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ENVIRONMENTAL SCIENCES

Consolidated Report on Vertebrate Fauna Surveys Conducted for the FerrAus Pilbara Project

Prepared for FerrAus Ltd

Final Report, Rev 0

August 2011

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Date: August 2011

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

FerrAus Limited (FRS) is developing the FerrAus Pilbara Project (FPP), located approximately 100 km south east of Newman.

The FPP involves several proposed mining and infrastructure components:

- four deposits: King Brown (KB), Tiger-Dugite (TD), Python-Gwardar (PG), Mirrin Mirrin(MM)
- a service corridor
- a rail corridor
- an accommodation village
- an airstrip
- associated secondary infrastructures (access tracks, facilities, waste dumps).

A number of vertebrate fauna surveys have been conducted for the FPP between 2007 and 2011 (three level 1, three level 2 and one targeted Mulgara survey). Collectively, the surveys conducted covered all project components. The scope of this report is to:

- provide a consolidated overview of survey methods and results for all vertebrate fauna surveys undertaken for the FPP
- discuss survey results in relation to the FPP, with emphasis on species and habitats of conservation significance
- provide management strategies and recommendations for impacts to fauna.

The methodology used across the different reports was consistent and provided a large number of fauna records across the entire study area. The different surveys met minor limitations but none significantly affected the results of the surveys.

Overall, 16 species of conservation significance are known to occur or may potentially occur in the study area. Six of these were recorded during the field surveys through direct sightings and secondary evidence was observed for an additional three:

- Fork-tailed Swift - Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (one flock)
- Peregrine Falcon - Schedule 4 of the *Wildlife Conservation Act 1950* (WC Act) (two sightings)
- Australian Bustard - Priority 4 on the Department of Environment and Conservation (DEC) Priority Fauna List (several sightings, locally common)
- Bush-Stone Curlew - Priority 4 on the DEC Priority Fauna List (two direct sightings)
- Rainbow Bee-eater - Migratory under the EPBC Act (several sightings, locally common)
- Crest-tailed Mulgara - Vulnerable under the EPBC Act, Schedule 1 under the WC Act (four captures and multiple potential active burrows)
- Greater Bilby - Vulnerable under the EPBC Act), Schedule 1 under the WC Act (one potential burrow complex)
- Ghost Bat – Priority 4 on the DEC Priority Fauna List (probable recording)
- Western Pebble Mouse - Priority 4 on the DEC Priority Fauna List (several inactive mounds, one potential active mound).

Several types of vertebrate fauna habitats were recorded in the study area, with the most represented habitats being Spinifex plain and mulga woodland. The main habitats of conservation

significance in the study area are considered to be major creek lines, sandplains, sand dunes and rocky slopes. Of the recorded conservation significant species, the study area contains important habitat for:

- Crest-tailed Mulgara – Spinifex plain habitats in the vicinity of the proposed service corridor between the RRA and DCA, at the RRA, airstrip, accommodation village and at some sections along the FEPR corridor
- Australian Bustard – occurs regularly in the study area and actively utilises the Spinifex sandplain and low rocky range/rocky slope habitats, and most likely other habitat types as well
- Bush Stone-curlew – recorded at the eastern boundary of its current known distribution range, with mulga woodland habitats considered to be of most importance
- Rainbow Bee-eater – suitable nesting habitat occurs along the numerous creeklines of the study area.

The main potential impacts of the FPP on fauna and fauna habitats are:

- clearing and earthworks leading to habitat loss, degradation and fragmentation
- displacement of individuals during construction
- alteration of habitat through associated impacts, such as irrigation to dispose of surplus mine water
- mortality from vehicles and machinery during construction and operation.

The FPP may also increase the risk level of the following threatening processes or hazards:

- incidence of fire leading to habitat modification
- abundance of feral animals leading to increased predation

Several management measures are recommended to avoid and minimise impacts to conservation significant species and fauna in general (section 5.3). Particular attention has been paid to the Crest-tailed Mulgara.

1 INTRODUCTION

FerrAus Limited (FRS) is developing the FerrAus Pilbara Project (FPP), located approximately 100 km south east of Newman (Figure 1-1). A number of vertebrate fauna surveys have been conducted for the FPP.

The purpose of this report is to consolidate the information collected in these surveys to present an overall picture of the vertebrate fauna values and assess potential impacts from the FPP on fauna. In this report, the use of the term 'fauna' refers only to vertebrate fauna.

1.1 PROJECT BACKGROUND

FerrAus proposes to develop the mine and rail components of the FPP within the inter-zone of the Gascoyne and Pilbara biogeographic regions of Western Australia (WA). The proposed actions include open strip mining of iron ore deposits at two mine site areas, identified as Robertson Range Area (RRA) and Davidson Creek Area (DCA), the provision of a Service Corridor (SC) that will connect the two mine sites, the development of a rail loop at the DCA, and the establishment of a rail line at one of two proposed alignments. The two rail line options are identified as the FerrAus Eastern Pilbara Rail (FEPR) and the Northern Rail Alignment (NRA).

The FPP is located approximately 475 km southeast of Port Hedland and lies within two Shire boundaries, the Shire of Meekatharra and the Shire of East Pilbara (Figure 1-1). The town of Newman is approximately 100 km west of the FPP.

The FPP lies within the Nyiyaparli Native Title and Use and Benefit of Aboriginals Reserve 41265 (Jigalong Aboriginal Reserve). The Jigalong Aboriginal Community is in the northeast corner of the Reserve, approximately 50 km from the FPP. The FPP is also partly located within the boundary of the Sylvania Pastoral Station. The closest pastoral station residence is the Robertson Range Homestead, which is northeast of the RRA and is not occupied.

The FPP is located approximately 35 km east of the BHP Billiton Iron Ore (BHPBIO) mining operations and rail infrastructure at Jimblebar. Mining and processing components would be located on tenements E52/1658, M52/1043, E52/1630 and M52/1034. The FPP involves open pit mining of several iron ore deposits at an annual rate of approximately 15 mtpa. This includes the mining of the following deposits within the DCA and RRA (Figure *1-2*):

- DCA: Python-Gwardar, Tiger-Dugite and Mirrin Mirrin deposits to below the watertable
- RRA: KB deposit, including the South West mineralised zone, to below the watertable.

To facilitate mining of these deposits and the production of 15 Mtpa of suitable iron ore product, the FPP would also involve (Figure *1-2*):

- dewatering of open pits at rates up to 13 GL/yr cumulative across operations
- crushing, screening and beneficiation of iron ore
- storage of residue material from beneficiation; with a residue storage facility (RSF) to be located at DCA
- waste rock dumps
- progressive rehabilitation where possible with final pit(s) void and permanent waste dumps
- establishment of a rail spur and loop enabling transport of ore to Port Hedland via either the Brockman Resources Marillana rail line or the Roy Hill rail line (the rail spur and loop is subject to a proposed State Agreement between FRS and the State of Western Australia)

- supporting infrastructure including a power station, administration buildings, mining infrastructure and workshops.

The mining of 2 mtpa from the RRA is currently approved under a mining proposal.

INDIAN OCEAN

PORT HEDLAND

117 °

118 °

119 °

120 °

121 °

-21 °

-22 °

-23 °

-24 °

Dampier

Karratha

TOWN OF PORT HEDLAND

SHIRE OF ROEBOURNE

SHIRE OF UPPER GASCOYNE

SHIRE OF MEEKATHARRA

SHIRE OF WILUNA

SHIRE OF MURCHISON

Marble Bar Road

Great Northern Highway

RTIO NAMMULDI

Wittenoom

RTIO BROCKMAN 2

RTIO BROCKMAN 4

Tom Price

RTIO MT TOM PRICE

RTIO MARANDOO

BHPBIO YANDI

BHPBIO AREA C

RTIO YANDICOOGINA

RTIO HOPE DOWNS

RTIO WEST ANGELAS

RTIO PARABURDOO

Paraburdoo

RTIO EASTERN RANGE

RTIO CHANNAR

BHPBIO MT WHALEBACK

Newman

FMG CLOUD BREAK

FMG CHRISTMAS CREEK

ROY HILL

MARILLANA

ROY HILL

NORTHERN RAIL ALIGNMENT

ETHEL CREEK

BHPBIO JIMBLEBAR

Jigalong Mission

SYLVANIA

COOBINA CHROMITE MINE

FPP662D-SEWPAC-PPL-EN-001

Source: Landgate & Calibre Rail 2008-2011

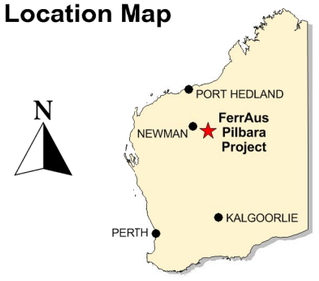
Legend

- Towns
- Mine Site
- Homestead
- Roads
- National / State Highway
- Sylvania Pastoral Licence
- Local Government Boundaries
- FerrAus Pilbara Project Area
- Jigalong Community CLT 3128/530 Lot 30 on Plan 240313
- Jigalong Aboriginal Reserve (Use & Benefit of Aboriginals Reserve 41265)
- RTIO Railways
- BHPBIO Railways
- FMG Railways
- Proposed FMG Christmas Creek Rail Extension
- NRA: FerrAus Proposed Alternate Alignment
- FEPR: FerrAus Proposed Rail Alignment (Preferred)
- Proposed Brockman Marillana Rail Alignment
- RHI Proposed Rail Alignment

Notes

BHPBIO - BHP Billiton Iron Ore
RTIO - Rio Tinto Iron Ore
RHI - Roy Hill Infrastructure
FMG - Fortescue Metals Group
FEPR - FerrAus East Pilbara Rail
NRA - Northern Rail Alignment (FerrAus)

Location Map



FerrAus LIMITED

FerrAus Pilbara Project
Figure1-1 FPP location map

Author: A.Jones	Date: 23/06/2011
Projection: MGA Zone 51	Dwg Version.: 2
Dwg No.: 2011 098	

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes.

The first rail option, identified as the FEPR, is the preferred rail option by which the newly constructed rail line extends to the BHP Billiton Iron Ore (BHPBIO) rail head, slightly north of the Marble Bar Road junction. The tracks will then be constructed to parallel BHPBIO's existing rail until Brockman Resources Marillana site where transport of material will continue on Brockman's proposed rail line up to Port Hedland.

The alternate railway alignment option, identified as Alternative Rail Option, runs immediately adjacent to the Marble Bar Road and links up to Hancock Prospecting Pty Ltd (HPPL) proposed rail line associated with its Roy Hill mine site.

1.2 SURVEYS CONDUCTED

Information from six technical reports has been collated in this report. The technical reports describe vertebrate fauna surveys conducted for the FPP between 2007 and 2011, as follows:

- Level 1 survey of Robertson Range tenement (M52/1034) in 2007, herein referred to as Survey VF01 (Ecologia 2007b).
- Level 1 survey of proposed service corridor and associated infrastructure in 2007, herein referred to as Survey VF02 (Ecologia 2007a)
- Level 2 survey of RRA tenement (M52/1034) in 2008, herein referred to as Survey VF03 (Ecologia 2008)
- Level 2 survey of PG deposit, service corridor and associated infrastructure areas in 2010, herein referred to as Survey VF04 (Phoenix 2010b)
- Level 2 survey of prospective DCA to Marillana rail corridor, herein referred to as Survey VF05 (Phoenix 2011b)
- Targeted Mulgara and Level 1 survey of MM, TD, proposed accommodation village and proposed airstrip, herein referred to as Survey VF06 (Phoenix 2011a).

The study area in this report represents the combined study areas for all six surveys and includes the four deposits, accommodation village, airstrip, service corridor and the prospective DCA to Marillana rail corridor (FEPR) (Figure 1-1).

A survey being conducted for the Alternative Rail Option is not included in the scope of this report.

1.3 SCOPE OF WORK AND SURVEY OBJECTIVES

1.3.1 Scope of this report

The scope of this report is to:

- provide a consolidated overview of survey methods and results for all vertebrate fauna surveys undertaken for the FPP
- discuss survey results in relation to the FPP, with emphasis on species and habitats of conservation significance
- describe potential impacts and risks to conservation significant fauna, based on the information available
- provide management recommendations for avoiding or minimising impacts to fauna.

119°0'0"E 119°30'0"E 120°0'0"E 120°30'0"E 121°0'0"E

22°30'0"S

23°0'0"S

23°30'0"S

N

Figure 1-2
Study area for all vertebrate fauna surveys undertaken for FerrAus Pilbara Project

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 3 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE: 50	PROJECT: FerrAus Pilbara Project
	Absolute Scale - 1:930,131

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Kilometers 0 4 8 16 24

Legend

- Survey VF05
- Surveys VF01, VF03, VF04 and VF06
- Survey VF02
- Surveys VF01 and VF03
- FerrAus Pilbara Project Tenements

1.3.2 Scope and survey objectives for technical reports

The survey scope and objectives for each vertebrate fauna survey conducted for the FPP are outlined below. While the wording of these is variable, all surveys had the overarching objective of adequately defining the fauna values of the respective study areas to assess potential impacts of the FPP (or project components) on fauna.

Survey VF01

Scope: to conduct a Level 1 fauna survey of the RRA tenement (now called KB deposit; M52/1034).

Specific objectives (for fauna):

- provide a review of fauna populations and habitats in the Survey VF01 study area
- assess the regional and local conservation value of fauna present, or likely to be present in the Survey VF01 study area
- identify fauna species of conservation value likely to occur in the Survey VF01 study area
- assess the current impact of land use on fauna habitats
- provide recommendations for fauna habitat management.

Survey VF02

Scope: to conduct a Level 1 fauna survey of proposed service corridor, running approximately 60 km northwest from the RRA to an existing haul road.

Specific objectives (for fauna):

- provide a review of fauna populations and habitats in the Survey VF02 study area
- assess the regional and local conservation value of fauna present, or likely to be present in the Survey VF02 study area
- identify fauna species of conservation value likely to occur in the Survey VF02 study area
- assess the current impact of land use on fauna habitats
- provide recommendations for fauna habitat management.

Survey VF03

Scope: to conduct a Level 2 fauna survey of the KB deposit (M52/1034).

Specific objectives:

- provide a review of background information (including literature and database searches)
- provide an inventory of vertebrate fauna species occurring in the Survey VF03 study area
- provide an inventory of species of biological and conservation significance recorded or likely to occur in the Survey VF03 study area and surrounds
- provide a map and detailed description of fauna habitats occurring in the Survey VF03 study area
- describe the characteristics of the faunal assemblage
- appraise the current knowledge base for the area (in relation to fauna)

- review regional and biogeographical significance of fauna, including conservation status of recorded species
- conduct a risk assessment to determine the likely impacts of threatening processes on fauna within the Survey VF03 study area.

Survey VF04

Scope: to conduct a Level 2 fauna survey of the following areas:

- PG deposit
- process and rail load out infrastructure area (including the rail loop) e.g. residue storage facility, waste stockpile, process plant, rail loop, etc (the process area)
- KB deposit infrastructure area (the infrastructure area) – a 358 ha area, immediately west of M52/1034.
- services corridor to the KB deposit in M52/1034 (the service corridor)
- accommodation village infrastructure area
- communication tower area
- expanded PG waste dump
- creek diversion.

Specific objectives:

- undertake a desktop review of existing information on fauna in the Survey VF04 study area including databases searches and previous survey reports
- undertake two seasonal systematic surveys of the Survey VF04 study area
- identify fauna species of conservation significance occurring or potentially occurring in the Survey VF04 study area
- assess potential impacts on fauna, conservation values and biodiversity from the FPP in a local and regional context
- provide management recommendations

Survey VF05

Scope: to undertake a combined Level 1 and Level 2 fauna survey of the proposed rail corridor (FEPR option).

Specific objectives:

- undertake a desktop review of existing information on fauna in the Survey VF05 study area including databases searches and previous survey reports
- undertake a Level 2 systematic field survey (two seasons) along section A (DCA mine site to the junction with the BHPBIO Jimblebar rail line) of the Survey VF05 study area
- undertake a Level 1 reconnaissance field survey along section B (junction with the BHPBIO Jimblebar rail line to the Brockmans' Marillana mine site) of the Survey VF05 study area
- identify fauna species of conservation significance occurring or potentially occurring in the Survey VF05 study area

- assess potential impacts on fauna, conservation values and biodiversity from the FPP in a local and regional context
- provide management recommendations.

Survey VF06

Scope: undertake –

- a Level 1 survey of MM deposit, TD deposit, proposed accommodation village and proposed airstrip
- a targeted survey for Crest-tailed Mulgara to more accurately determine the local distribution of a known population in the vicinity of the proposed service corridor between RRA and DCA, and within the RRA.

Specific objectives:

- Review existing desktop information from previous surveys to determine potential fauna in the Survey VF06 study area (Level 1 target areas)
- Conduct a reconnaissance survey to identify potential habitat for conservation significant species in the Survey VF06 study area (Level 1 target areas)
- Conduct a targeted trapping survey for Crest-tailed Mulgara in suitable habitat along the proposed service corridor between the RRA and DCA and within the RRA
- Map suitable habitat for Crest-tailed Mulgara in the Survey VF06 study area (targeted survey areas)
- assess potential impacts on fauna, conservation values and biodiversity from the FPP in a local and regional context
- provide management recommendations.

2 EXISTING ENVIRONMENT

2.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA (IBRA) REGION

The IBRA bioregions are defined as large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. Their purpose is to capture the large-scale geophysical patterns that occur across the Australian continent (Thackway & Cresswell 1995a). These patterns influence fauna assemblages at the broad scale.

The study area is situated in both the Augustus subregion of the Gascoyne bioregion (GAS3) and the Fortescue subregion of the Pilbara bioregion (PIL2). It also lies approximately 20 km from the western edge of the Trainor subregion of the Little Sandy Desert bioregion (LSD2)and along the Hamersley subregion of the Pilbara bioregion (PIL3) (Thackway & Cresswell 1995a). As a result, the study area contains elements of all four subregions.

The Fortescue subregion is comprised of alluvial plains and river frontages (DEWHA 2009a). This subregion supports permanent wetlands and is at the northern limit of Mulga (*Acacia aneura*). The prospective FEPR corridor is predominantly within this subregion. The corridor crosses the Fortescue River, which is a wetland of subregional significance.

The Augustus subregion is characterised by rugged, low, Proterozoic sedimentary and granite ranges, divided by broad flat valleys, and contains the headwaters of the Ashburton and Fortescue Rivers (Thackway & Cresswell 1995a). There are areas of alluvial valley-fill deposits, characteristic of this subregion within the study area. Mulga woodland over Spinifex occur predominantly on shallow stony loams on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga parkland (Desmond *et al.* 2001).

The Little Sandy Desert bioregion is an area of low rainfall, characterised by Quaternary dunefields and Proterozoic ranges of the Bangemall Basin. Soils consist of red sands associated with dunefields (the closest of which are situated approximately 20 km to the south-east of the study area) and plains (common in the study area). Alluvial plains within this subregion support river gum communities and bunch grassland (Thackway & Cresswell 1995b), of which several examples are present within the study area.

The Hamersley bioregion is a mountainous area of Proterozoic sedimentary ranges and plateaux. Elements of this subregion are present in the study area with limited numbers of rocky outcrops and rocky slopes

2.2 CLIMATE

The Pilbara District has a semi-desert to tropical climate with highly variable, mostly summer rainfall. The average rainfall over the District ranges from about 200mm to 350mm, although rainfall may vary widely from the average from year to year (DEWHA 2009b).

The nearest Bureau of Meteorology (BOM) weather station to the study area is located at Newman airport, ~75km west of the study area. Newman has its highest mean maximum temperatures (39°C) in January, the lowest maximum mean annual temperature (22.3°C) in July and an average annual rainfall of 310mm (BOM 2009) (Figure 2-1).

The effect of climate on the results of the surveys is included in the survey limitations section (section 3.4).

