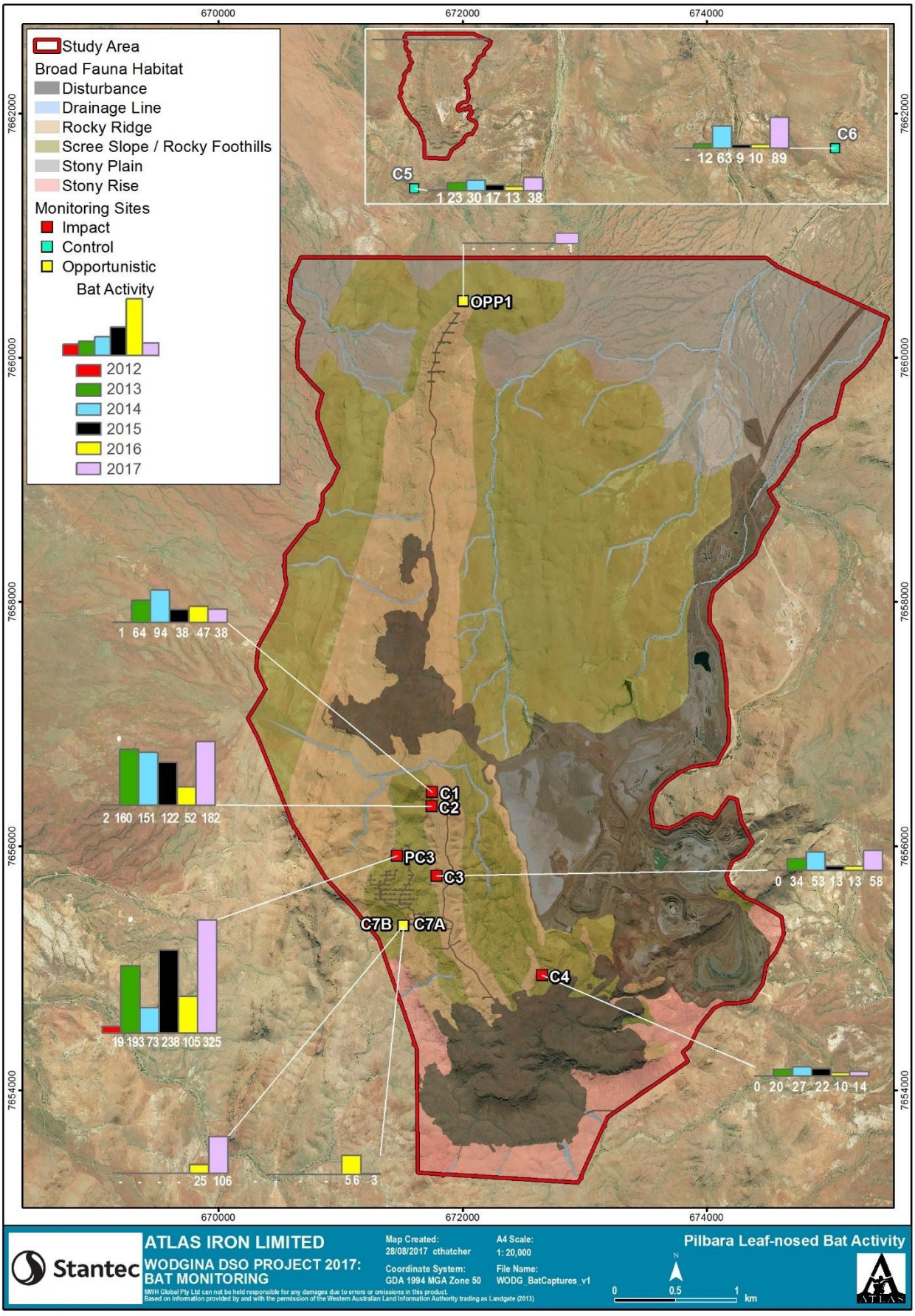


Figure D-2: Atlas Wodgina DSO Project Pilbara leaf-nosed bat records, 2012 – 2017 from Stantec (2017a).

Appendix E Vertebrate Fauna Identified from the Desktop Assessment

Legend:

A Current Survey

Database searches:

B NatureMap Database (DBCA 2018a)

C Protected Matters Search Tool (DoEE 2018a)

D Threatened and Priority Fauna Search (DBCA 2018b)

Literature Review

E Wodgina DSO Project: Terrestrial Vertebrate Fauna Assessment (Outback Ecology 2009b)

F Mt Dove DSO Project: Vertebrate Fauna Assessment (Outback Ecology 2011d)

G Turner River Hub: Terrestrial Vertebrate Fauna Baseline Survey (Outback Ecology 2010a)

H Hercules Project: Terrestrial Vertebrate Fauna Baseline Survey (Outback Ecology 2012f)

I Flora, Vegetation and Fauna Assessment Wodgina Mine and Proposed Airstrip (360 Environmental 2018c)

J Wodgina Mine and Additional Gas Pipeline: Flora, Vegetation, Fauna and Northern Quoll Assessment (360 Environmental 2018c)

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna			x	x				x	x		x	x
Dasyuridae	*Dasycercus blythi*	Brush-tailed Mulgara		P4		x		x						
	Dasycercus cristicauda	Crest-tailed Mulgara	VU	P4							x			
	Dasykaluta rosamondae	Little Red Kaluta			x	x				x	x			
	Dasyurus hallucatus	Northern Quoll	EN	EN	x	x		x	x	x	x	x	x	x
	Ningaui timealeyi	Pilbara Ningaui				x					x			
	Planigale ingrami	Long-tailed Planigale				x			x	x	x	x		
	Planigale maculata	Common Planigale				x								
	Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus				x								
	Pseudantechinus roryi	Rory's Pseudantechinus				x								
	Pseudantechinus woolleyae	Woolley's Pseudantechinus				x			x		x			
	Sminthopsis longicaudata	Long-tailed Dunnart		P4					x					
	Sminthopsis macroura	Stripe-faced Dunnart			x	x				x	x			x
	Sminthopsis ooldea	Ooldea Dunnart				x								
	Sminthopsis youngsoni	Lesser Hairy-footed Dunnart				x								
Thylacomyidae	*Macrotis lagotis*	Bilby	VU	VU		x	x	x						x
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum				x								
Macropodidae	*Lagorchestes conspicillatus leichardti*	Spectacled Hare-wallaby		P3		x		x			x			
	Notamacropus agilis	Agile Wallaby				x								
	Osphranter robustus	Euro			x	x			x	x	x	x		x
	Osphranter rufus	Red Kangaroo				x				x	x			
	Petrogale rothschildi	Rothschild's Rock-wallaby			x	x			x		x		x	x
Muridae	*Mus musculus*	*House Mouse				x	x				x			
	Notomys alexis	Spinifex Hopping-mouse			x	x				x	x		x	x
	Pseudomys chapmani	Western Pebble-mound Mouse		P4	x	x		x	x	x	x	x	x	x
	Pseudomys delicatulus	Delicate Mouse				x					x			
	Pseudomys desertor	Desert Mouse				x								
	Pseudomys hermannsburgensis	Sandy Inland Mouse				x				x	x			
	Zyzomys argurus	Common Rock-rat			x	x			x		x		x	x
Leporidae	*Oryctolagus cuniculus*	*Rabbit					x							
Rhinonycteridae	*Rhinonicteris aurantius* (Pilbara form)	Pilbara Leaf-nosed Bat	VU	VU	x	x	x	x	x	x	x	x		
Megadermatidae	*Macroderma gigas*	Ghost Bat	VU	VU	x	x		x	x	x	x	x		
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat				x			x	x	x	x		
	Taphozous georgianus	Common Sheathtail-bat			x	x			x	x	x	x		
Molossidae	*Austronomus australis*	White-striped Freetail-bat			x				x					
	Chaerephon jobensis	Greater Northern Freetail-bat				x			x		x			x
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat			x	x			x	x	x	x		
	Scotorepens greyii	Little Broad-nosed Bat			x	x			x	x	x	x		
	Vespadelus finlaysoni	Finlayson's Cave Bat			x	x			x	x	x	x		
Canidae	*Canis dingo*	Dingo												x
	Canis lupus	*Dog			x	x	x			x	x		x	x
	Vulpes vulpes	*Red Fox			x	x	x			x			x	
Felidae	*Felis catus*	*Cat			x	x	x		x	x	x		x	
Equidae	*Equus asinus*	*Donkey				x	x			x	x			
	Equus caballus	*Horse				x	x				x		x	x
Suidae	*Sus scrofa*	*Pig					x							
Camelidae	*Camelus dromedarius*	*Camel				x	x			x	x			
Bovidae	*Bos taurus*	*European Cattle			x	x			x	x	x	x	x	x

