CHRISTMAS CREEK
TERRESTRIAL VERTEBRATE FAUNA AND FAUNA HABITAT ASSESSMENT

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Job Number:	*11.044/J100459*
Report Number:	*11/098*
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Status:	*Final*
QA Review:	*Damian Buller*
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Content Review:	*Denise True*
Date:	*17/7/12*

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Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

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In preparing the report, ENV has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to ENV.

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EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned by Fortescue Metals Group Limited to undertake a Level Two vertebrate fauna survey of the Christmas Creek study area. The study area is located immediately north of Fortescue Marsh and approximately 120 km north-west of Newman in the Pilbara region of Western Australia. The study area covers an area of 667.4 km^2.

The terrestrial vertebrate fauna survey was conducted between 16th – 27th March 2011. Survey effort consisted of 560 pitfall trap-nights, 896 funnel trap-nights, 630 Elliott trap-nights and 378 cage trap-nights across nine sites. A total of 31.5 hours of systematic bird surveys, and nine person hours of nocturnal spotlighting were conducted at the nine sites, with three nights of AnaBat acoustic recording, four person hours of Western Pebble-mound Mouse (*Pseudomys chapmani*) mound searches and 12 person hours of searching for caves was conducted throughout the study area.

Four main fauna habitat types were identified in the study area: Stony Plain (Low habitat value for fauna), Drainage Line and Alluvial Plain (Moderate habitat value), Low Hill (Low habitat value), and Marsh (High habitat value). The condition of the habitats in the study area ranged from very good to degraded. Most of the habitats present were under significant grazing pressure by cattle, and the above average wet season rains resulted in an abundance of grasses and annual plants.

A total of 275 vertebrate fauna species (five amphibians, 84 reptiles, 149 birds and 37 mammals) were recovered from the literature review and database searches. The field survey therefore recorded about 44% of potentially occurring species. The database search covers a much larger area, with a greater variety of habitats. Some species identified in the databases and from the literature review may have specialist habitat needs and may never have occurred in the Christmas Creek area, while some species have declined historically and may have been locally extirpated from the study area. All of the bird and mammal species recorded have been previously listed for the vicinity of Christmas Creek, but one frog (Douglas's Toadlet *Pseudophyrne douglasi*), four reptile species (Mulga Dragon *Caimanops amphiboluroides*, *Diplodactylus pulcher*, *Delma elegans* and *Lerista timida*) and one bat (Pallid Long-eared Bat *Nyctophilus daedalus*) were not returned from the database search, and are therefore new records for the Christmas Creek area. All of these species occur widely in the Pilbara and would be expected to occur in the study area.

A total of 120 vertebrate species were recorded during the survey: four frog species, 45 reptile species, 11 mammal species and 60 birds. Species accumulation analyses showed that the survey was relatively comprehensive for reptiles (81.9% of 'expected' species were recorded) and birds (90.4% of 'expected' species recorded). The frog, reptile and bird fauna were dominated by small numbers of species. The Main's Frog (*Cyclorana mainii*) comprised 98.6% of the 672 individual frogs captured. Populations of granivorous birds had increased substantially following above average rainfall. The Budgerigar (*Melopsittacus undulatus*) and Zebra Finch (*Taeniopygia guttata*) comprised 36% of the 972 individual birds recorded at

sites. Four common and widespread reptile species (*Gehyra variegata,* Rock Ctenotus *Ctenotus saxatilis,* Leopard Ctenotus *C. pantherinus* and Beaked Gecko *Rhynchoedura ornata*) comprised 43% of the 296 individual reptiles recorded at sites.

Four species of conservation significance were recorded in the study area. A single individual of the Pilbara Olive Python (*Liasis olivaceus barroni*) was recorded from degraded Drainage Line habitat. This species is listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Schedule 1 under the Western Australian *Wildlife Conservation Act 1950*. Singles, pairs and a group of three individual Australian Bustard (*Ardeotis australis*) were recorded widely throughout the study area. The Australian Bustard is listed as a Priority 4 species by the Department of Environment and Conservation. The Rainbow Bee-eater (*Merops ornatus*) was recorded daily in small numbers throughout the study area. This species is listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*. Small numbers of the Western Star Finch (*Neochimia ruficauda subclarescens*), listed as a Priority 4 species by the Department of Environment and Conservation, were recorded in Alluvial Plain and Drainage Line habitat near free-standing water.

The Fortescue Metals Groups Database (from various sources) includes 195 records of conservation significant species including Australian Bustard (four records), Peregrine Falcon (*Falco peregrinus*: one record), Rainbow Bee-eater (one record), Western Pebble-mound Mouse (*Pseudomys chapmani*: 188 records) and a possible Ghost Bat roost. Bilby (*Macrotis lagotis*) activity has been recorded in the past but no activity was recorded during this survey.

The Australian Bustard and Rainbow Bee-eater are highly mobile species, and are unlikely to be impacted by localized vegetation clearance and disturbance associated in the study area. The Pilbara Olive Python typically occupies rocky habitat, as this species' preferred habitat does not occur in the study area it is unlikely to be impacted by further development in this area. The Western Star Finch is typically a resident species with a relatively small home range. It has specialized habitat requirements, typically inhabiting permanent water bodies and drainage lines and may be locally impacted by mine development if there is a direct impact to this habitat.

Mapping of potential suitable habitat for the EPBC Act listed Northern Quoll (*Dasyurus hallucatus*) was done to illustrate any potential critical habitat in the study area. Potential shelter and denning habitat (critical habitat) for the Northern Quoll was highly restricted (74 ha) to high relief gorge terrain in the northeast of the study area.

Twenty-three of the 275 vertebrate species identified from desktop analysis are of conservation significance. Of these, only four were recorded during the survey, while nine species were deemed as 'likely' to occur, nine species were deemed as 'possibly' occurring and one species deemed as 'highly unlikely' to occur within the study area. The conservation significant species 'likely' to occur includes four waterbirds and migrant shorebirds which will not be impacted by proposed mining activity. The Grey Falcon (*Falco hypoleucos*), and Peregrine Falcon are resident species which typically occur at low population densities in a wide range of habitats, and have large home ranges. These birds are unlikely to be impacted by mine-related disturbances in the study area. The Short-tailed Mouse (*Leggadina lakedownensis*) and the Western Pebble-mound Mouse (*Pseudomys chapmani*) have more potential to be impacted upon by developments because they are resident species with small home ranges and poor dispersal abilities. Both species have been recorded in the study area during previous surveys. Both species are found broadly across the Pilbara and therefore the loss of local habitat is unlikely to impact the overall conservation status of these rodents.

The habitat types sampled in the study area are widespread throughout the Pilbara and are typically disturbed throughout the region by cattle grazing, fire, and more locally by mining activities and associated infrastructure. The Newman land system is widespread in the Pilbara (>10,000 km^2) and covers 28% of the study area, and together with the Boolgeeda, McKay, Calcrete and Jamindie land systems, cover about half of the study area. Each of the habitats of the study area hosts subtly different fauna. Drainage Line and Alluvial Plain habitat was the richest for birds, but this included few records of conservation significant species except for the Western Star Finch. The only record of Pilbara Olive Python was adjacent to the Drainage Line habitat. Drainage Line and surrounding Alluvial Plain habitat was rich in species and hosted large populations of amphibians although none of the frog species are of conservation significance.

1 INTRODUCTION

1.1 THE PROJECT

ENV.Australia Pty Ltd (ENV) was commissioned by Fortescue Metals Group Limited (FMG), in February 2011, to undertake a terrestrial vertebrate fauna and fauna habitat assessment of the Christmas Creek study area). The purpose of the assessment is to provide documentation for submission of the Christmas Creek proposal to the EPA for assessment. A Public Environmental Review (PER) level of assessment is expected.

The Level Two (single season) terrestrial vertebrate fauna and fauna habitat assessment comprised:

- A review of relevant fauna databases to collate historical records;
- Collation and summarising of previous fauna surveys in the vicinity of the study area;
- A vertebrate habitat assessment within the study area;
- A trapping programme to document the species richness in the study area;
- Recording of opportunistic fauna sightings; and
- Targeted searching for Threatened and Priority Fauna.

1.2 LOCATION

The study area is 677.4 km^2 in size and located 120 km north-west of the Newman town site in the Christmas Creek Mining tenement, in the Pilbara region of Western Australia (Figure 1).

1.3 ENVIRONMENTAL ATTRIBUTES

1.3.1 Climate

The nearest accessible climate data to the study area is available from the Bureau of Meteorology (BoM) Newman Aero weather station located approximately 120 km south of the study area.

The Pilbara has an arid-tropical climate with two distinct seasons, a hot summer from October to April and a mild winter from May to September. The area experiences a wide temperature range, with an average annual maximum daytime temperature of 32°C (1996-2011). In summer, maximum daytime temperatures may reach 47°C, whilst in winter, minimum night time temperatures may fall to -2°C (BoM 2011).

Rainfall in the Pilbara is often sporadic, and throughout the year (in summer and winter). The Newman area has an average annual rainfall of 319.3 mm (1971-2011) (BoM 2011) with the

majority of rainfall occurring during the summer months (Figure 2). Summer rainfall is typically associated with tropical storms in the north, or tropical cyclones that cross the coast and move inland. Winter rainfall is typically the result of cold fronts moving north-easterly across the State.

For the three months preceding the survey Newman received 230.8 mm (January 2011-March 2011), compared with the long-term average of 176.4 mm (1971-2011). Rainfall for the year to date (April 2010 to March 2011) was 420.4 mm compared with 319.3 mm for the long-term average for the same period (1971-2011).

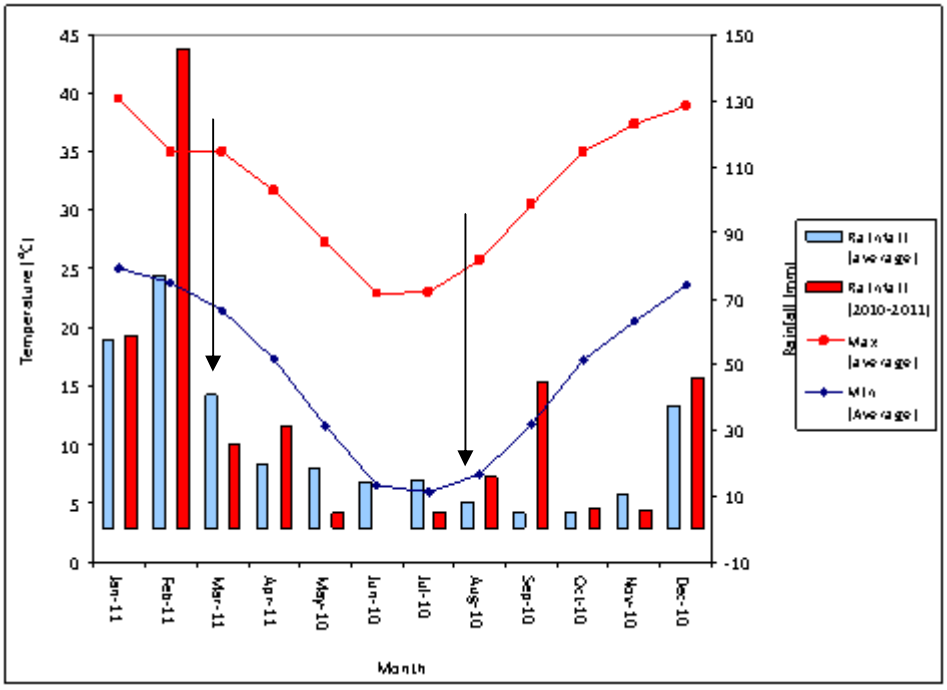


Figure 2: Average long-term (1971-2011) and 2010-2011 monthly rainfall and average maximum and minimum temperatures at Newman Airport (BoM 2011). Arrows indicate survey timing (March) and AnaBat survey in July-August 2011.

1.3.2 Interim Biogeographic Regionalisation for Australia

The Interim Biogeographic Regionalisation for Australia (IBRA) divided Australia into 85 bioregions based on major biological and geographical/geological attributes (Thackway and Cresswell 1995). These bioregions were further subdivided into 403 subregions, as part of a refinement of the IBRA framework (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] 2011a).

The study area is located on the border of the Chichester and Fortescue subregions of the Pilbara bioregion. The Chichester subregion is characterised by plains with a shrub steppe of *Acacia inaequilatera* over *Triodia wiseana* hummock grassland and *Eucalyptus leucophloia* tree steppe on rangelands (Kendrick and McKenzie 2001). The Fortescue subregion is

characterised by alluvial plains with *Acacia aneura* over grass communities and *Eucalyptus camaldulensis* woodlands fringing drainage lines (Kendrick 2001).

1.3.3 Land Systems

Land system mapping is based on regional patterns in topography, soils and vegetation. The land system mapping classified the Pilbara region into 102 land systems (van Vreeswyk *et al.* 2004). The study area comprises nine land systems (Table 1).

Table 1: Land Systems of the Study Area and relationship to broad habitat classification in this study (see Table 6).

Land System	Description	Habitats (current survey)	Extent within Pilbara Region (km²)	Proportion of the Pilbara Region (%)	Extent within Study Area (km²)	Proportion within Study Area (%)
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and Mulga shrublands	Stony Plain	7,748	4.3	4.06	0.05
Calcrete	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands	Alluvial Plain	1,444	0.8	0.02	0.001
Cowra	Plains fringing the Marsh land system and supporting snakewood and Mulga shrublands with some halophytic undershrubs	Marsh, Alluvial Plain	203	0.1	47.77	23.53
Jamindie	Stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with spinifex understorey	Alluvial Plain, Stony Plain	2,074	1.1	139.85	6.74
Marsh	Lakebeds and flood plains subject to regular inundation, supporting samphire shrublands, salt water couch grasslands and halophytic shrublands	Alluvial Plain	977	0.5	126.43	12.94
McKay	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands	Low Hill	4,202	2.3	21.49	0.51
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands	Low Hill	14,580	8.0	145.54	1.00
Turee	Stony alluvial plains with	Alluvial	581	0.3	166.11	28.59

Land System	Description	Habitats (current survey)	Extent within Pilbara Region (km²)	Proportion of the Pilbara Region (%)	Extent within Study Area (km²)	Proportion within Study Area (%)
	gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands	Plain, Stony Plain				
Warri	Low calcrete platforms and plains supporting Mulga and cassia shrublands	Alluvial Plain, Stony Plain	305	0.2	6.75	2.21

1.3.4 Geology

The following geological units occur in the study area, based on mapping by the Geological Survey of Western Australia (1990):

Afj: Jeerinah Formation – pelite, chert, and thin-bedded meta sandstone; intruded by Metadolerite sills in the Hamersley Range

Qa: Alluvium – unconsolidated silt, sand and gravel: in drainage channels and on adjacent floodplains

Qw: Alluvium and colluvium – red-brown sandy and clayey soil; on low slopes and sheetwash areas

Qc: Colluvium – unconsolidated quartz and rock fragments in soil; locally derived soil, and scree, and talus deposits

AHm: Marra Mamba Formation: Chert, banded ironstone formation, and pelite

Czr: Hematite – goethite deposits on banded iron-formation and adjacent scree deposits

Czk: Calcrete – sheet carbonate; found along major drainage lines

Czc: Colluvium – partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits

1.3.5 Soils

The following soil units occur in the study area, based on mapping by Tille (2006):

282-Chichester Ranges: Hills and dissected plateaux (with some stony plains) on basalt and sedimentary rocks of the Hamersley Basin. Stony soils with some red shallow loams and hard cracking clays. Spinifex grasslands with Kanji and Snappy Gum (and some tussock grasslands).

284-Fortescue Valley: Alluvial plains, hardpan was plains and sandplains (with stony plains, floodplains and some salt lakes) on alluvial deposits over sedimentary rocks of the Hamersley Basin. Red deep sands, red loamy earths and red/brown non-cracking clays with some red shallow loams and hard cracking clays. Mulga shrublands and spinifex grasslands (with some tussock grasslands and halophytic shrublands).

1.3.6 Vegetation

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). The study area is situated in the Hamersley Plateau which forms a part of the Fortescue Botanical District in the Eremaean Botanical Province of Western Australia (Beard 1975). Beard mapped the study area as follows:

$a_2Sr.t^1{}_3Hi$ / 173: Hummock grasslands, shrub steppe; kanji over soft spinifex & *Triodia wiseana* on basalt

$a_1Li/e_{16}Lr.t_3Hi$ / 562: Mosaic: Low woodland; mulga in valleys / Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana*

a_1Lp / 29: Sparse low woodland; mulga, discontinuous in scattered groups

k_3Ci / 676: Succulent steppe; samphire

A recent vegetation survey of the study area recorded 449 native plant taxa, plus 16 introduced species (ENV 2011a). A total of 23 broad vegetation types (*sensu* Mattiske Consulting 2005) were mapped. None of the mapped vegetation types were listed as a Threatened Ecological Community under the *Environment Protection and Biodiversity Conservation Act 1999* or as an Environmentally Sensitive Area under the *Environmental Protection Act 1986* (ENV 2011a).

1.4 PREVIOUS BIOLOGICAL STUDIES

The flora of the Pilbara was first systematically recorded at a broad level by Burbidge (1959) and Beard (1975). More recently, the Department of Agriculture and Food (van Vreeswyk *et*

al. 2004) conducted an inventory and condition survey of the Pilbara that provides a regional inventory of flora and a description of land resources.

A comprehensive and systematic field survey by the Department of Environment and Conservation (DEC) of Pilbara regional biodiversity was conducted from 2002-2007 (McKenzie *et al.* 2009). These biodiversity surveys have included among other fauna groups, systematic sampling of small mammals, microbats and birds (Gibson and McKenzie 2009, McKenzie and Bullen 2009, Burbidge *et al.* 2010).

In recent decades, an increase in resource development projects has resulted in a significant amount of site-specific (i.e. local scale) biological survey work being carried out, most of which is undertaken for approvals under the *Environmental Protection Act 1986* (WA). There have been a substantial number of Level 1 and 2 fauna surveys in the vicinity of the study area (i.e. within 50 km) within the last fifteen years (Table 2).

A comprehensive bibliography of biological survey work undertaken in the Pilbara is available at the DEC website (DEC 2011a). Those surveys most relevant to the current survey, and which are within the vicinity of the study area, are:

- *Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor* (Biota 2004);
- *Fauna survey of proposed Iron Ore Mine, Cloud Break* (Davis *et al*. 2005);
- *Fauna Habitats and Fauna Assemblages of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas* (Biota 2005);
- *Fauna Assessment- Cloudbreak Airstrip, Camp and Access Road (*ATA Environmental 2006);
- *Christmas Creek Terrestrial Vertebrate Fauna Desktop Assessment* (Ecologia 2010); and
- *BFS1-BFS2 Rail Alignment Fortescue Marsh Section Terrestrial Fauna Assessment* (ENV 2010).
- *Cloudbreak Level 2 Terrestrial Vertebrate Fauna Assessment (Ecologia 2011);*
- *Report on December 2009 search for the Night Parrot*. (Bamford 2010);
- *Christmas Creek Airstrip Flora, Vegetation and Fauna Assessment* (ENV 2011b);

1.4.1 Fortescue Metals Group Database

Records of conservation significant fauna recorded during surveys undertaken for Fortescue are compiled and stored on the Fortescue Environmental Database. This database provides information on location, date of collection, consultant who recorded data (source of data), and conservation status of conservation significant species. The FMG Database provided to ENV is a list of conservation significant species recorded at Christmas Creek areas from 2008 to 2011 by various consultants. The records extracted from the FMG Database located within the study area are included in Appendices and Figures.