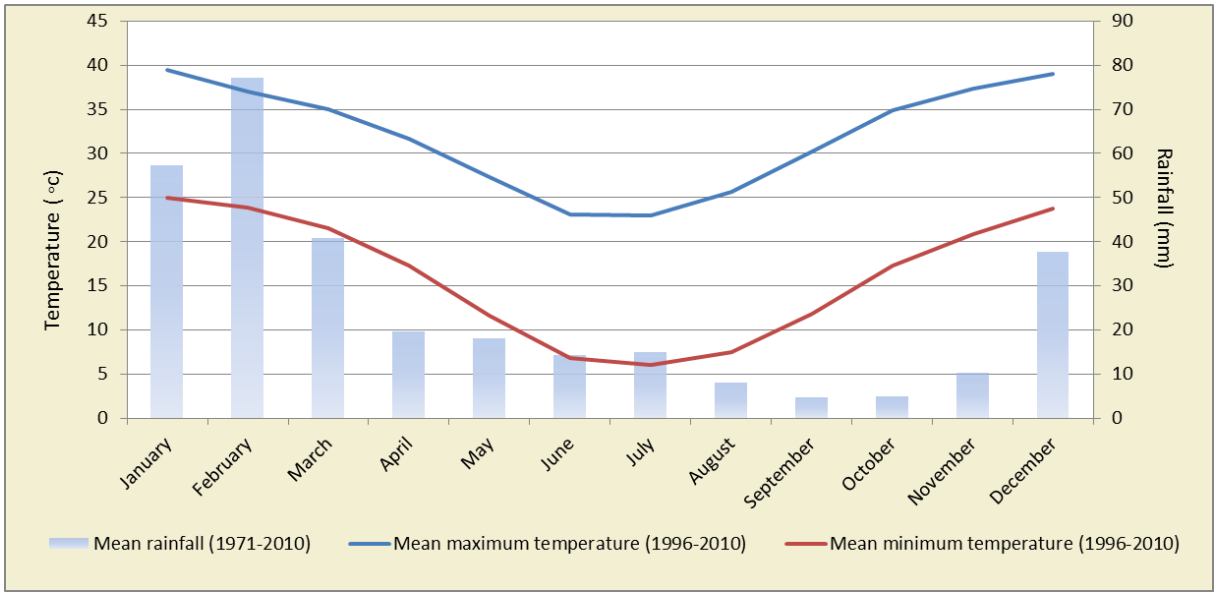

Figure 2-1 Long-term rainfall and temperature data for Newman (BOM 2011)

2.3 RELEVANT LEGISLATION AND AGREEMENTS FOR THE PROTECTION OF FAUNA IN WESTERN AUSTRALIA

Both state and federal legislation provides for the recognition and protection of fauna species of conservation significance in Western Australia. Several international agreements for the protection of migratory species also apply in Western Australia.

International

Migratory species are protected under the following international agreements:

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

Commonwealth

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES) require approval from the Minister for the Environment, Water, Heritage and the Arts. The EPBC Act provides for the listing of nationally threatened native species as matters on NES. Fauna species of national conservation significance may be classified as 'critically endangered', 'endangered', 'vulnerable', or 'conservation dependent'.

The EPBC Act is also the enabling legislation for protection of migratory species under the international agreements listed above.

State

Native species in Western Australia, which are under identifiable threat of extinction, are protected under the Western Australian *Wildlife Conservation Act 1950* (WC Act). Under the WC Act, the *Wildlife Conservation (Specially Protected Fauna) Notice 2008* recognises four classifications of rare and endangered fauna:

- **Schedule 1:** Fauna that is rare or is likely to become extinct.

- **Schedule 2:** Fauna presumed to be extinct.
- **Schedule 3:** Birds protected under an international agreement.
- **Schedule 4:** Other specially protected fauna.

In addition, the Department of Environment and Conservation (DEC) produces a list of Priority fauna species that have not been assigned statutory protection under the WC Act. Species on this list are considered to be of conservation priority because there is insufficient information to make an assessment of their conservation status, or they are considered to be rare but not threatened and are in need of monitoring. The DEC Priority Fauna List categories are:

- **Priority 1:** Taxa with few, poorly known populations on threatened lands.
- **Priority 2:** Taxa with few, poorly known populations on conservation lands.
- **Priority 3:** Taxa with several, poorly known populations, some on conservation lands.
- **Priority 4:** Taxa in need of monitoring – considered not currently threatened but could be if present circumstances change.
- **Priority 5:** Taxa in need of monitoring – considered not currently threatened but subject to a conservation program, the cessation of which could result in the species becoming threatened.

3 METHODS

3.1 DESKTOP REVIEWS AND DATABASE SEARCHES

Fauna databases and previous reports were consulted prior to each survey to generate potential species lists for the study area. The following databases were searched as part of the desktop reviews:

- Western Australian Museum Fauna Base
- Birds Australia Database (Birdata)
- EPBC Act Protected Matters database
- DEC Threatened fauna database
- DEC Naturemap database.

The database search coordinates varied for each survey; however, the combined database searches cover the entire study area and include an adequate buffer zone. Overall, all searches were appropriate for the scale of the individual surveys, despite minimal inconsistencies between survey methods.

In addition to the database searches, survey reports located in the vicinity of the study area were also consulted, including:

- East Jimblebar, Level 1 fauna survey (Ecologia 2005a)
- Hashimoto, Level 1 fauna survey (Ecologia 2006a)
- Jimblebar Marra Mamba, Level 1 fauna survey (Ecologia 2006b)
- Orebody 24 (Ecologia 2004b)
- Orebody 18 (Ecologia 1995a)
- Orebody 25 (Ecologia 1995b)
- Orebody 23 (Ecologia 1998)
- East Ophthalmia range (Ecologia 2004a)
- Jimblebar mine (Endersby 1994)
- Wheelarra hill(Ecologia 2005b).

In addition, the more recent surveys for the FPP built on the desktop reviews of the earlier surveys for the FPP.

3.2 FIELD SURVEYS

Field surveys comprised the following methods:

- systematic trapping for ground-dwelling mammals, reptiles and amphibians (level 2 surveys only),
- systematic bird surveys at all trapping sites plus additional surveys
- recording of bat echolocation calls using Anabat™ at trapping sites
- spotlighting for nocturnal species at all trapping sites
- additional active searches for reptiles and any other species.

Survey effort for each survey is summarized in Table 3-1.

3.2.1 Trapping for ground-dwelling mammals, reptiles and amphibians

Trapping for ground-dwelling mammals, reptiles and amphibians were undertaken only during level 2 surveys, with traps being open for fourteen to twenty nights (over two seasons) to attain a scientifically robust trapping effort. Survey site locations are shown in Figure 3-1. Survey methodology and trapping effort were devised in accordance with the EPA's Guidance Statement 56 (EPA 2004), and therefore conform to the Level 2 survey requirements.

Each site consisted of:

- ten pit traps consisting of five PVC pipes (150 mm diameter x 500 mm depth) and five buckets (20L) installed in a transect at approximately 20m intervals. The traps were installed flush with the substrate with a 6 m long, 30 cm high aluminium drift fence bisecting the bucket or pipe
- twenty funnel traps, one placed at each end of the 10 aluminium drift fences
- twenty Elliott traps, with one placed near and one placed between each pit trap, baited with universal bait
- two cage traps placed at each end of the trapping line, also baited with universal bait.

3.2.2 Avifauna surveys

Survey VF04 and Survey VF05: within each habitat targeted by a trapping site, six independent 20 minute bird surveys were conducted during each phase (a total of two hours per site), within an approximately 2.0 ha area. Surveying for bird species took place as early as possible in the morning (sunrise until 10:30am).

Survey VF03: 2.0 ha areas were searched during 20 minute set-time surveys at each trap site. Surveys were conducted between 5:00-9:00 and 15:00-18:00.

3.2.3 Bats

Anabat™ detectors were used each night to record the ultrasonic calls of bat species. Overnight recordings were taken at each trapping site within the study area and additional opportunistic sites were also surveyed. Dr Bob Bullen analysed the results.

3.2.4 Spotlighting

Night searches were undertaken to detect the presence of nocturnal species, they generally began at sunset and concluded between 9 and 10 pm when conditions became less ideal for nocturnal activity. The nocturnal surveys consisted predominantly of searches of the trapping sites using head torches and spotlights, with opportunistic records of fauna on roads being recorded as well. Searches were undertaken at each of the trapping sites. If conditions were good for nocturnal activity the survey effort was more important than during periods with poor nocturnal activity (e.g. cold windy night). At least 120 person-minutes of spotlight searches were conducted at each trapping site.

3.2.5 Active Searches

Active searches for reptile, amphibian and mammal species were undertaken for 2 person hours at each of the trapping sites. These surveys comprised investigating microhabitats such as hollow logs, under bark, under rocks, in leaf litter and in any cracks or crevices present.

Additional searches were undertaken in the study area where no trapping was undertaken. Secondary evidence, such as footprints, scats and burrows, was used to infer the presence of particular species and to focus active search efforts.

All the level 1 surveys were based on the same active search protocol and particularly targeted conservation significant species. At least 20min of active searching were conducted at each active survey site.

Table 3-1 Summary of overall survey effort

Survey	Type of survey	Timing		Trap sites (TN = Trap Nights)	Opportunistic Day Searching	Opportunistic Road Cruising	Opportunistic night searching	Bird survey	Anabat
		Phase 1 (only if LVL2)	Phase 2 (only if LVL 2)		All data in minutes				
Survey VF01	**LVL1**	12/4/7 - 13/4/7	-	-	1260	360	-	300	240
Survey VF02	**LVL1**	29/9/7 - 3/10/7	-	-	2140	370	150	-	360
Survey VF03	**LVL2**	2/4/8 - 13/4/8	14/10/8 - 26/10/8	6210 TN (6 sites x 20 nights)	1115	-	1890	1760	1800
Survey VF04	**LVL2**	6/4/10 - 16/4/10	1/9/10 - 11/9/10	6279 TN (9 sites x 14 nights)	1080	-	1080	2160	8000
Survey VF05	**LVL2**	15/9/10 - 25/9/10 and 11/10/10 - 17/10/10	28/3/11 - 7/4/11	5376 TN (8 sites x 14 nights)	3020	-	1020	2040	7215
Survey VF06	**Targeted + LVL1**	12/3/10 - 18/3/10	-	1250 TN (10 sites (Elliott traps only) x 5 nights)	960	-	-	-	-

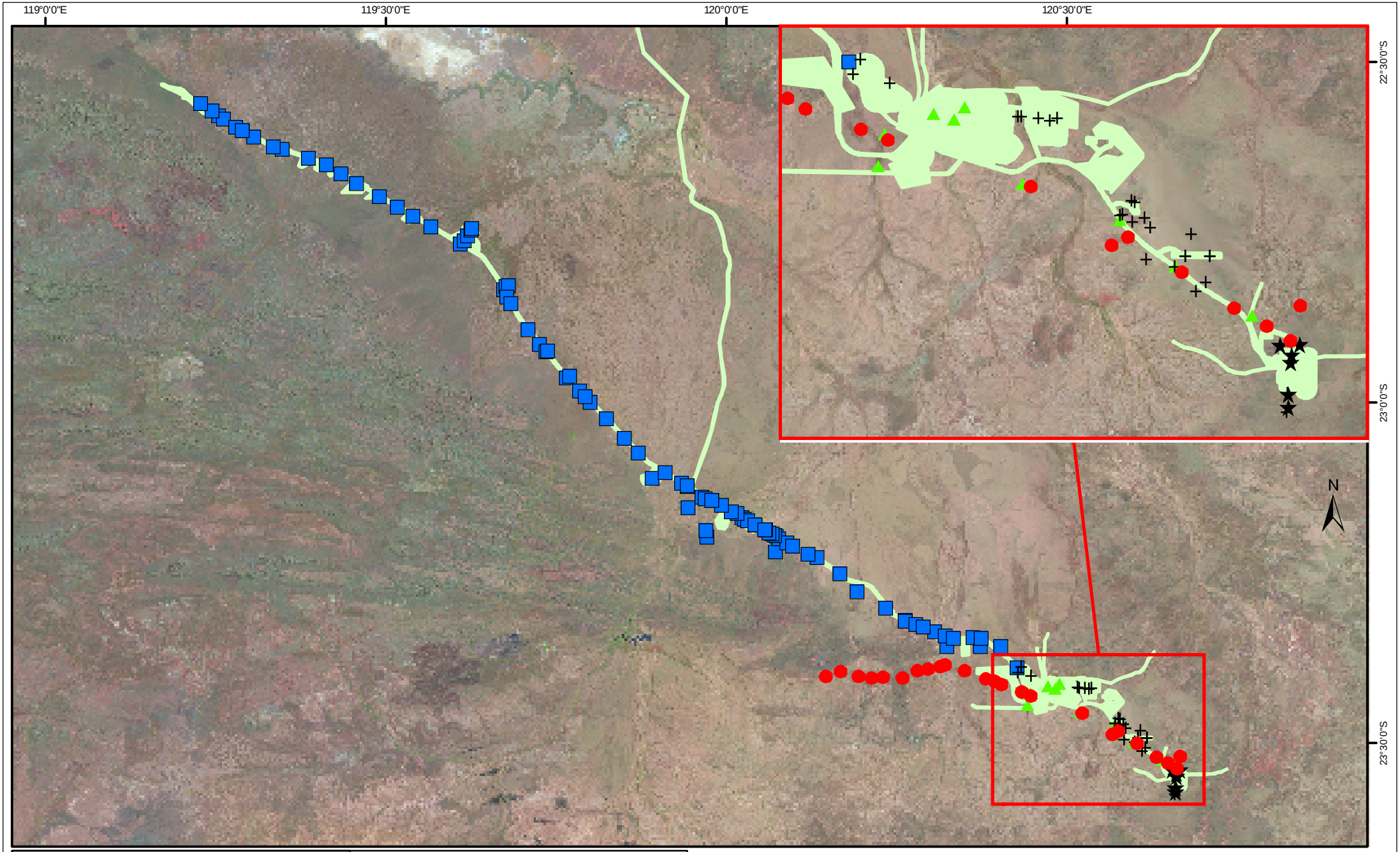

Figure 3-1
Survey sites of vertebrate fauna surveys undertaken for FerrAus Pilbara Project

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	PROJECT: FerrAus Pilbara Project
	Absolute Scale - 1:787,413 (Kilometers 0 4.5 9 18 27)

PHOENIX ENVIRONMENTAL SCIENCES

3.3 TAXONOMY AND NOMENCLATURE

The taxonomy and nomenclature used in this report follows the authorities listed below:

- Birds: Christidis and Boles (Christidis & Boles 2008);
- Reptiles: Wilson and Swan (Wilson & Swan 2010);
- Amphibians: Tyler and Doughty (Tyler & Doughty 2009); and
- Mammals: Van Dyck and Strahan (Van Dyck & Strahan 2008).

In order to provide homogeneity between reports, the most recent taxonomic work was used to update species list of previous reports.

3.4 SURVEY LIMITATIONS

Overall, the surveys didn't meet any major constraints and limitations encountered are considered minor in nature. The main survey limitations related to the following:

- Access/remoteness: minor access issues encountered due to terrain and heritage restrictions (Survey VF02 and VF05).
- Weather: conditions were not ideal (i.e. cold temperatures) for surveying during Survey VF04 (Phase 2) and VF05 (Phase 1). However, the very good conditions recorded during the other phases of these surveys compensated this and allowed good survey results.
- Trapping effort: this was reduced on two occasions; a trap site was lost in a creek bed after well above average rainfall in summer 2010-2011 and drilling activities destroyed four pits at another site during Survey VF04.
- Survey coverage: Survey VF05 focused on the proposed FEPR alignment at the time of the survey. Habitat characterisations and assessments would have to be extrapolated for some areas where the revised alignment deviates from the earlier alignment at the time of the survey.

4 RESULTS

4.1 SPECIES OF CONSERVATION SIGNIFICANCE

This section provides an overview of the conservation significant species recorded or considered likely to occur in the study area. Eight species of birds, six species of mammals and two species of reptiles occur or are likely to occur in the study area. These species are discussed in detail below. Species of conservation significance that are considered unlikely to occur in the study area are not included in this section, but are studied in section 4.3.

Six species of conservation significance were recorded in the field surveys through direct sightings and secondary evidence was observed in the study area for a further three (Table 4-1). Seven additional conservation significant species were not recorded but are considered likely to occur in the study area (Table 4-1). None of the amphibian species recorded in the surveys is conservation significant and there is not likely to be any conservation significant amphibian species present in the study area.

A further 24 species of conservation significance were identified in the desktop reviews but are considered unlikely to occur in the study area, either because there is no suitable habitat or the study area is outside the species current range (Table 4-1).

Table 4-1 Records and likelihood of occurrence of conservation significant fauna in the study area from the potential species identified through desktop reviews

Common name	CS[a]	Records	Likelihood of occurrence	Comment
Fork-tailed Swift	M	Recorded	Confirmed	Suitable habitat throughout the study area
Eastern Great Egret	M	NR	Unlikely	No suitable habitat present
Cattle Egret	M	NR	Unlikely	No suitable habitat present
Glossy Ibis	M	NR	Unlikely	No suitable habitat present
White-bellied Sea-Eagle	M	NR	Unlikely	May transit only
Grey Falcon	P4	Potential habitat	Possible	May forage in the study area but no suitable breeding habitat observed
Peregrine Falcon	S4	Recorded	Confirmed	Most likely transient records, likely to hunt in the study area but no suitable nesting habitat present
Australian Bustard	P4	Recorded	Confirmed	Frequently recorded in study area
Bush Stone-curlew	P4	Recorded	Confirmed	Suitable habitat at several locations in study area
Oriental Plover	M	Potential habitat	Possible	May visit the study area
Common Sandpiper	M	NR	Unlikely	No suitable habitat present
Common Greenshank	M	NR	Unlikely	No suitable habitat present
Marsh Sandpiper	M	NR	Unlikely	No suitable habitat present
Wood Sandpiper	M	NR	Unlikely	No suitable habitat present
Red-necked Stint	M	NR	Unlikely	No suitable habitat present
Long-toed Stint	M	NR	Unlikely	No suitable habitat present
Sharp-tailed Sandpiper	M	NR	Unlikely	No suitable habitat present
Curlew Sandpiper	M	NR	Unlikely	No suitable habitat present
Caspian Tern	M	NR	Unlikely	No suitable habitat present
Night Parrot	EN, S1	NR	Unlikely	One record from Minga Well 25km NW of study area (Fortescue Marsh).

Common name	CS[a]	Records	Likelihood of occurrence	Comment
Princess Parrot	VU, P4	NR	Unlikely	Study area is outside current known range of this species
Rainbow Bee-eater	M	Recorded	Confirmed	Recorded commonly in the study area and may breed along creeklines
Australian Reed-Warbler	M	NR	Unlikely	No suitable habitat present
Star Finch	P4	Potential habitat	Possible	May occur when conditions are favourable, after wet season
Crest-tailed Mulgara	VU, S1	Recorded	Confirmed	Known population recorded and suitable habitat throughout much of the study area
Brush-tailed Mulgara	P4	Potential habitat	Possible	May occur sympatrically with Crest-tailed Mulgara
Northern Quoll	EN, S1	NR	Unlikely	No suitable habitat and is at the southern extent of the species' range
Long-tailed Dunnart	P4	NR	Unlikely	Little habitat in study area
Greater Bilby	VU, S1	Secondary evidence	Possible	Potential habitat present but no records and no secondary evidence other than an unconfirmed disused burrow
Northern Marsupial Mole	EN, S1	Potential habitat	Possible	Suitable habitat present
Spectacled Hare-wallaby	P3	NR	Unlikely	Study area is outside current range of this species
Black-footed Rock-wallaby	VU, S1	NR	Unlikely	Little suitable habitat and study area is not within any of the known locations of remnant populations
Ghost Bat	P4	Probable recording	Possible	Unlikely to be a resident as no suitable roosting habitat present in study area.
Pilbara Leaf-nosed Bat	VU, S1	NR	Unlikely	No suitable habitat present
Western Pebble-mound Mouse	P4	Secondary evidence	Likely	Potential habitat and mounds recorded in study area
Great Desert Skink	VU, S1	NR	Unlikely	No suitable habitat present
Unpatterned Robust Lerista	P2	Potential habitat	Possible	Few records for the species so distribution not well known
Ramphotyphlops ganei	P1	NR	Unlikely	No suitable habitat present; thought to occur in gorge/gully habitats
Pilbara Olive Python	VU, S1	NR	Unlikely	Single location within study area containing marginal suitable habitat at the intersection of the FEPR corridor and the Fortescue River
Ctenotus uber johnstonei	P2	Potential habitat	Possible	Recent records a few km west of study area

a – CS refers to conservation significance ratings. M (Migratory, EPBC Act), P1-P4 (Priority 1-4, DEC Priority Fauna List), EN (Endangered, EPBC Act), VU (Vulnerable, EPBC Act), S1 (Schedule 1, WC Act).

4.1.1 Apus pacificus (Fork-tailed Swift)

Status: Migratory (EPBC Act)

Distribution and ecology:

The Fork-tailed Swift is a widespread migratory species that overwinters in Australia. It can be found across most of Western Australia, and is uncommon to moderately common in the north-west. They are mostly found over inland plains, and also above foothills, in coastal areas and over settlements. They

occur in a wide range of dry or open habitats, including riparian woodlands, tea-tree swamps, low scrub, heathland, saltmarsh, grassland and Spinifex sandplains, open farmland and inland and coastal sand-dunes. Fork-tailed Swifts are often found in areas of updraughts around cliffs, and normally forage several hundred metres above ground level (DSEWPC 2011a).

Records and likely distribution within the study area:

A small flock of Fork-tailed Swifts was seen flying over the FEPR corridor during Survey VF05 (Figure 4-1). Suitable habitat for this species is found across the whole study area.

4.1.2 Falco hypoleucos (Grey Falcon)

Status: Priority 4 (DEC Priority Fauna List)

Distribution and ecology:

The Grey Falcon is a widespread but rare species inhabiting much of the semi-arid interior of Australia. Its distribution is centred on inland drainage systems. It has a large foraging range extending from timbered plains, such as *Acacia* shrublands, into open grasslands. The species preys on other birds and mammals. It often occupies old nests of other species, particularly other raptors, in the tallest trees along watercourses.