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
	Capra hircus	*Goat				x								
Dromaiidae	*Dromaius novaehollandiae*	Emu				x				x	x			
Anatidae	*Anas gracilis*	Grey Teal				x					x			
	Anas rhynchotis	Australasian Shoveler				x								
	Anas superciliosa	Pacific Black Duck				x					x			
	Aythya australis	Hardhead				x								
	Chenonetta jubata	Australian Wood Duck				x								
	Cygnus atratus	Black Swan				x					x			
	Dendrocygna eytoni	Plumed Whistling Duck				x								
	Malacorhynchus membranaceus	Pink-eared Duck				x								
Phasianidae	*Coturnix ypsilophora*	Brown Quail				x				x	x			x
Podicipedidae	*Podiceps cristatus*	Great Crested Grebe				x								
	Poliocephalus poliocephalus	Hoary-headed Grebe				x								
	Tachybaptus novaehollandiae	Australasian Grebe				x						x		
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork				x			x		x			
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill				x								
	Platalea regia	Royal Spoonbill				x								
	Plegadis falcinellus	Glossy Ibis	MI	IA		x		x						
	Threskiornis spinicollis	Straw-necked Ibis				x					x			
Ardeidae	*Ardea garzetta*	Little Egret				x								
	Ardea ibis	Cattle Egret				x	x							
	Ardea intermedia	Intermediate Egret				x								
	Ardea modesta	Eastern Great Egret				x	x	x			x			
	Ardea novaehollandiae	White-faced Heron				x					x			
	Ardea pacifica	White-necked Heron			x	x					x			
	Nycticorax caledonicus	Rufous Night Heron				x								
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican				x								
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant				x								
	Phalacrocorax melanoleucos	Little Pied Cormorant				x					x			
	Phalacrocorax sulcirostris	Little Black Cormorant				x								
	Phalacrocorax varius	Pied Cormorant				x					x			
Anhingidae	*Anhinga novaehollandiae*	Australiasian Darter				x								
Pandionidae	*Pandion haliaetus*	Osprey	MI	IA		x	x							
Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk				x								
	Accipiter fasciatus	Brown Goshawk				x			x		x		x	
	Accipiter fasciatus fasciatus					x								
	Aquila audax	Wedge-tailed Eagle			x	x				x	x			
	Circus approximans	Swamp Harrier				x					x			
	Circus assimilis	Spotted Harrier				x					x		x	
	Elanus caeruleus	Black-shouldered Kite				x								
	Haliaeetus leucogaster	White-bellied Sea-Eagle				x	x							
	Hieraaetus morphnoides	Little Eagle				x						x		
	Haliastur indus	Brahminy Kite				x					x			
	Haliastur sphenurus	Whistling Kite			x	x				x	x	x	x	x
	Hamirostra isura	Square-tailed Kite				x								
	Hamirostra melanosternon	Black-breasted Buzzard			x									x
	Milvus migrans	Black Kite			x	x			x					
Otididae	*Ardeotis australis*	Australian Bustard				x				x	x		x	

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
Rallidae	*Fulica atra*	Eurasian Coot				x								
	Gallinula tenebrosa	Dusky Moorhen									x			
	Gallirallus philippensis	Buff-banded Rail				x								
	Tribonyx ventralis	Black-tailed Native-hen				x								
Turnicidae	*Turnix velox*	Little Button-quail			x	x			x		x	x	x	x
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew				x					x		x	
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt				x								
	Recurvirostra novaehollandiae	Red-necked Avocet				x								
Charadriidae	*Charadrius melanops*	Black-fronted Dotterel				x			x		x	x		
	Charadrius ruficapillus	Red-capped Plover				x								
	Charadrius veredus	Oriental Plover	MI	IA		x	x							
	Erythrogonys cinctus	Red-kneed Dotterel				x								
	Vanellus miles	Masked Lapwing				x								
	Vanellus tricolor	Banded Lapwing				x					x			
Rostratulidae	*Rostratula benghalensis*	Painted Snipe					x							
	Rostratula australis	Australian Painted Snipe	EN	EN			x							
Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper	MI	IA		x	x	x						
	Calidris canutus	Red Knot	MI; EN	IA			x							
	Calidris ferruginea	Curlew Sandpiper	CR; MI	VU; IA			x							
	Calidris melanotos	Pectoral Sandpiper	MI	IA			x							
	Calidris ruficollis	Red-necked Stint	MI	IA		x		x						
	Calidris subminuta	Long-toed Stint	MI	IA		x		x						
	Limosa lapponica	Bar-tailed Godwit	MI	IA			x							
	Limosa lapponica baueri	Bar-tailed Godwit (western Alaskan)	VU	VU			x							
	Limosa lapponica menzbieri	Bar-tailed Godwit (northern Siberian)	CR; MI	VU			x							
	Numenius madagascariensis	Eastern Curlew	CR; MI	VU; IA			x							
	Numenius phaeopus	Whimbrel	MI	IA							x			
	Tringa glareola	Wood Sandpiper	MI	IA		x		x						
	Tringa hypoleucos	Common Sandpiper	MI	IA		x	x							
	Tringa nebularia	Common Greenshank	MI	IA		x	x	x						
	Tringa stagnatilis	Marsh Sandpiper	MI	IA		x		x						
Glareolidae	*Glareola maldivarum*	Oriental Pratincole	MI	IA		x	x	x						
	Stiltia isabella	Australian Pratincole				x								
Laridae	*Larus novaehollandiae*	Silver Gull				x								
	Sterna caspia	Caspian Tern	MI	IA		x								
	Sterna hybrida	Whiskered Tern				x								
	Sterna leucoptera	White-winged Black Tern	MI	IA		x		x						
	Sterna nilotica	Gull-billed Tern	MI	IA		x								
Columbidae	*Columba livia*	*Domestic Pigeon					x							
	Geopelia cuneata	Diamond Dove			x	x			x		x	x	x	x
	Geopelia humeralis	Bar-shouldered Dove				x					x			
	Geopelia striata	Peaceful Dove				x					x			
	Geophaps plumifera	Spinifex Pigeon			x	x			x	x	x	x	x	x
	Ocyphaps lophotes	Crested Pigeon			x	x				x	x	x	x	x
	Phaps chalcoptera	Common Bronzewing				x				x	x			
	Phaps histrionica	Flock Bronzewing				x								
Cuculidae	*Cacomantis pallidus*	Pallid Cuckoo				x			x		x			
	Centropus phasianinus	Pheasant Coucal				x								

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
	Chrysococcyx basalis	Horsfield's Bronze Cuckoo				x				x	x			
	Chrysococcyx osculans	Black-eared Cuckoo					x				x			
Tytonidae	*Tyto alba*	Barn Owl				x					x			
Strigidae	*Ninox boobook*	Boobook Owl			x					x	x			
	Ninox connivens	Barking Owl				x								
Podargidae	*Podargus strigoides*	Tawny Frogmouth				x					x			
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar			x	x			x	x	x	x		x
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar				x			x		x		x	
Apodidae	*Apus pacificus*	Fork-tailed Swift	MI	IA		x	x	x						x
Alcedinidae	*Dacelo leachii*	Blue-winged Kookaburra			x	x					x			
	Todiramphus chloris	Collared Kingfisher									x			
	Todiramphus pyrrhopygius	Red-backed Kingfisher			x	x				x	x		x	x
	Todiramphus sanctus	Sacred Kingfisher				x			x		x			
Meropidae	*Merops ornatus*	Rainbow Bee-eater			x	x	x		x	x	x	x	x	x
Falconidae	*Falco berigora*	Brown Falcon				x			x	x	x			x
	Falco berigora berigora					x								
	Falco cenchroides	Australian Kestrel			x	x			x	x	x	x	x	x
	Falco hypoleucos	Grey Falcon		VU		x		x						
	Falco longipennis	Australian Hobby				x			x				x	
	Falco peregrinus	Peregrine Falcon		OS		x		x						
	Falco subniger	Black Falcon				x			x					
Cacatuidae	*Cacatua roseicapilla*	Galah			x	x			x	x	x	x	x	x
	Cacatua sanguinea	Little Corella			x	x			x	x	x		x	
	Nymphicus hollandicus	Cockatiel				x			x		x	x	x	
Psittacidae	*Melopsittacus undulatus*	Budgerigar			x	x			x		x	x		x
	Platycercus zonarius	Australian Ringneck				x				x	x			x
	Pezoporus occidentalis	Night Parrot	EN	CR			x							
Ptilonorhynchidae	*Ptilonorhynchus maculatus guttatus*	Western Bowerbird				x			x	x	x	x		
Climacteridae	*Climacteris melanura*	Black-tailed Treecreeper									x			
Maluridae	*Amytornis striatus*	Striated Grasswren				x			x		x	x		
	Amytornis striatus striatus	Striated Grasswren		P4		x								
	Malurus lamberti	Variegated Fairy-wren				x			x	x	x	x		x
	Malurus leucopterus	White-winged Fairy-wren				x				x	x		x	x
	Stipiturus ruficeps	Rufous-crowned Emu-wren				x								
Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater				x					x			
	Certhionyx variegatus	Pied Honeyeater				x			x		x			
	Epthianura tricolor	Crimson Chat				x				x			x	x
	Gavicalis virescens	Singing Honeyeater			x	x			x	x	x	x	x	x
	Lacustroica whitei	Grey Honeyeater							x		x			
	Lichenostomus leucotis	White-eared Honeyeater									x			
	Lichmera indistincta	Brown Honeyeater			x	x			x		x	x	x	x
	Manorina flavigula	Yellow-throated Miner			x	x			x	x	x	x	x	x
	Melithreptus gularis	Black-chinned Honeyeater				x					x			
	Ptilotula keartlandi	Grey-headed Honeyeater			x	x			x		x	x	x	
	Ptilotula ornatus	Yellow-plumed Honeyeater									x			
	Ptilotula penicillatus	White-plumed Honeyeater			x					x	x		x	x
	Ptilotula plumulus	Grey-fronted Honeyeater							x	x	x	x		
	Purnella albifrons	White-fronted Honeyeater									x			