Table 2: Summary of terrestrial fauna surveys in the vicinity of the study area

Survey	Survey Type	Dates	Methods	Key findings: significant species
Biota (2004) Stage A rail corridor (transect over about 300 km)	Level 2	20 Mar-7 Apr 2004	Trapping sites, pitfall, Elliott and funnel trapping; active search, spotlighting; bird survey; bat survey, SRE survey.	• Mulgara *Dasycercus* sp. • Bilby *Macrotis lagotis* • Pilbara Olive Python *Liasis olivaceus barroni* • Woma *Aspidites ramsayi* • Peregrine Falcon *Falco peregrinus* • *Ramphotyphlops ganei* • Spectacled Hare-wallaby *Lagorchestes conspicillatus* • Grey Falcon *Falco hypoleucos* • Bush Stone-curlew *Burhinus grallarius* • Australian Bustard *Ardeotis australis* • Western Star Finch *Neochmia ruficauda subclarescens* • Short-tailed Mouse *Leggadina lakedownensis* • Western Pebble-mound Mouse *Pseudomys chapmanii* • Ghost Bat *Macroderma gigas*
Biota (2005) Stage B Rail	Level 2 equivalent	Mar, Jun-Jul 2004	Trapping grids, pitfall, Elliott and funnel trapping; active search, spotlighting; bird survey; bat survey, SRE survey.	• Mulgara *Dasycercus* sp. • Peregrine Falcon *Falco peregrinus* • Australian Bustard *Ardeotis australis* • Long-tailed Dunnart *Sminthopsis longicaudata* • Short-tailed Mouse *Leggadina lakedownensis* • Western Pebble-mound Mouse *Pseudomys chapmani*
Davis *et al.* (2005) Cloudbreak	Level 2	7 Apr – 17 Apr 2005	Trapping grids, pitfall, cage, Elliott and funnel trapping; active search, spotlighting; bird survey; bat survey (bat recorders and mistnets)	• Peregrine Falcon *Falco peregrinus* • Grey Falcon *Falco hypoleucos* • Australian Bustard *Ardeotis australis* • Western Star Finch *Neochmia ruficauda subclarescens*
ATA Environmental (2006) Cloudbreak airstrip	Level 1 targeted	3 Jun, 22 Jun, 7 , 11 July 2006	Targeted search	• Northern Quoll *Dasyurus hallucatus*

Survey	Survey Type	Dates	Methods	Key findings: significant species
ENV (2009)	Level 1	5-7 Nov 2008	Observations, bird survey	• Australian Bustard *Ardeotis australis* • Rainbow Bee-eater *Merops ornatus* • Western Pebble-mound Mouse *Pseudomys chapmani*
Bamford (2010) Night Parrot [including data from previous Night Parrot surveys, mostly Fortescue marsh area]	Level 1 targeted	Various, over several years	Observations, Motion sensitive cameras, mist-netting, spotlighting, active searching	• White-bellied Sea-eagle *Haliaeetus leucogaster* • Eastern Great Egret *Ardea modesta* • Peregrine Falcon *Falco peregrinus* • Grey Falcon *Falco hypoleucos* • Common Greenshank *Tringa nebularia* • Wood Sandpiper *Tringa glareola* • Red-necked Stint *Calidris ruficollis* • Oriental Pratincole *Glareola maldivarum* • Bush Stone-curlew *Burhinus grallarius* • Night Parrot *Pezoporus occidentalis* • Rainbow Bee-eater *Merops ornatus* • Ghost Bat *Macroderma gigas*
ENV (2010) Roy Hill	Level 2	24 May - Jun 2010	Trapping sites, pitfall, Elliott and funnel trapping; active search, spotlighting; bird survey; bat survey	• Australian Bustard *Ardeotis australis* • Rainbow Bee-eater *Merops ornatus* • Bush Stone-curlew *Burhinus grallarius*
Ecologia (2011)	Level 2	18 Oct – 29 Oct 2010	Trapping grids, pitfall, Elliott and funnel trapping; active search, spotlighting; bird survey; bat survey	• Australian Bustard *Ardeotis australis* • Western Star Finch *Neochmia ruficauda subclarescens* • Rainbow Bee-eater *Merops ornatus* • Bush Stone-curlew *Burhinus grallarius* • Western Pebble-mound Mouse *Pseudomys chapmani*
ENV (2011b) Christmas Creek Airstrip Flora, Vegetation and Fauna Assessment	Level 1	24 Jan – 25 Jan 2011	Active search	• Rainbow Bee-eater *Merops ornatus* • Western Pebble-mound Mouse *Pseudomys chapmani*

2 METHODS

2.1 BACKGROUND TO SURVEY METHODS

2.1.1 Protection of Fauna and Fauna Habitat

Fauna, habitat, and faunal ecological communities are protected formally and informally by various legislative and non-legislative measures, which are outlined below. Species listed under these acts and other non-legislative measures are considered 'conservation significant' in this assessment.

2.1.2 Legislative Protection

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Western Australia *Wildlife Conservation Act 1950* (WC Act).
- Western Australia *Environmental Protection Act 1986* (EP Act).

2.1.3 Non-Legislative Protection

- Western Australian DEC Priority lists.
- Informal recognition of fauna of interest.

A short description of these legislative and non-legislative measures is given below, and definitions of the species conservation codes and ecological community categories they use, and those used by the DEC, are provided in Appendix A.

2.1.4 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect matters of national environmental significance, which are detailed in Appendix A. Under the EPBC Act, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the Act. Species are considered to be conservation significant if they are listed as Threatened (i.e. Critically Endangered, Endangered and Vulnerable, etc.), or Migratory.

Bird species protected as Migratory under the EPBC Act include those listed under international migratory bird agreements relating to the protection of birds which migrate between Australia and other countries, for which Australia has agreed. This includes the: Japan-Australia Migratory Bird Agreement (JAMBA); China-Australia Migratory Bird Agreement (CAMBA); Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Some marine fauna or terrestrial fauna that use marine habitats are listed as Marine under the EPBC Act. These species are only considered conservation significant when a proposed development occurs in a Commonwealth marine area (i.e. any Commonwealth Waters or Commonwealth Marine Protected Area). Outside of such areas, the EPBC Act does not consider these species to be matters of national environmental significance, so are not protected under the Act. Species listed as Marine under the EPBC Act have not been considered to be conservation significant in this assessment.

2.1.5 Wildlife Conservation Act 1950

The DEC, lists taxa under the provisions of the WC Act as protected and are classified as Schedule 1 to Schedule 4 according to their need for protection (see Appendix A). The WC Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the WC Act.

2.1.6 Environmental Protection Act 1986

Significant habitat necessary for the maintenance of fauna indigenous to Western Australia as well as TECs are given special consideration in environmental impact assessment, and areas covered by TECs have special status as Environmentally Sensitive Areas (ESAs) under the EP Act, and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

2.1.7 DEC Priority Lists

The DEC produces a list of Priority species that have not been assigned statutory protection under the WC Act. Priority Fauna are under consideration as 'Scheduled' fauna, but are in urgent need for further survey or require regular monitoring, and although not currently threatened may become so in the future. Appendix A provides definitions of Priority codes.

In addition, the DEC maintains a list of Priority Ecological Communities which identifies those communities that need further investigation before possible nomination for TEC status.

Although DEC Priority species and communities have no formal legal protection, they are under consideration as 'Scheduled' taxa under the WC Act or as ESAs under the EP Act.

2.1.8 Informal Recognition of Threatened Fauna

Certain populations or communities may be of local significance or interest because of their patterns of distribution and abundance. For example, fauna may be locally significant because they are range extensions to the previously known distribution or are newly discovered taxa and therefore have the potential to be listed as Threatened in the future. In addition, many species are in decline as a result of threatening processes, and relict populations of such species may assume local importance.

2.1.9 EPA Requirements for Fauna Surveys

The survey was carried out in a manner compliant with the EPA requirements for the environmental surveying and reporting of fauna surveys in Western Australia, as documented in:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002).
- *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56* (EPA 2004).
- *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2010).

According to the EPA *Guidance Statement No. 56* (EPA 2004), a baseline field fauna survey for environmental impact assessment should at the very least provide a comprehensive list of species occurring within a given area. There are two levels of fauna survey as delineated by the EPA:

- *Level One:* desktop study to collate historical knowledge, in conjunction with a reconnaissance survey (site inspection).
- *Level Two:* trapping and opportunistic field survey to characterise the fauna present, combined with a Level One survey. Where the scale and nature of the proposed impact is moderate to high, such as this survey, a Level Two survey will be required in most areas of the State, and is typically required for resource development projects.

2.1.10 EPBC Act referral guidelines

The significant impact guidelines provide overarching guidance on determining whether an action is likely to have a significant impact on a matter of national environmental significance protected by the EPBC Act. In the Pilbara region, the only vertebrate fauna species that has specific referral guidelines is the Northern Quoll (*Dasyurus hallucatus*).

2.2 DESKTOP REVIEW

The purpose of the desktop review was to collate faunal records from previous surveys within, and in the vicinity of the study area. The search area (whether a radial distance or a grid encompassing the study area) varies according to databases which are produced by various institutions. This involved a search of the following sources:

- Western Australian Museum (WAM) and DEC combined biological database *NatureMap* (DEC 2011b). An area search was conducted based on an approximate 40 km radius from the study area.

- Birds Australia's Birdata (Birdata 2011). An area search based on an approximately 1 degree grid cell (*c*. 10,000 km^2) encompassing the study area.

- DEC Threatened and Priority Fauna database (DEC 2011c). An area search was conducted based on an approximately 40 km radius from the study area.

- DSEWPaC *Protected Matters Search Tool* (DSEWPaC 2011b), also known as an EPBC Act search. An area search based on an approximately 10 km radius from a central point in the study area.

- Previous fauna surveys (e.g. previous ENV reports, other consultant reports and DEC reports).

Collectively, these sources were used to compile a list of species that have previously been recorded in the region (Appendix B). This list will invariably include some species that do not occur in the study area, because some fauna have a limited or patchy distribution, such as a high level of habitat specificity, are locally extinct or were erroneously identified in previous surveys. Some records were excluded from this list, such as extinct species and clearly erroneous records.

2.3 FIELD SURVEY

2.3.1 Additional Surveys

The terrestrial vertebrate fauna survey was conducted between 16th – 27th March 2011 but acoustic bat recordings were corrupted during the survey by high-pitched insect noises, and a more targeted survey approach was considered necessary for EPBC listed species such as Northern Quoll (*Dasyurus hallucatus*), Pilbara Leaf-nosed Bat (*Rhinonycteris aurantius*) and Pilbara Olive Python (*Liasis olivaceus*). Additionally, fauna diggings in the study area identified as Bilby (*Macrotis lagotis*) (Ecoscape 2009) required clarification. Therefore two additional surveys were undertaken in 2011.

Targeted Fauna Survey of the Christmas Creek Life of Mine area (Appendix C);

A Level 2 targeted survey for the Northern Quoll was conducted from 28th July - 5th August 2011 in the rocky hills, gullies and gorges in the northern part of the study area. The survey involved cage and Elliot trapping (a total of 1,273 trap nights), searching for indirect signs such as scats (19 person hours) and nocturnal searches (20 person hours). An additional bat survey was conducted during this targeted survey and results have been included in this current report (noted as Anabat survey phase 2). During this survey the only conservation significant species recorded was the Western Pebble-mound Mouse (mounds only).

Assessment of potential fauna diggings, Christmas Creek (ENV 2011c);

December 14th - 15th 2011 a Level 1 targeted survey was conducted to visit and assess 26 previously identified potential Bilby diggings in stony plain and low hill habitat in the study

area. This survey involved systematic searching (1 person hour) in a 2 ha quadrat surrounding each potential digging. One digging had been converted to a soil stockpile, but the remaining 25 diggings were accessed. No Bilby burrows were recorded during the survey.

2.3.2 Habitat Assessment

Vegetation communities and landforms were used to identify the broad fauna habitats in the study area. The habitat complexity and quality for vertebrate fauna was assessed. The vertebrate habitat assessments were documented systematically for each habitat type on standardised field sheets (Appendix D).

Each broad habitat type description includes information on:

- Location of the broad habitat type within the study area (GPS co-ordinate) and its relative percentage;
- Habitat condition was assessed at each site as 'completely degraded through to pristine; based on the scale given in Keighery (1994);
- Landscape position;
- Dominant vegetation and structure e.g. number of vegetation strata;
- Hollow-bearing trees and dead stags (e.g. average size and abundance of hollows);
- Description of any rock and rocky outcrops;
- Logs (e.g. abundance and size);
- Substrate (e.g. leaf litter);
- Wetlands, creeks, rivers, dams and other water bodies;
- Description of any observed nests and roosts;
- Subterranean roosts (e.g. caves, disused mineshafts and or adits);
- Associated fauna species observed using the habitat;
- Ecological processes important to the habitat;
- Disturbance e.g. cows, fire;
- A discussion of the wider extent of the habitat type e.g. regional context; and
- Photo showing a typical example of the broad habitat type.

At locations considered suitable for conservation significant fauna the coordinates, vegetation description and a photograph was taken. A map of potential critical habitat (shelter and denning) was prepared for the EPBC Act listed Northern Quoll based on knowledge (from literature and survey experience) of their broad habitat requirements.

2.3.3 Trapping Programme

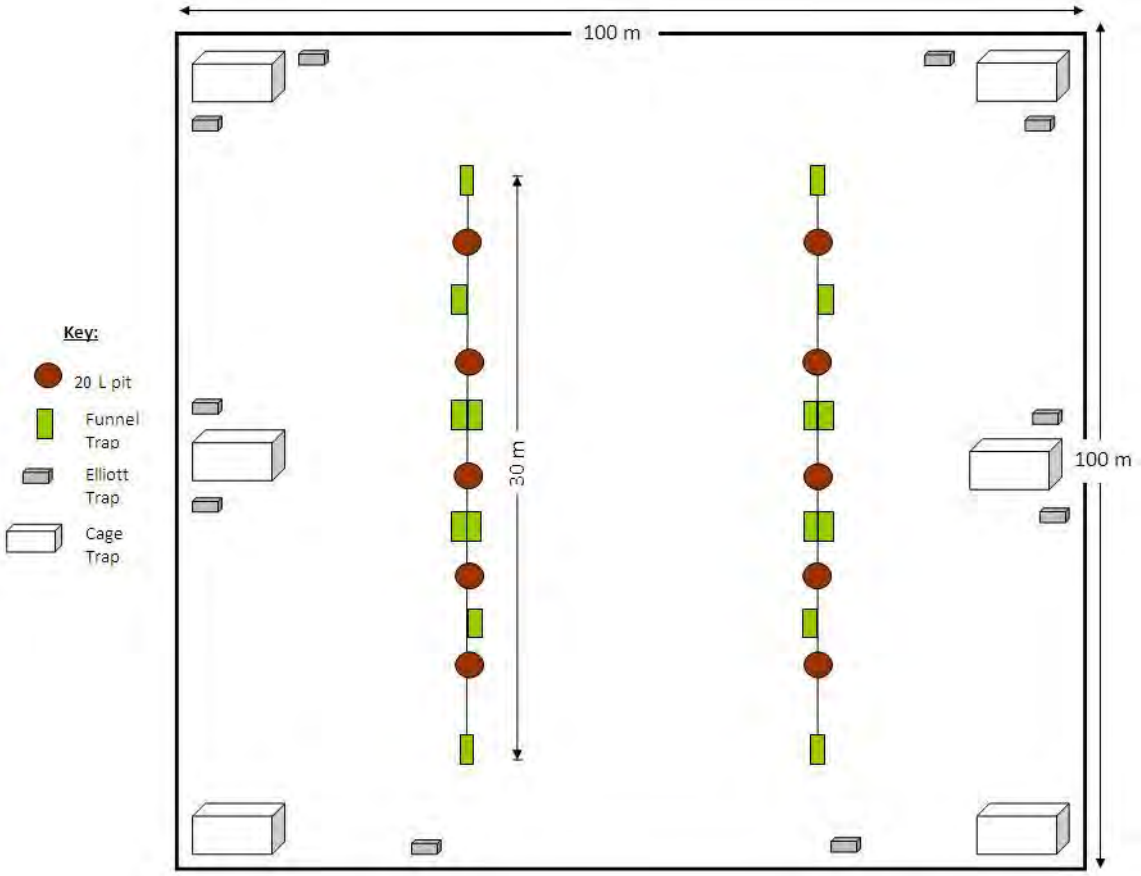
A total of nine sites were sampled in a broad range of habitats: Drainage Line and Alluvial Plain, Stony Plain and Low Hills. These were selected to obtain a broad coverage of the study area and to be in close proximity to one another. Access to the Fortescue Marsh was restricted because of above average rainfall before the survey causing boggy track conditions to the marsh. Mulga *Acacia aneura* woodland – a habitat type that borders the marsh and occurs patchily throughout the study area was adequately sampled. Sampling geographically close sites reduces travel time and ensures that traps can be checked in a timely manner to reduce the likelihood of animal deaths during hot weather, as per DEC requirements.

The trapping programme was conducted for seven nights at each of the sites, except one site which was partially shut down (pit and funnel traps) after the first day because of considerable ant activity which could have potentially caused trap deaths. Each of the nine trap sites consisted of a 100 m x 100 m quadrat. In each quadrat a total of 10 pitfall traps (20 L bucket) were set with a drift fence. These consisted of two lines of five pitfall traps at 5 m intervals each with a 30 m section of drift fence. A total of 16 funnel traps were set along the sides of the drift fence, and six cage traps and ten Elliott traps were operated at each site for seven nights (spaced equidistantly around the perimeter of the quadrat). Trap effort for each site was 70 pitfall trap nights, 140 funnel trap nights, 42 cage trap nights and 70 Elliott trap nights (Table 3), excluding the one site experiencing capture mortality due to ant predation.

When a threatened or priority fauna species was recorded, coordinate locations and number of individuals (including sex where possible) and habitat type was noted where possible.

Table 3: Summary of trap effort.

Trap Type	Trap Effort (nights)
Pitfall Traps	70
Funnel Traps	140
Cage Traps	42
Elliot Traps	70
Total	322



2.3.4 Opportunistic Searches

In addition to the trapping programme, opportunistic searches were conducted. These searches targeted habitats potentially supporting fauna of conservation significance. Active searching involved raking through leaf litter, investigating burrows, and tracks, and sampling of scats. Searches were conducted in different habitats throughout the study area (Table 4). A total of four person hours of searches was conducted in locations that contained suitable habitat for Western Pebble-mound Mouse (*Pseudomys chapmani*) (Table 4).

Table 4: Summary of systematic and opportunistic fauna searches.

Survey type	Where searched	Habitat type	Effort (person-hrs)
Active searching for reptiles and frogs in particular	Nine systematically searched sites	Drainage line, alluvial plain, stony plain, low hill	40.5
Search for mounds of Western Pebble-mound Mouse	1 km transect on low hills near site 5 communication tower	Low hill	4
Nocturnal search for night birds, snakes, geckos	Nine sites systematically searched; plus road between sites	Drainage line, alluvial plain, stony plain, low hill	13 hrs
Searches for caves suitable for cave dwelling bats	10 sites, in vicinity of AnaBat sampling	Low hill [breakaway/small gorge]	12 [March 2011]; 19 [July-August 2011]
			Total: 88.5 hrs

2.3.5 Ornithological Survey

Systematic ornithological surveys were undertaken for 15 mins at each site in the morning and again in the afternoon each day (3.5 hours each site) and each of the nine sites were subject to nocturnal surveys for a total of 1 hour (see section 2.4.5). Opportunistic records of conservation significant birds such as the Australian Bustard (*Ardeotis australis*), that were recorded in the study area, but not in sites, are included.

2.3.6 Nocturnal spotlighting

Spotlighting and head torching at night from vehicles and on foot is an important survey tool as much of the fauna is nocturnal and/or crepuscular, particularly conservation significant species such as the Northern Quoll (*Dasyurus hallucatus*) and Bilby (*Macrotis lagotis*). Nocturnal foot-based searches and road (car-based) traverses with the aid of spotlights were conducted to target this nocturnal fauna. At each of the nine systematic survey sites a total of 1-person hour of nocturnal searches was conducted (four fieldworkers searching for 15 mins each).

2.3.7 Acoustic Bat Recording

Bat recordings were undertaken at night, using acoustic bat units to document bat species in the area. Where possible the methodology was aligned with recommendations in the *EPBC Act* Survey Guidelines for Australia's Threatened Bats (Department of the Environment, Water, Heritage and the Arts 2009). The recording units convert ultrasonic echolocation signals produced by bats into audible electronic signals, which are later analysed for species-specific calls. AnaBat recording units were set up around caves and in Drainage Line and

Alluvial Plain habitat identified as potential roosting or foraging sites. Units were left in place for one night each at three locations during March. However, high pitched insect noises greatly reduced recording effectiveness because recording units rapidly filled up with insect recordings (phase 1). Consequently, further survey of additional sites was conducted over 7 nights (29 July to 4 August 2011; phase 2) to supplement the limited results from the March survey (Figure 3; Appendix E). A total of nine sites were surveyed. The coordinates of AnaBat locations were recorded with GPS and photographed. Bat survey locations and details are presented in Figure 3 and in Appendix E.

In addition to bat recordings, a total of 12 person hours of effort was spent searching for caves suitable as bat habitats during the March survey and a further 19 person hours during the July-August bat survey (Table 4).

2.4 STATISTICAL ANALYSIS

In order to assess the adequacy of the field survey, species accumulation curves were generated for the vertebrate faunal groups with adequate data (reptiles and birds). Note that this was done on systematic site data, but some additional reptiles and birds were recorded outside the sites (incidentally) but within the study area. Too few mammal and amphibian species were recorded for statistical analysis. The species accumulation curve is concerned with accumulation rates of new species over the sampled area. That is, as the number of trap nights/effort increases, the number of species should increase until the accumulation of species plateaus (the graph reaches an asymptote), indicating that an area has been adequately surveyed. Species accumulation curves can be useful in estimating total species richness and the proportion of species caught during the fauna survey.

The relative rates of species accumulation (beta diversity) was evaluated with non-parametric species richness estimators (generated using EstimateS version 8.0: Colwell 2005), and a species rarefaction graph prepared (using Cole rarefaction estimator). The mean of eight different estimators (Abundance-based Coverage Estimator of species richness, Incidence-based Coverage Estimator of species richness, the incidence-based estimator Chao1, Chao2 richness estimator, First-order Jackknife richness estimator, Second-order Jackknife richness estimator, and Bootstrap and Michaelis–Menten model based estimator) was used to generate ‘expected’ species richness. ‘Expected’ species richness is then compared to the actual or ‘observed’ species richness.

The sampling unit for analysis was the nine sites. To increase the number of sample units for analysis, each day of survey for each site, was considered as a sample (e.g. 9 sites multiplied by 7 days= 63 samples). Traps were partially closed at one site after the first day because of deaths caused by ants, affecting the sampling of reptiles. So the number of samples for birds and reptiles is not equal (n= 63 for bird species, and n= 56 for reptile species).

2.5 PERMITS

Fauna was trapped and collected in accordance with DEC Permit SF007863 issued to Dr Ron Firth (ENV).