There are no confirmed threats to the Grey Falcon but it is thought that clearing of the semi-arid zone for marginal farming has reduced habitat availability and overgrazing of arid zone rangelands may affect prey abundance (Garnett & Crowley 2000).

Records and likely distribution within the study area:

This species was not recorded in the surveys. It may forage in the study area and can breed on tall human infrastructures such as telecommunications towers.

4.1.3 Falco peregrinus (Peregrine Falcon)

Status: Schedule 4 (WC Act)

Distribution and ecology:

The Peregrine Falcon is a widespread species found across Australia, and has a large foraging range. In Western Australia, it can be rare or scarce to moderately common. The Peregrine Falcon's preferred habitat includes cliffs and wooded watercourses. Nesting occurs mainly on cliff ledges, granite outcrops, quarries and in trees with old raven or Wedge-tailed Eagle nests (Johnstone & Storr 1998).

Historically, the widespread use of DDT cause worldwide global decline of the Peregrine Falcon. The main current threat to the species in Australia is habitat loss, particularly woodland trees for nesting (DSEWPC 2011g).

Records and likely distribution within the study area:

A single bird was recorded at the PG deposit during Survey VF04 (Figure 4-1). There did not appear to be any suitable nesting habitat within the PG deposit, and the bird may have been transient in the area. Another single record was made along the FEPR corridor during Survey VF05 and most likely transiting. Major creek are likely to attract Peregrine Falcons especially after high rainfall, due to generally higher abundances of bird prey; however, no suitable nesting habitat has been recorded anywhere in the study area.

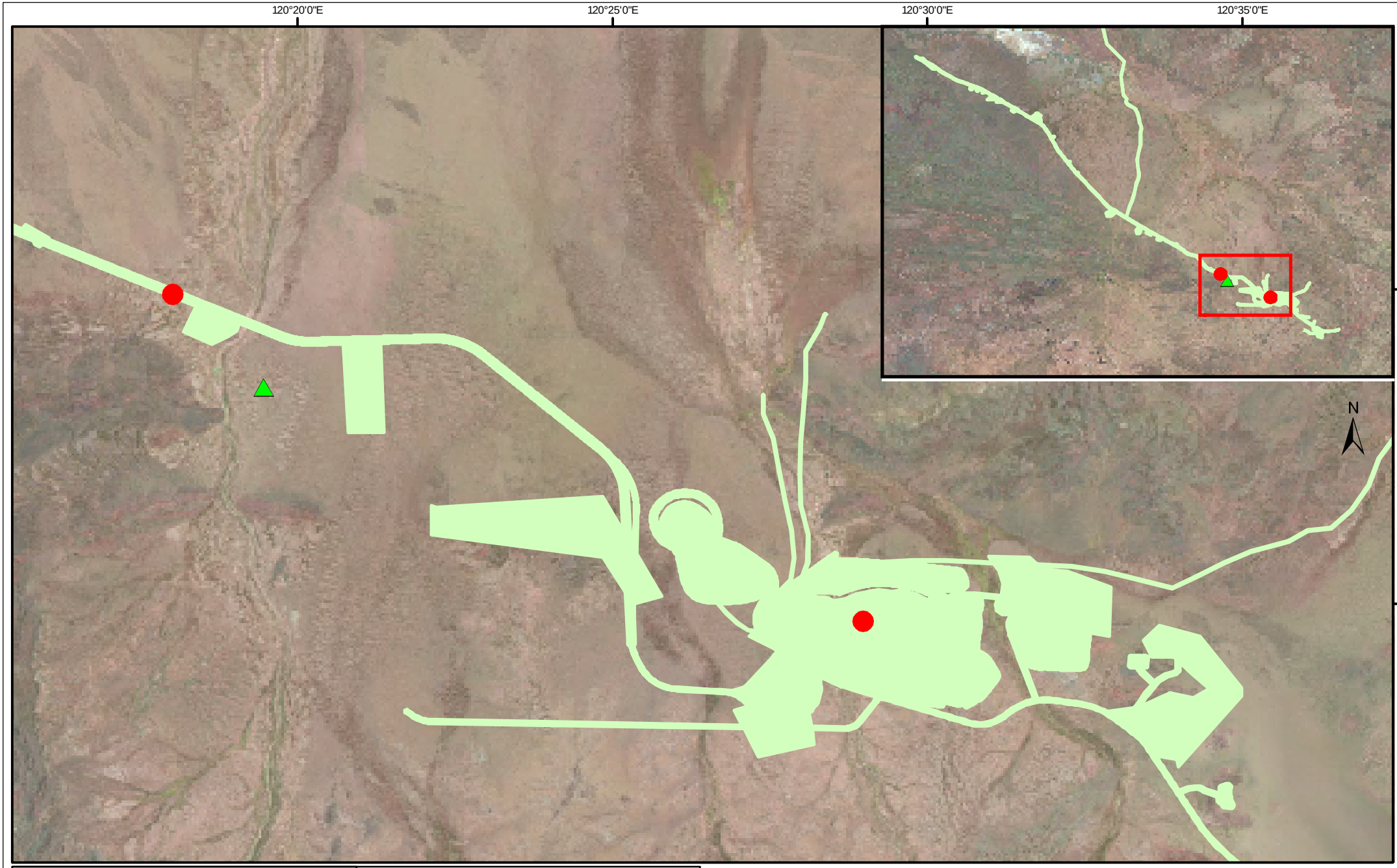

Figure 4-1
Fork-tailed Swift and Peregrine Falcon survey records

PHOENIX ENVIRONMENTAL SCIENCES

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	PROJECT: FerrAus Pilbara Project
	Absolute Scale - 1:144,558 (Kilometers 0 0.5 1 2 3)

▲ Fork-tailed Swift, Direct sighting

● Peregrine Falcon, Direct sighting

4.1.4 Ardeotis australis (Australian Bustard)

Status: Priority 4 (DEC Priority Fauna List)

Distribution and ecology:

The Australian Bustard is a large, ground-dwelling bird that favours open or lightly wooded grasslands, chenopod flats and plains, and heathlands and farming country (Johnstone & Storr 1998). Found across Australia, it is nomadic and highly mobile, and may range over large areas. Local abundance may vary from scarce to common depending on season and food supply (Johnstone & Storr 1998).

Key threats to the species include habitat alteration and loss, predation by Cats, Foxes and Dingoes, livestock grazing, hunting and invasion of habitats by woody weeds.

Records and likely distribution within the study area:

The Australian Bustard has been recorded across the study area in a range of habitats, including sandy Spinifex plains and low rocky ranges, and is relatively common (Figure 4-2). Direct sightings and tracks have been recorded at the proposed accommodation village (Survey VF06), at the TD deposit (Survey VF06) in the northwest of the study area (Survey VF04), along the length of the FEPR corridor (Survey VF05) and service corridor in Survey VF02, and across the RRA (Survey VF03).

Potential habitat has also been recorded at the proposed airstrip and MM deposit. The habitat across much of the study area and its surrounds is suitable for Australian Bustard, and its nomadic behaviour would make its occurrence in any one particular area likely.

4.1.5 Burhinus grallarius (Bush Stone-curlew)

Status: Priority 4 (DEC Priority Fauna List)

Distribution and ecology:

The Bush Stone-curlew is a relatively large, ground-dwelling bird that prefers lightly wooded country near daytime shelter such as thickets or long grass. It can be found across much of Australia except the arid interior and southern coast. In Western Australia, the species is considered to be uncommon to common in the northern subhumid and semiarid zones, and rare to uncommon and locally extinct further south (Johnstone & Storr 1998). The species is sedentary (stable home range and non-migratory) (Garnett & Crowley 2000).

The Bush Stone-curlew is a ground-dwelling species and therefore susceptible to predation and local disturbance by humans. Their numbers tend to decline around human settlements.

Records and likely distribution within the study area:

A single Bush Stone-curlew was recorded during nocturnal searches for Survey VF04 (Figure 4-3). Another individual was recorded during the Survey VF06 near the current campsite. Survey VF03 mentions a species record 55 km northwest of the study area and noted some suitable habitat is present in the vicinity of the KB deposit. Habitat potential was recorded at the proposed accommodation village and the TD deposit in Survey VF06. Little suitable habitat was reported for the proposed service corridor in Survey VF02. Potential habitat was recorded at six sites along the FEPR corridor (VF05).

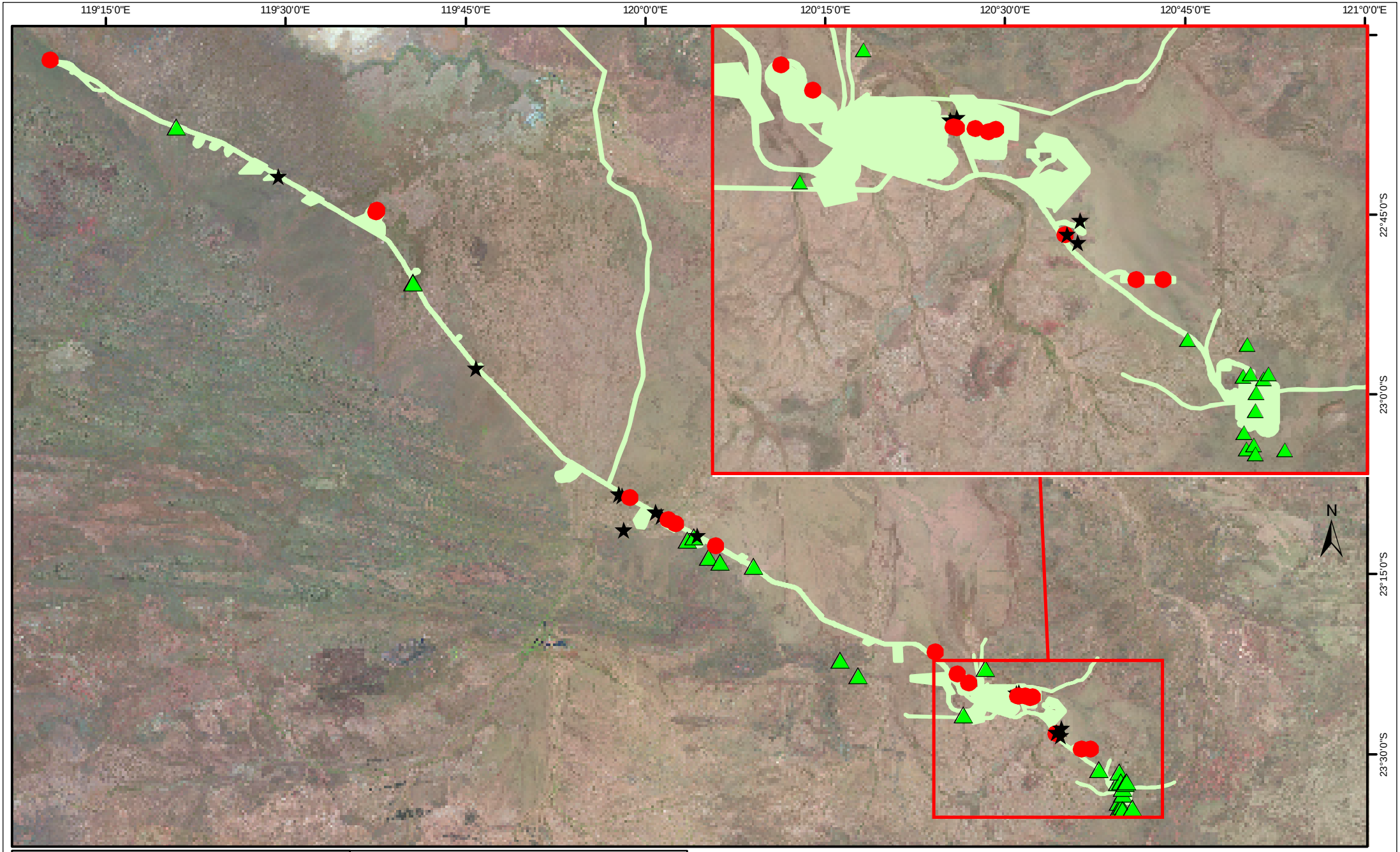

Figure 4-2
Australian Bustard survey records

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	Absolute Scale - 1:745,050 (Kilometers: 0, 4.5, 9, 18, 27)

PHOENIX ENVIRONMENTAL SCIENCES

PROJECT: FerrAus Pilbara Project

- Australian Bustard, Direct sighting
- Australian Bustard, Tracks
- Australian Bustard, Potential habitat

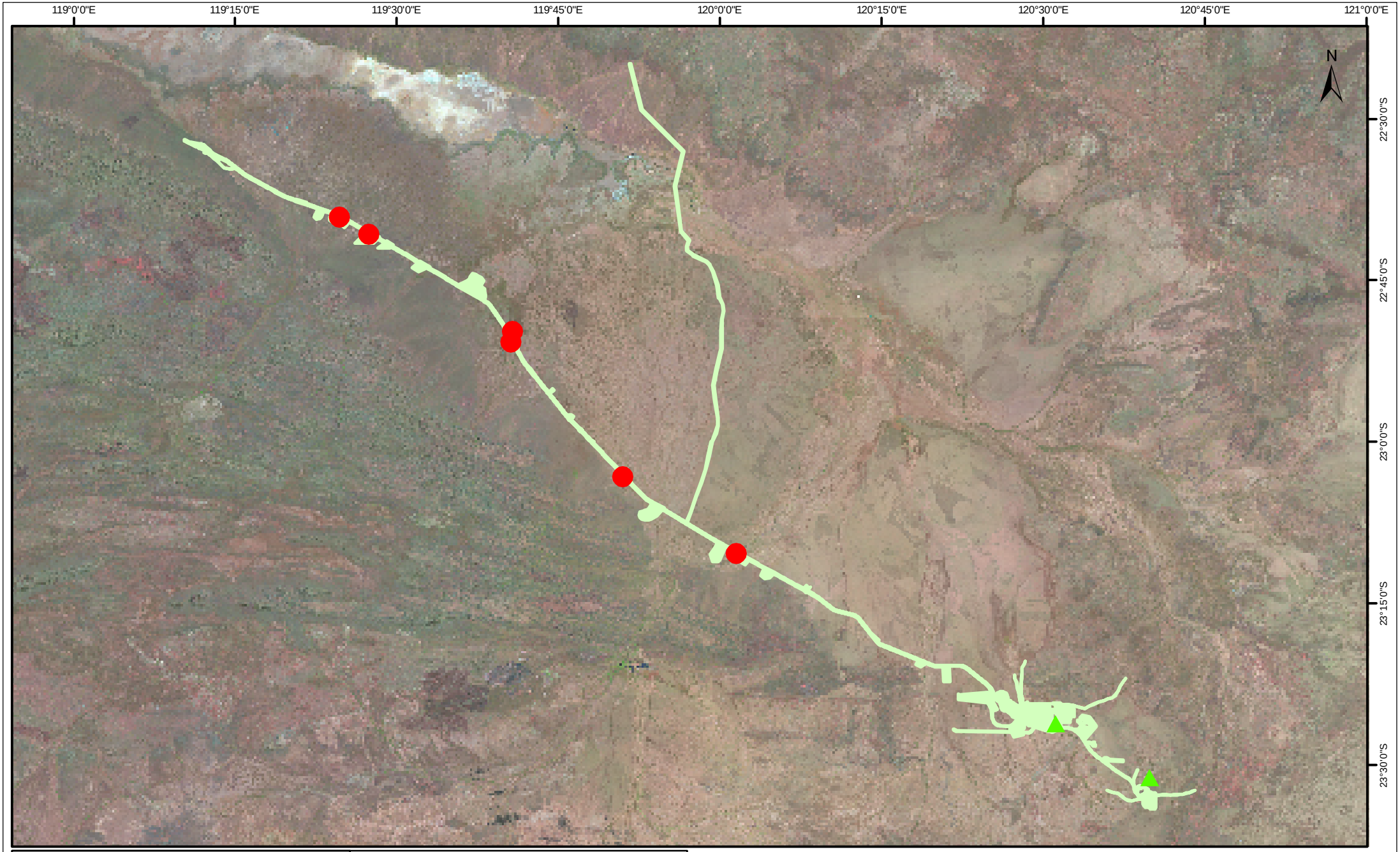

Figure 4-3
Bush Stone-Curlew survey records

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	Absolute Scale - 1:829,626

PHOENIX ENVIRONMENTAL SCIENCES

PROJECT: FerrAus Pilbara Project

Kilometers 0 5 10 20 30

- Bush Stone-Curlew, Potential habitat
- Bush Stone-curlew, Direct sighting

4.1.6 Charadrius veredus (Oriental Plover)

Status: Migratory (EPBC Act)

Distribution and ecology:

The Oriental Plover is a non-breeding visitor to Australia. It has a widespread distribution but most records are along the northwestern coast between Exmouth Gulf and Derby (DSEWPC 2011b). Inland habitats occupied by the species include sparsely vegetated plains or recently burnt open areas.

Records and likely distribution within the study area:

The species was not recorded in the surveys but suitable habitat exists.

4.1.7 Merops ornatus (Rainbow Bee-eater)

Status: Migratory (EPBC Act)

Distribution and ecology:

The Rainbow Bee-eater is a migratory bird that moves between Australia and Asia. It can be found across Australia, with complex seasonal movements depending on location and rainfall, preferring the more watered areas of the country. In Western Australia, the Rainbow Bee-eater can be found in lightly wooded, preferably sandy country near water, occurring as a resident, breeding visitor, postnuptial nomad, passage migrant or winter visitor, and being highly mobile, they can be scarce to common locally (Johnstone & Storr 1998).

Records and likely distribution within the study area:

The Rainbow Bee-eater has been recorded across much of the study area in a variety of habitats including creeklines, ridges, and open woodland (Figure 4-4). Three sightings were made along the proposed service corridor during Survey VF02. Four individuals were recorded in the north of the study area during Survey VF04. Birds were recorded at nine sites along the FEPR corridor in Survey VF05. Three individuals were seen at the proposed accommodation village (Survey VF06). Regular sightings were made during Survey VF03 on the KB deposit.

Suitable habitat for this species is found across the whole study area and it may breed in riparian areas along the major creeks, such as Davidson Creek.

4.1.8 Neochmia ruficauda subclarescens (Star Finch)

Status: Priority 4

Distribution and ecology:

The Star Finch is present in north-western WA. They are found in small flocks feeding in the vegetation around permanent water. The species can occur in arid habitat after the wet season, if the conditions (e.g. vegetation development) are good for breeding. Habitat alteration, clearance and drainage are responsible for the decline of the species throughout most of its range.

Records and likely distribution within the study area:

There are no previous records of Star Finch in the study area, located on the south-east limit of the species' distribution range. Suitable habitat may be available irregularly when the climatic conditions are favorable (e.g. after the wet season).

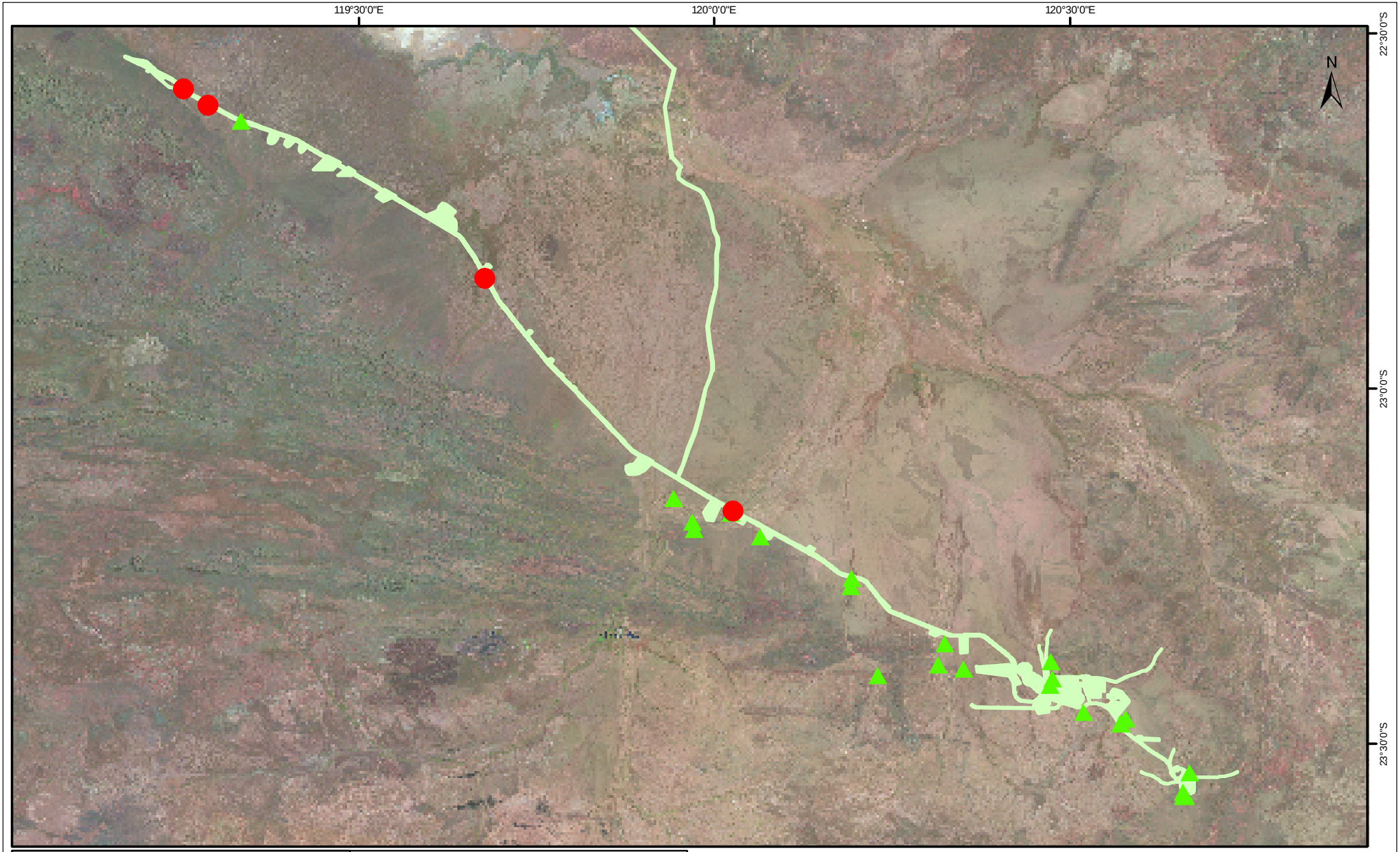

Figure 4-4
Rainbow Bee-eater survey records

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	Absolute Scale - 1:753,492

PHOENIX ENVIRONMENTAL SCIENCES

PROJECT: FerrAus Pilbara Project

Kilometers 0 3 6 12 18

▲ Rainbow Bee-eater, Direct sighting

● Rainbow Bee-eater, Potential habitat

4.1.9 Dasycercus cristicauda (Crest-tailed Mulgara) and Dasycercus blythi (Brush-tailed Mulgara)

Status: Crest-tailed Mulgara -Vulnerable (EPBC Act); Schedule 1 (WC Act)

Brush-tailed Mulgara – Priority 4 (DEC Threatened Fauna List)

Distribution and ecology:

A recent taxonomic revision of the *Dasycercus* genus using morphological and genetic analyses created two species of *Dasycercus*: Brush-tailed Mulgara (*D. blythi*) and Crest-tailed Mulgara (*D. cristicauda*). Despite this even experts may struggle to distinguish the species'. Previous records have not clearly distinguished between the two species, therefore exact distributions of the two species are unclear.