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
	Sugomel niger	Black Honeyeater							x					
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote				x					x			
	Pardalotus striatus	Striated Pardalote				x			x		x			
Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill				x								
	Gerygone fusca	Western Gerygone				x							x	
	Gerygone levigaster	Mangrove Gerygone									x			
	Gerygone tenebrosa	Dusky Gerygone				x					x			
	Smicrornis brevirostris	Weebill				x					x			x
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler				x					x			
	Pomatostomus temporalis	Grey-crowned Babbler			x	x					x			
Psophodidae	*Cinclosoma marginatum*	Western Quail-thrush				x								
Artamidae	*Artamus cinereus*	Black-faced Woodswallow			x	x			x	x	x	x	x	x
	Artamus cyanopterus	Dusky Woodswallow				x								
	Artamus leucorynchus	White-breasted Woodswallow				x					x			
	Artamus minor	Little Woodswallow				x			x		x	x	x	
	Artamus personatus	Masked Woodswallow				x								
Cracticidae	*Cracticus nigrogularis*	Pied Butcherbird				x			x	x	x	x	x	x
	Cracticus tibicen	Australian Magpie				x					x	x		x
	Cracticus torquatus	Grey Butcherbird				x				x				
Campephagidae	*Coracina maxima*	Ground Cuckoo-shrike				x								
	Coracina novaehollandiae	Black-faced Cuckoo-shrike			x	x			x	x	x	x	x	x
	Lalage tricolor	White-winged Triller				x			x		x			x
Oreoicidae	*Oreoica gutturalis*	Crested Bellbird				x				x	x			
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush				x			x		x	x	x	
	Pachycephala lanioides	White-breasted Whistler									x			
	Pachycephala rufiventris	Rufous Whistler				x				x	x			
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail				x								
	Rhipidura leucophrys	Willie Wagtail			x	x			x	x	x	x	x	x
	Rhipidura leucophrys leucophrys					x								
	Rhipidura phasiana	Mangrove Grey Fantail									x			
Monarchidae	*Grallina cyanoleuca*	Magpie-lark			x	x			x	x	x	x	x	x
Corvidae	*Corvus bennetti*	Little Crow				x					x			
Corvidae	*Corvus orru*	Torresian Crow			x	x			x	x	x	x	x	
Petroicidae	*Eopsaltria pulverulenta*	Mangrove Robin									x			
	Melanodryas cucullata	Hooded Robin				x								
	Petroica goodenovii	Red-capped Robin				x								
Alaudidae	*Mirafra javanica*	Horsfield's Bushlark				x					x			
Hirundinidae	*Cheramoeca leucosternus*	White-backed Swallow				x								
	Hirundo neoxena	Welcome Swallow				x					x	x		
	Hirundo rustica	Barn Swallow	MI	IA			x							
	Petrochelidon ariel	Fairy Martin				x			x		x	x		
	Petrochelidon nigricans	Tree Martin				x			x		x	x	x	x
Acrocephalidae	*Acrocephalus australis*	Australian Reed Warbler				x						x		
Locustellidae	*Eremiornis carteri*	Spinifex-bird			x	x			x	x	x	x		
	Megalurus cruralis	Brown Songlark								x	x			x
	Megalurus mathewsi	Rufous Songlark			x							x	x	x
Zosteropidae	*Zosterops lateralis*	Silvereye									x			
	Zosterops luteus	Yellow White-eye				x					x			

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird				x								
Passeriformes	*Passer montanus*	*Eurasian Tree Sparrow					x							
Estrildidae	*Emblema pictum*	Painted Finch			x	x			x	x	x	x	x	x
	Neochmia ruficauda	Star Finch				x								
	Taeniopygia guttata	Zebra Finch			x	x			x	x	x	x	x	x
Motacillidae	*Anthus australis*	Australian Pipit				x				x	x	x		
	Motacilla cinerea	Grey Wagtail	MI	IA			x							
	Motacilla flava	Yellow Wagtail	MI	IA			x							
Carphodactylidae	*Nephrurus levis*					x					x			
Diplodactylidae	*Crenadactylus ocellatus*	Clawless Gecko				x								
	Diplodactylus conspicillatus	Variable Fat-tailed Gecko				x				x	x	x		
	Diplodactylus savagei	Southern Pilbara beak-faced gecko				x			x		x	x		
	Lucasium stenodactylum					x			x	x	x	x		
	Lucasium wombeyi					x					x	x		
	Oedura fimbria	Western Marbled Velvet Gecko				x				x	x	x		
	Rhynchoedura ornata	Western Beaked Gecko				x				x	x			
	Strophurus ciliaris aberrans					x								
	Strophurus elderi					x					x	x		
	Strophurus jeanae					x								
Gekkonidae	*Gehyra pilbara*					x				x	x			
	Gehyra punctata					x					x	x		
	Gehyra purpurascens									x	x			
	Gehyra variegata					x			x	x	x	x		
	Heteronotia binoei	Bynoe's Gecko				x			x		x	x		
	Heteronotia planiceps					x			x					
	Heteronotia spelea	Desert Cave Gecko				x			x		x	x		
	Hemidactylus frenatus	*Asian House Gecko					x							
Pygopodidae	*Delma butleri*					x			x		x			x
	Delma elegans					x					x			
	Delma nasuta					x			x		x	x		
	Delma pax					x			x		x	x		
	Delma tincta					x					x			
	Lialis burtonis					x				x	x			
	Pygopus nigriceps					x					x			
Agamidae	*Ctenophorus caudicinctus*	Ring-tailed Dragon			x	x			x	x	x	x	x	x
	Ctenophorus isolepis	Military Dragon			x	x				x	x		x	x
	Ctenophorus isolepis isolepis	Military Dragon				x								
	Ctenophorus isolepis citrinus	Military Dragon				x								
	Ctenophorus nuchalis	Central Netted Dragon				x				x				
	Ctenophorus reticulatus	Western Netted Dragon				x								
	Diporiphora pindan	Pindan Dragon				x								
	Diporiphora valens	Southern Pilbara Tree Dragon				x							x	
	Diporiphora vescus	Northern Pilbara Tree Dragon				x								
	Gowidon longirostris	Long-nosed Dragon				x			x		x	x	x	x
	Pogona minor					x								
	Pogona minor minor	Western Bearded Dragon				x				x	x			
	Pogona minor mitchelli					x								
	Tympanocryptis cephalus	Coastal Pebble-mimic dragons				x								

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
	Carlia munda					x			x	x	x	x		
	Carlia triacantha					x			x	x		x		
	Cryptoblepharus ustulatus					x					x			
	Ctenotus duricola					x				x	x			x
	Ctenotus fallens					x								
	Ctenotus grandis					x				x	x	x		
	Ctenotus hanloni					x								
	Ctenotus helenae					x				x	x			x
	Ctenotus inornatus					x								
	Ctenotus leonhardii					x						x		
	Ctenotus pallasotus													x
	Ctenotus pantherinus	Leopard Ctenotus				x				x	x			x
	Ctenotus pantherinus pantherinus					x								
	Ctenotus pantherinus ocellifer					x								
	Ctenotus piankai					x								
	Ctenotus rubicundus					x			x		x			
	Ctenotus rufescens					x								
	Ctenotus saxatilis	Rock Ctenotus				x			x	x	x	x	x	x
	Ctenotus schomburgkii					x					x			
	Ctenotus serventyi					x					x			
	Cyclodomorphus melanops	Slender Blue-tongue				x			x		x			
	Cyclodomorphus melanops melanops					x								x
Scincidae	*Egernia cygnitos*	Western Pilbara Spiny-tailed Skink				x								
	Egernia depressa	Southern Pygmy Spiny-tailed Skink				x					x			
	Egernia epsisolus	Eastern Pilbara Spiny-tailed Skink				x								
	Egernia formosa										x			
	Egernia pilbarensis	Pilbara Skink									x			
	Eremiascincus richardsonii	Broad-banded Sand Swimmer				x					x			
	Eremiascincus fasciolatus	Narrow-banded Sand Swimmer										x		
	Lerista bipes					x				x	x			
	Lerista clara					x					x			
	Lerista desertorum										x			
	Lerista jacksoni					x					x	x		
	Lerista labialis					x								
	Lerista muelleri					x			x			x		
	Lerista verhmens					x								
	Liopholis striata	Night Skink								x	x			
	Menetia greyii					x					x			
	Menetia surda					x								
	Morethia ruficauda				x	x			x	x	x			
	Morethia ruficauda exquisita					x						x		
	Notoscincus ornatus					x					x			
	Notoscincus ornatus ornatus					x								
	Proablepharus reginae					x					x			
	Tiliqua multifasciata	Central Blue-tongue				x					x	x		
Varanidae	*Varanus acanthurus*	Spiny-tailed Monitor				x			x		x	x		
	Varanus brevicauda	Short-tailed Pygmy Monitor				x					x			
	Varanus bushi	Pilbara Mulga Monitor									x			