2.6 TAXONOMY

For the fauna species identified in the desktop assessment where there is doubt to their correct taxonomy (through subsequent name changes or taxonomic reviews) an effort was made to determine the current scientific name for each taxon. In cases where correct taxonomy of an old record cannot be determined, old scientific names may be presented. Some taxa names may be followed by 'sp.', indicating that the species name was not provided in the data source or the taxonomy is in doubt or cannot be reliably identified to species level (e.g. some bat calls).

Species were identified in the field using relevant field guides. Amphibians were identified with reference to Tyler and Knight (2009) and Cogger (2000); reptiles were identified with reference to Wilson and Swan (2010), and Storr *et al*. (1999, 2002). Birds were identified with reference to Simpson and Day (2004). Mammals were identified with reference to Menkhorst and Knight (2004), and van Dyck and Strahan (2008). Mammal scats, tracks and traces were identified with reference to Triggs (1996). Due to the recent recognition of a second mulgara species and therefore the ambiguity surrounding the distribution of these two species (Brush-tailed Mulgara *Dasycercus blythi* and Crest-tailed Mulgara *Dasycercus cristicauda*), the generic common name 'Mulgara' is used to cover both species (past reporting only considered Crest-tailed Mulgara as possible).

Taxonomy and nomenclature (system of principles, procedures and terms relating to naming) in this report follows the Tyler and Knight (2009) for amphibians, Wilson and Swan (2010) for reptiles, Christidis and Boles (2008) for birds, and van Dyke and Strahan (2008) for mammals.

3 RESULTS

3.1 SURVEY LIMITATIONS

As per EPA *Guidance Statement No. 56* (EPA 2004), the limitations and constraints associated with a survey need to be documented. These constraints are detailed in Table 5.

Table 5: Limitations and context associated with the Fauna Assessment

Limitation	Impact on Survey Outcomes
Experience levels/ Resources	The biologists that conducted the Christmas Creek Level 2 survey included practitioners that are regarded as suitably qualified in their respective fields: • Dr Ron Firth – Principal Zoologist • Dr Colin Trainor – Senior Zoologist • Mr John Trainer – Zoologist • Mr Mike Brown – Zoologist • Mr Glen Murray – Zoologist • Mr Stuart McKinnon – Field Assistant
Scope: sampling methods/ Intensity	This was a Level Two survey, comprising a desktop review of secondary data and primary field survey that included habitat assessment, trapping, AnaBat survey, systematic and opportunistic observations.
Sources of Information	The desktop analysis used a number of different resources to obtain a list of fauna species previously recorded within the vicinity of the study area, e.g. records from the DEC threatened fauna database search, NatureMap (DEC 2011b), and DSEWPaC Protected Matters Search Tool (DSEWPaC 2011b). Furthermore, all the previous fauna surveys identified in Section 3.3 assisted in developing an understanding of the overall faunal composition and status of conservation significant species.
Proportion of field survey completed	A total of 120 vertebrate fauna species were recorded from the fieldwork, and a total of 275 fauna species were recovered from secondary database searches. A total of nine 1 ha sites were each surveyed over 7 days. Survey effort at these sites totalled 560 pitfall trap-nights, 896 funnel trap-nights, 630 Elliott trap-nights, 378 cage trap-nights, and three Anabat trap nights (Figure 3). Incidental observations were made throughout the study area while travelling between sites. A total of 31.5 person hours was spent conducting the systematic bird censuses, nine person hours was spent conducting nocturnal surveys,

Limitation	Impact on Survey Outcomes
	four person hours was spent searching for Western Pebble-mound Mouse mounds, and 12 person hours was spent searching for caves.
Timing, weather, season.	The survey was undertaken from the 16th - 27th March 2011, with additional bat survey conducted between 29th July – 4th August (see below). The area had received 250.6 mm of rainfall in the three months preceding the March survey (Newman airport: BoM 2011). The daily maximum temperatures varied from 29.7-35.5 degrees Celsius (mean 33.5), with overnight temperatures ranging from 13.7-26.4 degrees Celsius (mean 21.2) (Newman airport: BoM 2011). The relatively high temperatures and high level of rainfall experienced before and during the survey period resulted in a high level activity for all animals. Ectothermic animals such as reptiles and frogs are more active in warm conditions. The rainfall received proceeding the survey increased the ability of the vegetation to generate and therefore provide a food source for ground dwelling species, especially herbivorous mammals. Due to weather conditions (i.e. high rainfall, flooding) at the time of the survey, many topographical low lying areas, such as the marsh, were inaccessible and therefore could not be accessed.
Trap Closures	Due to ant predation, all of the pitfall and funnel traps at Site 4 were pulled up after the first night of trapping. AnaBat sampling was done over 6 nights, however, as high frequency insect noises corrupted the data, only 3 nights of data was collected. To address this issue an additional bat survey was conducted over seven nights in July-August 2011.

3.2 HABITAT ASSESSMENT

3.2.1 Habitat Types

Four main fauna habitat types were identified in the study area and are summarised in Table 6 and mapped in Figure 3. For consistency, the ENV habitat types are compared with habitat types from a previous survey conducted at Cloudbreak mine directly adjacent to the Christmas Creek study area (Ecologia 2011). Two of the Ecologia (2011) habitats (Spinifex covered hills and Rocky escarpment) have been combined into the Low Hill habitat. The remaining habitats are directly comparable. These habitat assessments document the fauna habitat types present and the features and characteristics available to fauna. The locations and details of the fauna habitat assessments are provided in Appendix D. In addition to the fauna habitats, some sections of the study area are classified as cleared or degraded (following the habitat condition scale of Keighery 1994). These sections comprise roads, tracks, mine pits and borrow pits. Not all of the cleared and degraded areas could be mapped

as current aerial photographs were not available. Large areas of drill lines that occur along the haul road in the east of the study area were mapped as 'cleared or degraded'.

Table 6: Major Habitat Types of the Study Area.

Habitat Type[#]	Ecologia (2011)	Habitat Value	Area of Habitat Type (ha)
Drainage Line and Alluvial Plain	Creekline with fringing Acacia and Eucalypt	Moderate	8,647.8
Marsh	Low halophytic shrubland	High	18,409.8
Low Hill	Spinifex covered hills; rocky escarpment	Low	13,748.8
Stony Plain	Snakewood and Mulga woodland	Low	25,919.4
Cleared or Degraded	N/A	N/A	1,011.9
			Total: 67,737.59

[#] Reference to Keighery (1994)

Drainage Line and Alluvial Plain

The Drainage Line and Alluvial Plain habitat types are combined because they are closely associated and provide similar fauna habitat. The Drainage Lines intersected the study area in a north to south direction due to the water flowing off the hills towards the Fortescue Marsh. The vegetation in this habitat is characterised as Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* and *Acacia aneura* over *Acacia pruinocarpa* and *Acacia tetragonophylla* over *Triodia* and *Themeda* species.

Microhabitats present in this habitat include tree hollows, logs, leaf litter, thick vegetation and soft soil suitable for digging by burrowing fauna. Drainage line and alluvial plain habitat contain mature *Eucalyptus* trees that are larger than trees in the surrounding plains, so it is likely that it provides a corridor for some wildlife. In particular, birds, bats, large mammals (such as the Common Wallaroo *Macropus robustus*) and wide-ranging reptiles (such as snakes and goannas) are likely to use the drainage line as a movement corridor. This habitat type is considered to be of moderate habitat value.

Marsh

The Marsh habitat occurs to the south of the study area. No field surveys were conducted in this habitat type due to high rainfall prior to and during the survey which restricted access.

During periods of high rainfall, large areas of this habitat become inundated with water. The vegetation of this habitat type is characterised as being a Low Shrubland of *Tecticornia* and *Muellerolimon* species.

This habitat type includes a simple range of microhabitats with no tree hollows, few logs, sparse leaf litter and vegetation. However the soft substrate is suitable for burrowing and digging animals and the abundance of water provides episodic foraging opportunities to migratory shorebirds and resident waterbirds. More than 250,000 waterbirds have been estimated to occur at the marsh (Halse *et al.* 2005). It is considered to be of High habitat value.

Low Hill

The Low Hill habitat type occurs in the north of the study area and is characterised as low scree slopes. The vegetation of this habitat type is characterised as being a Hummock Grassland of *Triodia basedowii* with patches of *Eucalyptus leucophloia*, *Corymbia deserticola, Acacia* and *Hakea* species.

This habitat type contains a limited range of microhabitats with no tree hollows, few logs, sparse leaf litter and vegetation. Some sections of this habitat type contain areas of breakaways and rocky outcropping, but these are small, and contain few substantial caves or other important fauna microhabitats. This habitat type is considered to be of low habitat value.

Stony Plain

The Stony Plain habitat type consisted of a Low Woodland of *Acacia aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla* and *Acacia xiphophylla* over *Triodia* and *Aristida* species.

This habitat type contains limited microhabitats with the dominant *Acacia* species providing no tree hollows, few logs, limited leaf litter and sparse vegetation. This habitat type is considered to be of low habitat value.

3.3 FAUNA ASSEMBLAGE

The overall fauna assemblage in the study area has been compiled from surveys conducted within and surrounding the study area (see Appendix B) and records from the DEC NatureMap (DEC 2011b), DEC threatened fauna database search (DEC 2011c) and DSEWPaC Protected Matters Search Tool (DSEWPaC 2011b). All fauna species recorded previously in the region are listed in Appendix B, with conservation significant fauna potentially occurring and/or previously recorded for the study area listed in Appendix .

A total of 120 vertebrate fauna species (60 birds, 11 mammals, 45 reptiles and four amphibians) were recorded during systematic sampling in the study area (Appendix B). Four conservation significant species (Australian Bustard *Ardeotis australis*, Rainbow Bee-eater *Merops ornatus*, Western Star Finch *Neochima ruficauda subclarescens*, and Pilbara Olive

Python *Liasis olivaceus barroni*) were recorded (Figure 4). All of the bird species recorded had been listed previously in the vicinity of Christmas Creek. One amphibian (Douglas's Toadlet *Pseudophyrne douglasi*), four reptiles (*Caimanops amphiboluroides*, *Diplodactylus pulcher*, *Delma elegans* and *Lerista timida*) and one mammal (Pallid Long-eared Bat *Nyctophilus daedalus*) were not returned by the database search and are therefore new records for the Christmas Creek area.

A total of 275 vertebrate fauna species (five amphibians, 84 reptiles, 149 birds and 37 mammals) were identified from database searches, suggesting that approximately 44% of the potentially occurring fauna were recorded during the field survey. However, this secondary data was for a larger area, with a wider range of habitats than was surveyed in the study area, and includes historical records. Some of these species may not occur in the study area because of lack of suitable habitat, or if they once occurred, they have become locally extinct.

3.3.1 Amphibians

A total of 672 individual frogs of four species (Main's Frog *Cyclorana mainii*, Red Tree Frog *Litoria rubella*, Douglas's Toadlet *Pseudophryne douglasi* and Water-holding Frog *Cyclorana platycephala*) were recorded. The majority of captures (98.6%) were of Main's Frog, with only 10, four, two and one individual recorded of the Red Tree Frog, Douglas's Toadlet, Water-holding Frog, and Water-holding Frog respectively. Amphibian species richness was highest in the Drainage Line and Alluvial Plain habitat (four frogs), but fewer species occurred in the Low Hill (three species) and Stony Plain habitats (two species). Broad patterns of faunal species richness by habitat type are illustrated in Figure 5.

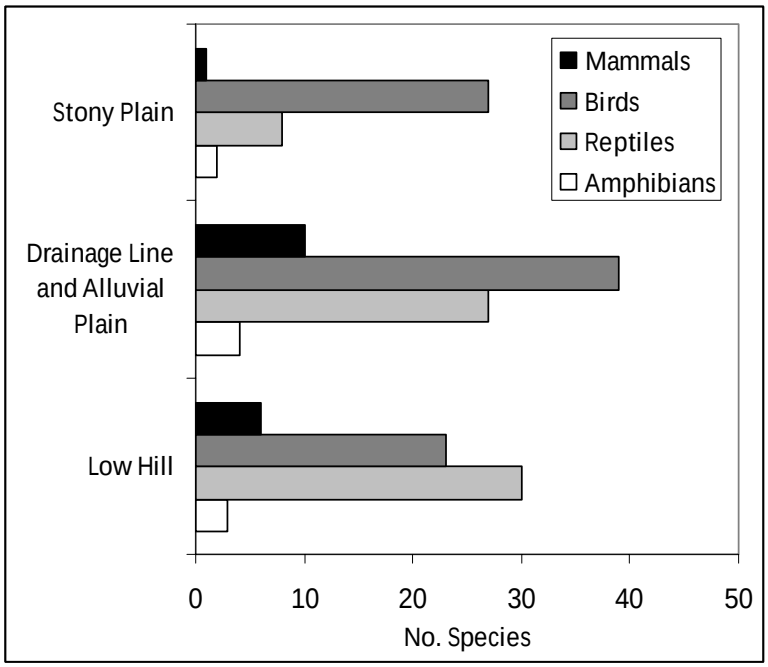


Figure 5. Patterns of faunal species richness (number of species) by habitat type.

3.3.2 Reptiles

A total of 296 individual reptiles of 43 species were recorded at the nine sites with an additional two species (*Ctenotus uber* and Pilbara Olive Python *Liasis olivaceus barroni*) recorded opportunistically. The four most commonly recorded species (*Gehyra variegata*, Rock Ctenotus *Ctenotus saxatilis*, Leopard Ctenotus *C. pantherinus* [see Plate 1] and Beaked Gecko *Rhynchoedura ornata*) comprised 43% of all records, and 37 reptile species were represented by less than 10 captures. Reptiles that were recorded infrequently, for example, as single individuals included: Yellow Spotted Monitor (*Varanus panoptes)*, Black-headed Monitor (*Varanus tristis)*, Pebble Dragon (*Typanocryptis cephalus*), Dwarf Bearded Dragon (*Pogona minor*), *Delma pax*, *Strophurus wellingtonae* and Yellow-faced Whipsnake (*Demansia psammophis*). Reptile species richness was relatively high (16-20 species) in all habitat types except the Stony Plain habitat, in which eight species were recorded (Figure 6).

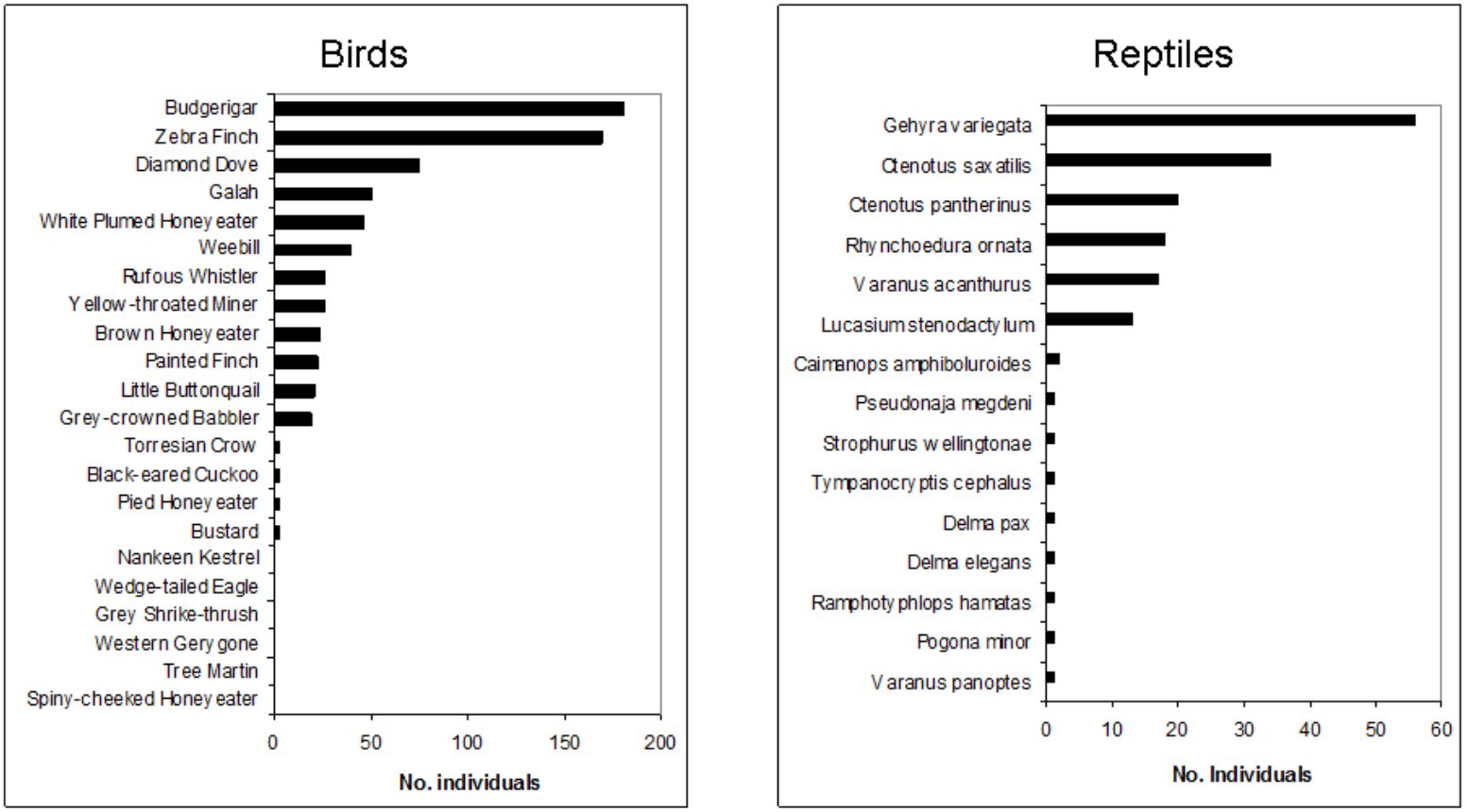


Figure 6. Patterns in the abundance (number of sightings and captures) of the most common and least commonly recorded birds and reptiles at the sites.

3.3.3 Birds

A total of 972 individual birds of 51 species were recorded during systematic site surveys. A further nine species recorded opportunistically in the study area: Pacific Black Duck (*Anas superciliosa*), Plumed Whistling Duck (*Dendrocygna eytoni*), Whistling Kite (*Haliastur sphenurus*), Black Kite (*Milvus migrans*), Eurasian Coot (*Fulica atra*), Black-fronted Dotterel (*Elseyornis melanops*), Banded Lapwing (*Vanellus tricolor*), Variegated Fairy Wren (*Malurus lamberti*) and Western Star Finch (*Neochima ruficauda subclarescens*). The most abundant and frequently recorded birds were Budgerigar (*Melopsittacus undulatus*) and Zebra Finch (*Taeniopygia guttata*): these comprised a remarkable 36% (351 individuals) of all birds observed.

The ten most common birds comprised 68% of all individual birds recorded (Figure 6 and Plate 2). Other common birds included Diamond Dove (*Geopelia cuneata*), Galah (*Cacatua roseicapilla*) and White-plumed Honeyeater (*Lichenostomus penicillatus*). Some of the most infrequently recorded birds (<4 individuals) included the Black-eared Cuckoo (*Chalcites osculans*), Australian Bustard (*Ardeotis australis*), Western Gerygone (*Gerygone fusca*) and Pied Honeyeater (*Certhionyx variegatus*) (Figure 6). Bird species richness was greatest in the Drainage Line, Stony Plain and Alluvial Plain habitats, but fewer birds were present in Low Hill habitat.

3.3.4 Mammals

A total of 11 mammal species were recorded (Appendix B). Two individual *Planigale* sp. were recorded from the Low Hill habitat, and a single House Mouse (*Mus musculus*) was captured in a drainage line. The House Mouse and European Cattle were the only introduced species recorded during this survey. A total of 37 mammals (including eight introduced species) were recorded for the study area by the database search, which included all species recorded during the survey, except the Pallid Long-eared Bat (*Nyctophilus daedalus*).

3.3.5 Bats

A total of eight bat species were recorded with AnaBat units in the study area, with five species recorded in the March survey and all eight species recorded during the July-August survey. All eight bat species were recorded at six sites of Drainage Line and Alluvial Plain habitat: Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*), Common Sheath-tailed Bat (*Taphozous georgianus*), Northern Freetailed-bat (*Chaerephon jobensis*), Lesser Long-eared Bat (*Nyctophilus geoffroyi*), Pallid Long-eared Bat (*N. daedalus*), Gould's Wattled Bat (*Chalinolobus gouldii*), Finlayson's Cave Bat (*Vespadelus finlaysoni*) and Little Broad-nosed Bat (*Scotorepens greyii*). In Low Hill habitat four bat species were recorded: Lesser Long-eared Bat, Little Broad-nosed Bat, Gould's Wattled Bat and Finlayson's Cave Bat. The conservation significant Pilbara Leaf-nosed Bat, *Rhinonicteris aurantia* (vulnerable under EPBC Act and S1 under the WC Act) and the Ghost Bat, *Macroderma gigas* (P4), were not recorded during this study.

3.4 DATA ANALYSIS

The species accumulation curves for reptiles and birds are illustrated in Figure 7. The species accumulation curve was approaching an asymptote for birds recorded systematically on sites (Figure 7). The number of bird species recorded (51 spp) was 90.4% of the mean expected species richness (56.4 spp). This is based on the mean of eight species richness accumulators and indicates a relatively complete bird survey. Bird species accumulated at a greater rate than reptiles, but reptiles (43 species) continued to accumulate throughout the survey (with little evidence of an asymptote) with 81.9% of the expected species (52.5 species) recorded. There were more than three times as many individual bird species recorded (972 individuals) compared to reptiles (296 individuals). The accumulation of individual birds was at a greater rate than the accumulation of reptile individuals (Figure 7).