The current distribution map listed for the Crest-tailed Mulgara under the EPBC Act 1999 shows a wide distribution, covering most of central Australia and spreading into north-western Western Australia (DSEWPC 2011c). It is likely that both species have been included in this map, particularly as the EPBC Act currently does not accept the recent taxonomic revision of the genus (DSEWPC 2011c) (where as the DEC does). Mulgara have now been recorded in Western Australia in the Great Victoria Desert, Goldfields, Gascoyne, Sandy Desert and Pilbara regions.

Recent surveys in Western Australia show that Crest-tailed Mulgara are found on medium to dense Spinifex plains (Phoenix 2010a; Thompson & Thompson 2007). No studies on the use of habitat by Crest-tailed Mulgara have been completed. However, Brush-tailed Mulgara do not show a preference for the amount of cover present in the area; rather they utilise a habitat mosaic between patches of mature Spinifex and shrubs to open areas, even after severe fires (Körtner *et al.* 2007).

Mulgara burrows are generally found under dense Spinifex hummocks or in open sand away from vegetation, but they also occur under Canegrass clumps, Nitre Bush hummocks, and small shrubs including melaleuca and grevillea (Körtner *et al.* 2007; Masters 2003; Thompson & Thompson 2007).

No home range studies have been completed for Crest-tailed Mulgara. Brush-tailed Mulgara have been reported to have home ranges from 1 hectare up to 25.5 hectares, with notable differences occurring between sexes and seasons. Brush-tailed Mulgara are noted as having a sedentary lifestyle, meaning that they maintain a stable home range and may live in one location for many years (Körtner *et al.* 2007; Masters 2003). This has important implications where stable populations may be disturbed by a proposed development, as disturbance within known Mulgara habitat could dramatically affect the entire population at that location.

Threatening processes for Mulgara are not well understood. Most likely, disturbance and destruction of habitat due to grazing, altered fire regimes, introduced herbivores and predators are affecting distribution and population size (Maxwell *et al.* 1996) (Woolley 2008a, b). Körtner *et al*. (2007) reported that decreased cover after severe fire may have led to increased predation of Brush-tailed Mulgara by cats and foxes.

Records and likely distribution within the study area:

Four Crest-tailed Mulgara have been captured alongside the proposed serice corridor between the RRA and the DCA during the Level 2 and targeted Crest-tailed Mulgara surveys (Surveys VF04 and VF05; Plate 1; Figure 4-5). A juvenile caught during VF05 was identified from tissue samples analysed by the South Australian Museum after Phoenix and Western Australian Museum mammologist staff could not provide a definitive identification.

Inactive burrows belonging to Mulgara species were found on the KB deposit (Survey VF01, VF03 and VF06) and the FEPR corridor (VF06). Survey VF03 located three burrows on the KB deposit that were attributed to Brush-tailed Mulgara (*Dasycercus blythi*). However, no animals were seen or captured to confirm species identity. Considering the later captures of Crest-tailed Mulgara only a few kilometers to the north, it is assumed that these burrows were incorrectly identified. There is still potential for Brush-tailed Mulgara to occur within the study area as the two species may be sympatric.

The habitat across much of the study area is suitable for Crest-tailed Mulgara. The extent of habitat for Mulgara has been mapped in the vicinity of the proposed pits and mine infrastructure areas but is not exhaustive for the entire study area (Figure 4-5). Spinifex plains are found across the main study sites including the proposed airstrip, lower part of the proposed accommodation village, and the deposits at MM and TD.

The known distribution of Crest-tailed Mulgara in the study area lies west of the existing main access track. This area is bordered to the north-west by 'Halfway Hill', a low hill range to the west, and continues past the KB deposit in the south. The known and potential habitat therefore includes both sides of the proposed service corridor between the PG and KB deposits. A large extent of potential habitat was also identified in a sandy plain along the FEPR corridor where no targeted trapping has been conducted. It is considered highly likely that there is considerable habitat potential immediately beyond the study areas (particularly to the west-southwest), but these areas have not been surveyed.

Plate 1 Crest-tailed Mulgara captured during the Level 2 survey in 2010 (Survey VF04)

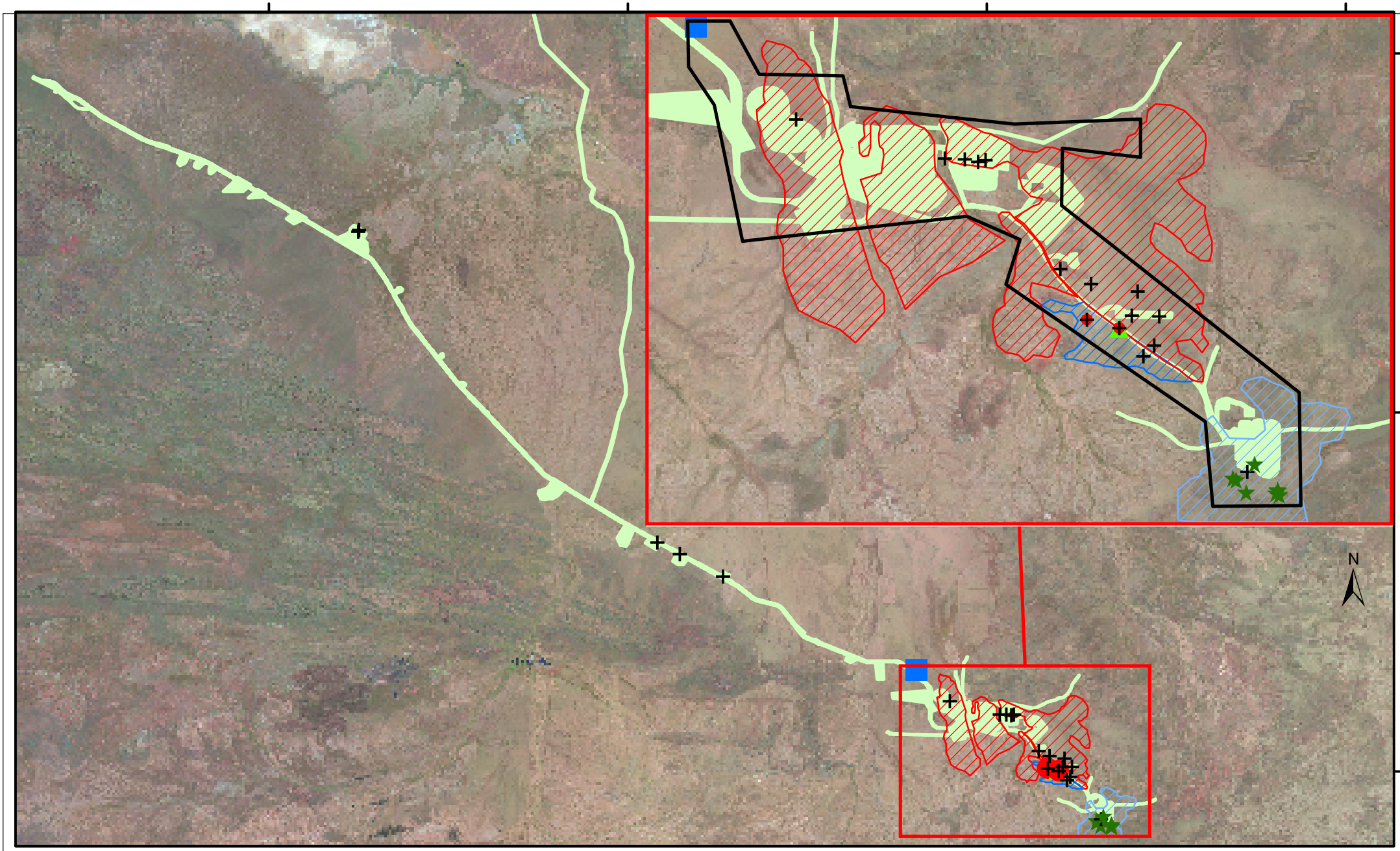

Figure 4-5
Mulgara species survey records

PHOENIX ENVIRONMENTAL SCIENCES

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	PROJECT: FerrAus Pilbara Project
	Absolute Scale - 1:759,787 (Kilometers 0 3 6 12 18)

4.1.10 Macrotis lagotis (Greater Bilby)

Status: Vulnerable (EPBC Act), Schedule 1 (WC Act)

Distribution and ecology:

The Greater Bilby is a rabbit-sized marsupial that originally occupied over 70% of the Australian mainland. It now occurs in less than 20% of its original range, with remaining Western Australian populations predominantly in the Great Sandy and Gibson Deserts. Habitat preferences include hummock grassland in plains and alluvial areas, open tussock grassland on uplands and hills, and mulga woodland/shrubland on ridges and rises (DSEWPC 2011e). The species is highly mobile and can have large foraging ranges. Home ranges in sandy deserts are usually temporary and may shift in response to changes in food availability (Van Dyck & Strahan 2008).

The massive decline in the Bilby's distribution is thought to be due to effects on food availability from changing fire regimes and grazing by rabbits and livestock; predation by Foxes and feral Cats; and drought (Van Dyck & Strahan 2008).

Records and likely distribution within the study area:

No records of the Greater Bilby were made in the surveys. An old burrow system possibly belonging to the species was recorded in Survey VF02, along the old proposed service corridor just north west of the KB deposit (Figure 4-6). The nearest record is approximately 30 km east of the study area. Suitable habitat occurs for the species but other than the unconfirmed burrow, no evidence of Bilby presence was recorded in the surveys, suggesting the likelihood of occurrence is low.

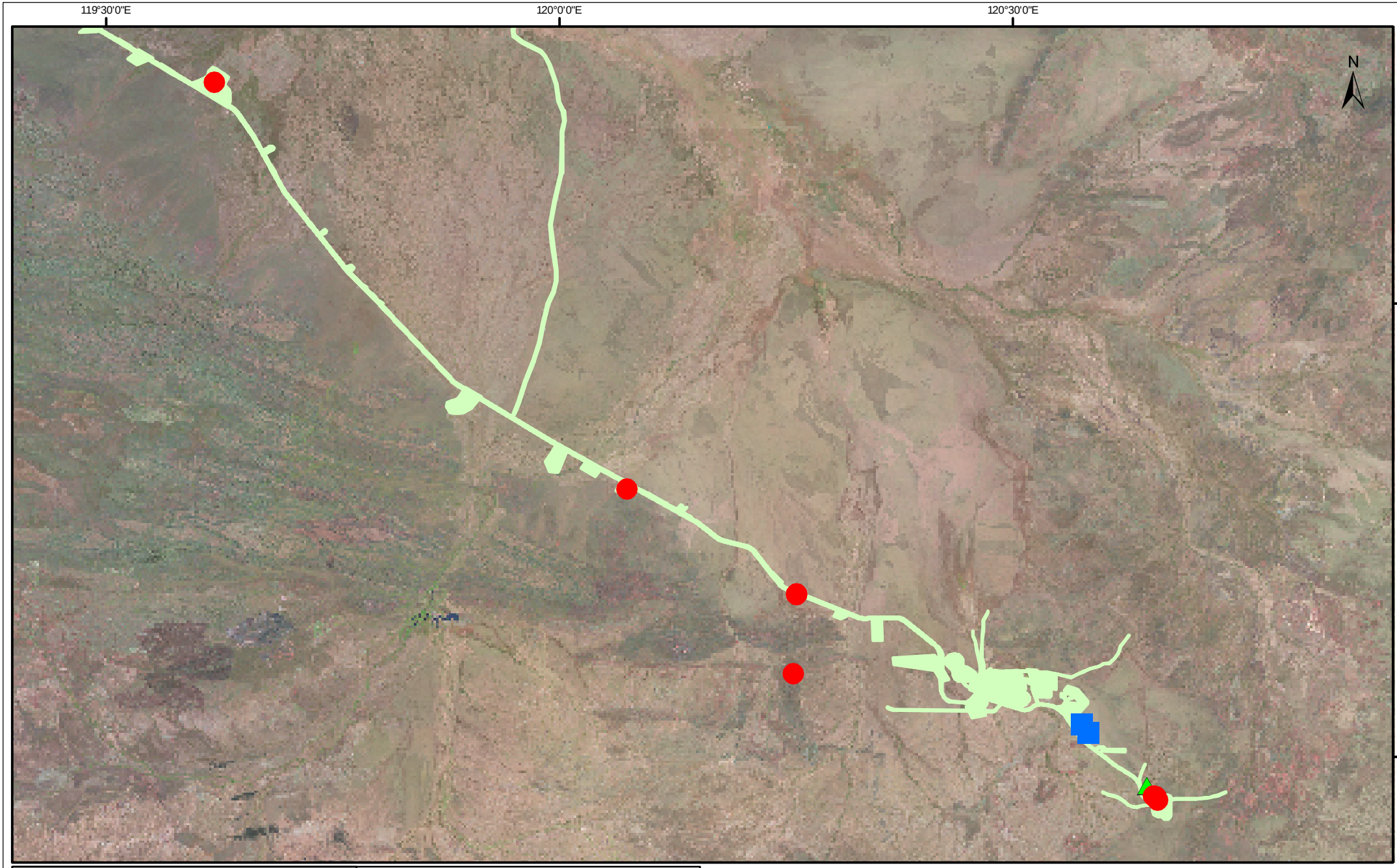

Figure 4-6
Greater Bilby and Western Pebble-mound Mouse survey records

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	Absolute Scale - 1:602,482

PHOENIX ENVIRONMENTAL SCIENCES

PROJECT: FerrAus Pilbara Project

Kilometers 0 3.5 7 14 21

- Greater Bilby, Potential burrow (old)
- Western Pebble-mound Mouse, Inactive mound
- Western Pebble-mound Mouse, Potential habitat

4.1.11 Notoryctes caurinus (Northern Marsupial Mole)

Status: Endangered (EPBC Act), Schedule 1 (WC Act)

Distribution and ecology:

The Northern Marsupial Mole is a blind marsupial adapted to living underground. It is associated with the sand-dune desert systems of inland Australia (Van Dyck & Strahan 2008) (DSEWPC 2011f). There are very few records of the species and its ecology and distribution are not well understood. In Western Australia, specimens have been collected from the Great Sandy, Little Sandy and Gibson Deserts (Benshemesh 2004). The study area lies close to the Little Sandy Desert. Dispersal by marsupial moles probably occurs underground and requires suitable sandy habitat for tunneling (Benshemesh 2004).

A key threat to the Northern Marsupial Mole is predation by Foxes, Cats and Dingoes (Benshemesh 2004). Other potential threats to the species are not well understood but may include habitat modification by cattle and Camel populations; and barriers to dispersal from larger roads, railways and pipeline trenches (Benshemesh 2004).

Records and likely distribution within the study area:

Potential habitat for the species was recorded at three sites within the same sandy plain along the FEPR alignment in Survey VF05 (Figure 4-7). The sites are 80 km west of the closest record of the species and close to the north-west corner of the Little Sandy Desert where the species occurs (Benshemesh 2004). Sandy substrates are required to facilitate inter-population movements between optimal habitats for the species; however, no broad scale habitat assessment was conducted. Consequently it is not known whether there is any connectivity to suitable habitat beyond the study area. No records were made in the targeted searches undertaken at these sites.

Given the lack of records and the limited knowledge on the species biology, distribution and regional habitat extent it is difficult to assess the likelihood of occurrence of this species in the study area. Trenches were dug in three dunes in March 2011 and no evidence was found of Marsupial Mole activity. If recorded, it would have resulted in the most westerly known population of the Northern Marsupial Mole and the first record from the Fortescue Basin.

4.1.12 Macroderma gigas (Ghost Bat)

Status: Priority 4 (DEC Priority Fauna List)

Distribution and ecology:

The Ghost Bat is restricted to northern Australia, common in the Northern Territory but limited to small or widely scattered colonies elsewhere within their range. This large bat roosts in shallow sandstone caves on cliff lines, under boulder piles, in deep limestone caves and within old mines. They use a wide range of habitats, being limited mainly by the availability of suitable roosting habitat (Churchill 2008). The foraging range of this species may cover as much as 60 ha and is conducted over the same area each night.

Threats to the ghost bat include disturbance to roost sites from mining operations, collapse of old mines and human disturbance.

Records and likely distribution within the study area:

A call reported as ‘probable’ was recorded at the PG deposit during Survey VF04 (Figure 4-7). Consequently a targeted search of the minor ridgeline area near this location was undertaken during the second phase of that survey. No caves of sufficient depth were located and it was therefore concluded that the call came from a transient individual. Suitable roosting habitat occurs approximately 30 km north-northwest in the Hamersley Range. No suitable habitat has been identified elsewhere in the study area.