Family	Scientific Name	Common Name	Status		A	B	C	D	E	F	G	H	I	J
			EPBC Act	WC Act										
	Varanus caudolineatus										x			
	Varanus eremius	Pygmy Desert Monitor				x				x	x			
	Varanus giganteus	Perentie			x	x			x		x			
	Varanus gouldii	Sand Monitor				x				x	x		x	x
	Varanus panoptes	Yellow-spotted Monitor				x					x		x	x
	Varanus panoptes panoptes					x								
	Varanus panoptes rubidus					x								
	Varanus pilbarensis	Northern Pilbara Rock Monitor				x					x		x	x
	Varanus tristis	Racehorse Monitor				x					x			
	Varanus tristis tristis	Racehorse Monitor				x								
Typhlopidae	*Anilios ammodytes*									x	x			
	Anilios ganei			P1							x			
	Anilios grypus								x		x	x		
	Anilios pilbarensis									x	x	x		
Pythonidae	*Antaresia perthensis*	Pygmy Python				x					x			
	Antaresia stimsoni	Stimson's Python				x			x		x	x		
	Antaresia stimsoni stimsoni					x								
	Aspidites melanocephalus	Black-headed Python				x					x			
	Aspidites ramsayi	Woma				x								
	Liasis olivaceus	Olive Python				x								
	Liasis olivaceus barroni	Pilbara Olive Python	VU	VU		x	x	x			x			
Elapidae	*Acanthophis wellsi*	Pilbara Death Adder									x			
	Brachyurophis approximans					x					x			
	Brachyurophis fasciolatus											x		
	Demansia psammophis	Yellow-faced Whipsnake				x					x			
	Demansia rufescens	Rufous Whipsnake				x			x		x	x		
	Furina ornata	Moon Snake				x			x	x	x			
	Pseudechis australis	Mulga Snake				x					x			
	Pseudonaja mengdeni	Western Brown Snake				x								
	Pseudonaja modesta	Ringed Brown Snake				x			x	x	x			
	Pseudonaja nuchalis	Gwardar; Northern Brown Snake				x					x			
	Simoselaps anomalus	Desert Banded Snake				x					x			
	Suta fasciata	Rosen's Snake				x						x		
	Suta punctata	Spotted Snake				x								
	Vermicella snelli					x					x			
Hylidae	*Cyclorana australis*	Giant Frog				x					x			
	Cyclorana maini	Sheep Frog				x			x		x	x		x
	Litoria rubella	Little Red Tree Frog				x			x		x	x		
Limnodynastidae	*Neobatrachus aquilonius*	Northern Burrowing Frog				x								
	Neobatrachus sutor	Shoemaker Frog				x					x			
	Notaden nichollsi	Desert Spadefoot				x					x			
	Platyplectrum spenceri	Centralian Burrowing Frog				x					x			
Myobatrachidae	*Uperoleia glandulosa*	Glandular Toadlet				x								
	Uperoleia russelli	Northwest Toadlet				x					x	x		
	Uperoleia saxatilis	Pilbara Toadlet				x								
	Uperoleia talpa	Ratcheting Toadlet				x								

Appendix F Fauna Habitat Assessments

Name	Habitat Type	Landform	Site Photograph
Wodg-01	Spinifex stony plain	Plain	
Condition	**Condition**	Excellent	
	Disturbance Type	Feral grazing	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	90	
	Soil	10	
	Leaf Litter	0	
	Vegetation	20	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60	
	Abundance (%)	>90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Never	
	Termite Presence	Rare	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	< 1	*Acacia inaequilatera, A. ?tumida, Grevillea wickhamii*.
Middle	Shrub	2	< 10	*Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg02	Drainage line	Drainage Line	
Condition	**Condition**	Good	
	Disturbance Type	Feral grazing,Weeds	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	35	
	Soil	40	
	Leaf Litter	5	
	Vegetation	20	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	<2	
Soil	**Type**	Sand	
	Colour	Grey	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to Flooding	
	Termite Presence	Rare	
	Woody Debris	Moderate	
	Peeling Bark	Rare	
	Rock Crevices	Rare	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	Moderate	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	7	< 10	*Corymbia hamersleyana, Acacia ?tumida*
Middle	Shrub	3	10–30	*Acacia pyrifolia, Acacia ?tumida, Sida* sp.
Lower	Hummock grass,Tussock grass	0.5	10–30	*Cencrhus ciliaris, Cymbopogon* sp., *Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg-03	Spinifex stony plain	Drainage Line	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral grazing	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	0	
	Soil	40	
	Leaf Litter	10	
	Vegetation	50	
Rocks	**Type**	N/A	
	Size (mm)	N/A	
	Abundance (%)	0	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	Yes - Semi-permanent	
	Termite Presence	Rare	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	Rare	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	6	< 1	*Corymbia hamersleyana*
Middle	Shrub	4	70–100	*Acacia ?tumida*
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg04	Spinifex stony plain	Plain	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral grazing	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	5	
	Soil	35	
	Leaf Litter	0	
	Vegetation	60	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60	
	Abundance (%)	<2	
	Exposed Bedrock (%)	0	
Soil	**Type**	Loam	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Never	
	Termite Presence	Rare	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	< 1	*Corymbia hamersleyana*
Middle	Shrub	1	10–30	*Acacia* sp. 1, *Acacia* sp. 2
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg05	Spinifex stony plain	Floodplain	
Condition	**Condition**	Good	
	Disturbance Type	Feral grazing,Weeds	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	0	
	Soil	5	
	Leaf Litter	5	
	Vegetation	90	
Rocks	**Type**	N/A	
	Size (mm)	N/A	
	Abundance (%)	0	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	Rare	
	Woody Debris	Moderate	
	Peeling Bark	Moderate	
	Rock Crevices	None	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	Moderate	
	Tree Hollows (>10 cm)	Rare	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	6	10–30	*Corymbia ?hamersleyana*
Middle	Shrub	3	10–30	*Acacia* sp. (miniritchie), *Acacia ?tumida*
Lower	Hummock grass	0.5	70–100	*Triodia* sp., *Cenchrus ciliaris*

Name	Habitat Type	Landform	Site Photograph
Wodg06	Spinifex stony plain	Drainage Line	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	0	
	Soil	15	
	Leaf Litter	70	
	Vegetation	15	
Rocks	**Type**	N/A	
	Size (mm)	N/A	
	Abundance (%)	0	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Ponding	
	Termite Presence	None	
	Woody Debris	Common	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	High	
	Tree Hollows (<10 cm)	Common	
	Tree Hollows (>10 cm)	Rare	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	6	10–30	*Corymbia ?hamersleyana*
Middle	Shrub	2	30–70	*Acacia ?tumida, Grevillea wickhamii*
Lower	Forb, Hummock grass	0.6	70–100	*Triodia* sp., Fabaceae

Name	Habitat Type	Landform	Site Photograph
Wodg07	Spinifex stony plain	Floodplain	
Condition	**Condition**	Excellent	
	Disturbance Type	Feral grazing,Weeds	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	0	
	Soil	90	
	Leaf Litter	5	
	Vegetation	5	
Rocks	**Type**	N/A	
	Size (mm)	N/A	
	Abundance (%)	0	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	Rare	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	High	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	< 1	*Corymbia ?hamersleyana*
Middle	Shrub	2	70–100	*Acacia* sp. (minniritchi)
Lower	Hummock grass	0.4	< 10	*Triodia* sp., some *Cenchrus ciliaris*

Name	Habitat Type	Landform	Site Photograph
Wodg08	Spinifex stony plain	Plain	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral grazing	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	35	
	Soil	25	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone,Quartzite	
	Size (mm)	20–60	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Never	
	Termite Presence	Rare	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	3	< 1	*Corymbia hamersleyana*
Middle	Shrub	2	0–5 (isolated clumps)	*Acacia* sp
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg09	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Excellent	
	Disturbance Type	Fire	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	70	
	Soil	0	
	Leaf Litter	0	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Cliffed (>60)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	< 1	*Eucalyptus leucophloia*
Middle	Shrub	2	0–5 (isolated clumps)	*Grevillea wickhamii*
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform
Wodg10	Rocky ridge and gorge	Ridge
Condition	**Condition**	Excellent
	Disturbance Type	N/A
	Fire Age	> 15
% Ground Cover	**Rock**	60
	Soil	5
	Leaf Litter	5
	Vegetation	30
Rocks	**Type**	Ironstone
	Size (mm)	200–600,20–60,600–2000,60–200,6–20
	Abundance (%)	>90
	Exposed Bedrock (%)	50–90
Soil	**Type**	Sandy loam
	Colour	Brown
Habitat Features	**Slope**	Cliffed (>60)
	Water	No - Prone to Flooding
	Termite Presence	None
	Woody Debris	Rare
	Peeling Bark	Rare
	Rock Crevices	Very common
	Burrowing Suitability	None
	Tree Hollows (<10 cm)	Rare
	Tree Hollows (>10 cm)	None

Site Photograph

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	< 10	*Eucalyptus leucophloia*
Middle	Shrub	3	< 1	*Grevillea wickhamii*
Lower	Hummock grass	0.4	10–30	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg11	Rocky foothills	Drainage Line	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	> 15	
% Ground Cover	**Rock**	15	
	Soil	15	
	Leaf Litter	0	
	Vegetation	70	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60	
	Abundance (%)	>90	
	Exposed Bedrock (%)	2–10	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Common	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	4	< 10	*Grevillea wickhamii*
Lower	Hummock grass	1	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg12	Drainage line	Drainage Line	
Condition	**Condition**	Degraded	
	Disturbance Type	Feral grazing,Weeds	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	0	
	Soil	35	
	Leaf Litter	5	
	Vegetation	60	
Rocks	**Type**	N/A	
	Size (mm)	N/A	
	Abundance (%)	0	
	Exposed Bedrock (%)	0	
Soil	**Type**	Silty loam	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Moderate	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	Common	
	Tree Hollows (>10 cm)	Rare	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	8	10–30	*Eucalyptus victrix*
Middle	Shrub	4	10–30	*Meleleuca* sp.
Lower	Hummock grass	0.5	30–70	*Cenchrus ciliaris*