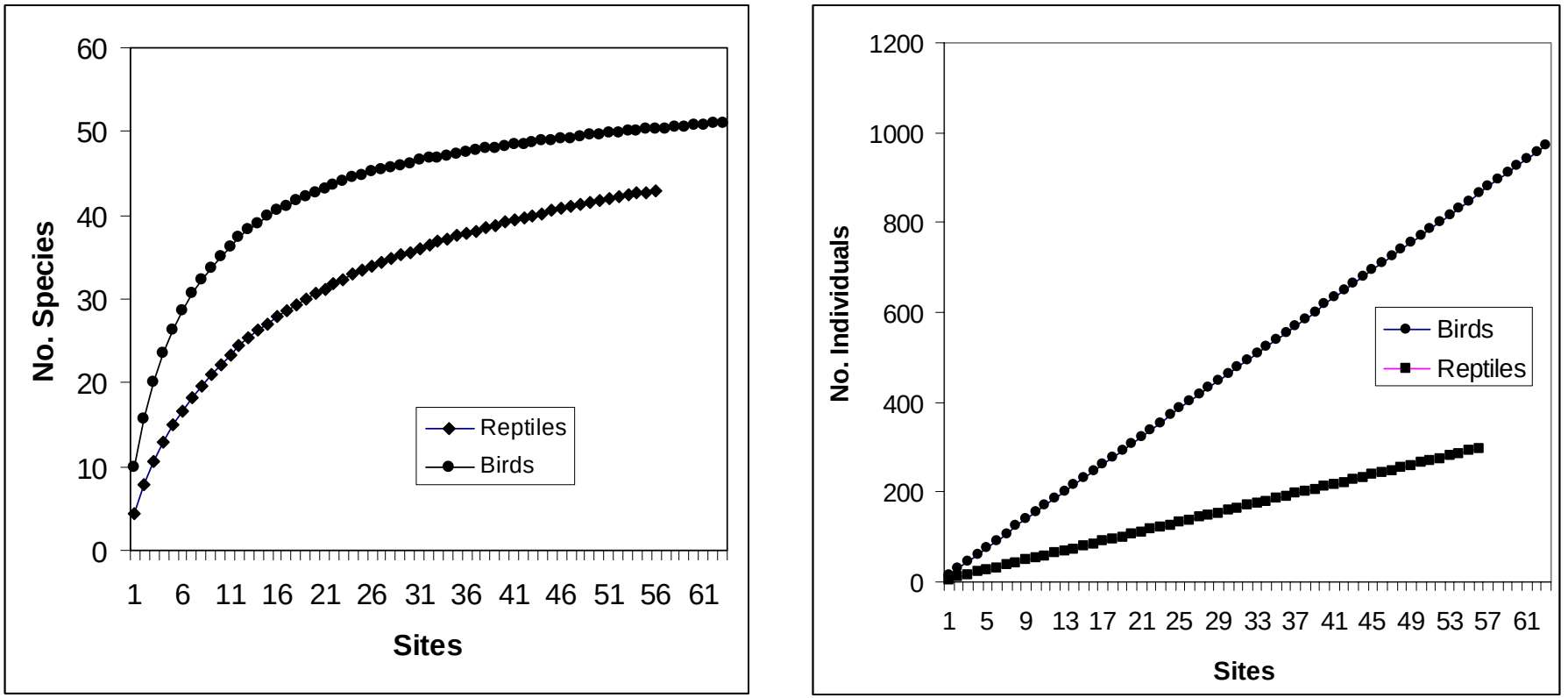


Figure 7. Species accumulation curves for reptiles and birds (left) and accumulation of individual reptiles and birds (right).

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Plate 1. Photographs of common reptiles and frogs recorded during the survey: Photo 1-Rock Ctenotus (*Ctenotus saxatilis*), Photo 2-Leopard Ctenotus (*C. pantherinus*), Photo 3-Broad-banded Sand-swimmer (*Eremiascincus richardsonii*), Photo 4-Spinifex Slender Blue-tongue (*Cyclodomorphus melanops*), Photo 5-*Strophurus wellingtonae*, Photo 6-Gecko *Lucasium wombeyi*, Photo 7-Pygmy Python (*Antaresia perthensis*), Photo 8-North-western Shovel-nosed Snake (*Brachyurophis approximans*), Photo 9-Main's Frog (*Cyclorana maini*), and Photo 10-Red Tree Frog (*Litoria rubella*).


Photo 1


Photo 2


Photo 3


Photo 4


Photo 5


Photo 6


Photo 7


Photo 8


Photo 9

Plate 2. Photographs of common birds recorded at Christmas Creek, from top left to clockwise: Photo 1-Spinifex Pigeon (*Geophaps plumifera*), Photo 2-Diamond Dove (*Geopelia cuneata*), Photo 3-Galah (*Cacatua roseicapilla*), Photo 4-White-winged Triller (*Lalage tricolor*), Photo 5-Black-faced Woodswallow (*Artamus cinereus),* Photo 6-White-plumed Honeyeater (*Lichenostomus penicillatus*), Photo 7-Yellow-throated Miner (*Manorina flavigula*), Photo 8-Painted Finch (*Emblema pictum*), Photo 9-Zebra Finch (*Taeniopygia guttata*) (photographed on Christmas Creek.)

3.5 COMPARISON WITH OTHER SURVEYS IN THE VICINITY OF CHRISTMAS CREEK

A large proportion of the vertebrate fauna recorded during the field survey has been recorded previously in the vicinity of Christmas Creek. One frog species (Douglas's Toadlet) was not recovered from the database search and appears to be the first record from the vicinity of Christmas Creek. Of the 60 bird species recorded, all had previously been recorded during a Pilbara wide survey (Burbidge *et al.* 2010) except for Eurasian Coot (*Fulica atra*) and Banded Lapwing (*Vanellus tricolor*). Both of these waterbird/shorebird species are known to range widely following rain and to use wetland habitat. Of the 45 reptile species recorded, four species (Mulga Dragon *Caimanops amphiboluroide*s, *Diplodactylus pulcher*, *Delma elegans* and *Lerista timida*) are new records for the Christmas Creek area.

Many vertebrate fauna surveys have been conducted in the vicinity of Christmas Creek, including at nearby Cloudbreak and the Fortescue Marsh (Table 2 and Table 7). In comparison with these studies, the present survey recorded a relatively rich frog and reptile fauna, but was notably low in bird and mammal species. Several of the previous studies recorded many small mammals during trapping, but in this field survey, only two small mammal species were recorded (House Mouse and *Planigale* sp.)

Table 7. Comparison of overall vertebrate fauna composition for the Christmas Creek region.

	Frogs	Reptiles	Birds	Mammals	Total
Current study	4	45	60	11	120
Biota (2004)	6	58	84	25	173
Biota (2005) Stage B Rail	2	42	105	26	175
Davis *et al.* (2005) Cloudbreak	1	28	99	25	153
Bamford (2010) Night Parrot	1	5	137	8	151
ENV (2009). Christmas Creek	0	12	24	6	42
ENV (2010). Roy Hill	0	19	62	11	92
ENV (2011b). Christmas Creek Airstrip	1	3	42	1	47
Ecologia (2011) Cloudbreak	1	47	63	17	128

Conservation significant species recorded in these previous studies include Australian Bustard, Western Pebble-mound Mouse, Rainbow Bee-eater, Western Star Finch, Bush Stone Curlew (*Burhinus grallarius*) and Short-tailed Mouse (*Leggadina lakedownensis*). The most notable records from previous studies are those of EPBC listed species the Night Parrot (*Pezoporus occidentalis*) at Minga Well in the vicinity of the Fortescue Marsh (Davis *et al.* 2005, Davis and Metcalf 2008), scats of Northern Quoll (*Dasyurus hallucatus*) at the edge of Cloudbreak airstrip (ATA Environmental 2006) and diggings of Bilby (*Macrotis lagotis*) to the east of Cloudbreak (Davis *et al.* 2005). None of these EPBC listed species have been previously recorded, or evidence found for the Christmas Creek study area.

3.6 CONSERVATION SIGNIFICANT FAUNA

Twenty three conservation significant species have been recorded from the vicinity of the study area (Appendix B). Of these, four were recorded during the current survey, nine species were deemed as 'likely' to occur, nine species were deemed as 'possibly' occurring and one species deemed as 'highly unlikely' to occur within the study area (see Appendix F for definitions).

Four species of conservation significance were recorded within the study area, the Pilbara Olive Python, Australian Bustard, Western Star Finch and the Rainbow Bee-eater (Appendix G). A single Pilbara Olive Python was opportunistically recorded on the haul road of the study area, adjacent to Drainage Line habitat. A total of nine Australian Bustards were recorded as singles or pairs at five different locations in the study area. These were observed in a range of habitats including Drainage Line and Alluvial Plain, and Stony Plain habitat. Approximately 10 Western Star Finch were opportunistically recorded as pairs and small mixed-species flocks with Zebra Finch in the Drainage Line and Alluvial Plain habitat. The Rainbow Bee-eater was recorded daily, in all habitats, throughout the study area. It is unclear whether these were part of a resident breeding population (which is present in the Pilbara) or whether they are part of the migratory population that travels north to tropical regions during each southern winter, as no nests were observed during the survey.

Potential suitable shelter/ denning habitat for the Northern Quoll is highly restricted in the study area, with only 74 ha of gorge and hill habitat identified in the northeast of the study area (Figure 8). In the Pilbara the Northern Quoll is typically restricted to gorge and hill habitat because it utilises small caves, crevices and/or boulder piles as den and shelter sites. It will also utilise hollows in large trees (if available) such as those that line the banks of large creek systems (which are absent from the study area).

4 DISCUSSION

The composition and current status of the vertebrate fauna of the Pilbara is relatively well known as a result of a number of recent systematic regional fauna surveys (Gibson and McKenzie 2009, McKenzie and Bullen 2009, Burbidge *et al.* 2010), and numerous surveys by consultants. There have been many vertebrate fauna studies in the vicinity of Christmas Creek, the adjacent Cloudbreak mine and surrounds of Fortescue Marsh (see Table 2, Table 7, and Figure 4).

Compared to other IBRA bioregions in Australia, the vertebrate fauna of the Pilbara is characterised by a species-poor amphibian fauna, is one of the richest bioregions for reptiles (>200 species), and has moderate levels of bird and mammal species richness (Atlas of Living Australia 2011). Since European settlement, between 18-31% of mammal species in the Pilbara have become regionally extinct (Abbott 2009, Baynes and McDowell 2010). Habitat loss is considered to be the main threat to fauna species in the Pilbara (Evans *et al.* 2011). Due to habitat degradation by cattle grazing and changed fire regimes (van Vreeswyk *et al.* 2004), and predation by introduced predators such as cats and foxes, are typically implicated in the decline of many conservation significant species known from the Pilbara (Abbott 2009).

The vertebrate fauna survey was adequate to record most reptiles (81.9% of the expected species) and birds (90.4%) but there were too few amphibians and mammals recorded to subject this data to species estimation analysis. A total of 120 terrestrial vertebrate fauna species were recorded during the survey. All of these species are typical of the Pilbara and almost all have been recorded previously.

Of the 120 vertebrate fauna species recorded, seven appear to be new records for the Christmas Creek area. Four reptile species (Mulga Dragon *Caimanops amphiboluroides*, *Diplodactylus pulcher*, *Delma butleri* and *Lerista timida* (previously listed within the *Lerista muelleri* complex) appear to be the first records for the Christmas Creek area. Recordings of the Pallid Long-eared Bat are new for the Christmas Creek area. These species occur widely in the Pilbara and although previously unrecorded, would be expected for the study area, based on knowledge of their habitat use and regional distribution patterns. It is likely that the reason only a few new species were recorded during this survey, is due to the relatively high number of biological surveys previously conducted in the study area and its surrounds (Biota 2004, Bamford 2005, Biota 2005, ATA Environmental 2006, and Ecologia 2011). The records of four amphibian species, including one species not previously listed (Douglas's Toadlet) for the Christmas Creek area, indicates a relatively comprehensive survey for this group, and attests to the above average rainfall before and at the time of the survey, which increases amphibian activity.

Habitat Types

Four major habitat types (Drainage Line and Alluvial Plain, Low Hill, Stony Plain and Marsh) were recorded in the study area. These broad habitat classes are widespread throughout the Pilbara (see Table 1 and Table 6) and are typically disturbed throughout the region by cattle grazing, fire, and more locally by mining activities and associated infrastructure. Each of these habitats hosts subtly different faunas.

Drainage Line and Alluvial Plain habitat was the richest for birds, but there were few species of conservation significance. This habitat type is known to support populations of the Western Star Finch. Reptiles were abundant in most habitats except Stony Plain. It is notable that of the 43 reptile species recorded during systematic sampling, none were conservation significant species. The Pilbara Olive Python was opportunistically observed in Drainage Line habitat. This habitat was rich in fauna species and hosted large amphibian populations. Access to the Marsh habitat was restricted due to flooding and high rainfall at the time of survey. The Marsh has been identified as potential Bilby habitat (Ecologia 2010). It is listed on the Australian Heritage Commission Register of the National Estate as an "Indicative Place", and in the *Directory of Important Wetlands in Australia* as a wetland of national and regional significance (Kendrick 2001; DEWPaC 2012).

Conservation Significant Fauna

Four vertebrate species of conservation significance were recorded in the study area, namely the Pilbara Olive Python, Australian Bustard, Western Star Finch and the Rainbow Bee-eater. The Pilbara Olive Python is listed as Vulnerable under the EPBC Act and is classified as Schedule 1 under the WC Act. The Australian Bustard and the Western Star Finch are rated as Priority 4 on the DEC priority list and the Rainbow Bee-eater is Migratory under the EPBC Act, and the WC Act (Schedule 3).

Pilbara Olive Python

The Pilbara Olive Python occurs in the rocky ranges of the Pilbara typically in escarpments, gorges, drainage lines and water holes (Pearson 1993). Such areas attract adequately sized prey (Pearson 2003). This large python is thought to be threatened because it has a small distribution, occurs in low population densities and may be affected by habitat disturbance such as grazing and fire. Although a Pilbara Olive Python was recorded adjacent to the Drainage Line habitat, it is notable that this is not the typical rocky habitat preferred by this species and it was thought to be observed dispersing or travelling through the area. As this species' preferred habitat does not occur in the study area it is unlikely to be impacted by further development in this area. The Pilbara Olive Python was not recorded from the vicinity of Christmas Creek during recent surveys (Biota 2005, Davis *et al*. 2005, ATA Environmental 2006, and Ecologia 2011).

Australian Bustard

The Australian Bustard is a wide ranging species that is distributed over the majority of northern and central Australia (Barrett *et al.* 2003, Ziembicki 2010) and has frequently been recorded in the vicinity of the study area (DEC 2011c, Ecologia 2011, Biota 2005, Bamford 2005, 2010). Australian Bustards have a broad preference for open habitats, ranging from open grassland plains to low shrublands and grassy open woodlands (Ziembicki 2010). It is a highly mobile species, which appears to be irruptive in relation to climate fluctuations, especially rainfall, and bushfires (Ziembicki 2010) therefore, any disturbances to the fauna habitats in the study area are unlikely to impact this species significantly in the local or regional setting. They can use very large home-ranges of up to about 10,000 km^2 (Ziembicki 2010).

Western Star Finch

The Western Star Finch is confined to the Pilbara region of Western Australia (Pizzey and Knight 2007) and typically inhabits areas of permanent water, including the Fortescue Marsh (Bamford 2010). This small finch drinks daily and generally breeds near water. The Western Star Finch was recorded in the Drainage Line habitat and has been previously recorded in the vicinity of the study area (Davis *et al.* 2005, Bamford 2010). It is a highly mobile species thus any disturbances to the fauna habitats in the study area are unlikely to significantly impact this species in the region, as a whole.

Rainbow Bee-eater

Despite having 'migratory' status under the *EPBC Act* the Rainbow Bee-eater is widespread bird of Australia and is commonly recorded during surveys in the Pilbara (Burbidge *et al.* 2010). The 'migratory' status for the species reflects the movement patterns of certain individuals (namely those found in the south-west) whom extend north into regions of northern Australia, Papua New Guinea and Indonesia during the non-breeding season (Johnstone & Storr 1998).The Rainbow Bee-eater was recorded in five of the nine sites during the survey. The Rainbow Bee-eater is a highly mobile species therefore any disturbances to the fauna habitats in the study area are unlikely to significantly impact this species in the region as a whole.

Conservation Significant Fauna Species Likely to Occur

Visiting and resident birds

The nine species classified in this study as 'Likely' to occur in the study area (Appendix F) are the Cattle Egret (*Ardea ibis*), Eastern Great Egret (*Ardea modesta*), Grey Falcon (*Falco hypoleucos*), Peregrine Falcon (*Falco peregrinus*), Bush Stone-curlew (*Burhinus grallarius*), Wood Sandpiper (*Tringa glareola*), Common Greenshank (*Tringa nebularia*), Short-tailed Mouse (*Leggadina lakedownensis*) and Western Pebble-mound Mouse (*Pseudomys chapmani*). All of these species, except the Short-tailed Mouse and Western Pebble-mound Mouse, are wide ranging migratory or nomadic birds that have high dispersal abilities and are unlikely to

rely particularly on habitats within the study area. The Wood Sandpiper and Common Greenshank are Palaearctic winter migrants, which could occur anywhere in Australia during the migration period (Geering *et al*. 2007). These migrants, as well as Cattle Egret and Eastern Great Egret are nomadic and would be expected to mainly use the Fortescue Marsh (wetland) habitat which is unlikely to be impacted by the mining development. Therefore, these species are not expected to be impacted by disturbances in the study area.

Short-tailed Mouse and Western Pebble-mound Mouse

The Short-tailed Mouse and Western Pebble-mound Mouse are more likely to be impacted by developments because they are resident species, with small home ranges and poor dispersal capabilities. Both species have been recorded in the study area during a previous survey (Biota 2005) but the majority of these records occurred outside of the study area. These species are found broadly across the Pilbara and therefore the loss of habitat within the study area is unlikely to impact these species' overall conservation status.

Conservation Significant Fauna Species Possible to Occur

A total of nine conservation significant species were considered to 'Possibly' occur within the study area (Appendix F).

Ramphotyphlops ganei

The ecology and habitat requirements of the blind snake *Ramphotyphlops ganei* are poorly known, but it is a Pilbara endemic with records between Newman and Pannawonica (Wilson and Swan 2010). There have been no records of this species during surveys in the vicinity of Christmas Creek (Biota 2005, Davis *et al*. 2005, ATA Environmental 2006, and Ecologia 2011). It may be associated with moist gorges and gullies according to Wilson and Swan (2010), and therefore if present, may occur in Low Hill habitat in the north of the study area.

Migratory birds

The Fork-tailed Swift (*Apus pacificus*) is a Palearctic winter migrant to Australia which would be expected to occur throughout Australia (Barrett *et al*. 2003). As an aerial species, the Fork-tailed Swift is unlikely to be impacted by terrestrial disturbances. The White-bellied Sea-eagle (*Haliaeetus leucogaster*) is listed on the EPBC Act as migratory, although it is typically a resident species through coastal Australia and inland rivers (Simpson and Day 2004). There are records of this eagle from along the Fortescue River at Roy Hill (Bamford 2010) and it would be expected at the Fortescue Marsh, but is unlikely to ever use the study area. The Oriental Plover (*Charadrius veredus*) is a Palearctic migratory shorebird that more frequently uses dry short grass habitat than most other shorebirds that visit Australia during the northern winter. During migration it could occur anywhere in Australia, but may prefer sparsely vegetated plains and samphire (Johnstone and Storr 1998). The occurrence of the Fork-tailed Swift, migrant shorebirds and waterbirds is infrequent and haphazard in the Pilbara in general, because of the lack of extensive suitable habitat (except, the Fortescue

Marsh). Any disturbances in the study area are unlikely to impact populations of these species.

Northern Quoll

There have been very few records of Northern Quoll (*Dasyurus hallucatus*) in the vicinity of Christmas Creek, the only confirmed record is a specimen collected near Cloudbreak in 1980 (DEC 2011c), with more recent records of scats collected near the Cloudbreak airstrip (ATA Environmental 2006) which lies about 8 km from the western most Christmas Creek tenement boundary. A targeted survey for the Northern Quoll at Christmas Creek did not record any evidence of this species (Appendix C). If the Northern Quoll was to occur in the Christmas Creek area, it may occur in areas of Low Hill terrain with relatively high relief including breakaway and gorge habitat which is highly limited in the study area. This gorge and breakaway habitat contains some rock crevices and small shallow caves that may provide shelter/den areas for the Northern Quoll. This habitat covers approximately 74 ha within the study area (Figure 8). Northern Quolls are known to prefer rocky habitat (Oakwood 2002; van Dyck & Strahan 2008) and have been previously recorded from this habitat within the Pilbara region (Biota 2009). Given the nearby records of scats of the Northern Quoll it is possible for the species to occur on the Christmas Creek lease. However, the lack of records or evidence from recent surveys of the Northern Quoll in the Christmas Creek lease, suggest that if present, Northern Quolls are in very low abundance.