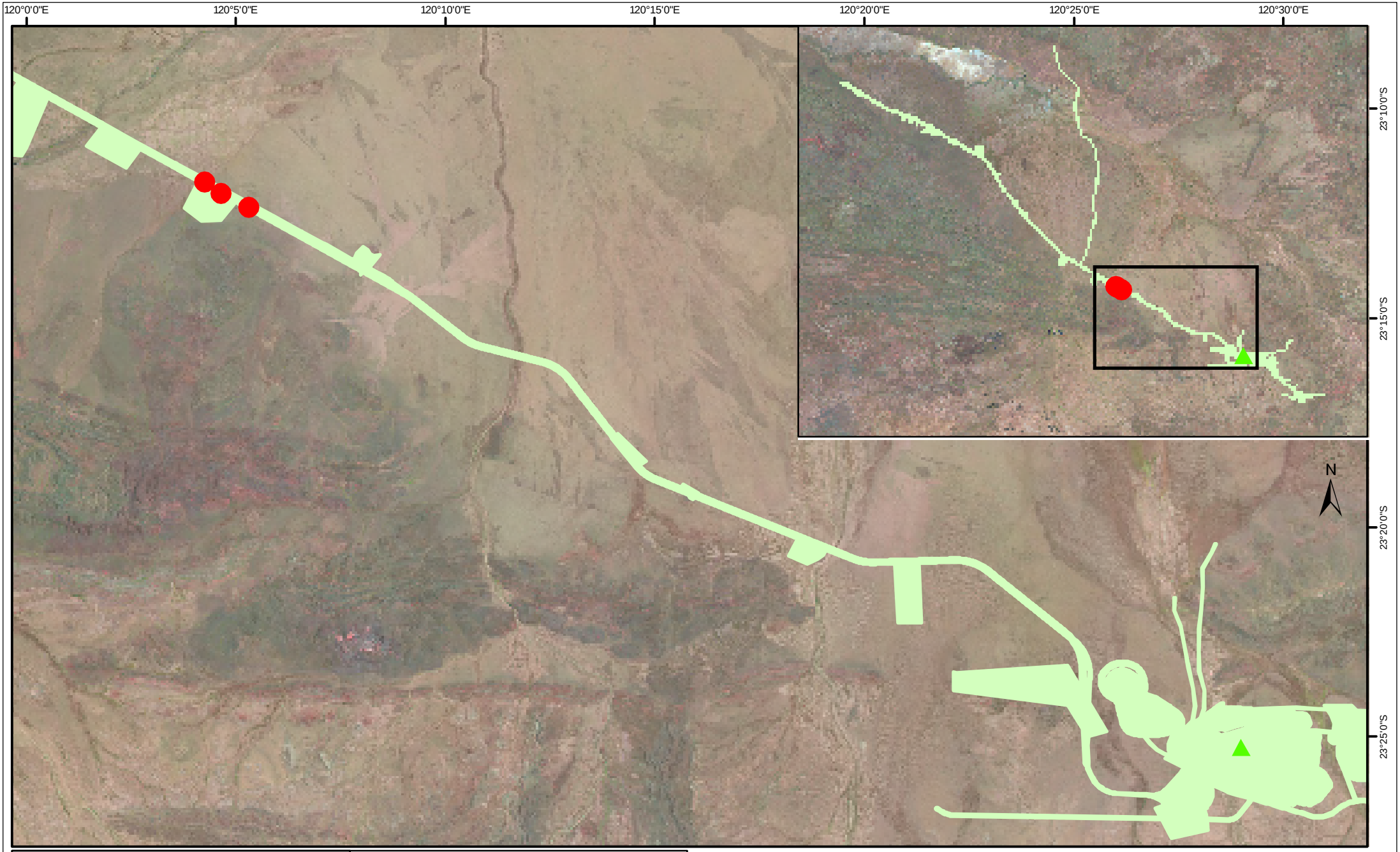

Figure 4-7
Northern Marsupial Mole and Ghost Bat survey records

AUTHOR: PR Langlands	CLIENT: FerrAus Ltd
DRAWN: PR Langlands	DATE: 21 June 2011
Coordinate System: Projection: Transverse Mercator; DATUM: GDA94; ZONE, 50	Absolute Scale - 1:213,175 (Kilometers 0 1 2 4 6)

PHOENIX ENVIRONMENTAL SCIENCES

PROJECT: FerrAus Pilbara Project

▲ Ghost Bat, Probable recording (Anabat)

● Northern Marsupial Mole, Potential habitat

4.1.13 Pseudomys chapmani (Western Pebble-mound Mouse)

Status: Priority 4 (DEC Priority Fauna List)

Distribution and ecology:

The Western Pebble-mound Mouse is widespread in the ranges of the central and southern Pilbara and extends into the Little Sandy Desert Ranges (Van Dyck & Strahan 2008). Originally classified as a Priority 1 species, recent survey records have found the species is widespread, and it has been downgraded to Priority 4.

These mice construct large mounds from small pebbles. Colonies of up to 25 mice may live inside a mound. Pebble size averages 3.5 grams, and the mounds may cover 0.5–9.0 m^2. The mounds are located on the gentle slopes of rocky ranges covered in rocky mulch, hard spinifex and sparse trees and shrubs (*Eucalyptus, Senna*, *Acacia* and *Ptilotus*). They are also often found near *Acacia*-dominated drainage lines (Van Dyck & Strahan 2008).

Threats to the Western Pebble-mound Mouse are not well known but feral Cat predation may be a key cause of the species' decline.

Records and likely distribution within the study area:

Several records of old and inactive mounds have been made in the study area (Figure 4-6). Several mounds were recorded in the low rocky range near the north-western section of the proposed service corridor in Survey VF02 and Survey VF03, one was potentially active. Suitable habitat is available for some distance in this area, inside and outside the study area. Four inactive mounds were recorded along the FEPR corridor in Survey VF05, and potential habitat was recorded at three of the survey sites along the corridor. Habitat with low potential for Western Pebble-mound Mouse was found in the vicinity of the proposed accommodation village during Survey VF06.

4.1.14 Lerista macropisthopus remota (Unpatterned Robust Lerista)

Status: Priority 2 (DEC Priority Fauna List)

Distribution and ecology:

This Lerista species favours sandy to sandy loam soils which support *Acacia* shrubland or woodland. It inhabits loose soil under leaf litter at the base of shrubs (Wilson & Swan 2010). Threats to this species are not well known, it is listed as conservation significant due to its very restricted distribution range.

Records and likely distribution within the study area:

Previous records were identified in the desktop review for Survey VF02; however, the species was not recorded in the surveys and subsequent desktop reviews did not identify this species. It is possible this species occurs in the study area as suitable habitat occurs.

4.1.15 Ctenotus uber johnstonei

Status: Priority 2

Distribution and ecology:

This subspecies of *C. uber* is found at a remote location, north-east of the study area in inland WA (Storr *et al.* 1999). The obvious vertebral stripe is a diagnostic feature. Little is known about the biology of this subspecies in relation to the super-species *C. uber*.

Records and likely distribution within the study area:

Several recent records are located few kilometres west of the study area (DEC 2011). These records are a long distance away from the previously known distribution range of the species. Given the few data

available on the sub-species biology and habitat, it is not possible to assess the likelihood of occurrence of *C. u. johnstonei* in the study area. Of all the specimens collected during the surveys, all were identified as *C. u. uber*.

4.2 FAUNA HABITATS OF THE STUDY AREA

The following five broad fauna habitats have been identified across the study area:

- Spinifex sandplain
- Mulga woodland
- Major creeklines and floodplains
- Low rocky ranges and rocky slopes
- Sand dunes.

The sandplains, sand dunes, major creeklines and rocky slopes are considered to be of high value because of their capacity to support conservation significant fauna or serve as important habitat for fauna generally.

Deep Spinifex sandplains and sand dunes are not common in the Pilbara and those of the study area are of special interest, due to their location at the intersection of the Little Sandy Desert, Hamersley Range and Fortescue Floodplain.

Creeklines are important habitats for fauna generally and a wide range of conservation significant species utilise these habitats, especially migratory species. Riparian habitats in the Pilbara are limited in extent and therefore all such habitats are considered to be of regional importance, requiring special conservation attention (Burbidge *et al.* 2010).

These habitats and their capacity to support conservation significant fauna are discussed below.

4.2.1 Spinifex sandplain

Spinifex sandplains form the dominant habitat type across the study area. The habitat consists of sandy plains vegetated with hummock grassland (predominantly Spinifex) and scattered trees and shrubs. The deep sandy substrate provides ideal habitat for burrowing reptiles and mammals, especially combined with the cover provided by large areas of mature Spinifex hummocks. Patches of low shrubs provide habitat for small birds, and small ground-dwelling birds utilise the Spinifex hummocks. Larger trees provide nesting habitat and shelter for birds and reptiles in the open landscape.

Conservation significant species potentially using this habitat:

Crested-tailed Mulgara (*Dasycercus cristicauda*) ; Brush-tailed Mulgara (*Dasycercus blythi*); Greater Bilby (*Macrotis lagotis*); Fork-tailed Swift (*Apus pacificus*); Australian Bustard (*Ardeotis australis*); Oriental Plover (*Charadrius veredus*); Grey Falcon (*Falco hypoleucos*); Rainbow Bee-eater (*Merops ornatus*); Unpatterned Robust Lerista (*Lerista macropisthopus remota*).

4.2.2 Mulga woodland

Mulga woodlands form a major habitat in the study area. These open to moderately dense woodlands occur on sandy plains and rocky slopes. The understorey can be composed of tussock or hummock grasses. The woodlands provide nesting and shelter habitats for birds and reptiles. Tussocks and hummocks provide habitat for small birds, reptiles and mammals.

Conservation significant species potentially using this habitat:

Greater Bilby (*Macrotis lagotis*); Fork-tailed Swift (*Apus pacificus*); Australian Bustard (*Ardeotis australis*); Bush Stone-curlew (*Burhinus grallarius*); Grey Falcon (*Falco hypoleucos*); Rainbow Bee-eater (*Merops ornatus*); Unpatterned Robust Lerista (*Lerista macropisthopus remota*).

4.2.3 Major creeklines and floodplains

Several major creek lines are found across the study area, including Davidson Creek, Caramulla Creek, Jimblebar Creek, Weeli Wolli Creek and the Fortescue River which intersects the FEPR corridor. Dominant vegetation is generally *Eucalyptus* and *Corymbia* trees up to 15 metres in height over a variably dense understorey of mixed *Acacia* species, low shrubs and tussock grasses. The creek beds and surrounding soils consist of coarse transported gravels and sands. The woodlands of the floodplains also provide nesting and shelter habitats for birds and reptiles. Burrowing reptiles and mammals utilise sandy substrates and fine gravels for burrows. Tussock grasses and low shrubs provide habitat for small birds, reptiles and mammals.

Conservation significant species potentially using this habitat:

Fork-tailed Swift (*Apus pacificus*); Australian Bustard (*Ardeotis australis*) ; Bush Stone-curlew (*Burhinus grallarius*); Grey Falcon (*Falco hypoleucos*); Peregrine Falcon (*Falco peregrinus*); Rainbow Bee-eater (*Merops ornatus*).

4.2.4 Low rocky ranges and rocky slopes

Low rocky ranges and rocky slopes are found in several places across the study area. A low rocky range (Robertson Range) is located in the northern section of the KB deposit area. A low rocky ridge occurs in the north-western section of the proposed service corridor surveyed in 2007 (Survey VF02), covering approximately 20 km of the proposed route. Several rocky slopes are located along the FEPR alignment. The location of the proposed accommodation village is a small rocky ridge and associated rocky slopes.

Vegetation in these areas generally comprises sparse Mulga and eucalypt trees and small tree stands. The understorey consists of Spinifex hummock grasslands and mixed low shrubs. More open areas consist of open shrublands of Grevillea and Acacia over hummock grassland. The ground surface varies from skeletal sands to clay and rocky substrates.

Rock cracks, boulders, crevices, small caves and overhangs provide shelter for a wide variety of reptiles and mammals. However, suitable habitat for nesting birds-of-prey is limited, and caves large enough for bat roosts were not identified. Large trees and dense tree stands provide nesting habitat and shelter for birds and reptiles. Rocky scree slopes provide suitable habitat for the Western Pebble-mound Mouse.

Conservation significant species potentially using this habitat:

Western Pebble-mound Mouse (*Pseudomys chapmani*); Fork-tailed Swift (*Apus pacificus*); Australian Bustard (*Ardeotis australis*); Rainbow Bee-eater (*Merops ornatus*).

4.2.5 Sand dunes

A series of sand dunes occurs at two locations along the FEPR corridor. The dunes are part of larger sand plains and vary in size, with the highest recorded at 5-10 m high with a large base. One site is situated along the BHP railway and comprises low dunes over a small area. The other site is a large sandy plain along Section A of the FEPR corridor with several parallel dunes situated at irregular distances from each other, near a rocky slope.

Spinifex and *Dolichandrone heterophylla* were the two main types of vegetation found in the dune systems of the study area. Despite the small size of the area where they are found, these dunes can still support species that are found in larger homogeneous sand dune systems such as the Northern Marsupial Mole; however trenching for this species was completed in March 2011 and no evidence of presence was recorded.

Conservation significant species potentially using this habitat:

Northern Marsupial Mole (*Notoryctes caurinus*); Australian Bustard (*Ardeotis australis*); Rainbow Bee-eater (*Merops ornatus*), Crested-tailed Mulgara (*Dasycercus cristicauda*) ; Brush-tailed Mulgara (*Dasycercus blythi*).

4.3 VERTEBRATE FAUNA ASSEMBLAGE OF THE STUDY AREA

The desktop reviews identified 389 vertebrate species as potentially occurring. These included 188 birds, 139 reptiles, 43 native mammals and 11 amphibians (Table 4-2). This list is likely to be an overestimate of the actual fauna assemblage for the study area because the area is at the margins of the range of some species identified in the desktop reviews, or suitable habitat is lacking. Species for which this might be the case are assessed in the sub-sections below, while those species likely to be present that are conservation significant have been described in section 4.1.

The field surveys confirmed the presence or likely presence of 208 native vertebrate species, as well as nine introduced mammal species (Table 4-2). The fauna assemblage of the study area is dominated by birds (100 species recorded) and reptiles (75 species recorded).

Table 4-2 Number of species recorded from each group during the survey

Group	No of potential species identified in desktop reviews	Number of recorded species
Native amphibians	11	4
Native birds	188	100
Native mammals	43	28
Introduced mammals	8	9
Reptiles	139	75
Total native species	**381**	**208**
Total species	**389**	**217**

4.3.1 Amphibians

Four species of amphibian were recorded during in the surveys (Table 4-3), two hylid species and two myobatrachid species. The two hylid species recorded were Water-Holding Frog (*Cyclorana platycephala*) and Desert Tree Frog (*Litoria rubella*). The two myobatrachid species were Centralian Burrowing Frog (*Platyplectrum spenceri*) and Russell's Toadlet (*Uperoleia russelli*).

Table 4-3 Amphibian species recorded in surveys of the FPP

Species	Common name	Desktop reviews	Records
HYLIDAE			
Cyclorana maini	Main's Frog	●	
Cyclorana platycephala	Water-Holding Frog	●	●
Litoria rubella	Desert Tree Frog	●	●
MYOBATRACHIDAE			
Limnodynastes spenceri	Spencer's Frog	●	
Neobatrachus centralis	Desert Trilling Frog	●	
Neobatrachus kunapalari	Kunapalari Frog	●	
Neobatrachus sutor	Shoemaker Frog	●	
Notaden nichollsi	Desert Spadefoot	●	
Platyplectrum spenceri	Centralian Burrowing Frog	●	●
Pseudophryne douglasi	Gorge Toadlet	●	
Uperoleia russelli	Russell's Toadlet	●	●

Species	Common name	Desktop reviews	Records
Totals		**11**	**4**
Total conservation significant species		**0**	**0**

4.3.2 Birds

The field surveys recorded 100 avifauna species from 41 families (Table 4-4). The speciose family was Meliphagidae (honeyeaters) with 11 species recorded. The Accipitridae (hawks, eagles and kites) and Accanthizidae (gerygones and thornbills) also had high species representations with eight species each.

Several migratory wetland birds were identified in the desktop reviews: Cattle Egret (*Ardea ibis*), Eastern Great Egret (*Ardea modesta*), Glossy Ibis (*Plegadis falcinellus*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Common Sandpiper (*Actitis hypoleucos*), Common Greenshank (*Tringa nebularia*), Marsh Sandpiper (*Tringa stagnatilis*), Wood Sandpiper (*Tringa Glareola*), Red-necked Stint (*Calidris ruficollis*), Long-toed Stint (*Calidris subminuta*), Sharp-tailed Sandpiper (*Calidris acuminuta*), Curlew Sandpiper (*Calidris ferruginea*) and the Caspian Tern (*Hydropogne caspia*). None of these species are likely to occur in the study area due to the lack of suitable habitat.

Two conservation significant parrot species were identified in the desktop reviews but were not recorded and are unlikely to occur in the study area: Night Parrot (*Pezoporus occidentalis*; Endangered; Schedule 1) and Princess Parrot (*Polytelis alexandrae*; Vulnerable; Priority 4). The nearest recent (2005) record of the rare Night Parrot is from Minga Well, 25 km north of the northern end of the proposed FEPR alignment of the study area (FMG 2005). There are very few records of this species at all and consequently its habitat preferences and distribution are not well understood (DSEWPC 2011h). The current known range of the Princess Parrot is east of the study area. Princess Parrots are an eruptive nomadic species that can sporadically occur in large numbers in areas where they haven't been previously recorded usually when conditions are favorable (such as following large rainfall events). The nearest previous record is located 90 km north east of the study area (1981). The chance for Princess Parrot to occur in the study area is low.

Table 4-4 Bird species recorded in surveys of the FPP

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
CASUARIIDAE						
Dromaius novaehollandiae	Emu				●	●
PHASIANIDAE						
Coturnix pectoralis	Stubble Quail				●	
Coturnix ypsilophora	Brown Quail				●	
ANSERANATIDAE						
Anseranas semipalmata	Magpie Goose				●	●
ANATIDAE						
Dendrocygna eytoni	Plumed Whistling-Duck				●	
Dendrocygna arcuata	Wandering Whistling-Duck				●	
Stictonetta naevosa	Freckled Duck				●	
Cygnus atratus	Black Swan				●	
Tadorna tadornoides	Australian Shelduck				●	
Chenonetta jubata	Australian Wood Duck				●	

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Malacorhynchus membranaceus	Pink-eared Duck				●	
Anas rhynchotis	Australasian Shoveler				●	
Anas gracilis	Grey Teal				●	●
Anas superciliosa	Pacific Black Duck				●	●
Aythya australis	Hardhead				●	
PODICIPEDIDAE						
Tachybaptus novaehollandiae	Australasian Grebe				●	
Poliocephalus poliocephalus	Hoary-headed Grebe				●	
Podiceps cristatus	Great Crested Grebe				●	
COLUMBIDAE						
Phaps chalcoptera	Common Bronzewing				●	●
Ocyphaps lophotes	Crested Pigeon				●	●
Geophaps plumifera	Spinifex Pigeon				●	●
Geopelia cuneata	Diamond Dove				●	●
Geopelia striata	Peaceful Dove				●	
Geopelia humeralis	Bar-shouldered Dove				●	
PODARGIDAE						
Podargus strigoides	Tawny Frogmouth				●	●
EUROSTOPODIDAE						
Eurostopodus argus	Spotted Nightjar				●	●
AEGOTHELIDAE						
Aegotheles cristatus	Australian Owlet-nightjar				●	●
APODIDAE						
Apus pacificus	Fork-tailed Swift	M			●	●
ANHINGIDAE						
Anhinga novaehollandiae	Australasian Darter				●	
PHALACROCORACIDAE						
Microcarbo melanoleucos	Little Pied Cormorant				●	
Phalacrocorax carbo	Great Cormorant				●	
Phalacrocorax sulcirostris	Little Black Cormorant				●	●
Phalacrocorax varius	Pied Cormorant				●	
PELECANIDAE						
Pelecanus conspicillatus	Australian Pelican				●	●
ARDEIDAE						
Ardea pacifica	White-necked Heron				●	
Ardea modesta	Eastern Great Egret	M			●	
Ardea intermedia	Intermediate Egret				●	
Ardea ibis	Cattle Egret	M			●	
Egretta novaehollandiae	White-faced Heron				●	
Egretta garzetta	Little Egret				●	
Nycticorax caledonicus	Nankeen Night-Heron				●	
THRESKIORNITHIDAE						

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Plegadis falcinellus	Glossy Ibis	M			●	
Threskiornis spinicollis	Straw-necked Ibis				●	
Threskiornis molucca	Australian White Ibis				●	
Platalea regia	Royal Spoonbill				●	
Platalea flavipes	Yellow-billed Spoonbill				●	
ACCIPITRIDAE						
Elanus axillaris	Black-shouldered Kite				●	
Lophoictinia isura	Square-tailed Kite				●	
Hamirostra melanosternon	Black-breasted Buzzard				●	●
Haliaeetus leucogaster	White-bellied Sea-Eagle	M			●	
Haliastur sphenurus	Whistling Kite				●	●
Milvus migrans	Black Kite				●	●
Accipiter fasciatus	Brown Goshawk				●	●
Accipiter cirrocephalus	Collared Sparrowhawk				●	●
Circus assimilis	Spotted Harrier				●	●
Circus approximans	Swamp Harrier				●	
Aquila audax	Wedge-tailed Eagle				●	●
Hieraaetus morphnoides	Little Eagle				●	●
FALCONIDAE						
Falco cenchroides	Nankeen Kestrel				●	●
Falco berigora	Brown Falcon				●	●
Falco longipennis	Australian Hobby				●	●
Falco hypoleucos	Grey Falcon			P4	●	
Falco peregrinus	Peregrine Falcon		S4		●	●
RALLIDAE						
Porphyrio porphyrio	Purple Swamphen				●	
Gallirallus philippensis	Buff-banded Rail				●	
Porzana pusilla	Baillon's Crake				●	
Porzana tabuensis	Spotless Crake				●	
Tribonyx ventralis	Black-tailed Native-hen				●	
Fulica atra	Eurasian Coot				●	
OTIDIDAE						
Ardeotis australis	Australian Bustard			P4	●	●
BURHINIDAE						
Burhinus grallarius	Bush Stone-curlew			P4	●	●
RECURVIROSTRIDAE						
Himantopus himantopus	Black-winged Stilt				●	
Recurvirostra novaehollandiae	Red-necked Avocet				●	
Cladorhynchus leucocephalus	Banded Stilt				●	
CHARADRIIDAE						
Charadrius ruficapillus	Red-capped Plover				●	
Charadrius veredus	Oriental Plover	M			●	