Name	Habitat Type	Landform	Site Photograph
Wodg13	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	65	
	Soil	0	
	Leaf Litter	5	
	Vegetation	30	
Rocks	**Type**	Shist?	
	Size (mm)	200–600,20–60,600–2000,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Orange	
Habitat Features	**Slope**	Cliffed (>60)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	< 1	*Corymbia ?hamersleyana, Ficus* sp.
Middle	Shrub	2	< 1	*Grevillea wickhamii, Acacia* spp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg14	Ironstone ridge top	Ridge	
Condition	**Condition**	Very Good	
	Disturbance Type	Fire	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	70	
	Soil	0	
	Leaf Litter	0	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	105	< 1	*Acacia* spp, *Grevillea wickhamii*
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg15	Spinifex stony plain	Drainage Line	
Condition	**Condition**	Good	
	Disturbance Type	Weeds	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	0	
	Soil	25	
	Leaf Litter	5	
	Vegetation	70	
Rocks	**Type**	N/A	
	Size (mm)	N/A	
	Abundance (%)	0	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	Moderate	
	Tree Hollows (>10 cm)	Rare	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	3	< 10	*Corymbia hamersleyana*
Middle	Shrub	2	< 10	*Acacia pyrifolia*, *Acacia inaequilatera*, *Acacia* sp.
Lower	Hummock grass	0.5	70–100	*Triodia* sp., *Cenchrus ciliaris*, *Themeda* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg16	Spinifex stony plain	Slope	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Moderately inclined (5-15)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Rare	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	2.5	< 10	*Acacia inaequilatera*, *Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg17	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Very steep (45-60)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	3	< 10	*Grevillea wickhamii*, *Acacia inaequilatera*, *Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg18	Spinifex stony plain	Plain	
Condition	**Condition**	Good	
	Disturbance Type	Tracks	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	70	
	Soil	0	
	Leaf Litter	0	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	0–5 (isolated clumps)	*Corymbia hamersleyana*
Middle	Shrub	2	0–5 (isolated clumps)	*Acacia inaequilatera, Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform
Wodg19	Rocky ridge and gorge	Ridge
Condition	**Condition**	Excellent
	Disturbance Type	N/A
	Fire Age	5 to 15
% Ground Cover	**Rock**	75
	Soil	0
	Leaf Litter	5
	Vegetation	20
Rocks	**Type**	Ironstone
	Size (mm)	200–600,60–200
	Abundance (%)	>90
	Exposed Bedrock (%)	50–90
Soil	**Type**	Sandy loam
	Colour	Brown
Habitat Features	**Slope**	Cliffed (>60)
	Water	No - Never
	Termite Presence	None
	Woody Debris	Rare
	Peeling Bark	Rare
	Rock Crevices	Very common
	Burrowing Suitability	None
	Tree Hollows (<10 cm)	None
	Tree Hollows (>10 cm)	None

Site Photograph

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	< 1	*Ficus* sp.
Middle	Shrub	3	0–5 (isolated clumps)	*Grevillea wickhamii*
Lower	Hummock grass	0.5	10–30	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg20	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Very Good	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	70	
	Soil	0	
	Leaf Litter	5	
	Vegetation	25	
Rocks	**Type**	Quartzite,Silica shist?	
	Size (mm)	200–600,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Very steep (45-60)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	< 1	*Acacia inaequilatera*
Middle	Shrub	3	< 10	*Acacia inaequilatera, Grevillea wickhamii, Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg21	Rocky foothills	Hill	
Condition	**Condition**	Good	
	Disturbance Type	Tracks	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Quartzite	
	Size (mm)	20–60,60–200	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	10–20	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	2	< 1	*Acacia inaequilatera*
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg22	Spinifex stony plain	Plain	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral grazing	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	40	
	Soil	30	
	Leaf Litter	0	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Never	
	Termite Presence	Moderate	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	2	< 10	*Acacia* sp., *Acacia ?tumida*
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg23	Stony rise	Hill	
Condition	**Condition**	Very Good	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone,Shale	
	Size (mm)	20–60	
	Abundance (%)	>90	
	Exposed Bedrock (%)	20–50	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Moderately inclined (5-15)	
	Water	No - Never	
	Termite Presence	Rare	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	3	10–30	*Acacia* sp.
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg24	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Very Good	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	5	
	Vegetation	35	
Rocks	**Type**	Quartzite	
	Size (mm)	20–60,60–200	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	Common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	3	< 10	*Grevillea wickhamii*
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg25	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Very Good	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	75	
	Soil	0	
	Leaf Litter	0	
	Vegetation	25	
Rocks	**Type**	Quartzite	
	Size (mm)	200–600,20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Cliffed (>60)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	0–5 (isolated clumps)	*Ficus* sp.
Middle	Shrub	2	< 10	*Grevillea wickhamii*, *Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia sp.*

Name	Habitat Type	Landform	Site Photograph
Wodg26	Ironstone ridge top	Ridge	
Condition	**Condition**	Very Good	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	65	
	Soil	0	
	Leaf Litter	0	
	Vegetation	35	
Rocks	**Type**	Quartzite	
	Size (mm)	60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Silty loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	< 1	*Corymbia hamersleyana*
Middle	Shrub	1	< 10	*Grevillea wickhamii*, *Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg27	Rocky foothills	Hill	
Condition	**Condition**	Good	
	Disturbance Type	Fire	
	Fire Age	3 to 5	
% Ground Cover	**Rock**	80	
	Soil	0	
	Leaf Litter	0	
	Vegetation	20	
Rocks	**Type**	Ironstone	
	Size (mm)	60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	20–50	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	0	< 1	-
Lower	Hummock grass	0.3	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg28	Spinifex stony plain	Plain	
Condition	**Condition**	Good	
	Disturbance Type	Fire	
	Fire Age	3 to 5	
% Ground Cover	**Rock**	70	
	Soil	5	
	Leaf Litter	0	
	Vegetation	25	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	3	< 10	*Acacia inaequilatera*, *Grevillea wickhamii*
Lower	Hummock grass	0.4	10–30	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg29	Rocky foothills	Hill	
Condition	**Condition**	Good	
	Disturbance Type	Fire	
	Fire Age	3 to 5	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	20–50	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

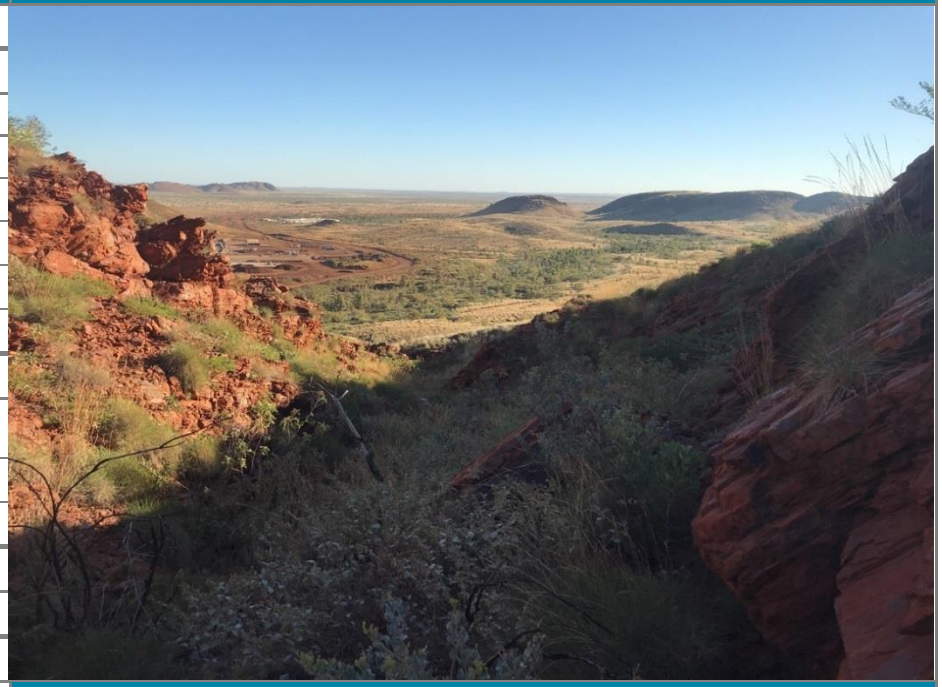
Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	0	< 1	-
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg30	Rocky foothills	Hill	
Condition	**Condition**	Very Good	
	Disturbance Type	Fire	
	Fire Age	3 to 5	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	10–20	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Moderately inclined (5-15)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	0	< 1	-
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg31	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	70	
	Soil	0	
	Leaf Litter	15	
	Vegetation	15	
Rocks	**Type**	Ironstone	
	Size (mm)	200–600,20–60,2–6,600–2000,60–200,6–20	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Clayey sand	
	Colour	Red	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Moderate	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Shrub	1.5	0–5 (isolated clumps)	*Gossypium* sp., *Grevillea wickhamii*
Middle	Shrub	1	10–30	*Solanum* sp.
Lower	Hummock grass,Shrub	0.5	10–30	*Triodia sp., Indigofera sp, Cymbopogon ambiguus*