Mulgara

The Brush-tailed Mulgara (*Dasycercus blythi*) has only recently been reclassified and separated from the genetically and morphologically distinct Crest-tailed Mulgara (*Dasycercus cristicauda*; *EPBC Act*: Vulnerable) (Woolley 2005, 2006). As such previous records did not distinguish between the two species; there is some ambiguity over the precise distribution of both species which is repeated in published distribution maps in textbooks (van Dyck and Strahan 2008). This was confirmed by the recent verification (by genetic analysis) of the presence of a population of Crest-tailed Mulgara about 100 km southeast of Newman (Phoenix Environmental Sciences 2011). There are previously unconfirmed reports of Mulgara from the vicinity of Cloudbreak airstrip (ATA Environmental 2006), and unconfirmed reports of indirect signs along the Stage B rail corridor on sandplain habitat (Biota Environmental Sciences 2005). Mulgara are known to inhabit spinifex grasslands over sandy soils which are used to dig day-time burrows. This habitat is however limited and restricted to the Marsh areas of the Christmas Creek study area. Past observations suggest that Mulgara could possibly occur in the study area, but the lack of confirmed records for the area indicates that it is most likely to be absent. Brush-tailed Mulgara has been previously recorded within 40 km of the study area (DEC 2011c).

Bilby

There were no sightings of Bilby (*Macrotis lagotis*) activity (diggings or scratchings) during the survey. ENV was commissioned in December 2011 to undertake an additional assessment with Rick Southgate (Bilby expert) on what had formerly been identified as Bilby diggings by

Ecoscape (2009) and ATA Environmental (2006). The location of 25 fauna diggings was assessed in addition to a 200 m x 100 m quadrat surrounding the point location of each digging. The assessment concluded that it was highly unlikely that any of the previous diggings belonged to the Bilby. In addition no signs such as burrows, tracks and scats of the Bilby were found. Bilbies occupy a variety of habitats, particularly desert with hummock grassland (Southgate *et al.* 2007; Johnson 2008). Despite a lack of ideal Bilby habitat within the study area, there remains previous records of Bilbies within the general area (DEC 2011c; Thompson & Thompson 2008) and as such it is possible for the Bilby to exist within the study area.

Ghost Bat

The Ghost Bat is mostly absent from the Fortescue sub-region with no known roosts (Armstrong and Anstee 2000), but there was a mist-net capture of one individual on the Fortescue Marsh by Bamford (2010). Suitable caves for Ghost Bat appear to be absent from the vicinity of Christmas Creek, but occasionally young bats might disperse between roosts in the Hamersley and Chichester IBRA-sub regions.

Pilbara Leaf-nosed Bat

There appear to be no suitable roosts for the Pilbara Leaf-nosed Bat in the vicinity of Christmas Creek, and there are no previous records of this bat from near Christmas Creek. This bat can forage up to about 10-15 km from a roost (Bob Bullen *pers. comm*.) and it is therefore possible that the bat could fly into the study area from a roost located outside the study area. This bat forages in open vegetation (Bullen & McKenzie 2002) including hummock grasslands over low rolling hills, shallow gullies and along creeks and watercourses (Armstrong 2001).

Night Parrot

The Night Parrot (*Pezoporus occidentalis*) was considered Highly Unlikely to occur in the study area. This is one of Australia's most poorly known birds, with about 30 records throughout much of central Australia during the past 130 years (Garnett *et al.* 2011). There has only been one 'confirmed' Pilbara record, in April 2005 with the observation of a single bird at Minga Well on the Fortescue Marsh (Davis *et al.* 2008). Despite the lack of information on the ecology of the Night Parrot, it is considered Endangered in the *EPBC Act* and *The Action Plan for Australian Birds* (Garnett *et al.* 2011). This species is considered as Highly Unlikely to occur in the vicinity of Christmas Creek, which is moderated by the total lack of information regarding the habitat preferences of the species. At least six surveys, totaling more than 280 person-days of effort has failed to record the Night Parrot in and about Minga Well since the initial record (Bamford 2010).

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FIGURES

620000 720000 820000 920000

7600000 7500000 7400000

Wittenoom

Munjina

Roy Hill

Karijini National Park

Karijini National Park

Fortescue Marsh

BHP RIO

Road

Newman

Road

Port Hedland

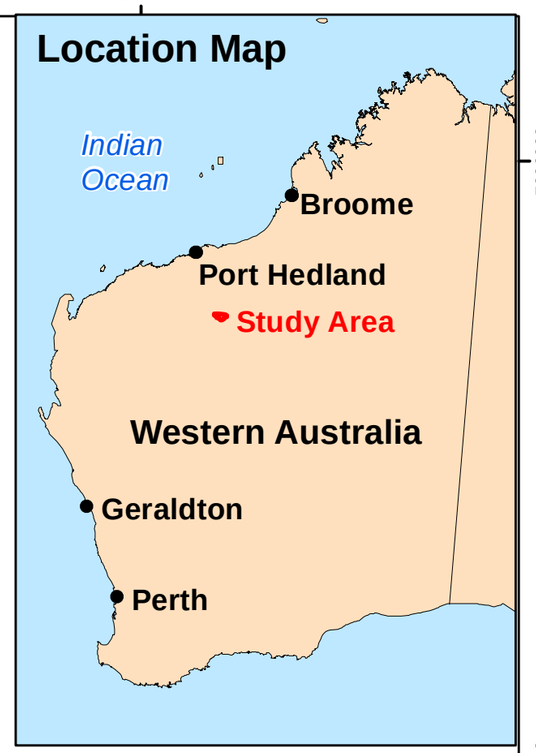
Railway

Great Northern Highway

Marble Bar Road

Newman

Location Map



Legend

- Christmas Creek Study Area
- Tracks
- Roads
- Railway
- National Parks and Reserves
- Fortescue Marsh

CLIENT		JOB NO.	
Fortescue Metals Group Ltd		J100459	
AUTHOR	DRAWN	DATE	
J. Trainer	M. Mikkonen	26-04-2012	
SCALE		PROJECTION	
1:1,000,000 @ A3		GDA 94 MGA 50	

env Australia

N

0 20 40

Kilometres

Regional Location

Christmas Creek Study Area Terrestrial Vertebrate Fauna and Fauna Habitat Assessment

FIGURE 1

760000 770000 780000 790000 800000

7530000 7520000 7510000

AB 2 HA8 HA6 HA5 HA7 AB 9 AB 10 HA9 AB 1 HA4 AB 6 AB 5 AB 8 AB 7 AB 3 AB 4 HA2 HA3 HA1

Legend

Christmas Creek Study Area

Opportunistic search

Trap Site Location

AnaBat Locations

Anabat Phase 1

Anabat Phase 2

Habitat Type

Drainage Line and Alluvial Plain

Low Hill

Marsh

Stony Plain

Cleared or Developed

env Australia

CLIENT	Fortescue Metals Group Ltd
JOB NO.	J100459
AUTHOR	J. Trainer
DRAWN	M. Mikkonen
DATE	5-06-2012
SCALE	1:120,000 @ A3
PROJECTION	GDA 94 MGA 50

N

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Kilometres

Habitat Map and Survey Summary

Christmas Creek Study Area Terrestrial Vertebrate Fauna and Fauna Habitat Assessment

FIGURE 3

760000 770000 780000 790000 800000

7530000 7520000 7510000

Legend

Source of Location

- Present study
- Coffey
- ENV.Australia (2009)
- Appendix C
- Ecoscape (2009)
- FMG
- Source – not given

Fauna Species

- Australian Bustard
- Ghost Bat (possible roost)
- Peregrine Falcon
- Pilbara Olive Python
- Rainbow Bee-eater
- Western Pebble-Mound mouse
- Western Star Finch

env Australia

CLIENT: Fortescue Metals Group Ltd
JOB NO.: J100459
AUTHOR: J. Trainer
DRAWN: T. Ellis
DATE: 27-09-2012
SCALE: 1:120,000 @ A3
PROJECTION: GDA 94 MGA 50

N

0 2 4 6
Kilometres

Location of Conservation Significant Fauna Species

Christmas Creek Study Area Terrestrial Vertebrate Fauna and Fauna Habitat Assessment

FIGURE 4

760000 770000 780000 790000 800000

7530000

7520000

7510000

Potential Shelter/Den Habitat for the Northern Quoll

Legend

- Christmas Creek Study Area
- Potential Shelter/Den Habitat

env Australia

CLIENT	Fortescue Metals Group Ltd
AUTHOR	J. Trainer
DRAWN	M. Mikkonen
SCALE	1:120,000 @ A3
JOB NO.	J100459
DATE	11-07-2012
PROJECTION	GDA 94 MGA 50

N

0 2 4 6

Kilometres

Potential Critical Habitat for the Northern Quoll

Christmas Creek Study Area Terrestrial Vertebrate Fauna and Fauna Habitat Assessment

FIGURE **8**

APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

CHRISTMAS CREEK VERTEBRATE FAUNA AND FAUNA HABITAT ASSESSMENT APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

A1: *Environment Protection and Biodiversity Conservation Act 1999* (*Cth*): Threatened Species and Threatened Ecological Communities Codes

The *EPBC Act* prescribes seven matters of national environmental significance:-

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance;
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Species in the categories ExW, CE, E, V and M (see below), and Threatened Ecological Communities in the CE and E categories are protected as matters of national environmental significance under the *EPBC Act*.

Category	Code	Category
Extinct	Ex	Taxa for which there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	ExW	Taxa known to survive only in cultivation, in captivity or as a naturalised population well outside its past range; or not recorded in its known and/or expected habitat at appropriate seasons anywhere in its past range despite exhaustive surveys over a timeframe appropriate to its life cycle and form.
Critically Endangered	CE	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	E	Taxa not critically endangered and facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Vulnerable	V	Taxa not critically endangered or endangered and facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	CD	Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within five years.

Category	Code	Category
Migratory	Mi	Taxa that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations, that are included in an international agreement approved by the Minister for the Environment, Heritage and the Arts and that have been placed on the national List of Migratory Species under the provisions of the EPBC Act. At present there are four such agreements: • the Bonn Convention • the China-Australia Migratory Bird Agreement (CAMBA) • the Japan-Australia Migratory Bird Agreement (JAMBA) • the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Marine	Ma	Taxa protected in a Commonwealth Marine Protected Area by virtue of section 248 of the *EPBC Act*. These taxa include certain seals, crocodiles, turtles and birds, as well as various marine fish. Commonwealth marine areas are matters of national environmental significance under the *EPBC Act*. An action will require approval if the: • action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or • action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area[1] The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters. The Commonwealth marine area stretches from 3 to 200 nautical miles (approximately 5-370 km) from the coast. Marine protected areas are marine areas which are recognised to have high conservation value.

A2: Western Australian Threatened Fauna Categories

Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

A3: Department of Environment and Conservation Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX B

PREVIOUSLY RECORDED FAUNA SPECIES AND THOSE RECORDED DURING THE SURVEY

APPENDIX B

B1: AMPHIBIAN SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = DEC Protected Matters Search, B= Listed in Naturemap, C = Listed by Birds Australia, D= EPBC Protected Matters search, E= Previous Fauna Surveys (<50 km), F= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

AMPHIBIANS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
HYLIDAE										
Cyclorana maini	Main's Frog					x				x
Cyclorana platycephala	Water-holding Frog					x				x
Litoria rubella	Little Red Tree Frog					x			x	x
MYOBATRACHIDAE										
Pseudophryne douglasi	Douglas's Toadlet									x
LIMNODYNASTIDAE										
Notaden nichollsi	Desert Spadefoot					x			x	

[X] fauna species recorded.
[*] denotes introduced species.

APPENDIX B

B2: REPTILIAN SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = DEC Protected Matters Search, B= Listed in Naturemap, C = Listed by Birds Australia, D= EPBC Protected Matters search, E= Previous Fauna Surveys (<50 km), F= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

REPTILES		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
CHELUIDAE										
Chelodina steindachneri	Plate-shelled Turtle					x			x	
AGAMIDAE										
Amphibolurus longirostris	Long-nosed Dragon					x			x	x
Caimanops amphiboluroides	Mulga Dragon									x
Ctenophorus caudicinctus caudicinctus	Ring-tailed Rock Dragon					x			x	x
Ctenophorus isolepis	Military Sand Dragon					x			x	
Ctenophorus nuchalis	Central Netted Dragon					x			x	
Ctenophorus reticulatus	Western Netted Dragon					x			x	
Pogona minor	Dwarf Bearded Dragon					x				x
Tympanocryptis cephala	Pebble Dragon					x				x
DIPLODACTYLIDAE										
Diplodactylus conspicillatus	Fat-tailed Gecko					x			x	x
Diplodactylus pulcher										x
Diplodactylus savagei	Southern Pilbara Beak-faced Gecko					x				x
Lucasium stenodactylum	Pale-snouted Ground Gecko					x				x
Lucasium wombeyi						x			x	x
Oedura marmorata	Marbled Velvet Gecko					x				
Rhynchoedura ornata	Beaked Gecko					x			x	x
Strophurus elderi	Jewelled Gecko					x			x	
Strophurus wellingtonae						x			x	x
CARPHODACTYLIDAE										
Nephrurus wheeleri cinctus						x				
GEKKONIDAE										
Gehyra punctata						x			x	x
Gehyra variegata						x			x	x

REPTILES		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
Heteronotia binoei	Bynoe's Gecko					x			x	x
Heteronotia spelea	Desert Cave Gecko					x			x	x
PYGOPODIDAE										
Delma butleri										x
Delma elegans						x				x
Delma haroldi						x				
Delma nasuta						x			x	x
Delma pax						x			x	x
Delma tincta						x				
Lialis burtonis	Burton's Snake-lizard					x			x	
Pygopus nigriceps	Western Hooded Scaly-foot					x			x	
SCINCIDAE										
Carlia munda						x			x	x
Carlia tricantha						x				
Cryptoblepharus plagiocephalus						x			x	
Ctenotus ariadnae									x	
Ctenotus atlas						x				
Ctenotus duricola						x				x
Ctenotus greeri						x				
Ctenotus hanloni									x	
Ctenotus helenae						x			x	
Ctenotus pantherinus	Leopard Ctenotus					x			x	x
Ctenotus piankai									x	
Ctenotus rubicundus									x	
Ctenotus saxatilis	Rock Ctenotus					x			x	x
Ctenotus uber						x				x
Cyclodomorphus melanops	Spinifex Slender Blue-tongue					x			x	x
Egernia formosa						x			x	
Eremiascincus richardsonii	Broad-banded Sand-swimmer					x				x
Lerista amicorum						x				
Lerista flammicauda						x				
Lerista macropisthopus						x			x	
Lerista muelleri						x			x	x
Lerista timida										x
Menetia greyii						x			x	
Menetia surda surda						x				
Morethia ruficauda						x			x	x
Notoscincus ornatus						x				

REPTILES		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
Proablepharus reginae						x				
Tiliqua multifasciata	Centralian Blue-tongue					x			x	x
VARANIDAE										
Varanus acanthurus	Spiny-tailed Monitor					x			x	x
Varanus brevicauda	Short-tailed Monitor					x			x	
Varanus bushi	Pilbara Mulga Monitor								x	
Varanus caudolineatus	Striped-tailed Monitor					x			x	
Varanus giganteus	Perentie								x	
Varanus gouldii	Gould's Sand Monitor					x			x	x
Varanus panoptes rubidus	Yellow-spotted Monitor					x			x	x
Varanus tristis tristis	Black-headed Monitor					x			x	x
TYPHLOPIDAE										
Ramphotyphlops ammodytes						x			x	x
Ramphotyphlops ganei				P1	x	x				
Ramphotyphlops grypus	Beaked Blind Snake					x			x	x
Ramphotyphlops hamatus						x				
BOIDAE										
Antaresia perthensis	Pygmy Python					x			x	x
Antaresia stimsoni stimsoni	Western Stimson's Python					x				
Aspidites melanocephalus	Black-headed Python								x	
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1					x		x
ELAPIDAE										
Acanthophis wellsi	Pilbara Death Adder					x				
Brachyurophis approximans	Northwestern Shovel-nosed Snake					x				x
Demansia psammophis cupreiceps	Yellow-faced Whip-Snake					x			x	x
Demansia rufescens	Rufous Whipsnake									x
Furina ornata	Moon Snake					x			x	x
Pseudechis australis	Mulga Snake					x			x	
Pseudonaja modesta	Ringed Brown Snake					x				
Pseudonaja nuchalis	Gwardar					x			x	x
Suta punctata	Spotted Snake					x			x	x

[X] fauna species recorded.
[*] denotes introduced species.

APPENDIX B

B3: AVIAN SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = DEC Protected Matters Search, B= Listed in Naturemap, C = Listed by Birds Australia, D= EPBC Protected Matters search, E= Previous Fauna Surveys (<50 km), F= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

BIRDS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
CASUARIIDAE										
Dromaius novaehollandiae	Emu					x	x		x	
PHASIANIDAE										
Coturnix ypsilophora	Brown Quail								x	x
ANATIDAE										
Anas gracilis	Grey Teal					x	x		x	
Anas superciliosa	Pacific Black Duck					x	x		x	x
Aythya australis	Hardhead						x			
Cygnus atratus	Black Swan								x	
Dendrocygna eytoni	Plumed Whistling Duck					x			x	x
Malacorhynchus membranaceus	Pink-eared Duck								x	
Tadorna tadornoides	Australian Shelduck						x		x	
PODICIPEDIDAE										
Poliocephalus Poliocephalus	Hoary-headed Grebe					x	x		x	
Tachybaptus novaehollandiae	Australasian Grebe					x	x		x	
COLUMBIDAE										
Geopelia cuneata	Diamond Dove					x	x		x	x
Geopelia placida	Peaceful Dove					x	x		x	
Geophaps plumifera	Spinifex Pigeon					x	x		x	x
Ocyphaps lophotes	Crested Pigeon					x	x		x	x
Phaps chalcoptera	Common Bronzewing					x			x	x
PODARGIDAE										
Podargus strigoides	Tawny Frogmouth					x	x		x	
CAPRIMULGIDAE										
Eurostopodus argus	Spotted Nightjar					x	x		x	
AEGOTHELIDAE										
Aegotheles cristatus	Australian Owlet-nightjar					x	x		x	
APODIDAE										
Apus pacificus	Fork-tailed Swift	Mi						x		
ANHINGIDAE										
Anhinga melanogatser	Darter					x	x		x	
PHALACROCORACIDAE										

BIRDS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
Phalacrocorax melanoleucos	Little Pied Cormorant						x		x	
Phalacrocorax sulcirostris	Little Black Cormorant						x			
PELECANIDAE										
Pelecanus conspicillatus	Australian Pelican	Ma				x	x		x	
CICONIIDAE										
Ephippiorhynchus asiaticus	Black-necked Stork					x	x			
ARDEIDAE										
Ardea ibis	Cattle Egret	Mi						x		
Ardea modesta	Eastern Great Egret	Mi				x	x	x	x	
Ardea pacifica	White-necked Heron					x	x		x	
Egretta novaehollandiae	White-faced Heron					x	x		x	
Nycticorax caledonicus	Nankeen Night Heron						x			
THRESKIORNITHIDAE										
Platalea flavipes	Yellow-billed Spoonbill					x			x	
Threskiornis spinicollis	Straw-necked Ibis					x	x		x	
ACCIPITRIDAE										
Accipiter cirrhocephalus	Collared Sparrowhawk					x	x		x	
Accipiter fasciatus	Brown Goshawk					x	x		x	
Aquila audax	Wedge-tailed Eagle					x	x		x	x
Circus assimilis	Spotted Harrier					x	x		x	
Circus approximans	Swamp Harrier					x				
Elanus axillaris	Black-shouldered Kite						x		x	
Haliaeetus leucogaster	White-bellied Sea Eagle	Mi				x			x	
Haliastur sphenurus	Whistling Kite					x	x		x	x
Hamirostra melanosternon	Black-breasted Buzzard						x		x	
Hieraaetus morphnoides	Little Eagle						x		x	
Lophoictinia isura	Square-tailed Kite					x			x	
Milvus migrans	Black Kite						x		x	x
FALCONIDAE										
Falco berigora	Brown Falcon					x	x		x	x
Falco cenchroides	Nankeen Kestrel					x	x		x	x
Falco hypoleucos	Grey Falcon			P4	x	x			x	
Falco longipennis	Australian Hobby					x	x		x	
Falco subniger	Black Falcon								x	
Falco peregrinus	Peregrine Falcon		S4		x	x	x		x	
RALLIDAE										
Fulica atra	Eurasian Coot						x		x	x
Gallinula ventralis	Black-tailed Native Hen								x	
Gallirallus philippensis	Buff-banded Rail					x				
OTIDAE										
Ardeotis australis	Australian Bustard			P4	x	x	x		x	x
TURNICIDAE										
Turnix velox	Little Button-quail					x	x		x	x
BURHINIDAE										