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Charadrius australis	Inland Dotterel				●	
Elseyornis melanops	Black-fronted Dotterel				●	
Erythrogonys cinctus	Red-kneed Dotterel				●	
Vanellus tricolor	Banded Lapwing				●	
SCOLOPACIDAE						
Actitis hypoleucos	Common Sandpiper	M			●	
Tringa nebularia	Common Greenshank	M			●	
Tringa stagnatilis	Marsh Sandpiper	M			●	
Tringa glareola	Wood Sandpiper	M			●	
Calidris ruficollis	Red-necked Stint	M			●	
Calidris subminuta	Long-toed Stint	M			●	
Calidris acuminata	Sharp-tailed Sandpiper	M			●	
Calidris ferruginea	Curlew Sandpiper	M			●	
TURNICIDAE						
Turnix velox	Little Button-quail				●	●
GLAREOLIDAE						
Stiltia isabella	Australian Pratincole				●	
LARIDAE						
Gelochelidon nilotica	Gull-billed Tern				●	
Hydroprogne caspia	Caspian Tern	M			●	
Chlidonias hybrida	Whiskered Tern				●	
Chroicocephalus novaehollandiae	Silver Gull				●	
CACATUIDAE						
Eolophus roseicapillus	Galah				●	●
Cacatua sanguinea	Little Corella				●	●
Nymphicus hollandicus	Cockatiel				●	●
PSITTACIDAE						
Polytelis alexandrae	Princess Parrot	VU		P4	●	
Barnardius zonarius	Australian Ringneck				●	●
Psephotus varius	Mulga Parrot				●	●
Melopsittacus undulatus	Budgerigar				●	●
Neopsephotus bourkii	Bourke's Parrot				●	●
Pezoporus occidentalis	Night Parrot	EN, M	S1	CR	●	
CUCULIDAE						
Centropus phasianinus	Pheasant Coucal				●	
Chalcites basalis	Horsfield's Bronze-Cuckoo				●	●
Chalcites osculans	Black-eared Cuckoo				●	●
Cacomantis pallidus	Pallid Cuckoo				●	●
STRIGIDAE						
Ninox connivens peninsularis	Barking Owl				●	
Ninox novaeseelandiae	Southern Boobook				●	●

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
TYTONIDAE						
Tyto javanica	Eastern Barn Owl				●	●
HALCYONIDAE						
Dacelo leachii	Blue-winged Kookaburra				●	●
Todiramphus pyrrhopygius	Red-backed Kingfisher				●	●
Todiramphus sanctus	Sacred Kingfisher				●	
MEROPIDAE						
Merops ornatus	Rainbow Bee-eater	M			●	●
CLIMACTERIDAE						
Climacteris melanura	Black-tailed Treecreeper				●	
PTILINORHYNCHIDAE						
Ptilonorhynchus guttatus	Western Bowerbird				●	●
MALURIDAE						
Malurus splendens	Splendid Fairy-wren				●	●
Malurus leucopterus	White-winged Fairy-wren				●	●
Malurus lamberti	Variegated Fairy-wren				●	●
Stipiturus ruficeps	Rufous-crowned Emu-wren				●	●
Amytornis striatus whitei	Striated Grasswren				●	●
ACANTHIZIDAE						
Calamanthus campestris wayensis	Rufous Fieldwren				●	
Pyrrholaemus brunneus	Redthroat				●	
Smicrornis brevirostris	Weebill				●	●
Gerygone fusca	Western Gerygone				●	●
Acanthiza robustirostris	Slaty-backed Thornbill				●	●
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				●	●
Acanthiza uropygialis	Chestnut-rumped Thornbill				●	●
Acanthiza apicalis	Inland Thornbill				●	●
Aphelocephala leucopsis	Southern Whiteface				●	●
Aphelocephala nigricincta	Banded Whiteface				●	●
PARDALOTIDAE						
Pardalotus rubricatus	Red-browed Pardalote				●	●
Pardalotus striatus	Striated Pardalote				●	
MELIPHAGIDAE						
Certhionyx variegatus	Pied Honeyeater				●	●
Lichenostomus virescens	Singing Honeyeater				●	●
Lichenostomus keartlandi	Grey-headed Honeyeater				●	●
Lichenostomus plumulus	Grey-fronted Honeyeater				●	
Lichenostomus penicillatus	White-plumed Honeyeater				●	●
Purnella albifrons	White-fronted Honeyeater				●	
Manorina flavigula	Yellow-throated Miner				●	●
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				●	●

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Conopophila whitei	Grey Honeyeater				●	●
Epthianura tricolor	Crimson Chat				●	●
Epthianura aurifrons	Orange Chat				●	
Sugomel niger	Black Honeyeater				●	●
Lichmera indistincta	Brown Honeyeater				●	●
Melithreptus gularis	Black-chinned Honeyeater				●	
POMATOSTOMIDAE						
Pomatostomus temporalis	Grey-crowned Babbler				●	●
Pomatostomus superciliosus	White-browed Babbler				●	●
EUPETIDAE						
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush				●	●
Psophodes occidentalis	Chiming Wedgebill				●	
NEOSITTIDAE						
Cinclosoma castaneothorax	Varied Sittella				●	●
CAMPEPHAGIDAE						
Coracina maxima	Ground Cuckoo-shrike				●	●
Coracina novaehollandiae	Black-faced Cuckoo-shrike				●	●
Lalage sueurii	White-winged Triller				●	●
PACHYCEPHALIDAE						
Pachycephala rufiventris	Rufous Whistler				●	●
Colluricincla harmonica	Grey Shrike-thrush				●	●
Oreoica gutturalis	Crested Bellbird				●	●
ARTAMIDAE						
Artamus personatus	Masked Woodswallow				●	●
Artamus superciliosus	White-browed Woodswallow				●	
Artamus cinereus	Black-faced Woodswallow				●	●
Artamus cyanopterus	Dusky Woodswallow				●	
Artamus minor	Little Woodswallow				●	●
Cracticus torquatus	Grey Butcherbird				●	●
Cracticus nigrogularis	Pied Butcherbird				●	●
Cracticus tibicen	Australian Magpie				●	●
RHIPIDURIDAE						
Rhipidura albiscapa	Grey Fantail				●	
Rhipidura leucophrys	Willie Wagtail				●	●
CORVIDAE						
Corvus coronoides	Australian Raven				●	●
Corvus bennetti	Little Crow				●	
Corvus orru	Torresian Crow				●	●
MONARCHIDAE						
Grallina cyanoleuca	Magpie-lark				●	●
PETROICIDAE						

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Petroica goodenovii	Red-capped Robin				●	●
Melanodryas cucullata	Hooded Robin				●	●
ALAUDIDAE						
Mirafra javanica	Horsfield's Bushlark				●	●
ACROCEPHALIDAE						
Acrocephalus australis	Australian Reed-Warbler	M			●	
MEGALURIDAE						
Megalurus gramineus	Little Grassbird				●	
Cincloramphus mathewsi	Rufous Songlark				●	●
Cincloramphus cruralis	Brown Songlark				●	●
Eremiornis carteri	Spinifexbird				●	
HIRUNDINIDAE						
Cheramoeca leucosterna	White-backed Swallow				●	●
Hirundo neoxena	Welcome Swallow				●	
Petrochelidon ariel	Fairy Martin				●	
Petrochelidon nigricans	Tree Martin				●	●
NECTARINIIDAE						
Dicaeum hirundinaceum	Mistletoebird				●	●
ESTRILDIDAE						
Taeniopygia guttata	Zebra Finch				●	●
Neochmia ruficauda subclarescens	Star Finch			P4	●	
Emblema pictum	Painted Finch				●	●
MOTACILLIDAE						
Anthus novaeseelandiae	Australasian Pipit				●	●
Totals					**189**	**101**
Total conservation significant species (threatened)					**7**	**3**
Total migratory species					**19**	**2**

4.3.3 Mammals

The field surveys recorded 28 native and nine introduced mammal species (Table 4-5). The native mammal assemblage comprised 11 bat species, eight dasyurids, five Muridae species, two macropods, the Greater Bilby and the Short-beaked Echidna.

The only directly captured conservation significant mammal was Crest-tailed Mulgara (*Dasycercus cristicauda*; Schedule 1). Burrows identified as those of Brush-tailed Mulgara (*Dasycercus blythi*; Priority 4) were recorded in Survey VF03, however subsequent records of the Crest-tailed Mulgara suggest the burrows may have belonged to the latter species. A probable record of the Ghost Bat (*Macroderma gigas*; Priority 4) was made from Anabat^{tm} recordings in September 2010 and attributed to a transient individual given the absence of potential habitat or further records. Secondary evidence (inactive mounds) of the Western Pebble-mound Mouse (*Pseudomys chapmani*; Priority 4) was recorded.

Potential habitat exists for two additional conservation significant species; Greater Bilby (*Macrotis lagotis*) and Northern Marsupial Mole (*Notoryctes caurinus*), both Endangered (EPBC Act) and Schedule

1 (WC Act). Marsupial Mole trenching was completed in March 2011 and no evidence of presence was recorded. A possible burrow complex belonging to the Greater Bilby was found during Survey VF02.

A further five conservation significant species identified in the desktop reviews are considered unlikely to be present in the study area due to range restrictions and/or lack of suitable habitat, as summarized below; Northern Quoll (*Dasyurus hallucatus*; Endangered), Black-footed Rock-wallaby (*Petrogale lateralis*; Vulnerable; Schedule 1), Spectacled Hare-wallaby (*Lagochestes conspicillatus*; Priority 3), Long-tailed Dunnart (*Sminthopsis longicaudat*a; Priority 4) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*; Vulnerable; Schedule 1).

The study area occurs at the southern extreme of the known range for the Northern Quoll and no suitable habitat occurs within the FEPR corridor. Populations of the Black-footed Rock-wallaby are now known from a few isolated locations, none of which are close to the study area; and the species is generally associated with rocky habitats, of which there are few in the study area.

The range of the Spectacled Hare-wallaby no longer extends nearly as far south as the study area and the species is therefore considered highly unlikely to be present. Marginal habitat exists for the Long-tailed Dunnart at the north-western end of the proposed service corridor (Survey VF02) and at various sections of the FEPR corridor. The species is considered unlikely to occur, especially considering the survey effort undertaken to date. No suitable habitat for the Pilbara Leaf-nosed Bat (deep warm humid caves) is present within the study area.

Table 4-5 Mammal species recorded in surveys of the FPP

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
TACHYGLOSSIDAE						
Tachyglossus aculeatus	Short-beaked Echidna				●	●
DASYURIDAE						
Antechinomys laniger	Kultarr					●
Dasycercus cristicauda	Crest-tailed Mulgara	VU	S1		●	●
Dasycercus blythi	Brush-tailed Mulgara			P4	●	●a
Dasykaluta rosamondae	Kaluta				●	●
Dasyurus hallucatus	Northern Quoll	EN	S1			
Ningaui ridei	Wongai Ningaui				●	●
Ningaui temialeyi	Pilbara Ningaui				●	
Planigale sp.					●	
Pseudantechinus roryi	Rory's Pseudantechinus				●	
Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus				●	
Pseudantechinus woolleyae	Woolley's Pseudantichinus				●	
Sminthopsis crassicaudata	Fat-tailed Dunnart				●	●
Sminthopsis longicaudata	Long-tailed Dunnart			P4	●	
Sminthopsis macroura	Stripe-faced Dunnart				●	●
Sminthopsis ooldea	Ooldea Dunnart				●	●
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart				●	●
Sminthopsis sp. EHA002					●	
THYLACOMYIDAE						
Macrotis lagotis	Greater Bilby	VU	S1		●	
NOTORYCTIDAE						
Notoryctes caurinus	Northern Marsupial Mole	EN	S1			
MACROPODIDAE						

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby			P3	●	
Macropus robustus	Euro				●	●
Macropus rufus	Red Kangaroo				●	●
Petrogale lateralis lateralis	Black-footed Rock-wallaby	VU	S1		●	
Petrogale rothschildi	Rothschild's Rock-wallaby				●	
Petrogale sp.					●	
MEGADERMATIDAE						
Macroderma gigas	Ghost Bat			P4	●	○
HIPPOSIDERIDAE						
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1		●	
EMBALLONURIDAE						
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat				●	●
Taphozous georgianus	Common Sheath-tailed Bat				●	●
Taphozous hilli	Hill's Sheath-tailed Bat				●	●
MOLOSSIDAE						
Chaerophon jobensis	Northern Freetail Bat				●	●
Mormopterus beccarii	Beccari's Freetail Bat				●	●
Tadarida australis	White-striped Freetail Bat				●	●
VESPERTILIONIDAE						
Chalinolobus gouldii	Gould's Wattled Bat				●	●
Chalinolobus morio	Chocolate Wattled Bat				●	
Nyctophilus bifax daedalus	North-western Long-eared Bat				●	
Nyctophilus geoffroyi	Lesser Long-eared Bat				●	●
Scotorepens balstoni	Inland Broad-nosed Bat				●	
Scotorepens greyii	Little Broad-nosed Bat				●	●
Vespadelus finlaysoni	Finlayson's Cave Bat				●	●
MURIDAE						
Notomys alexis	Spinifex Hopping-mouse				●	●
Pseudomys chapmani	Western Pebble-mound Mouse			P4	●	●
Pseudomys desertor	Desert Mouse				●	●
Pseudomys hermannsburgensis	Sandy Inland Mouse				●	●
Zyzomys argurus	Common Rock-rat				●	●
INTRODUCED MAMMALS						
**Mus musculus*	House Mouse				●	●
**Canis lupus*	Dog/Dingo				●	●
**Vulpes vulpes*	Red Fox				●	●
**Felis catus*	Cat				●	●
**Oryctolagus cuniculus*	European Rabbit				●	●
**Equus asinus*	Donkey				●	●
Equus caballus	Horse					●

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
**Camelus dromedarius*	One-humped Camel				●	●
**Bos taurus*	Cow				●	●
Totals					**51**	**37**
Total conservation significant species					**10**	**4b**
Total natives					43	28
Total introduced					8	9

a – Survey VF03 identified burrows of Brush-tailed Mulgara, however, subsequent records of Crest-tailed Mulgara suggest the burrows were may have been those of the latter species.

b – includes Brush-tailed Mulgara record which may have been a misidentification.

4.3.4 Reptiles

A total of 75 reptile species were recorded in the field surveys (Table 4-6). The most well represented families were Scincidae (skinks) with 26 species, Gekkonidae (gekkos) with 15 species, Agamidae (dragons) with nine species and Varanidae (monitors) with nine species. Ten snake species were recorded.

No reptile species of conservation significance were recorded in the study area. Five conservation significant species were identified in the desktop reviews: Pilbara Olive Python (*Liasis olivaceus barroni*; Vulnerable, Schedule 1), Great Desert Skink (*Egernia kintorei*; Vulnerable; Schedule 1), *Ctenotus uber Johnstonei* (Priority 2), *Ramphotyphlops ganei* (Priority 1) and *Lerista macropisthopus remota* (Priority 2).

The Pilbara Olive Python is primarily found in gorges and dissected drainage lines (Wilson & Swan 2010). This species is considered unlikely to occur due to lack of suitable habitat in the study area; the only marginal suitable habitat for this species occurs at the intersection of the Fortescue River and the FEPR corridor.

The Great Desert Skink is unlikely to occur in the study area due to lack of suitable habitat; it generally occurs on large uniform red sandplains and sand ridges, or in the Gibson Desert on sandplains with a surface cover of fine gravel (DSEWPC 2011d). *Ramphotyphlops Ganei* is possibly associated with gorges and gullies (Wilson & Swan 2010) and therefore unlikely to occur in the study area.

Table 4-6 Reptile species recorded in surveys of the FPP

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
CHELUIDAE						
Chelodina steindachneri	Steindachner's Turtle				●	
GEKKONIDAE						
Crenadactylus ocellatus	Clawless Gecko				●	
Diplodactylus conspicillatus	Fat-tailed Gecko				●	●
Diplodactylus mitchelli					●	
Diplodactylus pulcher	Beautiful Gecko				●	●
Diplodactylus savagei					●	
Gehyra pilbara					●	
Gehyra punctata	Spotted Dtella				●	●
Gehyra purpurascens					●	●
Gehyra variegata					●	●

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Heteronotia binoei	Bynoe's Gecko				●	●
Heteronotia spelea	Desert Cave Gecko				●	
Lucasium stenodactylus	Sand-plain Gecko				●	●
Lucasium wombeyi					●	
Nephrurus laevissimus					●	
Nephrurus levis	Smooth Knob-tailed Gecko				●	●
Nephrurus wheeleri	Banded Knob-tailed Gecko				●	●
Oedura marmorata	Marbled Velvet Gecko				●	●
Rhynchoedura ornata	Beaked Gecko				●	●
Strophurus assimilis						●
Strophurus ciliaris	Northern Spiny-tailed Gecko				●	●
Strophurus elderi	Jewelled Gecko				●	●
Strophurus jeanae					●	●
Strophurus wellingtonae					●	●
PYGOPODIDAE						
Delma butleri					●	
Delma desmosa					●	●
Delma elegans					●	
Delma haroldi					●	
Delma nasuta					●	●
Delma pax					●	●
Delma tincta					●	●
Lialis burtonis	Burton's Snake-lizard				●	●
Pygopus nigriceps	Western Hooded Scaly-foot				●	●
SCINCIDAE						
Carlia munda					●	●
Carlia triacantha					●	●
Cryptoblepharus buchananii					●	
Cryptoblepharus carnabyi					●	
Cryptoblepharus plagiocephalus	Fence Skink				●	
Cryptoblepharus ustulatus					●	
Ctenotus ariadnae					●	●
Ctenotus atlas					●	
Ctenotus brooksi					●	
Ctenotus calurus	Blue-tailed Ctenotus				●	●
Ctenotus duricola					●	●
Ctenotus dux					●	
Ctenotus grandis					●	●
Ctenotus greeri					●	
Ctenotus hanloni					●	●
Ctenotus helenae					●	●
Ctenotus leonhardii					●	●
Ctenotus nasutus					●	

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Ctenotus pantherinus	Leopard Ctenotus				●	●
Ctenoptus piankai					●	
Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus				●	●
Ctenotus rubicundus					●	
Ctenotus rutilans					●	
Ctenotus saxatilis	Rock Ctenotus				●	●
Ctenotus schomburgkii					●	●
Ctenotus serventyi					●	
Ctenotus uber					●	●
Ctenotus uber johnstonei				P2	●	
Cyclodomorphus melanops	Spinifex Slender Blue-tongue				●	●
Egernia depressa	Pygmy Spiny-tailed Skink				●	
Egernia formosa					●	
Egernia inornata	Desert Skink				●	●
Egernia kintorei	Great Desert Skink	VU		S1	●	
Egernia striata	Night Skink				●	●
Eremiascincus fasciolatus					●	
Eremiascincus richardsonii	Broad-banded Sand-swimmer				●	●
Lerista amicorum					●	●
Lerista bipes					●	●
Lerista frosti					●	
Lerista ips					●	
Lerista labialis					●	
Lerista macropisthopus remota	Unpatterned Robust Lerista			P2	●	
Lerista muelleri					●	
Lerista neander					●	●
Lerista timida					●	●
Lerista zietzi					●	
Menetia greyii					●	●
Morethia ruficauda					●	●
Notoscincus ornatus					●	●
Proablepharus reginae					●	
Tiliqua multifasciata	Centralian Blue-tongue				●	●
AGAMIDAE						
Amphibolurus longirostris	Long-nosed Dragon				●	●
Caimanops amphiboluroides	Mulga Dragon				●	●
Ctenophorus caudicinctus	Ring-tailed Dragon				●	●
Ctenophorus isolepis	Central Military Dragon				●	●
Ctenophorus nuchalis	Central Netted Dragon				●	●
Ctenophorus reticulatus	Western Netted Dragon				●	●
Diporiphora winneckei	Canegrass Dragon				●	●
Moloch horridus	Thorny Devil				●	●
Pogona minor	Dwarf Bearded Dragon				●	●

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Tympanocryptis cephalus	Pebble Dragon				●	
VARANIDAE						
Varanus acanthurus	Spiny-tailed Monitor				●	●
Varanus brevicauda	Short-tailed Pygmy Monitor				●	●
Varanus bushi					●	
Varanus caudolineatus	Stripe-tailed Monitor				●	●
Varanus eremius	Pygmy Desert Monitor				●	●
Varanus giganteus	Perentie				●	●
Varanus gilleni	Pygmy Mulga Monitor					●
Varanus gouldii	Gould's Monitor				●	●
Varanus mertensi	Merten's Water Monitor				●	
Varanus mitchelli	Mitchell's Water Monitor				●	
Varanus panoptes	Yellow-spotted Monitor				●	●
Varanus pilbarensis	Pilbara Rock Monitor				●	
Varanus tristis	Black-headed Monitor				●	●
TYPHLOPIDAE						
Ramphotyphlops ammodytes					●	
Ramphotyphlops endoterus					●	
Ramphotyphlops ganei				P1	●	
Ramphotyphlops grypus	Beaked Blind Snake				●	●
Ramphotyphlops hamatus					●	●
Ramphotyphlops waitii					●	
PYTHONIDAE						
Antaresia perthensis	Pygmy Python				●	●
Antaresia stimsoni	Stimson's Python				●	
Aspidites melanocephalus	Black-headed Python				●	
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1		●	
ELAPIDAE						
Acanthophis wellsi	Pilbara Death Adder				●	●
Brachyurophis approximans	NW Shovel-nosed Snake				●	
Demansia psammophis	Yellow-faced Whipsnake				●	●
Demansia rufescens	Rufous Whipsnake				●	
Furina ornata	Moon Snake				●	●
Parasuta monachus	Monk Snake				●	
Pseudechis australis	Mulga Snake; King Brown Snake				●	●
Pseudonaja modesta	Ringed Brown Snake				●	●
Pseudonaja nuchalis	Gwardar				●	●
Simoselaps anomalus	Desert Banded Snake				●	
Simoselaps bertholdi	Jan's Banded Snake				●	
Suta fasciata	Rosen's Snake				●	
Suta punctata	Little Spotted Snake				●	●
Vermicella snelli					●	

Species	Common name	EPBC	WCA	DEC	Desktop reviews	Records
Totals					**139**	**75**
Total conservation significant species					**5**	**0**

5 ASSESSMENT OF POTENTIAL IMPACTS

5.1 ASSESSMENT APPROACH

5.1.1 Purpose

The purpose of this preliminary description of potential impacts and hazards to fauna of conservation significance that may result from the implementation of the FPP is to identify aspects of the FPP that are a priority for additional information, revision or management.