Name	Habitat Type	Landform	Site Photograph
Wodg32	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Pristine	
	Disturbance Type	N/A	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	73	
	Soil	0	
	Leaf Litter	2	
	Vegetation	25	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,2–6,60–200,6–20	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	20–50	
Soil	**Type**	Clayey sand	
	Colour	Red	
Habitat Features	**Slope**	Very steep (45-60)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	0–5 (isolated clumps)	-
Middle	Shrub	1.5	< 1	*Grevillea wickamii*, *Acacia* sp.
Lower	Hummock grass,Shrub	0.5	10–30	*Acacia* sp., *Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg33	Rocky foothills	Hill	
Condition	**Condition**	Pristine	
	Disturbance Type	N/A	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	65	
	Soil	0	
	Leaf Litter	5	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,2–6,60–200,6–20	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Red	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	Rare	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	0–5 (isolated clumps)	*Acacia inaequilatera*
Middle	Shrub	2	0–5 (isolated clumps)	*Grevillea wickhamii*
Lower	Hummock grass,Shrub	0.5	10–30	*Triodia* sp., *Ptilotus* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg34	Spinifex stony plain	Plain	
Condition	**Condition**	Good	
	Disturbance Type	Feral trampling,Tracks,Weeds	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	25	
	Soil	35	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	N/A	0	0–5 (isolated clumps)	-
Middle	Shrub	1.5	0–5 (isolated clumps)	*Acacia* sp., *Acacia ?pyrifolia*
Lower	Hummock grass, Tussock grass	0.2	30–70	*Triodia* sp., *Cenchrus ciliaris* (sparse some along road)

Name	Habitat Type	Landform	Site Photograph
Wodg35	Spinifex stony plain	Plain	
Condition	**Condition**	Good	
	Disturbance Type	Feral trampling,Weeds	
	Fire Age	> 15	
% Ground Cover	**Rock**	45	
	Soil	15	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	0	
Soil	**Type**	Clayey sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	N/A	0	0–5	-
Middle	Shrub	2	0–5	-
Lower	Hummock grass,Shrub, Tussock grass	0.5	30–70	Primarily *Triodia* sp., *Cenchrus ciliaris* near bare clay that looked like it was flooded.

Name	Habitat Type	Landform	Site Photograph
Wodg36	Spinifex stony plain	Plain	
Condition	**Condition**	Excellent	
	Disturbance Type	Feral trampling	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	40	
	Soil	20	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,60–200,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	<2	
Soil	**Type**	Clayey sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	3	< 1	Unknown
Middle	Shrub	1.5	< 10	Unknown
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg37	Spinifex stony plain	Plain	
Condition	**Condition**	Good	
	Disturbance Type	Feral trampling,Weeds	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	0	
	Soil	45	
	Leaf Litter	5	
	Vegetation	50	
Rocks	**Type**	N/A	
	Size (mm)	2–6	
	Abundance (%)	<2	
	Exposed Bedrock (%)	0	
Soil	**Type**	Loamy sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	High	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	0–5 (isolated clumps)	Unknown
Middle	Shrub	2	10–30	*Acacia* sp. and smaller shrubs 1 m
Lower	Hummock grass,Shrub, Tussock grass	0.2	10–30	*Triodia* sp., some larger shrubs, sparse *Indigofera* sp, *Senna* sp., tussock grasses

Name	Habitat Type	Landform	Site Photograph
Wodg38	Spinifex stony plain	Plain	
Condition	**Condition**	Excellent	
	Disturbance Type	Tracks	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	35	
	Soil	15	
	Leaf Litter	10	
	Vegetation	40	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Red	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Common	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Shrub	3.5	10–30	-
Middle	Shrub	0	10–30	*Acacia* sp.
Lower	Hummock grass	0.5	10–30	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg39	Spinifex stony plain	Plain	
Condition	**Condition**	Excellent	
	Disturbance Type	Feral trampling	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	5	
	Soil	45	
	Leaf Litter	5	
	Vegetation	45	
Rocks	**Type**	Unknown	
	Size (mm)	2–6,6–20	
	Abundance (%)	2–10	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Common	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	High	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	0–5 (isolated clumps)	-
Middle	Shrub	4	10–30	Shrubs 1.5m
Lower	Hummock grass, Shrub, Tussock grass	0.5	30–70	Primarily *Triodia* sp., some tussock grasses, sparse *Ptilotus* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg40	Drainage line	Drainage Line	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral trampling,Tracks,Weeds	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	2	
	Soil	50	
	Leaf Litter	13	
	Vegetation	35	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,6–20	
	Abundance (%)	2–10	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	Yes - Semi-permanent	
	Termite Presence	None	
	Woody Debris	Common	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	High	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	10–30	*Acacia* sp.
Middle	Shrub	2	10–30	*Grevillea wickamii*
Lower	Hummock grass,Shrub,Tussock grass	0.2	10–30	*Cenchrus ciliaris, Indigofera* sp, *Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg41	Spinifex stony plain	Drainage Line	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	30	
	Soil	25	
	Leaf Litter	5	
	Vegetation	40	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,60–200,6–20	
	Abundance (%)	10–20	
	Exposed Bedrock (%)	<2	
Soil	**Type**	Sand	
	Colour	Red	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Common	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	< 1	Shrubs, almost none in some areas largely just mid stratum of same species
Middle	Shrub	2	10–30	Unknown
Lower	Hummock grass,Shrub	0.2	10–30	Primarily *Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg42	Spinifex stony plain	Drainage Line	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral trampling	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	30	
	Soil	25	
	Leaf Litter	5	
	Vegetation	40	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,60–200,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	0	
Soil	**Type**	Loamy sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Prone to Flooding	
	Termite Presence	None	
	Woody Debris	Common	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	N/A	0	0–5 (isolated clumps)	-
Middle	Shrub	3	10–30	Unknown
Lower	Hummock grass, Shrub	0.2	10–30	Primarily *Triodia* sp., some shrubs

Name	Habitat Type	Landform	Site Photograph
Wodg43	Spinifex stony plain	Plain	
Condition	**Condition**	Excellent	
	Disturbance Type	Feral trampling	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	30	
	Soil	20	
	Leaf Litter	5	
	Vegetation	45	
Rocks	**Type**	Unknown	
	Size (mm)	20–60,2–6,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sandy loam	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	Rare	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	N/A	0	0–5 (isolated clumps)	-
Middle	Shrub	2	< 10	Unknown
Lower	Hummock grass,Shrub	0.2	30–70	Primarily *Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg44	Drainage line	Drainage Line	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	2	
	Soil	50	
	Leaf Litter	13	
	Vegetation	35	
Rocks	**Type**	Unknown	
	Size (mm)	20–60, 2–6, 6–20	
	Abundance (%)	2–10	
	Exposed Bedrock (%)	0	
Soil	**Type**	Sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	Yes - Semi-permanent	
	Termite Presence	None	
	Woody Debris	Very Common	
	Peeling Bark	Rare	
	Rock Crevices	Rare	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	10–30	*Acacia* spp.
Middle	Shrub	3	10–30	*Grevillea wickhamii*
Lower	Hummock grass,Shrub,Tussock grass	0.3	10–30	*Triodia* sp, *Cenchrus ciliaris*, *Indigofera* sp.

Name	Habitat Type	Landform	Site Photograph
Wodg45	Drainage line	Drainage Line	
Condition	**Condition**	Excellent	
	Disturbance Type	N/A	
	Fire Age	Unknown (no evidence)	
% Ground Cover	**Rock**	35	
	Soil	15	
	Leaf Litter	15	
	Vegetation	35	
Rocks	**Type**	Unknown	
	Size (mm)	200–600,20–60,2–6,60–200,6–20	
	Abundance (%)	20–50	
	Exposed Bedrock (%)	<2	
Soil	**Type**	Sand	
	Colour	Red	
Habitat Features	**Slope**	Level (0-3)	
	Water	Yes - Semi-permanent	
	Termite Presence	None	
	Woody Debris	Very Common	
	Peeling Bark	Rare	
	Rock Crevices	Rare	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	5	10–30	Unknown
Middle	Shrub	3	10–30	*Indigofera* sp.
Lower	Hummock grass, Shrub, Tussock grass	0.3	10–30	*Triodia* sp., *Solanum* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline 01	Rocky ridge and gorge	Ridge	
Condition	**Condition**	Very Good	
	Disturbance Type	Fire	
	Fire Age	1 to 3	
% Ground Cover	**Rock**	80	
	Soil	10	
	Leaf Litter	0	
	Vegetation	10	
Rocks	**Type**	Ironstone	
	Size (mm)	200–600,20–60,600–2000,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Very steep (45-60)	
	Water	No - Never	
	Termite Presence	Rare	
	Woody Debris	Rare	
	Peeling Bark	Rare	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	Rare	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	0–5 (isolated clumps)	*Ficus* sp. *Eucalyptus leucophloia*
Middle	Shrub	1.5	< 10	*Acacia inaequilatera*
Lower	Hummock grass	0.5	10–30	*Triodia* sp., *Sida* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline02	Drainage line	Drainage Line	
Condition	**Condition**	Very Good	
	Disturbance Type	Feral grazing	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	25	
	Leaf Litter	5	
	Vegetation	10	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,2–6,60–200,6–20	
	Abundance (%)	50–90	
	Exposed Bedrock (%)	2–10	
Soil	**Type**	Sand	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to Flooding	
	Termite Presence	Rare	
	Woody Debris	Moderate	
	Peeling Bark	Moderate	
	Rock Crevices	Rare	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	Common	
	Tree Hollows (>10 cm)	Moderate	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	8	10–30	*Eucalyptus victrix*
Middle	Shrub	3	< 10	*Acacia pyrifolia, Acacia ?tumida, Grevillea wickhamii, Melaleuca* sp.
Lower	Hummock grass,Tussock grass	0.5	< 10	*Triodia* sp., *Cymbopogon* sp., *Sida* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline03	Rocky foothills	Gully	
Condition	**Condition**	Excellent	
	Disturbance Type	Fire	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	60	
	Soil	0	
	Leaf Litter	0	
	Vegetation	40	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	2–10	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	3	< 1	*Acacia inaequilatera*, *Hakea* sp.
Lower	Hummock grass	0.4	30–70	*Triodia* sp.