BIRDS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
Burhinus grallarius	Bush Stone-curlew			P4	x	x			x	
RECURVIROSTRIDAE										
Himantopus himantopus	Black-winged Stilt					x	x		x	
CHARADRIIDAE										
Charadrius veredus	Oriental Plover	Mi						x		
Elseyornis melanops	Black-fronted Dotterel					x	x		x	x
Erythrogonys cinctus	Red-kneed Dotterel					x			x	
Vanellus tricolor	Banded Lapwing					x			x	x
SCOLOPACIDAE										
Tringa glareola	Wood Sandpiper	Mi				x			x	
Tringa nebularia	Common Greenshank	Mi				x			x	
GLAREOLIDAE										
Stiltia isabella	Australian Pratincole					x			x	
CACATUIDAE										
Cacatua roseicapilla	Galah					x	x		x	x
Cacatua sanguinea	Little Corella					x	x		x	x
Nymphicus hollandicus	Cockatiel					x	x		x	x
PSITTACIDAE										
Barnardius zonarius	Australian Ringneck					x	x		x	x
Melopsittacus undulatus	Budgerigar					x	x		x	x
Neopsephotus bourkii	Bourke's Parrot					x			x	
Pezoporus occidentalis	Night Parrot	EN	S1					x	x	
CUCULIDAE										
Centropus phasianinus	Pheasant Coucal								x	
Chalcites basalis	Horsfield's Bronze-Cuckoo						x		x	
Chalcites osculans	Black-eared Cuckoo								x	x
Cuculus pallidus	Pallid Cuckoo						x		x	x
STRIGIDAE										
Ninox novaeseelandiae	Southern Boobook Owl					x	x		x	
TYTONIDAE										
Tyto javanica	Eastern Barn Owl								x	
HALCYONIDAE										
Dacelo leachii	Blue-winged Kookaburra					x	x		x	x
Todiramphus pyrrhopygia	Red-backed Kingfisher					x	x		x	x
Todiramphus sanctus	Sacred Kingfisher					x	x		x	x
MEROPIDAE										
Merops ornatus	Rainbow Bee-eater	Mi				x	x	x	x	x
PTILONORHYNCHIDAE										
Chlamydera guttata	Western Bowerbird						x		x	
MALURIDAE										
Amytornis striatus	Striated Grasswren					x				
Malurus lamberti	Variegated Fairy-wren					x	x		x	x
Malurus leucopterus	White-winged Fairy-wren					x	x		x	x
Stipiturus ruficeps	Rufous-crowned Emu-wren								x	

BIRDS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
ACANTHIZIDAE										
Acanthiza apicalis	Inland Thornbill					x			x	
Aphelocephala leucopsis	Southern Whiteface								x	
Acanthiza robustirostris	Slaty-backed Thornbill					x			x	
Acanthiza uropygialis	Chestnut-rumped Thornbill					x			x	
Calamanthus campestris	Rufous Fieldwren					x			x	
Gerygone fusca	Western Gerygone					x			x	x
Pyrrholaemus brunneus	Redthroat								x	
Smicrornis brevirostris	Weebill					x	x		x	x
PARDALOTIDAE										
Pardalotus rubricatus	Red-browed Pardalote					x	x		x	x
Pardalotus striatus	Striated Pardalote						x		x	
MELIPHAGIDAE										
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					x	x		x	x
Epthianura aurifrons	Orange Chat					x			x	
Epthianura tricolor	Crimson Chat					x	x		x	x
Certhionyx niger	Black Honeyeater					x	x		x	
Certhionyx variegatus	Pied Honeyeater					x	x		x	x
Lichenostomus keartlandi	Grey-headed Honeyeater					x	x		x	
Lichenostomus penicillatus	White-plumed Honeyeater					x	x		x	x
Lichenostomus plumulus	Grey-fronted Honeyeater						x		x	
Lichenostomus virescens	Singing Honeyeater					x	x		x	x
Lichmera indistincta	Brown Honeyeater					x	x		x	x
Manorina flavigula	Yellow-throated Miner					x	x		x	x
Melithreptus gularis	Black-chinned Honeyeater						x		x	
Phylidonyris albifrons	White-fronted Honeyeater						x			
POMATOSTOMIDAE										
Pomatostomus temporalis	Grey-crowned Babbler					x	x		x	x
Pomatostomus superciliosus	White-browed Babbler					x			x	
CINCLOSOMATIDAE										
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush					x	x			
Psophodes occidentalis	Chiming Wedgebill					x				
NEOSITTIDAE										
Daphoenositta chrysoptera	Varied Sittella					x			x	
CAMPEPHAGIDAE										
Coracina novaehollandiae	Black-faced Cuckoo-shrike					x	x		x	x
Coracina maxima	Ground Cuckoo-shrike								x	
Lalage tricolor	White-winged Triller					x	x		x	x
PACHYCEPHALIDAE										
Colluricincla harmonica	Grey Shrike-thrush					x	x		x	x
Oreoica gutturalis pallescens	Crested Bellbird					x			x	x
Pachycephala rufiventris	Rufous Whistler					x	x		x	x
ARTAMIDAE										
Artamus personatus	Masked Woodswallow					x	x		x	
Artamus superciliosus	White-browed Woodswallow						x		x	

BIRDS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
Artamus cinereus	Black-faced Woodswallow					x	x		x	x
Artamus minor	Little Woodswallow					x	x		x	
Cracticus torquatus	Grey Butcherbird						x		x	x
Cracticus nigrogularis	Pied Butcherbird					x	x		x	x
Gymnorhina tibicen	Australian Magpie					x	x		x	
Strepera graculina	Pied Currawong					x	x		x	
DICRURIDAE										
Grallina cyanoleuca	Magpie-Lark					x	x		x	x
Rhipidura fuliginosa	Grey Fantail								x	
Rhipidura leucophrys	Willie Wagtail					x	x		x	x
CORVIDAE										
Corvus bennetti	Little Crow					x	x		x	x
Corvus orru	Torresian Crow					x	x		x	x
PETROICIDAE										
Melanodryas cucullata	Hooded Robin					x	x		x	
Petroica goodenovii	Red-capped Robin					x	x		x	
ALAUIDAE										
Mirafra javanica	Singing Bushlark					x			x	x
SYLVIIDAE										
Acrocephalus australis	Australian Reed Warbler					x				
Cincloramphus mathewsi	Rufous Songlark					x	x		x	x
Cincloramphus cruralis	Brown Songlark					x	x		x	
Eremiornis carteri	Spinifex Bird					x			x	
HIRUNDINIDAE										
Cheramoeca leucosternus	White-backed Swallow						x			
Hirundo ariel	Fairy Martin					x	x		x	
Hirundo nigricans	Tree Martin						x		x	x
Hirundo neoxena	Welcome Swallow					x				
DICAEIDAE										
Dicaeum hirundinaceum	Mistletoebird					x	x		x	
ESTRILDIDAE										
Emblema pictum	Painted Finch					x	x		x	x
Neochmia ruficauda subclarescens	Star Finch			P4					x	x
Taeniopygia guttata	Zebra Finch					x	x		x	x
MOTACILLIDAE										
Anthus novaeseelandiae	Richard's Pipit					x	x		x	x

[X] fauna species recorded.
[*] denotes introduced species.

APPENDIX B

B4: MAMMALIAN SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = DEC Protected Matters Search, B= Listed in Naturemap, C = Listed by Birds Australia, D= EPBC Protected Matters search, E= Previous Fauna Surveys (<50 km), F= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

MAMMALS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
DASYURIDAE										
Dasycercus sp.	Mulgara			P4	x	x				
Dasykaluta rosamondae	Kaluta					x			x	
Dasyurus hallucatus	Northern Quoll	EN	S1		x	x		x		
Ningaui timealeyi	Pilbara Ningaui					x			x	
Planigale maculata	Common Planigale					x			x	
Planigale sp.									x	x
Sminthopsis macroura	Stripe-faced Dunnart					x			x	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart								x	
PHALANGERIDAE										
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum					x				
THYLACOMYIDAE										
Macrotis lagotis	Bilby	VU	S1					x	x	
MACROPODIDAE										
Macropus robustus	Common Wallaroo					x			x	
Macropus rufus	Red Kangaroo					x			x	
EMBALLONURIDAE										
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat								x	x
Taphozous georgianus	Common Sheath-tailed Bat								x	x
MEGADERMATIDAE										
Macroderma gigas	Ghost Bat			P4	x	x				
HIPPOSIDERIDAE										
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1					x		
VESPERTILIONIDAE										
Chalinolobus gouldii	Gould's Wattled Bat					x			x	x

MAMMALS		Conservation Codes								
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D	E	F
Nyctophilus daedalus	Pallid Long-eared Bat									x
Nyctophilus geoffroyi	Lesser Long-eared Bat								x	x
Scotorepens greyii	Little Broad-nosed Bat					x			x	x
Vespadelus finlaysoni	Finlayson's Cave Bat					x			x	x
MOLOSSIDAE										
Chaerephon jobensis	Northern Free-tailed Bat					x			x	x
Mormopterus beccarii	Beccari's Free-tailed Bat								x	
Tadarida australis	White-striped Free-tailed Bat					x			x	
MURIDAE										
Leggadina lakedownensis	Short-tailed Mouse			P4	x	x			x	
**Mus musculus*	House Mouse					x			x	x
Pseudomys chapmani	Western Pebble-mound Mouse			P4	x	x			x	
Pseudomys desertor	Desert Mouse					x			x	
Pseudomys hermannsburgensis	Sandy Inland Mouse					x			x	
Zyzomys argurus	Common Rock-rat					x			x	
LEPORIDAE										
**Oryctolagus cuniculus*	Rabbit					x		x		
CANIDAE										
Canis lupus	Dingo/Dog					x				
**Vulpes vulpes*	Fox								x	
FELIDAE										
**Felis catus*	Cat					x		x	x	
EQUIDAE										
**Equus asinus*	Donkey					x			x	
**Equus caballus*	Horse					x			x	
CAMELIDAE										
**Camelus dromedarius*	Camel								x	
BOVIDAE										
**Bos taurus*	European Cattle					x			x	x

[X] fauna species recorded.
[*] denotes introduced species.

APPENDIX C

ENV.AUSTRALIA - TARGETED FAUNA SURVEY OF THE CHRISTMAS CREEK LIFE OF MINE AREA

TARGETED FAUNA SURVEY OF THE CHRISTMAS CREEK STUDY AREA

TARGETED FAUNA SURVEY OF THE CHRISTMAS CREEK STUDY AREA

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Content Review:	*Denise True*
Date:	*12/07/12*

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Also it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to

any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

ENV will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned by Fortescue Metals Group Limited to undertake a Targeted Fauna Survey of the Christmas Creek Project Area (study area).

The primary aim of the survey was to verify the presence or absence of the Northern Quoll (*Dasyurus hallucatus*) in the study area. A secondary aim of the survey was to search for the Pilbara Olive Python (*Liasis olivaceus barroni*) and signs (pebble mounds) of the Western Pebble-mound Mouse (*Pseudomys chapmani*).

The field survey included a seven night trapping programme (cage and Elliott traps) and 19 hours of searches for signs of the Northern Quoll (faecal matter and latrine sites). Motion sensitive cameras were deployed for a total of eight nights. Searches for the Pilbara Olive Python and signs of the Western Pebble-mound Mouse were conducted, and nocturnal searches for the Northern Quoll and Pilbara Olive Python were conducted in the study area.

No Northern Quolls were captured in traps and no signs of the Northern Quoll were observed while walking transects and along the trapping transects. No images of the Northern Quoll were recorded by the motion sensitive cameras.

No Pilbara Olive Pythons or their signs were observed during searching in gorges/ gullies. No Northern Quolls or Pilbara Olive Pythons were observed during spotlighting.

A total of 75 Western Pebble-mound Mouse mounds were recorded, 11 of which were considered active and 64 were considered inactive.

Mapping of potential critical habitat (shelter/Den) for the Northern Quoll (*Dasyurus hallucatus*) was done to illustrate potential critical habitat in the study area, Potential denning habitat for the Northern Quoll was highly restricted (74 ha) to high relief gorge terrain in the northeast of the study area. The Pilbara Olive Python prefers gorges, drainage Lines and waterholes and this habitat covers 22,917 ha of the study area.

Despite a number of surveys and substantial effort (taking into account previous surveys) there is no evidence of the Northern Quoll occurring on the Christmas Creek Lease. The majority of the study area is not typical Northern Quoll habitat (rocky hills and gorges), and as such, disturbance and the clearing of habitat associated with the Mine should have little impact on the species locally, and little to no impact regionally.

There is currently only one known record of the Pilbara Olive Python on the Christmas Creek lease (observed during an associated ENV survey in 2011). The individual observed was most likely transiting through the area as it was observed crossing the road adjacent to a drainage line in a heavily disturbed area of the lease (main access road surrounded by mining activity) in stony plain habitat which is not its preferred habitat. The majority of the study area consists of stony plain habitat; therefore the clearing of this habitat type associated with mining activity should have little impact on the species locally and little to no impact

regionally. Accordingly there should be no significant impact on the species regionally as a result of mining in the study area.

Signs of the Western Pebble-mound Mouse have been previously recorded at Christmas Creek and adjacent areas, and active and inactive mounds were found to be widespread during this survey. This species also has a widespread distribution throughout the Pilbara. Given its widespread distribution, the clearing of habitat as a result of mining within the Christmas Creek study area will have no significant impact on the species locally or regionally.

1 INTRODUCTION

1.1 PURPOSE

ENV.Australia Pty Ltd (ENV) was commissioned by Fortescue Metals Group Limited (FMG) in July to undertake a targeted fauna survey of the Christmas Creek Project Area (study area).

1.1.1 Objectives

The primary objective of the survey was to verify the presence or absence of the Northern Quoll (*Dasyurus hallucatus)* in the study area. The Northern Quoll is a threatened species and listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and is listed as Schedule 1 (Fauna that is rare or likely to become extinct) under the *Wildlife Conservation (Specially Protected Fauna) Notice 2010*.

A secondary objective of the survey was to search for the Pilbara Olive Python (*Liasis olivaceus barroni*) and signs (pebble mounds) of the Western Pebble-mound Mouse (*Pseudomys chapmani*). The Pilbara Olive Python is a threatened species and listed as Vulnerable under the EPBC Act and is listed as Schedule 1 (Fauna that is rare or likely to become extinct) under the *Wildlife Conservation (Specially Protected Fauna) Notice 2010*. The Western Pebble-mound Mouse is listed as Priority 4 on the Department of Conservation and Environment (DEC) Priority list.

The work included a desktop review and field survey comprising:

- A review of relevant fauna databases for the region to collate historical records of the targeted species;
- Previous fauna surveys in the vicinity of the study area were collated and summarised;
- A trapping programme;
- Searches for signs of the Northern Quoll, particularly faecal matter and latrine sites;
- Searches for the Pilbara Olive Python and signs of the Western Pebble-mound Mouse; and
- Nocturnal searches for the Northern Quoll and Pilbara Olive Python in the study area.

1.1.2 Location

The project area is 67,737.6 hectares (ha) and located approximately 120 kilometres (km) north of the Newman town site within the Christmas Creek Mining tenement, in the Pilbara region of Western Australia (Figure 1).

1.2 ENVIRONMENTAL ATTRIBUTES

1.2.1 Climate

The Pilbara has an arid-tropical climate with two distinct seasons, a hot summer from October to April and a mild winter from May to September. The area experiences a wide temperature range, with an average annual maximum daytime temperature of 32°C (1996-2011). In summer, maximum daytime temperatures may reach 47°C, whilst in winter, minimum night time temperatures may fall to -2°C (BoM 2011).

Rainfall in the Pilbara is often sporadic and throughout the year (in summer and winter). The Newman area has an average annual rainfall of 319.3 mm (1971-2011) (BoM 2011) with most rainfall occurring during the summer months (Figure 2). Summer rainfall is typically associated with tropical storms in the north, or tropical cyclones that cross the coast and move inland. Winter rainfall is commonly the result of cold fronts moving north-easterly across the State.

For the three months preceding the survey Newman Airport received 47.2 mm (May 2011-July 2011), compared with the long-term average of 47 mm (1971-2011). Rainfall for the year to date (August 2010 to July 2011) was 427.6 mm compared with 319.3 mm for the long-term average for the same period (1971-2011). Overall, rainfall was above the long term average.

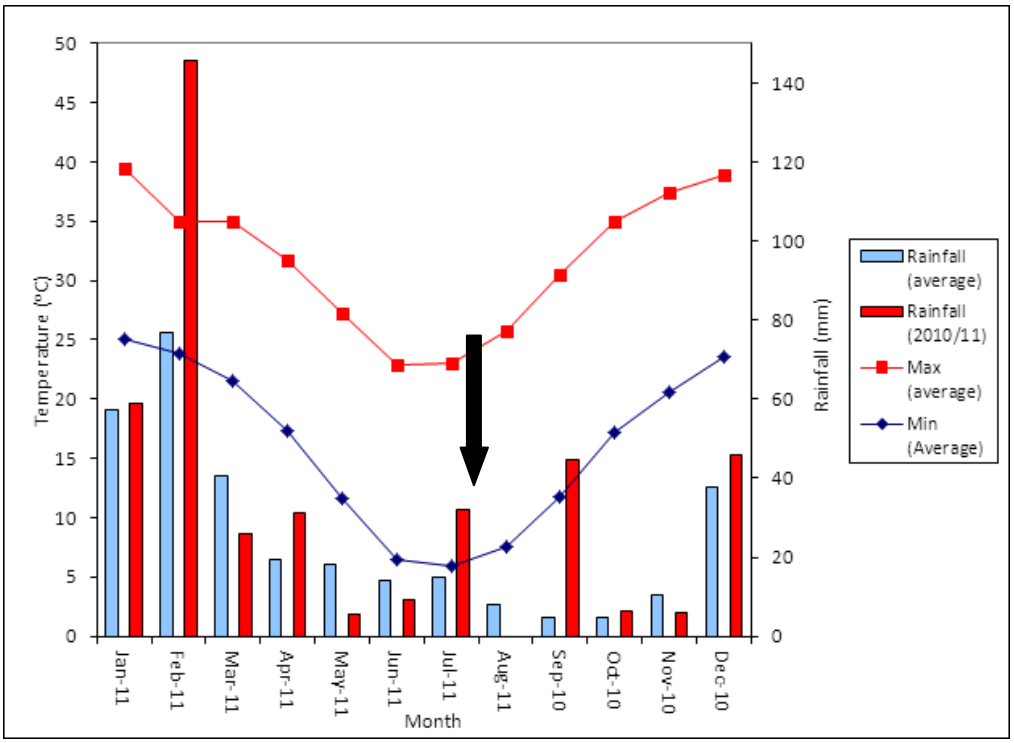

Figure 2: Average long-term (1971-2011) and 2010-2011 Monthly Rainfall and average Maximum and Minimum Temperatures at Newman Airport (BoM 2011). Arrow indicates when the survey was undertaken (28 July to 5 August 2011).

1.2.2 Interim Biogeographic Regionalisation for Australia

The Interim Biogeographic Regionalisation for Australia (IBRA) divided Australia into 85 bioregions based on major biological and geographical/geological attributes (Thackway and Cresswell 1995). These bioregions were further subdivided into 403 subregions, as part of a refinement of the IBRA framework (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] 2011a).

The study area is located on the border of the Chichester and Fortescue subregions of the Pilbara bioregion. The Chichester subregion is characterised by plains with a shrub steppe of *Acacia inaequilatera* over *Triodia wiseana* hummock grassland and *Eucalyptus leucophloia* tree steppe on rangelands (Kendrick and McKenzie 2001). The Fortescue subregion is characterised by alluvial plains with *Acacia aneura* over grass communities and *Eucalyptus camaldulensis* woodlands fringing drainage lines (Kendrick and McKenzie 2001).

1.2.3 Land Systems

Land system mapping is based on regional patterns in topography, soils and vegetation. The land system mapping classified the Pilbara region into 102 land systems (van Vreeswyk *et al.* 2004). The project area comprises nine land systems (Table 1).

Table 1: Land Systems of the Project Area

Land System	Description	Extent within Pilbara Region (km²)	Proportion of the Pilbara Region (%)	Extent within Project Area (km²)	Proportion within Project Area (%)
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and Mulga shrublands	7,748	4.3	4.06	0.05
Calcrete	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands	1,444	0.8	0.02	0.001
Cowra	Plains fringing the Marsh land system and supporting snakewood and Mulga shrublands with some halophytic undershrubs	203	0.1	47.77	23.53
Jamindie	Stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with spinifex understorey	2,074	1.1	139.85	6.74
Marsh	Lakebeds and flood plains subject to regular inundation, supporting samphire shrublands, salt water couch grasslands and halophytic shrublands	977	0.5	126.43	12.94
McKay	Hills, ridges, plateaux remnants	4,202	2.3	21.49	0.51

Land System	Description	Extent within Pilbara Region (km²)	Proportion of the Pilbara Region (%)	Extent within Project Area (km²)	Proportion within Project Area (%)
	and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands				
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands	14,580	8.0	145.54	1.00
Turee	Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands	581	0.3	166.11	28.59
Warri	Low calcrete platforms and plains supporting Mulga and cassia shrublands	305	0.2	6.75	2.21

1.2.4 Geology

The following geological units occur in the project area, based on mapping by the Geological Survey of Western Australia (1990):

Afj: Jeerinah Formation – pelite, chert, and thin-bedded meta sandstone; intruded by Metadolerite sills in the Hamersley Range

Qa: Alluvium – unconsolidated silt, sand and gravel: in drainage channels and on adjacent floodplains

Qw: Alluvium and colluvium – red-brown sandy and clayey soil; on low slopes and sheetwash areas

Qc: Colluvium – unconsolidated quartz and rock fragments in soil; locally derived soil, and scree, and talus deposits

AHm: Marra Mamba Formation: Chert, banded ironstone formation, and pelite

Czr: Hematite – goethite deposits on banded iron-formation and adjacent scree deposits

Czk: Calcrete – sheet carbonate; found along major drainage lines

Czc: Colluvium – partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits

1.2.5 Soils

The following soil units occur in the project area, based on mapping by Tille (2006):

282-Chichester Ranges: Hills and dissected plateaux (with some stony plains) on basalt and sedimentary rocks of the Hamersley Basin. Stony soils with some red shallow loams and hard cracking clays. Spinifex grasslands with Kanji and Snappy Gum (and some tussock grasslands).