5.1.2 Method

The method used in this report for the description and preliminary assessment of potential impacts is based on:

- identification of relevant fauna values (i.e. fauna habitats, assemblages, abundance, distribution and conservation significance)
- identification of important ecological processes, including threatening processes, that influence these values
- prediction of how the FPP (as described) might affect these processes.

The assessment criteria for the summary of potential impacts are derived from State and Commonwealth guidelines and are presented as follows:

1. No fauna species should become extinct as a result of the proposal.
2. The formal conservation status of any fauna species should not be upgraded as a result of the proposal.
3. The abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels should not be significantly affected.

5.1.3 Scope and limitations

This summary of potential impacts is limited to the information made available for, and presented in, this report. It is expected that, as changes are made to the design and planned management of the FPP, the precise nature and magnitude of any impacts to conservation significant fauna and their habitats will also change as a result. In addition, potential impacts to fauna populations from the FPP will vary over time, depending on the natural variability of the environment (e.g. rainfall, fire, etc.) and fauna populations themselves (e.g. breeding cycles, predator/prey relationships, etc.).

5.2 FAUNA VALUES

For the purposes of this summary, fauna values have been grouped into:

- conservation significant fauna and habitats, as described in sections 4.1 and 4.2.
- fauna assemblages and distribution, as described in section 4.3.

These values are summarised below.

5.2.1 Conservation significant fauna and habitats

Up to 16 species of conservation significance may potentially occur in the study area (Table 5-1). Six of these were recorded during the field surveys through direct sightings and secondary evidence was observed for an additional three (Table 5-1).

Of the recorded species, the study area contains important habitat for:

- Crest-tailed Mulgara – Spinifex plain habitats on deep sandy soils in the vicinity of the proposed service corridor between the RRA and DCA, at the KB deposit, airstrip, accommodation village (lower slopes) (Figure 4-5).
- The FEPR corridor also includes a large sandplain with potential for Mulgara; however, no targeted surveys or detailed habitat mapping has been conducted for this part of the study area.

- Australian Bustard – occurs regularly in the study area and is actively utilising the Spinifex sandplain and low rocky range/rocky slope habitats, and most likely other habitat types as well.
- Bush Stone-curlew – recorded at the eastern boundary of its current distribution range in Mulga woodland.
- Rainbow Bee-eater – suitable nesting habitat occurs along the numerous creeklines of the study area.

5.2.2 Fauna assemblages

The location of study area at the confluence of three different bioregions (see section 2.1) influences the overall vertebrate fauna assemblage, which, although it largely reflects a typical inland Pilbara assemblage, it also contains some species more prevalent in the inland Australian deserts (e.g. Crest-tailed Mulgara).

The recorded assemblage is considerably lower than the potential species list because several species identified through the desktop reviews are unlikely to occur because records of some species identified in the desktop reviews were at the margins of their ranges (e.g. Princess Parrot) or no suitable habitat occurs in the study area (e.g. Northern Quoll). As the north-western end of the FEPR corridor study area (Survey VF05) tends close to the Fortescue Marsh system, the potential species list also picks up some wetland bird species (e.g. shorebirds).

5.3 THREATENING PROCESSES

Many threatening processes across the Australian continent have adversely affected ecosystems and biodiversity at local, regional and even continental scales. Understanding potential threatening processes arising from development proposals is critical to understanding and managing impacts to fauna.

5.3.1 Habitat loss (population scale)

Habitat loss (through clearing or degradation) is one of the major causes of faunal species decline globally (Hassan *et al.* 2005). Many species have critical, narrow habitat requirements for breeding or feeding and any loss of such habitat can have major detriments on these species. Others can use several types of habitats depending on the season and reproductive cycle but may be affected by broad scale loss of habitat.

Excessive loss of habitat may also reduce the size of a population to the point where it is no longer viable in the presence of other threats. Conservation significant species may be particularly sensitive to habitat loss, thus affecting population survival.

5.3.2 Habitat fragmentation

Loss or interruption of habitat connectivity, particularly if the habitat is linear and distinctive, such as creeklines and corridors, can affect population survival by restricting population movements and gene flow. For small, terrestrial fauna, disruptions to population movement and gene flow can also be caused by obstructions such as roads, rail and pipelines. This can also exacerbate other processes, such as predation and the availability of refuges during times of ecological stress.

5.3.3 Habitat degradation

Fire is a primary factor that has influenced the vegetation patterns of most of arid inland Australia. Australian fauna species have evolved with, and adapted to, the occurrence of fire. Since European settlement however, the fire regime has changed species declines in some areas. For example, increased fire frequency or severity can lead to habitat modification, affect prey abundance and expose species to increased risk of predation from reduced vegetation cover.

The impacts of emissions from mining operations, such as dust, light and noise, on fauna are more difficult to determine. Studies are available showing that intensive lighting may affect fauna behaviour more than noise (e.g. Rich C. & Longcore T. (2006)).

Habitat degradation may also result from the increased spread of weeds. This may occur through increased vehicle activity or heavy equipment during construction and operation. Introduced weeds can drive irreversible changes in vegetation structure and function with a number of potential adverse consequences for native fauna (e.g. reduced habitat cover, reduced food resources).

These processes may see habitat integrity reduced to such a point that individuals are displaced to other areas, increasing the pressure on those areas and/or increasing the susceptibility of fauna populations to other threatening processes.

5.3.4 Species' interactions

The adverse impacts on native fauna from introduced species, such as feral Cats, Foxes are well established. Introduced grazing species, such as Rabbits, Goats, Camels and domestic livestock, can degrade habitats and deplete vegetation that may be a food source for native species.

5.3.5 Hydrological and riparian (fluvial) processes

Water regimes of arid inland Australia are critical for the conservation and preservation of native fauna communities. Burbidge *et al.* (2010) demonstrated how riparian habitats are essential for a large number of bird species in the Pilbara. For example, species such as the Princess Parrot can occur after exceptional rainfall events, every 15-20 years where they have not been recorded before. Vegetation with specific hydrological requirements, such as Mulga and groundwater-dependent vegetation, may also be important summer refuges for avifauna and centres of endemism for smaller, terrestrial fauna.

5.3.6 Direct mortality

Individual fauna may be killed or critically injured as a result of impacts or secondary encounters with mobile equipment and vehicles. Vehicle activities are the main threat to local fauna in terms of direct mortality. Species such as Red Kangaroos and Emus are common victims of truck and car movements. This also represents a safety issue for humans. Various small mammals and reptiles (e.g. bobtails, snakes) are likely to cross roads or tracks during the day and night. There is a minor issue that some avifauna species may be at risk of collision with aerial structures such as powerlines. Species most susceptible to such a hazard are large flying birds with lower aerial manoeuvrability.

5.4 ASSESSMENT OF PREDICTED POTENTIAL IMPACTS

Potential impacts to fauna generally are described below. The magnitude of potential impacts to fauna will depend to some extent on the final project footprint and planned activities, in addition to those variables listed above. Potential impacts to conservation significant fauna are summarized in Table 5-1. Detailed impact assessments for each species and assessments against significant impact criteria for matters of NES are provided in Appendix 1 and 2. Impact assessments for species listed under the WC Act or on the DEC Priority Fauna List are provided in Appendix 3. Impacts discussed in the assessment tables consider potential impacts at the local (within study area boundary) and regional (IBRA subregion) scale.

5.4.1 Direct habitat loss

Clearing of vegetation and earthworks during construction will result in the loss of areas of known habitat for Crest-tailed Mulgara, Australian Bustard, Bush Stone-curlew, Western Pebble-mound Mouse and Rainbow Bee-eater. Potential habitat for Northern Marsupial Mole, Unpatterned Robust Lerista, Brush-tailed Mulgara and Greater Bilby will also be disturbed.

Clearing for the development of the mine and infrastructure components of the FPP will result in the loss of known and potential Crest-tailed Mulgara habitat. This may lead to decline and contraction of local populations.

Habitat loss for the Australian Bustard will occur at several points within the study area, including the deposit areas, infrastructure areas and along the FEPR corridor; however, habitat for this species is wide spread in the region. Habitat loss for the Bush Stone-curlew may also occur at several points along the FEPR corridor and mining areas. Of most concern for this species is the potential removal of any woodland habitat, which the species tends to prefer.

The Rainbow Bee-eater can forage in a wide range of habitats (rocky outcrops, open mulga woodlands) but needs sandy substrate to breed, close to water courses if possible. The FPP will result in loss of some foraging habitat for this species and possibly a minor loss of breeding habitat where the FPP footprint intercepts rivers, creeklines and more generally sandy habitat.

Any disturbance to rocky scree slopes will affect habitat for the Western Pebble-mound Mouse. Suitable habitat may be disturbed at several points along the FEPR corridor and in the vicinity of the proposed accommodation village.

5.4.2 Habitat fragmentation

The construction of any infrastructure around creek lines and rivers in the study area (e.g. Fortescue River, Jimblebar Creek) may cause a barrier to dispersal for species that move along watercourses, such as the Pilbara Olive Python. Also, any disruption to water regime may impact fauna habitat downstream.

There is potential for the future FEPR to act as a barrier to movement and dispersal for small ground-dwelling fauna. Crest-tailed Mulgara are of particular concern regarding habitat fragmentation along the FEPR that intersects with a large sandplain where no targeted survey has been conducted to date.

5.4.3 Displacement of individuals

Short-term displacement of individuals is likely to occur during construction and may affect some conservation significant species including Crest-tailed Mulgara, Australian Bustard and Bush Stone-curlew. Displacement of any Crest-tailed Mulgara individuals may have a long-term impact on the local population as studies on Brush-tailed Mulgara are have revealed that they are generally sedentary (Körtner *et al.* 2007; Masters 2003). There is potential for long-term reduction in local occurrence of Bush Stone-curlews in the study area as this species tends to decline in numbers around areas of human activity.

5.4.4 Interruption of ecological water requirements and fluvial processes

The riparian and woodland habitat associated with Davidson Creek immediately downstream of the proposed MM, PG and TD pits may be affected by any dewatering process that is required to enable mining below the water table. These potentially groundwater dependent ecosystems will require monitoring and management to ensure their continued presence. Any diversion of creeklines may have similar impacts at the point of diversion as well as downstream.

5.4.5 Increased risk of fire

The FPP may increase the risk of accidental fire from the use of heavy machinery during construction and operation, and also the operation of the FEPR. Species of conservation significance that may be affected by increased incidence of fire in the study area include the Crest-tailed Mulgara, Australian Bustard, Bush Stone-curlew and Western Pebble-mound Mouse. Crest-tailed Mulgara can survive in recently burnt habitats but are then more exposed to predation. The Northern Marsupial Mole, Unpatterned Robust Lerista and Brush-tailed Mulgara may also be affected if present in the study area.

Conversely, the FPP will result in an increased level of surveillance and also of fire-fighting resources, so there is a real likelihood that the severity of fires in the area may be reduced as a result.

5.4.6 Increased abundance of feral animals

The FPP presents a minor risk of increasing the spread or abundance of feral animals and opportunistic native species such as the Australian Magpie and Pied Butcherbird which predate small native passerines.

Species of conservation significance that may be affected by increased abundance of feral animals (especially Feral Cats, Foxes and Dingoes) in the study area include the Crest-tailed Mulgara, Australian Bustard, Bush Stone-curlew and Western Pebble-mound Mouse. If present, the Marsupial Mole may also be impacted as moles are known to be prey items for Cats, Foxes and Dingoes.

5.4.7 Inappropriate waste management leading to health effects on fauna

Inappropriate management or disposal of waste, particularly food waste, could present a risk to native fauna generally. Direct or indirect feeding of native fauna on human food sources such as food waste favours disease, mortality, physiological deficiencies, intra- and inter-specific conflicts. Inappropriate disposal of food waste can also attract feral animals.

Table 5-1 Summary of conservation significant species likelihood of occurrence and potential impacts

Common name	CS	Records	Likelihood of occurrence	Potential impacts
Fork-tailed Swift	M	Recorded	Flock recorded flying over the FEPR corridor. Suitable habitat throughout the study area and the region	None likely
Eastern Great Egret	M	Unlikely	Unlikely, no suitable habitat present	None likely
Cattle Egret	M	Unlikely	Unlikely, no suitable habitat present	None likely
Glossy Ibis	M	Unlikely	Unlikely, no suitable habitat present	None likely
White-bellied Sea-Eagle	M	Unlikely	Unlikely	None likely
Grey Falcon	P4	Potential habitat	Not recorded. May forage in the study area but no suitable breeding habitat has been observed	None likely
Peregrine Falcon	S4	Recorded	Recorded at PG deposit and along FEPR corridor. Most likely transient records. Likely to hunt in the study area but no suitable nesting habitat present.	None likely
Australian Bustard	P4	Recorded	Frequently recorded within and near the study area in multiple habitat types including sandy Spinifex plains and low rocky ranges.	Direct loss of habitat. Risk of disruption to breeding cycle if construction takes place in breeding season. Vehicle mortalities during construction and operation. Some displacement of individuals during construction.
Bush Stone-curlew	P4	Recorded	Recorded but apparently rare in study area. Suitable habitat at several locations in study area.	Direct loss of habitat may reduce local population size. Risk of disruption to breeding cycle if construction takes place in breeding season. Vehicle mortalities during construction and operation. Some displacement of individuals during construction and possible long-term displacement due to increased human activity in study area.
Oriental Plover	M	Potential habitat	Not recorded in the surveys but suitable habitat exists and it may visit the study area.	None likely
Common Sandpiper	M	Unlikely	Unlikely, no suitable habitat present	None likely
Common Greenshank	M	Unlikely	Unlikely, no suitable habitat present	None likely
Marsh Sandpiper	M	Unlikely	Unlikely, no suitable habitat present	None likely
Wood Sandpiper	M	Unlikely	Unlikely, no suitable habitat present	None likely

Common name	CS	Records	Likelihood of occurrence	Potential impacts
Red-necked Stint	M	Unlikely	Unlikely, no suitable habitat present	None likely
Long-toed Stint	M	Unlikely	Unlikely, no suitable habitat present	None likely
Sharp-tailed Sandpiper	M	Unlikely	Unlikely, no suitable habitat present	None likely
Curlew Sandpiper	M	Unlikely	Unlikely, no suitable habitat present	None likely
Caspian Tern	M	Unlikely	Unlikely, no suitable habitat present	None likely
Night Parrot	EN, S1	Unlikely	Unlikely to occur in study area. One record from Minga Well 25km NW of study area.	None likely
Princess Parrot	VU, P4	Unlikely	Study area is outside current known range of this species	None likely
Rainbow Bee-eater	M	Recorded	Recorded commonly in the study area in several habitat types (creeklines, ridges, and open woodland). May breed along creeklines.	Possible direct loss of habitat if hydrological flows and riparian habitat are disturbed. Possible disturbance to breeding activity along creeklines in the study area.
Australian Reed-Warbler	M	Unlikely	Unlikely, no suitable habitat present	None likely
Star Finch	P4	Potential habitat	Not recorded. May occur when conditions are favourable, after wet season	Direct loss of habitat. Negligible risk of road mortality.
Crest-tailed Mulgara	VU, S1	Recorded	Known population in the study area in and around the service corridor between the RRA and DCA - western side of road only. Suitable habitat throughout much of the study area, including a portion of the FEPR corridor.	Direct loss of habitat. Possible disruption to population in vicinity of service corridor and displacement of individuals may disrupt breeding cycle and lead to population decline. Potential for vehicle fatalities from the service corridor. Same effects are expected along the FEPR corridor if the species is present, but surveys are required to confirm presence.
Brush-tailed Mulgara	P4	Potential habitat	Not recorded but suitable habitat exists throughout much of study area. Lack of records and presence of Crest-tailed Mulgara suggests likelihood is fairly low, although they could occur.	Direct loss of habitat. Possible displacement of individuals, if present. Potential for vehicle fatalities from service corridor.

Common name	CS	Records	Likelihood of occurrence	Potential impacts
Northern Quoll	EN, S1	Unlikely	Unlikely to occur in study area. Study area contains no suitable habitat and is at the southern extent of the species' range	None likely
Long-tailed Dunnart	P4	Unlikely	Unlikely. Little habitat in study area for this species.	None likely
Greater Bilby	VU, S1	Potential habitat	No records. Suitable habitat present but no records and no secondary evidence other than an unconfirmed disused burrow just NW of KB deposit	None likely
Northern Marsupial Mole	EN, S1	Potential habitat	Possible, suitable habitat present at three sites along FEPR corridor	Habitat disturbance and fragmentation
Spectacled Hare-wallaby	P3	Unlikely	Unlikely. Study area outside current range of this species	None likely
Black-footed Rock-wallaby	VU, S1	Unlikely	Unlikely. Little suitable habitat and study area is not within any of the known locations of remnant populations.	None likely
Ghost Bat	P4	Probable recording	Unlikely to be a resident as no suitable roosting habitat present in study area.	None likely
Pilbara Leaf-nosed Bat	VU, S1	Unlikely	Unlikely, no suitable habitat present	None likely
Western Pebble-mound Mouse	P4	Recorded	Potential habitat and inactive mounds recorded in study area.	Minor loss of suitable habitat. Fragmentation at a local scale.
Great Desert Skink	VU, S1	Unlikely	Unlikely, no suitable habitat present	None likely
Unpatterned Robust Lerista	P2	Potential habitat	Not recorded but potential habitat exists and may occur in study area. Few records for the species. Identified in WAM database search for original proposed service corridor.	Direct loss of potential habitat, possible fragmentation of populations from the FEPR corridor and possible local decline in populations if present in proposed disturbance areas.
Ramphotyphlops ganei	P1	Unlikely	No suitable habitat in study area; thought to occur in gorge/gully habitats	None likely
Pilbara Olive Python	VU, S1	Unlikely	Unlikely. Single location within study area containing marginal suitable habitat for this species at the intersection	FEPR corridor could be a barrier to dispersal along the Fortescue River.

Common name	CS	Records	Likelihood of occurrence	Potential impacts
			of the FEPR corridor and the Fortescue River	

6 MANAGEMENT RECOMMENDATIONS

Central to conservation strategies for threatened species is the protection of habitat. Protection of habitat for conservation significant species has the added benefit of protecting broader species assemblages and helping to maintain whole of ecosystem functions. This concept is equally relevant at the FPP level and focus should be on avoiding or minimising impacts to important habitat as much as individual animals.

Not all the potential impacts of the FPP on fauna can be avoided and therefore recommendations are made to minimise and/or rectify impacts where possible.

6.1.1 Avoidance, minimisation and mitigation of habitat disturbance

Disturbance to important fauna habitats that support or are likely to support conservation significant species (sand plains, sand dunes, rocky slopes, riparian habitats) should be avoided as far as possible. This includes clearing, earthworks and any other human activities. Where such activities can't be avoided, all measures should be taken to minimise any disturbance to these habitats. Human activity in areas outside the footprint should be restricted.

Infrastructure design and installation in the proximity of riparian habitats must be planned to minimise any effect on hydrological flows and maintain riparian habitat connectivity. Creek diversions and dewatering strategies must be considered very carefully taking into account the maintenance of water regimes/hydrological flows and downstream watersheds.

If dewatering is proposed for DCA, re-injection of groundwater downstream of the pits is recommended to maintain the riparian and woodland habitat associated with Davidson Creek.

Design of criteria for rehabilitation following ceasing of mining operations should include fauna habitat and assemblage characteristics. Previous rehabilitation projects in WA have highlighted the importance considering fauna in rehabilitation criteria (e.g. Comer & Wooller 2002).

6.1.2 Controlling the risk of incidental fire

Standard operating procedures should be developed and implemented for all aspects of the FPP to minimise the risk of accidental fire.

6.1.3 Feral animal control, waste management and weed management

A local feral animal control plan should be considered to counteract any influence of the FPP on feral animal abundance. Such a plan would involve trapping and baiting for local introduced feral species (particularly cats and foxes) across the FPP area on a regular and long-term basis.

Appropriate waste control measures should be implemented to reduce the risk of attracting feral species, or affecting the health of native species. It is important to ensure that no fauna species can access food waste. The use of plain-enclosed waste containers is recommended rather than large mesh-type containers like those currently used at the site. The existing containers can potentially allow animals to access food waste. Feeding of native fauna must also be prohibited.

The spread of weeds can be limited by cleaning any equipment that has been used recently beyond the study area. Light vehicles (especially hire cars) should be especially targeted with standard cleaning procedures (removing mud, dirt, plant material and any soil attachment in general).