Name	Habitat Type	Landform
Pipeline04	Spinifex stony plain	Drainage Line

Condition	**Condition**	Very Good
	Disturbance Type	Weeds
	Fire Age	5 to 15
% Ground Cover	**Rock**	65
	Soil	20
	Leaf Litter	5
	Vegetation	10
Rocks	**Type**	Basalt,Ironstone
	Size (mm)	20–60,60–200
	Abundance (%)	50–90
	Exposed Bedrock (%)	0
Soil	**Type**	Sand
	Colour	Brown
Habitat Features	**Slope**	Gently inclined (3-5)
	Water	No - Prone to Flooding
	Termite Presence	None
	Woody Debris	Moderate
	Peeling Bark	Rare
	Rock Crevices	None
	Burrowing Suitability	Low
	Tree Hollows (<10 cm)	Rare
	Tree Hollows (>10 cm)	None

Site Photograph

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	10	< 10	*Eucalyptus victrix*
Middle	Shrub	6	< 10	*Acacia ?tumida, Acacia pyrifolia*
Lower	Hummock grass	0.2	10–30	*Triodia* sp., *Cymbopogon* sp., *Sida* sp., *Cenchrus* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline05	Spinifex stony plain	Drainage Line	
Condition	**Condition**	Very Good	
	Disturbance Type	Weeds	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	40	
	Soil	15	
	Leaf Litter	15	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	2–10	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to Flooding	
	Termite Presence	Rare	
	Woody Debris	Moderate	
	Peeling Bark	Rare	
	Rock Crevices	None	
	Burrowing Suitability	Low	
	Tree Hollows (<10 cm)	Rare	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	7	10–30	*Eucalyptus victrix*
Middle	Shrub	3	10–30	*Acacia ?tumida, Acacia pyrifolia, Grevillea wickhamii*
Lower	Hummock grass	0.3	10–30	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline06	Rocky foothills	Hill	
Condition	**Condition**	Excellent	
	Disturbance Type	Fire	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	40	
	Soil	0	
	Leaf Litter	0	
	Vegetation	60	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	10–20	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Steep (15-45)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	None	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	0	< 1	-
Middle	Shrub	1	0–5 (isolated clumps)	*Acacia* sp.
Lower	Hummock grass	0.5	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline 07	Rocky foothills	Hill	
Condition	**Condition**	Very Good	
	Disturbance Type	Fire	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	40	
	Soil	0	
	Leaf Litter	0	
	Vegetation	60	
Rocks	**Type**	Ironstone	
	Size (mm)	20–60,60–200	
	Abundance (%)	>90	
	Exposed Bedrock (%)	10–20	
Soil	**Type**	Sandy loam	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Never	
	Termite Presence	None	
	Woody Debris	None	
	Peeling Bark	None	
	Rock Crevices	Moderate	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	None	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	2	0–5 (isolated clumps)	*Grevillea wickhamii, Hakea ?lorea*
Middle	Shrub	1	0–5 (isolated clumps)	*Grevillea wickhamii, Hakea ?lorea*
Lower	Hummock grass	0.2	30–70	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline08	Drainage line	Gully	
Condition	**Condition**	Very Good	
	Disturbance Type	N/A	
	Fire Age	5 to 15	
% Ground Cover	**Rock**	85	
	Soil	5	
	Leaf Litter	5	
	Vegetation	5	
Rocks	**Type**	Basalt	
	Size (mm)	20–60	
	Abundance (%)	2–10	
	Exposed Bedrock (%)	50–90	
Soil	**Type**	Sand	
	Colour	Brown	
Habitat Features	**Slope**	Moderately inclined (5-15)	
	Water	Yes - Semi-permanent	
	Termite Presence	None	
	Woody Debris	Moderate	
	Peeling Bark	Moderate	
	Rock Crevices	Very common	
	Burrowing Suitability	None	
	Tree Hollows (<10 cm)	Rare	
	Tree Hollows (>10 cm)	None	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	4	< 10	*Melaleuca* sp.
Middle	Shrub	2	< 10	*Melaleuca* sp.
Lower	Hummock grass	0.4	< 10	*Triodia* sp.

Name	Habitat Type	Landform	Site Photograph
Pipeline09	Major Drainage Line	Drainage Line	
Condition	**Condition**	Good	
	Disturbance Type	Feral grazing	
	Fire Age	Cattle	
% Ground Cover	**Rock**	20	
	Soil	45	
	Leaf Litter	5	
	Vegetation	30	
Rocks	**Type**	Ironstone	
	Size (mm)	6-20, 20-60	
	Abundance (%)	20-50	
	Exposed Bedrock (%)	2-10	
Soil	**Type**	Sand	
	Colour	Brown	
Habitat Features	**Slope**	Gently inclined (3-5)	
	Water	No - Prone to flooding	
	Termite Presence	None	
	Woody Debris	Moderate	
	Peeling Bark	Moderate	
	Rock Crevices	Rare	
	Burrowing Suitability	Moderate	
	Tree Hollows (<10 cm)	Common	
	Tree Hollows (>10 cm)	Moderate	

Vegetation

Stratum	Form/s	Height (m)	Cover (%)	Species
Upper	Tree	8	<10	*Eucalyptus vitrix*
Middle	Shrub	2	<10	*Meleleuca* sp., *Acacia pyrifolia*
Lower	Hummock grass	0.4	10-30	*Sida* sp., *Triodia* sp.

Appendix G BatCall WA: Acoustic Survey of Bat Activity

Wodgina, Pilbara WA,
July 2018

Acoustic Survey of Bat Activity.

Prepared for Stantec Australia

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Issue 1
8 August 2018

Document Revision History

Issue	Date	Revision History
A	1 Aug 2018	Initial draft prepared for client review
B	3 Aug 2018	Second draft with PGb data added
1	8 Aug 2018	First formal issue

Summary
Bat presence, with an estimate of activity level, is presented for five sites at Wodgina, in the Pilbara, WA. Stantec Australia (Stantec) carried out an echolocation based survey during July2018. Bat Call WA has reviewed the recordings made and provided species lists and activity levels for the bats present.

Six species of echolocating bats were confirmed present including one of two EPBC Act listed species in the Pilbara, the Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) (PLNb). PLNb calls were detected in low numbers at two sites. There was no indication of PLNb roosting within the study area. A summary of PLNb call numbers and timing is provided.

No calls of the other EPBC Act listed species, Ghost bat (*Macroderma gigas*) (PGb) were recorded although the species is known to be present in the area. This presence was confirmed by the collection of PGb scats at five sites. Activity levels for the common species are provided by site.

Habitats
The sites for the survey were chosen by Stantec. Details of the sites are presented in table 1. Four are in cave entrances and one is on a breakaway. The locations are shown in relation to local features in figure 1.

Characteristics of the bat calls recorded are presented in table 2. Taxonomy presented herein is after Reardon *et al.* (2014) and Jackson and Groves (2015).

Timing, Moon Phase and Weather
The echolocation surveys were conducted between 4th to 12th July 2018. The sampling evenings were cool and dry with minimum overnight temperatures between 10 and 15^{O}C. No rain fell during this phase. The moon in this period was last quarter.

Survey Team
Sites were chosen and detectors placed by Stantec ecologists. Bob Bullen of Bat Call WA completed analysis of audio and echolocation recordings.

Sampling
The survey consisted of completing a total of twenty overnight bat sound recordings, beginning at twilight, at five locations within the survey area. The recordings were "continuous" (Hyder *et al.* 2010) made using ultrasonic SM2BAT SongMeter (Wildlife Acoustics Inc, USA) detectors. The audio settings used followed the manufacturer's recommendations contained in the user manuals.

For the ultrasonic recordings, once reformatted as .wav files, COOL EDIT 2000 (now available as AUDITION from Adobe Systems Inc.) was used to display each sequence for identification. Calls were identified manually. Only good quality call sequences were used. Details of calls analysed are provided in Table 2 as recommended by Australasian Bat Society (ABS 2006). Reference data for the species identified are available in Bullen and McKenzie 2002, McKenzie and Bullen 2003 and McKenzie and Bullen 2009.