284-Fortescue Valley: Alluvial plains, hardpan was plains and sandplains (with stony plains, floodplains and some salt lakes) on alluvial deposits over sedimentary rocks of the Hamersley Basin. Red deep sands, red loamy earths and red/brown non-cracking clays with some red shallow loams and hard cracking clays. Mulga shrublands and spinifex grasslands (with some tussock grasslands and halophytic shrublands).

1.2.6 Vegetation Mapping

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). The project area is situated in the Hamersley Plateau which forms a part of the Fortescue Botanical District in the Eremaean Botanical Province of Western Australia (Beard 1975). Beard mapped the project area as follows:

$a_2Sr.t^1{}_3Hi$ / 173: Hummock grasslands, shrub steppe; kanji over soft spinifex and *Triodia wiseana* on basalt

$a_1Li/e_{16}Lr.t_3Hi$ / 562: Mosaic: Low woodland; mulga in valleys / Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana*

a_1Lp / 29: Sparse low woodland; mulga, discontinuous in scattered groups

k_3Ci / 676: Succulent steppe; samphire

A recent vegetation survey was undertaken at Christmas Creek and 430 native plant taxa and 17 introduced species were recorded. A total of 18 broad vegetation types (*sensu* Mattiske Consulting 2005) and three mosaics of two existing vegetation types were identified and mapped (ENV. Australia 2011a). None of the vegetation types were listed as a Threatened Ecological Community under the *Environmental Protection and Biodiversity Conservation Act 1999* or as an Environmentally Sensitive Area under the *Environmental Protection Act 1986*.

2 METHODOLOGY

2.1 BACKGROUND TO SURVEY METHODOLOGY

2.1.1 Protection of Fauna and Fauna Habitat

Fauna, habitat and faunal ecological communities are protected formally and informally by various legislative and non-legislative measures, which are outlined below. Species listed under these acts and other non-legislative measures are considered 'conservation significant' in this assessment.

Legislative Protection

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Western Australia *Wildlife Conservation Act 1950* (WC Act).
- Western Australia *Environmental Protection Act 1986* (EP Act).

Non-Legislative Protection

- Western Australian Department of Environment and Conservation (DEC) Priority lists.
- Informal recognition of fauna of interest.

A short description of these legislative and non-legislative measures is given below, and definitions of the species conservation codes and ecological community categories they use, and those used by the DEC, are provided in Appendix A.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect matters of national environmental significance. Under the EPBC Act, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the Act. Species are considered to be conservation significant if they are listed as Threatened (i.e. Critically Endangered, Endangered or Vulnerable), or Migratory.

Some marine fauna or terrestrial fauna that use marine habitats are listed as Marine under the EPBC Act. These species are only considered conservation significant when a proposed development occurs in a Commonwealth marine area (i.e. any Commonwealth Waters or Commonwealth Marine Protected Area). Outside of such areas the EPBC Act does not consider these species to be matters of national environmental significance, so are not protected under the Act. As such species only listed as Marine under the EPBC Act have not been considered in this assessment.

Wildlife Conservation Act 1950

The DEC lists taxa under the provisions of the WC Act as protected and are classified as Schedule 1 to Schedule 4 according to their need for protection (Appendix A). The Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the WC Act.

Environmental Protection Act 1986

Significant habitat necessary for the maintenance of fauna indigenous to Western Australia as well as TECs are given special consideration in environmental impact assessment, and areas covered by TECs have special status as Environmentally Sensitive Areas (ESAs) under the EP Act, and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

DEC Priority Lists

The DEC produces a list of Priority species that have not been assigned statutory protection under the WC Act. Priority Fauna are under consideration as 'Scheduled' fauna, but are in urgent need for further survey or require regular monitoring, and although not currently threatened may become so in the future (Appendix A).

In addition, the DEC maintains a list of Priority Ecological Communities which identifies those communities that need further investigation before possible nomination for TEC status.

Although DEC Priority species and communities have no formal legal protection, they are under consideration as 'Scheduled' taxa under the WC Act or as ESAs under the EP Act.

Informal Recognition of Threatened Fauna

Certain populations or communities may be of local significance or interest because of their patterns of distribution and abundance. For example, fauna may be locally significant because they are range extensions to the previously known distribution or are newly discovered taxa and therefore have the potential to be listed as Threatened in the future. In addition, many species are in decline as a result of threatening processes, and relict populations of such species may assume local importance.

2.1.2 Environmental Protection Authority Requirements for Fauna Surveys

The survey was carried out in a manner compliant with the Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of fauna surveys in Western Australia, as documented in:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002).
- *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56* (EPA 2004).

- *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA-DEC 2010).

- *Environment Protection and Biodiversity Conservation Act 1999 draft referral guidelines for the endangered Northern Quoll, Dasyurus hallucatus* - EPBC Act Policy Statement 3.25 (DSEWPaC 2011c)

2.1.3 Desktop Review

Prior to fieldwork, a desktop review of historical records and past surveys undertaken near the study area was compiled. The database review included the following;

- DSEWPaC *Protected Matters Search Tool* (DSEWPaC 2011b), also known as an EPBC Act search. An area search based on an approximately 10 km radius from a central point in the project area.

- DEC Threatened and Priority Fauna database (DEC 2011a). An area search was conducted based on an approximate 40 km radius search from the centre of the study area.

- Western Australian Museum (WAM) and DEC combined biological database *NatureMap* (DEC 2011b). An area search was conducted based on an approximate 40 km radius from the centre of the study area.

2.1.4 Trapping Programme

The survey was undertaken from 28 July to 5 August 2011. The trapping programme methodology followed as closely as possible and where practical, the methodology outlined in the EPBC Act referral guidelines for the endangered Northern Quoll, EPBC Act Policy Statement 3.25 (DSEWPaC 2011c).

Ten transects were established in areas considered most likely to support Northern Quolls *i.e*. gorges/ gullies and drainage lines where either rocky breakaways were present or where there were relatively large trees (*Eucalyptus vitrix* and or *E. camaldulensis*) with some hollows present, or those that were considered most likely to have hollows present. Access constrained the trapping survey due to limited tracks in the northern sections of the lease. Therefore transects had to be placed in relatively close proximity to existing tracks so that traps could be checked in a timely manner to avoid potential animal ethics issues such as heat exposure. In addition much of the lease area contains habitat considered unlikely to support Northern Quolls (Mulga flats and low rocky hills with little or no boulders, cracks and crevices or trees with hollows or hollow logs), primarily due to an absence of denning sites.

Each transect consisted of 10 cage traps (60 x 20 x 20 cm) spaced approximately 50 m apart (each transect approximately 450 m long) with an Elliott trap (33 x 10 x 9 cm) in between each cage trap (nine Elliott traps per transect) and left open for 7 nights (three transects were only open for 6 nights). Traps were baited with a mixture of oats, peanut butter, sardines and water and rebaited every second day and checked around or just after dawn. Calico bags were used as a shade over the cage traps. Elliott traps where possible, were placed under or partly

under vegetation or were covered with vegetation. The co-ordinates for the beginning, middle and end of each transect were recorded (Appendix B; also see Figures 3a, b, c).

2.1.5 Northern Quoll Transects

Five transects of varying lengths were walked in gorges/gullies that were considered most likely to support Northern Quolls (noting as above that these areas were at most considered marginal Northern Quoll habitat) (Appendix C and Figures 3a,b,c). Signs of the Northern Quoll (scats) were searched for in these locations. The 10 transects that were trapped were also searched for scats. A total of 19 person hours were undertaken searching for signs of the Northern Quoll.

2.1.6 Motion Sensitive Cameras

Moultrie Game Spy D-55IR Digital motion sensitive cameras were established at four locations for two nights each (total of eight camera nights) (Appendix D and Figures 3a, b, c). The same bait used in the traps was placed in the field of view of the cameras each day as an attractant.

2.1.7 Pilbara Olive Python and Western Pebble-mound Mouse Searches

Searches totalling 19 person hours were undertaken for the Pilbara Olive Python in the vicinity of the 10 trapping transects and the five transects that were walked in gorges/ gullies while looking for signs of the Northern Quoll.

Eleven transects were walked by four personnel in parallel, separated by about 25 m (totalling 44 transects) of varying length in areas considered to be suitable for Western Pebble-mound Mouse mounds (Appendix E and Figures 4a, b, c). When mounds were located they were recorded as either active or inactive based on criteria defined by Anstee (1996) (Appendix F and Figures 4a, b, c).

An overview map of the study area is also presented and displays all of the associated work undertaken during this survey (Figure 5).

2.1.8 Nocturnal Searches

Spotlighting was conducted on foot at four trap sites (one, two, three and four - Figure 3a, 3b), and from vehicles whilst travelling to, from, and between sites on two separate nights searching for Northern Quoll and Pilbara Olive Pythons.

2.1.9 Habitat Mapping

Mapping of potential suitable habitat for the Northern Quoll was done to illustrate any potential critical habitat (shelter/den) in the study area.

2.1.10 Permits

Fauna was trapped and collected in accordance with DEC Permit SF008142 issued to Dr Ron Firth (ENV).

2.2 TAXONOMY

Taxonomy and nomenclature (system of principles, procedures and terms relating to naming) in this report follows van Dyck and Strahan (2008) for mammals and Wilson and Swan (2010) for reptiles.

3 RESULTS

3.1 VARIABLES INFLUENCING THE SURVEY

It is important to note that the variables associated with individual surveys are often difficult to predict, as is the extent to which they influence survey outcomes. Survey variables are detailed in Table 2.

Table 2: Variables Associated with the Survey

Variable	Impact on Survey Outcomes
Access	Access was limited to some extent in the northern sections of the lease where potential Northern Quoll habitat is present. However, it is important to note that most of the gorges inspected were not deemed as ideal Northern Quoll habitat. They were not well developed geologically and had not formed well developed cracks, crevices and fractures and there were no large boulders that Northern Quolls utilise for shelter/dens.
Experience levels	The scientists who conducted these surveys were practitioners suitably qualified in their respective fields: • Co-ordinating Zoologist: Dr Ronald Firth (Principal Zoologist). • Field Staff: Dr Ronald Firth, James Sansom, Hayden Ajduk and Christopher Knuckey.
Timing, weather, season.	The Northern Quoll and Western Pebble-mound Mouse do not undertake seasonal periods of inactivity or torpor; therefore targeted surveys can be conducted throughout the year. The Pilbara Olive Python probably becomes less active when temperatures fall as a result of its ectothermic metabolism.
Sources of information	The desktop analysis used a number of different resources to obtain information on the Northern Quoll, Pilbara Olive Python and Western Pebble-mound Mouse previously recorded within the vicinity of the project area e.g. records from the DEC threatened fauna database search, NatureMap (DEC 2011b), and DSEWPaC Protected Matters Search Tool (DSEWPaC 2011b). Furthermore, previous fauna surveys identified in Section 3.3 assisted in developing an understanding of the likelihood of the Northern Quoll, Pilbara Olive Python and Western Pebble-mound Mouse occurring on the lease.
Completeness	The number of survey sites and effort is outlined in sections 2.1.4 to 2.1.8 and 3.4 to 3.8. The trapping programme methodology followed as closely as possible and where practical the methodology outlined in the EPBC Act referral guidelines for the endangered Northern Quoll, EPBC Act policy statement 3.25. The survey is considered to be sufficient to

Variable	Impact on Survey Outcomes
	meet regulatory expectations.

3.2 DATABASE REVIEW

The DEC threatened fauna database search provided two previous Northern Quoll records from 1980 in the Chichester Range. There were no records for the Pilbara Olive Python.

3.3 RECENT FAUNA SURVEYS FOR THE CHRISTMAS CREEK AREA

A number of fauna surveys have been undertaken on the Christmas Creek Lease and adjacent areas in the last seven years. The results of these past surveys complement and provide context for the fauna targeted during this survey, as such, they are discussed very briefly below.

ENV 2011b

A Level 1 survey for the proposed Christmas Creek study area was undertaken in January 2011. Western Pebble-mound Mouse mounds were recorded; no signs of the Northern Quoll or Pilbara Olive Python were recorded.

ENV 2011c

A Level 2 fauna survey was undertaken by ENV in March 2011. No Northern Quolls or their signs were recorded from that survey. One Pilbara Olive Python was recorded crossing the main Christmas Creek access road at dusk in March 2011 near Marandoo Creek (in stony plain habitat). This is not the typical rocky habitat preferred by this species and it was probably recorded while dispersing or travelling through the area. No Western Pebble-mound Mouse mounds were recorded during this survey.

Ecologia 2011

Ecologia undertook a Level 2 fauna survey in October 2010 on the adjacent Cloudbreak lease. They did not capture, or record signs of the Northern Quoll or Pilbara Olive Python, but they did record Western Pebble-mound Mouse mounds.

ENV 2010

ENV carried out a Level 2 fauna survey on the Roy Hill station in May-June of 2010. No captures or signs of the Northern Quoll, Pilbara Olive Python or Western Pebble-mound Mouse were made.

ATA 2006

ATA Environmental undertook a Level 1 survey in July 2006 of the proposed Cloudbreak airstrip, camp and access road. Scats of the Northern Quoll were recorded at two locations during this survey. No Pilbara Olive Pythons were recorded. Several Western Pebble-mound Mouse mounds were observed during this survey.

Davis *et al*. 2005

A Level 2 fauna survey was undertaken by Davis *et al*. (2005) on the border of Cloudbreak lease in April 2005. No capture or signs of the Northern Quoll, Pilbara Olive Python or Western Pebble-mound Mouse were made.

Biota 2005

Biota carried out a Level 2 fauna survey as part of the FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas in March and June-July 2004. No captures or signs of the Northern Quoll, Pilbara Olive Python or Western Pebble-mound Mouse were recorded from the Christmas Creek section. A Northern Quoll scat was recorded from the Mt Nicholas Mine area, which is approximately 40 km from the edge of the current Christmas Creek lease.

Biota 2004

Biota undertook a Level 2 fauna survey of the proposed FMG Stage A Rail Corridor in March-April 2004. Scats of the Northern Quoll were recorded from several survey sites; however, these were from granite outcrops of the Abydos Plain and not near the Christmas Creek lease. No Pilbara Olive Python or Western Pebble-mound Mouse or their signs were recorded.

3.4 TRAPPING PROGRAMME

No Northern Quolls were captured in the current trapping programme. The only vertebrate fauna species captured was one individual House Mouse (*Mus musculus*). Total trap effort for the survey was 1273 trap nights and is considered more than adequate given the lack of suitable habitat within the study area. Images of transects can be seen in Appendix G.

3.5 NORTHERN QUOLL TRANSECTS

No signs of the Northern Quoll were observed while walking transects in gorges/ gullies and along the trapping transects.

3.6 MOTION CAMERAS

No images of the Northern Quoll were recorded by the motion sensitive cameras. Total camera trap effort for the survey was eight camera nights. The cameras are well maintained and validated as working prior to each survey. Records of erroneous and non-targeted species

(particularly common and widespread species) captured on camera such as Cows, Crows etc. are not presented.

3.7 PILBARA OLIVE PYTHON AND WESTERN PEBBLE-MOUND MOUSE SEARCHES

No Pilbara Olive Python or their signs were observed during active searching in gorges/ gullies.

A total of 75 Western Pebble-mound Mouse mounds were recorded of which 11 were considered active and 64 inactive (Figure 4a, 4b and 4c and Appendix G).

3.8 NOCTURNAL SEARCHES

No Northern Quolls or Pilbara Olive Pythons were observed while carrying out spotlighting on foot and from vehicles.

3.9 HABITAT MAPPING

Mapping of potential critical habitat for the Northern Quoll was done to illustrate potential shelter/den sites in the study area). Potential shelter/denning habitat for the Northern Quoll was highly restricted, with 74 ha of gorge and breakaway habitat mapped in the northeast of the study area (Figure 6).

4 DISCUSSION

Northern Quoll

A number of fauna surveys have been undertaken on the Christmas Creek lease or in adjacent areas that are in close proximity (Biota 2004, 2005; Davis *et al.* 2005; ATA Environmental 2006; ENV 2010; Ecologia 2011; ENV 2011b,c). Like this survey, most did not record any Northern Quolls or their signs, however, ATA Environmental (2006) did record scats at two locations during an assessment of the proposed Cloudbreak airstrip, camp and access road. These two locations are approximately 8 km from the north-western edge of the Christmas Creek lease boundary. Due to the presence of these Northern Quoll scats, the relatively large home-range size of Northern Quolls (up to 150 ha), and movements between den sites on consecutive nights of up to 1.85 km for males (Oakwood 2002), it is plausible that Northern Quolls may occur on the Christmas Creek lease. However, given the lack of records from other recent surveys, the trapping effort during this present survey (1273 trap nights), the searches for signs (19 person hours) and the nocturnal searching (20 person hours) did not reveal any evidence of Northern Quolls in the Christmas Creek lease, suggests that if present, Northern Quolls are in very low abundance, or occasional visitors to the area for foraging. Potential shelter/denning habitat for the Northern Quoll was highly restricted, with 74 ha of gorge and breakaway habitat mapped in the northeast of the study area (Figure 6). This habitat does contain rock crevices for which the Northern Quoll could den in (van Dyck & Strahan 2008; Oakwood 2002).

Pilbara Olive Python

Though no Pilbara Olive Pythons were recorded during the survey one individual was recorded in March 2011 (ENV 2011c). This Pilbara Olive Python was found crossing the main Christmas Creek mine access road adjacent to degraded drainage line habitat. The Pilbara Olive Python typically occurs in the rocky ranges in escarpments, gorges and water holes (Pearson 1993). Typical habitat was searched during the survey but no Pilbara Olive Pythons were recorded. Therefore this species may occur in low densities, making it less likely to be recorded during the survey.

Western Pebble-mound Mouse

A number of the recent surveys undertaken on the Christmas Creek Lease and adjacent areas have recorded Western Pebble-mound Mouse mounds (ATA Environmental 2006; Ecologia 2011; ENV 2011b). During this survey 75 were recorded 11 of which were considered active. The Western Pebble-mound Mouse appears to be widespread (and presumably relatively common) in the northern sections of the lease where low gentle sloping rocky hills dominate, which is the known habitat of this species (Ford and Johnson 2007).

Potential Impacts on the Targeted Fauna

Despite a number of surveys and substantial effort (while taking into account the presence of Northern Quoll scats at Cloudbreak airstrip recorded during a previous survey) there is no evidence that the Northern Quoll occurs on the Christmas Creek Lease. The majority of the study area is not typical Northern Quoll habitat (rocky hills and gorges), and as such, disturbance and the clearing of habitat associated with mining should have little impact on the species locally, and little to no impact regionally.

There is currently only one known record for the Pilbara Olive Python on the Christmas Creek lease (ENV 2001c). This individual was most likely moving through stony plain habitat which is not its preferred rocky habitat (Pearson 1993). The majority of the study area comprises stony plain habitat, therefore the clearing of habitat should have little impact on the species locally and little to no impact regionally. Accordingly there should be no significant impact or change to the species conservation status as a result of mining.

Signs of the Western Pebble-mound Mouse have been recorded in the past at Christmas Creek and adjacent areas (ATA Environmental 2006; Ecologia 2011; ENV 2011b) and the mounds (active and inactive) were found to be widespread during this survey. This species has a widespread distribution throughout the Pilbara (Gibson and McKenzie 2009). Given its widespread distribution on the Christmas Creek lease and broadly in the Pilbara, and that disturbance associated with mining is for the most part restricted to stony plain, clearing of habitat as a result of mining will have no significant impact on the species locally or regionally.