6.1.4 Additional surveys, translocation and management of Crest-tailed Mulgara

A management plan should be developed for this species in order to provide a consistent, appropriate management framework across the study area.

Additional surveys are required in areas identified as potential habitat but where no targeted searches or trapping has been conducted to date. Specific target areas are immediately east and west of the known population, within the proposed locations for the airstrip , irrigation areas, the proposed MM and TD pits and also the large sandplain along the FEPR corridor that intersects the

proposed alignment (and associated borrow pits). Additional information along the FEPR corridor should be used to inform the final alignment.

Translocation program protocols should be developed as part of the management plan in the event that Crest-tailed Mulgara are recorded under development footprints that cannot be changed. The aim of Translocation should be undertaken to avoid direct mortalities. Survival chances must be maximised by undertaking translocations during optimal conditions and into suitable habitats.

Management plans, translocation and monitoring protocols need to meet specific guidelines and ethic requirements in order to be consistent with conservation principles. Previous translocation programs in WA for other species have shown good results when adequately conducted and monitored (Anstee & Armstrong 2001).

6.1.5 Road Traffic

To minimise direct fauna casualties and/or the severity of injuries, vehicle speed limits should be lowered near sensitive areas and at dawn and dusk. In the proximity of Crest-tailed Mulgara habitat, the speed limit should be further reduced and driving at night should be avoided as far as practicable. Off-road driving should be strictly prohibited.

6.1.6 Biological corridors

The installation of structures (e.g. fauna culverts/tunnels) to maintain habitat connectivity should be considered for parts of the footprint that intersect sandplain habitats. Placement of such structures should concentrate in areas that are likely to be fragmented and that can support conservation significant species, particularly Crest-tailed Mulgara.

Riparian habitat connectivity should also be considered in the design of creekline and river crossings.

6.1.7 Aerial structures

Risk of avifauna collision with large aerial infrastructures (e.g. cables, power lines) should be minimised by installing these structures underground as far as practicable. If aerial structures are required for the FPP it is recommended that visual deterrents (e.g. large, colourful plastic devices) are attached to the less visible parts of the structures, at adequate distance intervals. These types of installations are being used worldwide with encouraging results.

6.1.8 Environmental awareness

An environmental awareness program for all on-site staff and contractors should be developed that encompasses all relevant aspects relating to mitigation and management of fauna. The program should be implemented via inductions and ongoing training to encourage responsible, appropriate behaviour toward fauna species and habitats.

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APPENDIX 1 DETAILED IMPACT ASSESSMENT FOR ENDANGERED AND VULNERABLE SPECIES UNDER THE EPBC ACT

Common name	**Northern Marsupial Mole**	**Crest-tailed Mulgara**	**Greater Bilby**	**Pilbara Olive Python**
CS	EN (EPBC), S1 (WCA)	VU (EPBC), S1 (WCA)	VU (EPBC), S1 (WCA)	VU (EPBC), S1 (WCA)
Record type	Possible - potential habitat	Recorded	Unlikely	Possible - potential habitat
Records and habitat summary	Sand dunes with potential to support this species occur at three sites along the FEPR corridor (sites bp61, bp62 and bp64) in the same sandy plain. Dispersal by marsupial moles requires continuous sandy substrate between suitable habitat to connect populations (Recovery plan for Marsupial Moles). The sites are within the FPP footprint, 80 km west of the closest record of but its distribution is not well known (very few records to date). The species was not recorded during a targeted survey of the dune sites.	Known population in the study area in and around the service corridor between the RRA and DCA - western side of road only. Suitable habitat occurs in several locations throughout the study area, including a portion of the FEPR corridor.	No records. Suitable habitat present but no records and no secondary evidence other than an unconfirmed disused burrow just NW of KB deposit.	The only marginal suitable habitat for this species occurs at the intersection of the Fortescue River and the FEPR corridor.
Potential threats to species from Project				
Clearing leading to loss of foraging, nesting/roosting and/or breeding habitat and habitat fragmentation	Likely, high on local scale, moderate on regional scale. Note that no evidence of population has been recorded. FEPR corridor may form a barrier to dispersal for this species.	Likely, high on a local scale, negligible on a regional scale. Loss of suitable habitat during construction. The FPP will result in the loss of suitable habitat for Crest-tailed Mulgara. Same effects are expected along the FEPR in addition to fragmentation if the species is present, but surveys are required to make this assumption.	Likely, minor on a local scale, negligible on a regional scale. Loss of potential habitat but likelihood of occurrence is low.	Unlikely but need to ensure connectivity at the Fortescue River crossing.

Common name	Northern Marsupial Mole	Crest-tailed Mulgara	Greater Bilby	Pilbara Olive Python
Displacement of individuals	Possible, high on a local scale (if present), moderate on a regional scale (if present). Note that no evidence of population has been recorded.	Likely, moderate on a local scale, negligible on a regional scale. Short-term displacement during construction but also potential for long-term reduction in occurrence of this species in the study area.	Unlikely. No known population in study area.	Unlikely
Increased incidence of fire leading to habitat modification/degradation and/or decreased prey abundance	Possible, moderate a local scale (if present), negligible on a regional scale. Risk is modification of vegetation overlying dunes leading to decreases in prey abundance.	Possible, minor on a local scale, negligible on a regional scale. Brush-tailed Mulgara do not show a preference for the amount of cover present in the area; rather they utilise a habitat mosaic between patches of mature Spinifex and shrubs to open areas, even after severe fires. No comparative studies for Crest-tailed but assume similar.	Possible, negligible.	Unlikely
Increased abundance of feral animals leading to increased predation	Possible, moderate on a local scale, negligible on a regional scale. Moles known to be prey items for Foxes, Cats and Dingoes.	Possible, minor on a local scale, negligible on a regional scale. if Project results in increased abundance of Cats, Foxes and Dingoes in the study area	Unlikely. No known population in study area.	Unlikely
Direct mortality, especially vehicle mortality	Unlikely. Moles rarely travel over the surface.	Possible, moderate on a local scale, negligible on a regional scale.	Unlikely. No known population in study area.	Unlikely

Common name	Northern Marsupial Mole	Crest-tailed Mulgara	Greater Bilby	Pilbara Olive Python
VU species - is this an important population?	n/a	Unknown if this is an important population. Not at edge of range. Only a few records so not likely to be a large population but not clear if 1 and 2 apply. There is currently no recovery plan for Crest-tailed Mulgara.	No - no known population present.	No - no known population present.
MNES significant impact criteria – will the FPP:				
Lead to a long-term decrease in size of a population (CE, E) or important population (VU)	Possible, if the species is present in the suitable habitats of the study area and any of this habitat is removed or distrubed by the FPP. Loss of habitat for this species is likely to lead to a decrease in the size of the local population (if present)	Possible. Loss of habitat from vegetation clearing/groundworks and fragmentation will result in loss of populations at these areas, if present. Potential for roadkill from service corridor as records are as close as 100 m from service corridor.	Unlikely, no known population present	Unlikely
Reduce the area of occupancy of the species (CE, E) or an important population (VU)	Unknown. Given the limited knowledge on the current distribution range of the species around the study area this impact cannot be assessed.	Unlikely. Impacts likely to be on a local scale only.	Unlikely	Unlikely

Common name	Northern Marsupial Mole	Crest-tailed Mulgara	Greater Bilby	Pilbara Olive Python
Fragment an existing population (CE, E) or important population (VU) into two or more populations.	Possible. If there is a population present in the study area dunes, disturbance to dune habitat and/or surrounding sands, and installation of the FEPR corridor, could fragment the population	Likely. Existing road may already have fragmented population but this is not certain. The FEPR corridor is located in a large sandplain, potential habitat for the species. Effect of linear infrastructures on restricting movement of Mulgara is not well known. It is unkown whether existing population occurs east of the service corridor and in the sandplain located along the FEPR corridor.	Unlikely. No known population present.	Possible. Need to ensure adequate connectivity is maintained along the Fortescue River where it is intersected by the FEPR corridor.
Adversely affect habitat critical to the survival of a species.	Likely, if the species is present in the dunes of the study area and any of the dune habitat is removed or disturbed by the FPP. This species is a habitat specialist and highly dependent on sandy substrates (particularly dunes but may also occupy sandy plains). It lives almost exclusively underground within the dune sands, moving about by digging back-filled tunnels in search of invertebrate prey (Benshemesh 2004).	Likely - at local scale only. Habitat removal may impact population but it is unlikely to result in decline of species as impacts likely at a local scale only. Project will result in direct loss of habitat.	Unlikely. No definitive evidence of population present	Unlikely

Common name	Northern Marsupial Mole	Crest-tailed Mulgara	Greater Bilby	Pilbara Olive Python
Disrupt the breeding cycle of a population (CE, E) or important population (VU)	Possible. Only if moles present and habitat is removed. No known population present.	Possible, if the population is also present on the east side of the service corridor. Brush-tailed Mulgara are noted as having a sedentary lifestyle with stable home range and may live in one location for many years. Breeding cycle may be disrupted by displacement of individuals and fatalities from vehicles, particularly along service corridor.	Unlikely. No definitive evidence of population present	Unlikely
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely. Extent of suitable habitat is small in scale compared to available habitat for the species.	Unlikely. Impacts at local scale only. Project will result in direct loss of habitat.	Unlikely	Unlikely
Result in invasive species that are harmful to a critically endangered, endangered or vulnerable species becoming established in the critically endangered, endangered or vulnerable species' habitat.	Unlikely	Possible, if project causes increased fire frequency this may facilitate increased predation by cats and foxes, both of which are present in the study area.	Unlikely	Unlikely
Introduce disease that may cause the species to decline	Unlikely	Unlikely	Unlikely	Unlikely
Interfere with the recovery of a critically endangered or endangered species, or interfere substantially with the recovery of a vulnerable species	Unlikely. The study area is not in a location where moles have been confirmed. The recovery plan for marsupial moles (ref) for 2005-2010 was focussed on building better knowledge of species distribution, population structure and ecology. There are no known mole populations under particular threat in Australia (Benshemesh 2004).	Unlikely. Impacts at local scale only.	Unlikely	Unlikely

Common name	Northern Marsupial Mole	Crest-tailed Mulgara	Greater Bilby	Pilbara Olive Python

Key to ratings

Likelihood of occurrence

Likely

Possible

Unlikely

Scale of impact if it occurs ('unlikely' events are not given a scale rating)

High

Moderate

Minor

Negligible

Scales

Local - study area

Regional - IBRA subregions that study area occurs in: Augustus and Fortescue

APPENDIX 2 DETAILED IMPACT ASSESSMENT FOR MIGRATORY SPECIES UNDER THE EPBC ACT

Common name	**Fork-tailed Swift**	**Oriental Plover**	**Rainbow Bee-eater**	**Eastern Great Egret, Cattle Egret, Glossy Ibis, White-bellied Sea-Eagle, Common Sandpiper, Common Greenshank, Marsh Sandpiper, Wood Sandpiper, Red-necked Stint, Long-toed Stint, Sharp-tailed Sandpiper, Curlew Sandpiper, Caspian Tern, Australian Reed-Warbler**
CS	M	M	M	M
Likelihood of occurrence	Recorded	Potential habitat	Recorded	None of these species is likely to occur in study area
Description	Small flock seen flying over FEPR corridor. Suitable habitat widespread in the study area and the region.	Not recorded in the surveys but suitable habitat exists and it may visit the study area.	Recorded commonly in the study area in several habitat types (creeklines, ridges, and open woodland). Suitable breeding habitat along creeklines in study area	No suitable habitat present in study area
Important habitat present in study area?	No	No	Creeklines for breeding	No
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	No	No	Possible direct loss of habitat if hydrological flows and riparian habitat are disturbed.	No
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	No	No	No	No

Common name	**Fork-tailed Swift**	**Oriental Plover**	**Rainbow Bee-eater**	**Eastern Great Egret, Cattle Egret, Glossy Ibis, White-bellied Sea-Eagle, Common Sandpiper, Common Greenshank, Marsh Sandpiper, Wood Sandpiper, Red-necked Stint, Long-toed Stint, Sharp-tailed Sandpiper, Curlew Sandpiper, Caspian Tern, Australian Reed-Warbler**
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	No	No	No	No
Potential impacts			Possible disruption to breeding activity along creeklines	

Important habitat for Migratory species:

Habitat utilised by mig species occasionally or periodically within a region that supports an ecologically significant proportion of the population

Habitat that is of critical importance to the species at particualr life-cycle stages

Habitat utilised by mig species which is at the limit of the species range

Habitat in an area where the species is declining

APPENDIX 3 DETAILED IMPACT ASSESSMENT FOR SCHEDULE SPECIES UNDER THE WC ACT AND DEC PRIORITY SPECIES

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
CS	S1 (WCA)	P4	P2	P4	P4	P4	P4	P4	P4
Record type	Recorded	Potential habitat	Potential habitat	Recorded	Recorded	Potential habitat	Potential habitat	Probable recording,	Recorded - disused mounds only
Records and habitat summary	Recorded at PG deposit and along FEPR corridor. Most likely transient records. Likely to hunt in the study area but no suitable nesting habitat present.	Not recorded. May forage in the study area but no suitable breeding habitat has been observed other than a telecommunications tower near the camp.	Not recorded but potential habitat exists and may occur in study area. Few records for the species. Identified in WAM database search for original proposed service corridor.	Frequently recorded within and near the study area in multiple habitat types including sandy Spinifex plains and low rocky ranges	Recorded but appears to be low population density in the study area. Suitable habitat occurs at a few locations in the study area (KB deposit, TD deposit, accommodation village and six sites on the FEPR corridor.	May occur when conditions are favourable for breeding after the wet season	Not recorded but suitable habitat exists throughout much of study area. Burrows recorded in 2007 more likely to be Crest-tailed Mulgara. Two species may occur sympatrically; however the lack of records suggests the likelihood is fairly low.	Probable recording at P/G. No suitable roosting habitat in study area and call most likely from a transient individual. Species foraging range typically extends only 2 km from roost sites.	Not recorded but suitable habitat and inactive mounds recorded at several locations in the study area.

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Potential threats to species from Project									
Clearing leading to loss of foraging, nesting/roosting and/or breeding habitat and habitat fragmentation	Negligible	Negligible - foraging habitat only and on small scale relative to foraging range of this species	Likely, moderate on a local scale, negligible on a regional scale Potential habitat will be removed and FEPR corridor may fragment populations.	Likely, moderate on a local scale, negligible on a regional scale. Known habitat will be removed.	Likely, moderate on a local scale, moderate on a regional scale. Records in the region are scattered and not common. Seem to prefer some woodland habitats over others and loss of any of this habitat could fragment populations.	Possible direct loss of habitat if hydrological flows and riparian habitat are disturbed.	Likely, moderate on a local scale, negligible on a regional scale. Loss of suitable habitat during construction. The FPP will result in the loss of suitable habitat for Brush-tailed Mulgara.	Unlikely	Likely, minor on a local scale, negligible on a regional scale Potential habitat will be removed and / or fragmented.

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Displacement of individuals	Unlikely	Unlikely	Possible, negligible. During vegetation clearing and earthworks. Mortality more likely.	Possible, moderate on a local scale, negligible on a regional scale. May occur during vegetation clearing and earthworks.	Possible, minor on a local scale, negligible on a regional scale. Apparently rare in study area. Short-term displacement during construction but also potential for long-term reduction in occurrence of this species in the study area due to increased human activity.	Unlikely	Possible, moderate on a local scale, negligible on a regional scale. If present in the study area, Brush-tailed Mulgara may be displaced during construction.	Unlikely	Possible, if present. Negligible.

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Increased incidence of fire leading to habitat modification/degradation and/or decreased prey abundance	Unlikely	Unlikely	Possible, moderate on a local scale, negligible on a regional scale. Species inhabits loose soil under leaf litter. Changes in leaf litter density may affect this species.	Possible, minor on a local scale, negligible on a regional scale.	Possible, minor on a local scale, negligible on a regional scale.	Unlikely	Possible, minor on a local scale, negligible on a regional scale. Brush-tailed Mulgara do not show a preference for the amount of cover present in the area; rather they utilise a habitat mosaic between patches of mature Spinifex and shrubs to open areas, even after severe fires.	Possible, negligible	Possible, negligible
Increased abundance of feral animals leading to increased predation	Unlikely	Unlikely	Unlikely	Possible, minor on a local scale, negligible on a regional scale. if Project results in increased abundance of Cats, Foxes and Dingoes in the study area	Possible, minor on a local scale, negligible on a regional scale. If Project results in increased abundance of Cats, Foxes and Dingoes in the study area.	Unlikely	Possible, minor on a local scale, negligible on a regional scale. If Project results in increased abundance of Cats, Foxes and Dingoes in the study area.	Unlikely	Possible, minor on a local scale, negligible on a regional scale. Predation by feral Cats a concern for this species.

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Direct mortality, especially vehicle mortality	Unlikely	Unlikely	Possible, minor on a local scale, negligible on a regional scale. May occur during vegetation clearing and earthworks	Possible, moderate on a local scale, negligible on a regional scale. During vegetation clearing and earthworks, as well as during operation from vehicles. Powerlines and similar structures also a risk to this species	Possible, minor on a local scale, negligible on a regional scale. During vegetation clearing and earthworks, as well as during operation from vehicles.	Possible, negligible.	Possible, minor on a local scale, negligible on a regional scale.	Unlikely	Possible, negligible.
Adapted from MNES criteria									

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Lead to a long-term decrease in size of a population	Unlikely	Unlikely, no known population present	Possible, if populations are present in proposed distrubance areas. Impacts at local scale only.	Unlikely, the species is nomadic and suitable habitat is common and widespread in the region.	Possible. Displacement of some individuals during construction and increased human activity may drive long-term reduction in numbers of Stone-curlew in study area. Already rare in study area.	Unlikely	Unlikely. Not recorded in any surveys. May still be present but no substantive/important population likely to be present.	Unlikely	Unlikely. No active population recorded in study area.
Reduce the area of occupancy of a population	Unlikely	Unlikely, no loss of critical habitat and only small-scale loss of foraging habitat	Unlikely, impacts at local scale only	Unlikely. Some displacement of individuals only	Unlikely, impacts at local scale only.	Unlikely	Unlikely. No known population in study area. Any impacts at local scale only.	Unlikely	Unlikely. Any impacts at local scale only.
Fragment a population into two or more populations.	Unlikely	Unlikely	Possible, populations will be fragmented by the FEPR corridor if present in this vicinity. Unlikely to cross the FEPR corridor as fossorial.	Unlikely	Possible. Loss of any preferred habitat for this species in the Pilbara could fragment populations	Unlikely	Unlikely. No known population in study area.	Unlikely	Likely, minor on a local scale, negligible on a regional scale.

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Adversely affect habitat critical to the survival of a species	Unlikely	Unlikely, no critical habitat present in study area	Unlikely, suitable habitat is present but not likely to be highly restricted. Local scale impacts only.	Unlikely. Suitable habitat is common and widespread in region. Some direct loss of habitat from clearing for the FPP but negligible relative to extent of regional habitat.	Unlikely. Loss of some habitat but not highly restricted. Large extents of suitable habitat for this species exist to the south and west of the study area	Unlikely	Unlikely. No known population in study area, therefore the potential habitat is not critical.	Unlikely	Unlikely. Some loss of potential habitat but no active population recorded in study area.
Disrupt the breeding cycle of a population	Unlikely	Unlikely, no breeding habitat present in study area.	Unlikely, no known population present in study area	Possible, only if clearing occurs during breeding season. Species is likely to breed in the study area.	Possible, only if clearing occurs during breeding season. The species is probably breeding in the study area.	Unlikely	Unlikely. No known population in study area.	Unlikely	Unlikely. No active population recorded in study area.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely	Unlikely, no critical habitat present in study area	Unlikely, impacts at local scale only	Unlikely. Minor loss of habitat at local scale only.	Unlikely. Some loss of habitat but impacts at local scale only and not likely to cause species decline	Unlikely	Unlikely. Loss of habitat at local scale only. Unlikely to lead to decline in species.	Unlikely	Unlikely

Common name	Peregrine Falcon	Grey Falcon	Unpatterned Robust Lerista	Australian Bustard	Bush Stone-curlew	Star Finch	Brush-tailed Mulgara	Ghost Bat	Western Pebble-mound Mouse
Result in invasive species that are harmful to the Priority species becoming established in the Priority species' habitat	Unlikely	Unlikely	Unlikely	Possible, if Project results in increased abundance of Cats, Foxes and Dingoes in the study area	Possible, if Project results in increased abundance of Cats, Foxes and Dingoes in the study area	Unlikely	Possible, if project causes increased fire frequency this may facilitate increased predation by cats and foxes, in the study area and surrounding areas	Unlikely	Possible, if Project results in increased abundance of Cats, Foxes and Dingoes in the study area
Introduce disease that may cause the species to decline	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

Key to ratings

Likelihood of occurrence

Likely

Possible

Unlikely

Scale of impact if it occurs ('unlikely' events are not given a scale rating)

High

Moderate

Minor

Negligible

Scales

Local - study area

Regional - IBRA subregions that study area occurs in: Augustus and Fortescue