Bat activity was then characterised as "Low", "Medium" , "High" or "Very High" based on the rate of call sequences recorded.

- Low species activity is referred when a species is recorded with call spacing less often than ten minutes,

- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a at least an hour followed by sporadic records for the remainder of the session.
- High species activity refers to call recording more often than two minutes apart for at least two hours followed by reasonably regular records for the remainder of the session.
- Very High species activity refers to call recording more often than two minutes apart for at least four hours followed by regular records for the remainder of the session.

Survey Limitations

The sites surveyed were accessible on foot and the detectors, using omnidirectional microphones, were set on the ground with the microphone horizontal. Species are unlikely to be under-represented as a result.

Bat species density away from cave or adit entrances is impossible to estimate from echolocation records. Bat activity is therefore substituted as an approximate guide to the relative numbers of each species using the study area.

Results of bat fauna survey

An assemblage of six echolocating bat species was confirmed as present at the study sites in July including the PLNb, table 3. Species activity levels were low to very high, which is expected for the study area habitat and the times of year, see criteria below.

PLNb were detected at two sites, figures 1 and 2, the overhang and one cave entrance. All detections were in low numbers indicating foraging bats away from their roost. The earliest PLNb call detected at Bat 2, was 50 minutes after civil twilight indicating that the bat was possibly from the Wodgina satellite roost cave approximately 4 km west. The nearest known permanent diurnal PLNb roosts are the Yule River, Glacier Valley and East Turner River roosts all approximately 25 km distant, figure 3. No indication of roosting PLNb was detected in the study area.

No calls of the PGb were recorded although it is commonly detected in caves in the ridges to the west. It is expected that PGb occasionally forage across the ridges and water courses of the study area. This was confirmed by the collection of scats at five sites which shows that PGb would use caves in the area as nocturnal feeding roosts and possibly occasional diurnal roosts. The sites, see table 4, are well spread across the study area. None were in caves reported by the Stantec ecologists to have the characteristics of semi-permanent diurnal roosts.

Three common species, *Austronomus australis, Taphozous georgianus* and *Vespadelus finlaysoni* dominated bat presence in the area in July. *Chalinolobus gouldii* and *Scotorepens greyii* were also detected.

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Table 1 Microbat Site Specific details.

	Date	Recording Time & SM2 unit	Habitat	Easting	Northing
BAT1	5 July	One overnight recording using SM2-00	Cave entrance	675433	7657156
BAT2	4-10 July	Seven overnight recordings using SM2-03	Overhang	675400	7657435
BAT3	7-10 July	Four overnight recordings using SM2-08	Cave entrance	677637	7659608
BAT4	6 July	One overnight recording using SM2-10	Cave entrance	676379	7657174
BAT5	6-12 July	Seven overnight recordings using SM2-01	Cave entrance	676073	7657091
BAT6	5 July	SM2-09 failed to record	Cave entrance	675889	7657201

Note 1: Coordinates are Zone 50K

Table 2: Summary of Echolocation call characteristics for microbat species present.

Genus species Authority	Common name	Typical F_{peak} kHz Note 1	Ave. Q Note 1	Typical Duration msec	Typical Call Shape
Austronomus australis (Gray 1838)	White-striped free-tailed bat	12	7	12 - 23	CF– shallow FM
Chalinolobus gouldii (Grey 1841)	Gould's wattled bat	32	10	7 - 11	FM
Rhinonicteris aurantia (Gray 1845)	Pilbara leaf-nosed bat	120	30	5 - 8	CF
Scotorepens greyii (Gray 1843)	Little broad-nosed bat	38	10	7 - 13	FM
Taphozous georgianus Thomas 1915	Common sheath-tailed bat	24.5	14	9 - 18	CF– shallow FM
Vespadelus finlaysoni (Kitchener, Jones and Caputi 1987)	Inland cave bat	55	14	4 - 8	FM

Note 1: Fpeak and Q are defined in McKenzie and Bullen 2003, 2009.
Note 2: Taxonomy follows Jackson and Groves (2015).

Table 3. Survey microbat lists presented by site.

Note: No bats were recorded at Bat 5 due to detector failure

Site	*Austronomus australis*	*Chalinolobus gouldii*	*Rhinonicteris aurantia*	*Scotorepens greyii*	*Taphozous georgianus*	*Vespadelus finlaysoni*
BAT1	Low				Low	
BAT2	Low	Low	Low	Low	Low	Low
BAT3	Low	Low	Low		Very High	Med
BAT4	Low				Med	Low
BAT5						

Table 4. Sites where PGb scats were located.

Site	*Scat Age*	*Easting*	*Northing*
PGb scat 1	Old	675400	7657435
PGb scat 2	Fresh	677065	7659757
PGb scat 3	Fresh	676606	7657570
PGb scat 4	Recent	676050	7657056
PGb scat 5	Old	670103	7653453

Figure 1. Detector sites in relation to features in the study area. The orange pins denote sites where PLNb were detected. PLNb call numbers and timing of the closest calls to civil twilight are also noted. The Yellow pins denote the sites where microbat calls were recorded but no PLNb or PGb were detected. Pink pins denote sites where PGb scats were collected. Site PGb scat 5 is 6.5 km to the south-west.

Figure 2. Temporal patterns of PLNb calls detected. The patterns are consistent with foraging bats away from their roosts in cool weather.

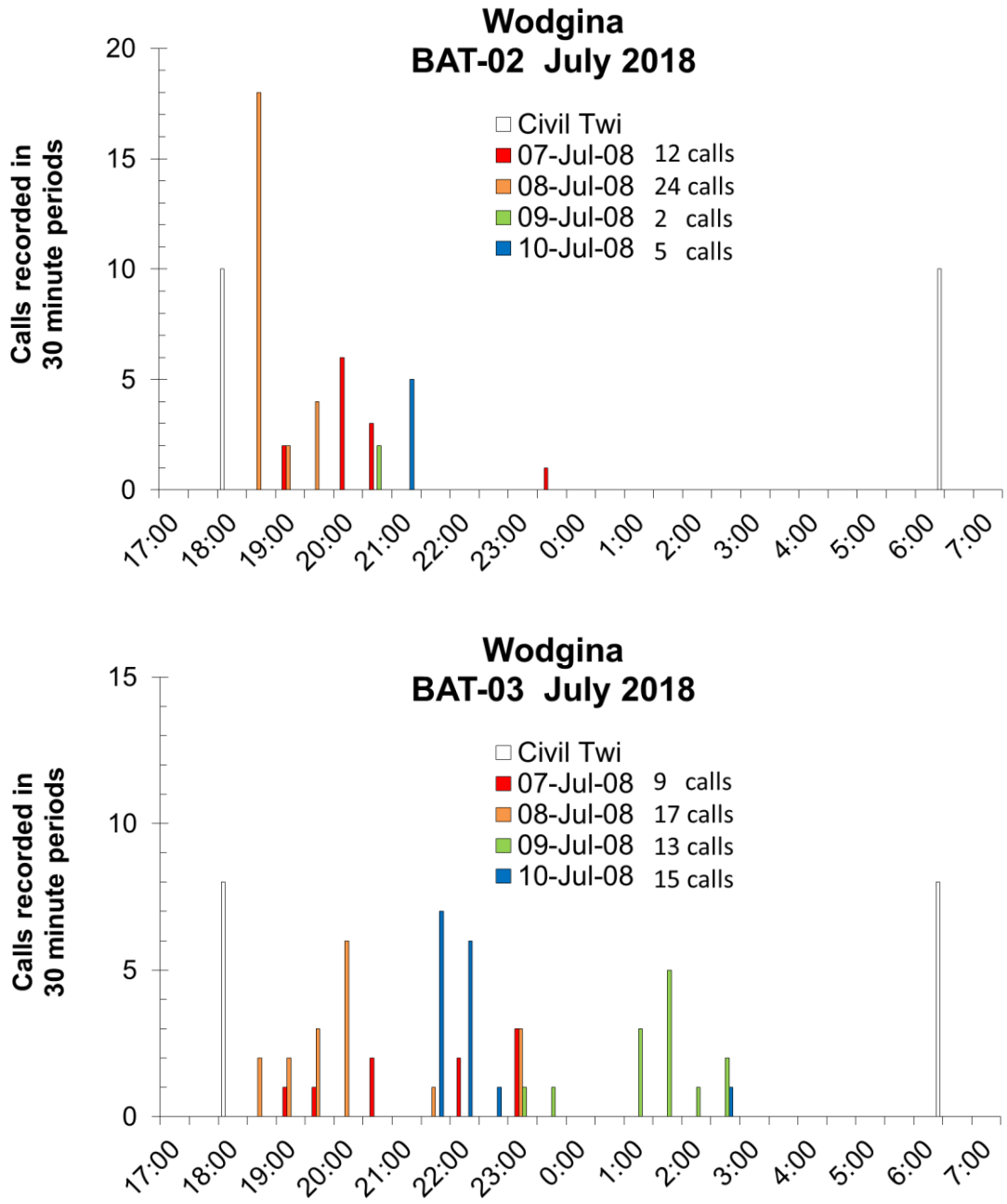

Figure 3. Location of the study area in relation to known PLNb roosts in the district. The orange pins denote sites where PLNb were detected. The red dots indicate known permanent diurnal PLNb roosts while the yellow dot indicates the known satellite roost cave complex west of the Wodgina mine.

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