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FIGURES

620000
720000
820000
920000
7600000
7500000
7400000

Wittenoom
Munjina
Roy Hill
BHP RIO
Road
Newman
Port Hedland
Railway
Great
Northern
Highway
Marble
Bar
Road

Karijini
National Park

Karijini
National Park

Newman

Location Map

Legend

- Christmas Creek Survey Area
- Tracks
- Roads
- Railway
- National Parks and Reserves

N

0 15 30 45
Kilometres

CLIENT		**JOB NO.**	
Fortescue Metals Group Ltd		J100798	
AUTHOR	**DRAWN**	**DATE**	
R. Firth	M. Mikkonen	09-09-2011	
SCALE		**PROJECTION**	
1:1,000,000 @ A3		GDA 94 MGA 50	

env Australia

Regional Location

Christmas Creek Targeted Fauna Survey

FIGURE 1

S

Q1 Trap Line & Transect

E

S

Q2 Trap Line & Transect

E

Cam4

N

0 200 400

Metres

Legend

- Christmas Creek Survey Area
- Motion Sensitive Cameras
- Quoll Trap Lines
- Quoll Transects

env Australia

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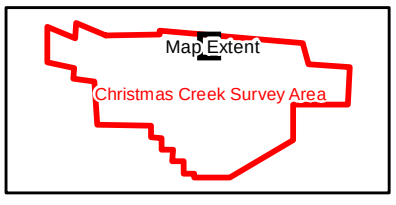
DRAWN	M. Mikkonen
SCALE	1:10,000 @ A3
JOB NO.	J100798
DATE	20-09-2011
PROJECTION	GDA 94 MGA 50



Quoll Trap Line and Motion Sensitive Camera Locations and Quoll Transect Locations

Christmas Creek Targeted Fauna Survey

FIGURE 3a

Q3 Trap Line & Transect

Q4 Trap Line & Transect

Q5 Trap Line & Transect

Q6 Trap Line & Transect

Q7 Trap Line & Transect

Cam1

Cam2

N

0 200 400 Metres

Legend

- Christmas Creek Survey Area
- Motion Sensitive Cameras
- Quoll Trap Lines
- Quoll Transects

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SCALE	1:10,000 @ A3
JOB NO.	J100798
DATE	20-09-2011
PROJECTION	GDA 94 MGA 50

Map Extent

Christmas Creek Survey Area

Quoll Trap Line and Motion Sensitive Camera Locations and Quoll Transect Locations

Christmas Creek Targeted Fauna Survey

FIGURE **3b**

Q10 Trap Line & Transect

S

Cam3

E

Q8 Trap Line & Transect

S

E

Q9 Trap Line & Transect

E

S

N

0 200 400

Metres

Legend

- Christmas Creek Survey Area
- Motion Sensitive Cameras
- Quoll Trap Lines
- Quoll Transects

env Australia

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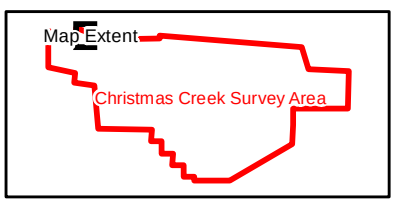
Fortescue Metals Group Ltd	J100798
AUTHOR / **DRAWN**	**DATE**
R. Firth / M. Mikkonen	20-09-2011
SCALE	**PROJECTION**
1:10,000 @ A3	GDA 94 MGA 50



Quoll Trap Line and Motion Sensitive Camera Locations and Quoll Transect Locations

Christmas Creek Targeted Fauna Survey

FIGURE **3c**

Legend

Christmas Creek Survey Area

Pebble Mound Locations

Active

Inactive

Pebble mound Mouse Transect Lines

N

0 0.5 1 2 Kilometres

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AUTHOR
R. Firth

DRAWN
M. Mikkonen

DATE
09-09-2011

SCALE
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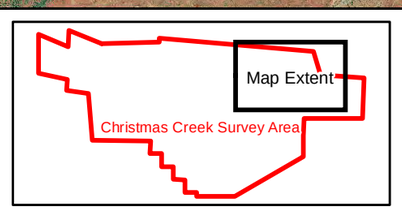

Western Pebble-mound Mouse Transect and Mound Locations

Christmas Creek Targeted Fauna Survey

FIGURE 4a

S
E
E
E
S
S
N
0 200 400 800
Metres

Legend

Christmas Creek Survey Area

Pebble Mound Locations

Active

Inactive

Pebble mound Mouse Transect Lines

env Australia

CLIENT	JOB NO.
Fortescue Metals Group Ltd	J100798
AUTHOR / **DRAWN**	**DATE**
R. Firth / M. Mikkonen	20-09-2011
SCALE	**PROJECTION**
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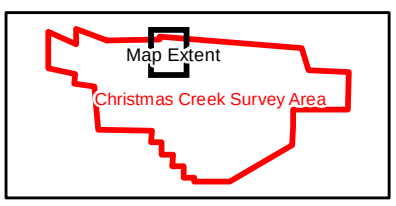


Western Pebble-mound Mouse Transect and Mound Locations

Christmas Creek Targeted Fauna Survey

FIGURE **4b**

S

E

E

S

N

0 200 400 800

Metres

Legend

Christmas Creek Survey Area

Pebble Mound Locations

Active

Inactive

Pebble mound Mouse Transect Lines

env Australia

CLIENT
Fortescue Metals Group Ltd

JOB NO.
J100798

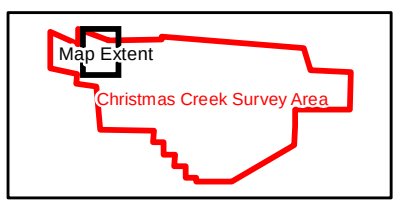
AUTHOR
R. Firth

DRAWN
M. Mikkonen

DATE
20-09-2011

SCALE
1:20,000 @ A3

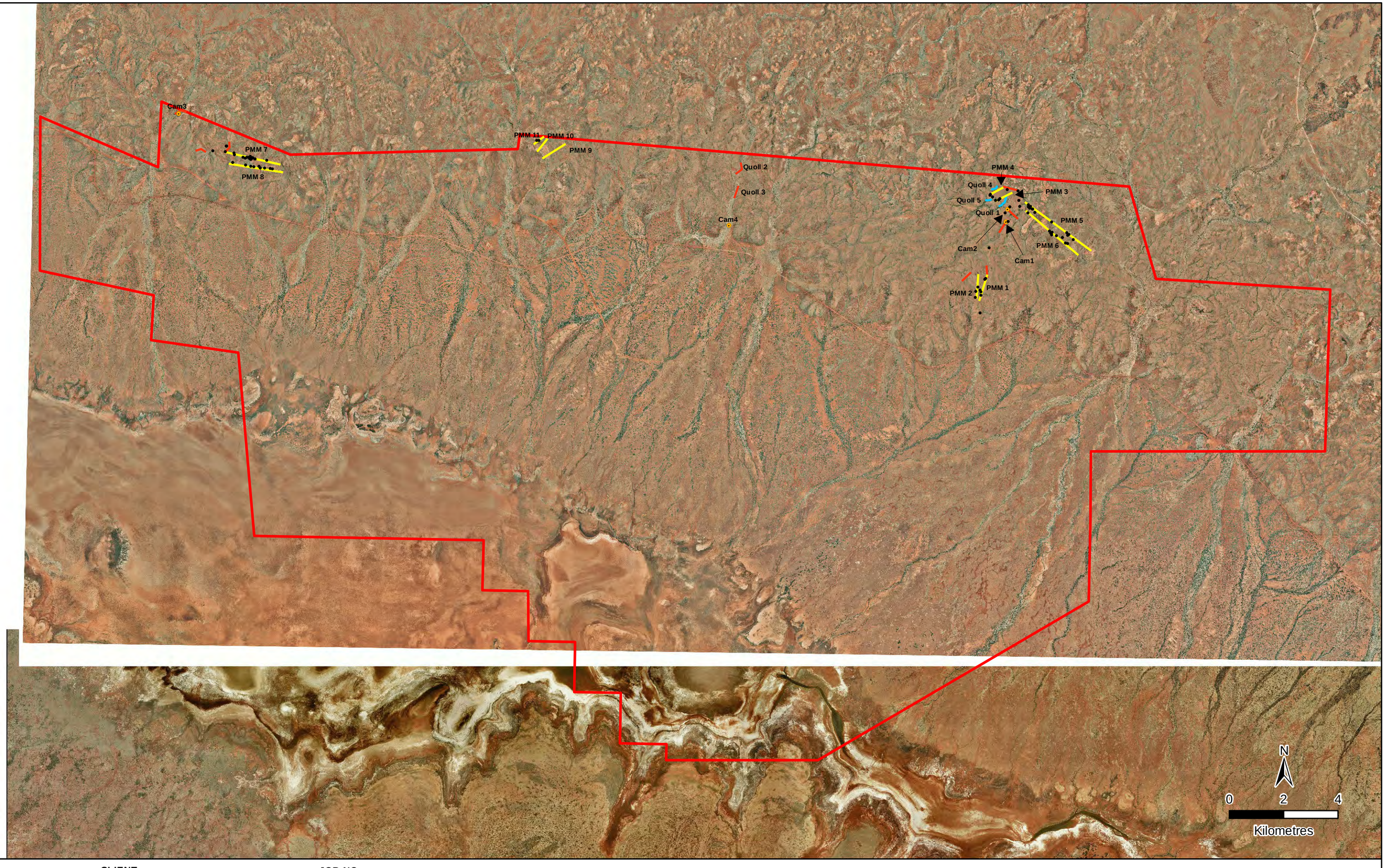
PROJECTION
GDA 94 MGA 50



Western Pebble-mound Mouse Transect and Mound Locations

Christmas Creek Targeted Fauna Survey

FIGURE **4c**



CLIENT
Fortescue Metals Group Ltd

JOB NO.
J100798

AUTHOR
R. Firth

DRAWN
M. Mikkonen

DATE
24-04-2012

SCALE
1:125,000 @ A3

PROJECTION
GDA 94 MGA 50

Legend

- Christmas Creek Survey Area
- Motion Sensitive Cameras
- Pebble Mound Locations
  - Active
  - Inactive
- Pebble mound Mouse Transect Lines
- Quoll Trap Lines
- Quoll Transects

Survey Overview

Christmas Creek Targeted Fauna Survey

FIGURE 5

760000 770000 780000 790000 800000

7530000 7520000 7510000

Potential Shelter/Den Habitat for the Northern Quoll

Legend

- Christmas Creek Targeted Fauna Survey
- Potential Shelter/Den Habitat

env Australia

CLIENT	Fortescue Metals Group Ltd
AUTHOR	J. Trainer
DRAWN	M. Mikkonen
SCALE	1:120,000 @ A3
JOB NO.	J100798
DATE	11-07-2012
PROJECTION	GDA 94 MGA 50

N

0 2 4 6

Kilometres

Potential Critical Habitat for the Northern Quoll

Christmas Creek Targeted Fauna Survey

FIGURE 6

APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

TARGETED FAUNA SURVEY OF THE CHRISTMAS CREEK STUDY AREA
APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

A1: *Environment Protection and Biodiversity Conservation Act 1999* (*Cth*): Threatened Species and Threatened Ecological Communities Codes

The *EPBC Act* prescribes seven matters of national environmental significance:-

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance;
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Species in the categories ExW, CE, E, V and M (see below), and Threatened Ecological Communities in the CE and E categories are protected as matters of national environmental significance under the *EPBC Act*.

Category	Code	Category
Extinct	Ex	Taxa for which there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	ExW	Taxa known to survive only in cultivation, in captivity or as a naturalised population well outside its past range; or not recorded in its known and/or expected habitat at appropriate seasons anywhere in its past range despite exhaustive surveys over a timeframe appropriate to its life cycle and form.
Critically Endangered	CE	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	E	Taxa not critically endangered and facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Vulnerable	V	Taxa not critically endangered or endangered and facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	CD	Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within five years.

Category	Code	Category
Migratory	Mi	Taxa that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations, that are included in an international agreement approved by the Minister for the Environment, Heritage and the Arts and that have been placed on the national List of Migratory Species under the provisions of the EPBC Act. At present there are four such agreements: • the Bonn Convention • the China-Australia Migratory Bird Agreement (CAMBA) • the Japan-Australia Migratory Bird Agreement (JAMBA) • the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Marine	Ma	Taxa protected in a Commonwealth Marine Protected Area by virtue of section 248 of the *EPBC Act*. These taxa include certain seals, crocodiles, turtles and birds, as well as various marine fish. Commonwealth marine areas are matters of national environmental significance under the *EPBC Act*. An action will require approval if the: • action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or • action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area[1] The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters. The Commonwealth marine area stretches from 3 to 200 nautical miles (approximately 5-370 km) from the coast. Marine protected areas are marine areas which are recognised to have high conservation value.

A2: Western Australian Threatened Fauna Categories

Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

A3: Department of Environment and Conservation Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX B
NORTHERN QUOLL TRAP LINE LOCATIONS

APPENDIX B

NORTHERN QUOLL TRAP LINE LOCATIONS

Trap Line #	Start		Middle		End	
	Easting	Northing	Easting	Northing	Northing	Easting
1	782165	7526996	782207	7526752	781982	7526570
2	782080	7526151	-	-	781928	7525685
3	792376	7525974	-	-	791811	7526109
4	791988	7525278	791988	7525278	792371	7524920
5	791931	7524816	791670	7524418	791670	7524418
6	791215	7523206	791241	7522751	791241	7522751
7	790647	7522947	-	-	790302	7522636
8	762110	7527428	762318	7527490	762490	7527374
9	763209	7527386	763358	7527551	763347	7527769
10	761353	7528773	761555	7528914	761768	7528852

#Australian Geocentric 1994 (GDA94) Zone 50K

APPENDIX C
NORTHERN QUOLL TRANSECT LOCATIONS

APPENDIX C

NORTHERN QUOLL TRANSECT LOCATIONS

Trap Line #	Start		Point 2		Point 3		Point 4		Point 5		End	
	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing
1	791962	7525811	791406	7525691	791874	7525527	791820	7525486	791774	7525433	791658	7525377
2	782165	7526996	782207	7526752	-	-	-	-	-	-	781982	7526570
3	782080	7526151	-	-	-	-	-	-	-	-	781928	7525685
4	791392	7525998	791508	7526033	791555	7526049	791591	7526112	-	-	791628	7526122
5	791165	7525614	791225	7525598	791355	7525619	-	-	-	-	791405	7525648

[#]Australian Geocentric 1994 (GDA94) Zone 50K

APPENDIX D
MOTION SENSITIVE CAMERA LOCATIONS

APPENDIX D

MOTION SENSITIVE CAMERA LOCATIONS

Camera #	Easting	Northing	Habitat
1	791931	7524816	Gorge
2	791988	7525278	Gorge
3	761483	7528801	Drainage Line
4	781730	7524680	Drainage Line

[#]Australian Geocentric 1994 (GDA94) Zone 50K

APPENDIX E
WESTERN PEBBLE-MOUND MOUSE TRANSECT LOCATIONS

APPENDIX E

WESTERN PEBBLE-MOUND MOUSE MOUND TRANSECT LOCATIONS

Transect #	Start		End	
	Easting	Northing	Northing	Easting
1	791244	7522882	790947	7521901
2	790853	7521991	790916	7522886
3	792170	7525887	791535	7525577
4	791329	7525810	791827	7526086
5	792621	7525535	795066	7523751
6	794585	7523582	792660	7525220
7	763209	7527389	765230	7526926
8	765337	7526635	763579	7525919
9	774872	7527146	775719	7527677
10	774677	7527400	775049	7527875
11	774922	7527948	774543	7527664

#Australian Geocentric 1994 (GDA94) Zone 50K

APPENDIX F
WESTERN PEBBLE-MOUND MOUSE MOUND LOCATIONS

APPENDIX F

WESTERN PEBBLE-MOUND MOUSE MOUND LOCATIONS

Pebble Mound #	Easting	Northing	Activity
1	793625	7524788	Active
2	774681	7527795	Active
3	763255	7527583	Inactive
4	790990	7522288	Inactive
5	790810	7522026	Inactive
6	763266	7527594	Inactive
7	791713	7525655	Inactive
8	791558	7525592	Inactive
9	792852	7525368	Inactive
10	794174	7524401	Inactive
11	794255	7524333	Inactive
12	763559	7527267	Inactive
13	763877	7527173	Inactive
14	764011	7527171	Inactive
15	764103	7527125	Inactive
16	764165	7527135	Inactive
17	764154	7527091	Inactive
18	764237	7527145	Inactive
19	764309	7527110	Inactive
20	764499	7526775	Inactive
21	790995	7521446	Inactive
22	764273	7526834	Inactive
23	763965	7526884	Inactive
24	791329	7523845	Inactive
25	792413	7525586	Inactive

Pebble Mound #	Easting	Northing	Activity
26	791163	7522684	Inactive
27	763211	7527384	Inactive
28	791376	7525817	Inactive
29	792771	7525436	Inactive
30	791910	7525131	Inactive
31	794016	7524226	Inactive
32	792079	7525349	Inactive
33	763949	7527150	Inactive
34	764150	7526847	Inactive
35	763482	7526980	Inactive
36	792379	7525942	Inactive
37	792027	7524807	Inactive
38	790825	7522247	Inactive
39	791028	7522099	Inactive
40	791671	7525600	Inactive
41	791447	7525716	Inactive
42	791355	7525773	Inactive
43	791988	7525982	Inactive
44	792759	7525358	Inactive
45	792810	7525302	Inactive
46	792902	7525278	Inactive
47	793003	7525143	Active
48	794203	7524300	Inactive
49	794417	7524152	Inactive
50	794218	7524001	Inactive
51	794136	7524024	Inactive
52	793801	7524286	Active
53	793626	7524322	Active

Pebble Mound #	Easting	Northing	Activity
54	793597	7524378	Inactive
55	793536	7524457	Active
56	792755	7525126	Inactive
57	763529	7527334	Inactive
58	764094	7527181	Inactive
59	764135	7527202	Inactive
60	764741	7527070	Inactive
61	764942	7526745	Inactive
62	764870	7526757	Inactive
63	764459	7526842	Inactive
64	791202	7522722	Inactive
65	791019	7522221	Active
66	790906	7522392	Active
67	792833	7525324	Active
68	792922	7525279	Inactive
69	793640	7524418	Active
70	793616	7524406	Inactive
71	792454	7525374	Inactive
72	762759	7527413	Inactive
73	764223	7527155	Inactive
74	764668	7526773	Inactive
75	774762	7527788	Active

#Australian Geocentric 1994 (GDA94) Zone 50K

APPENDIX G
PLATES

TARGETED FAUNA SURVEY OF THE CHRISTMAS CREEK STUDY AREA
APPENDIX G

PLATES

Quoll trap site 1

Quoll trap site 2

Quoll trap site 3

Quoll trap site 4

Quoll trap site 5

Quoll trap site 6

Quoll trap site 8

Quoll trap site 9

Quoll trap site 10

Example of a gorge walked during the survey

Example of an active Western Pebble-mound Mouse mound located during the survey

APPENDIX D
HABITAT ASSESSMENT DATA SHEETS

CHRISTMAS CREEK VERTEBRATE FAUNA AND FAUNA HABITAT ASSESSMENT APPENDIX D

HABITAT ASSESSMENT DATA SHEETS

Habitat Assessment - HA 1

Broad Fauna Habitat: Stony Plain

UTM Co-ordinates 50 796732 Easting, 7518471 Northing

Habitat Value: Low

Total Area of Habitat: 25919.44

Proportion of Project Area: 38.3%

Habitat Structure and Microhabitats

Aspect:		Exfoliating Slabs:	None	
Soils:	Red Clay	Surface rocks:	Small: Common	Large: None
Boulders:	None	Tree Hollows:	Small: None	Large: None
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	0% Leaf litter, 15% Woody Debris, 55% Bare Ground.			

Vegetation

Low Woodland of *Acacia aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla* and *Acacia xiphophylla* over species of *Triodia* and *Aristida*.
Vegetation Condition: Degraded
Fire Age: Young

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

Habitat Assessment - HA 2

Broad Fauna Habitat: Alluvial Plain

UTM Co-ordinates 50 795569 Easting, 7519064 Northing

Habitat Value: Moderate

Total Area of Habitat: 8647.72 ha

Proportion of Project Area: 12.8%

Habitat Structure and Microhabitats

Aspect:		Exfoliating Slabs:	None	
Soils:		Surface rocks:	Small: Moderate	Large: Rare
Boulders:	None	Tree Hollows:	Small: None	Large: None
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	5% Leaf litter, 5% Woody Debris, 50% Bare Ground.			

Vegetation

Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* and *Acacia anuera* over *Acacia pruinocarpa* and *Acacia tetragonophylla* over *Triodia* and *Themeda* species.
Vegetation Condition: Very Good
Fire Age: Old

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

Disturbances- Weeds, Cattle

Habitat Assessment - HA 3

Broad Fauna Habitat: Alluvial Plain

UTM Co-ordinates 50 795944 Easting, 7518923 Northing

Habitat Value: Moderate

Total Area of Habitat: 8647.72 ha

Proportion of Project Area: 12.8%

Habitat Structure and Microhabitats

Aspect:		Exfoliating Slabs:	None	
Soils:		Surface rocks:	Small: Moderate	Large: rare
Boulders:	None	Tree Hollows:	Small: None	Large: None
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	10% Leaf litter, 5% Woody Debris, 25% Bare Ground.			

Vegetation

Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* and *Acacia anuera* over *Acacia pruinocarpa* and *Acacia tetragonophylla* over *Triodia* and *Themeda* species.
Vegetation Condition: Good
Fire Age:Old

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

Disturbances- Weeds, Cattle

Habitat Assessment - HA 4

Broad Fauna Habitat: Stony Plain

UTM Co-ordinates 50 771439 Easting, 7523774 Northing

Habitat Value: Low

Total Area of Habitat: 25919.44

Proportion of Project Area: 38.3%

Habitat Structure and Microhabitats

Aspect:		Exfoliating Slabs:	None	
Soils:		Surface rocks:	Small: Common	Large: None
Boulders:	None	Tree Hollows:	Small: None	Large: None
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	15% Leaf litter, 5% Woody Debris, 80% Bare Ground.			

Vegetation

Low Woodland of *Acacia aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla* and *Acacia xiphophylla* over species of *Triodia* and *Aristida*.
Vegetation Condition: Very Good
Fire Age: Recent

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

Disturbances- Cattle

Habitat Assessment - HA 5

Broad Fauna Habitat: Low Hill (Breakaway)

UTM Co-ordinates 50 776150 Easting, 7526618 Northing

Habitat Value: Moderate

Total Area of Habitat: 13748.79 ha

Proportion of Project Area: 20.3%

Habitat Structure and Microhabitats

Aspect:	Hill	Exfoliating Slabs:	Moderate	
Soils:		Surface rocks:	Small: Common	Large: Moderate
Boulders:	Rare	Tree Hollows:	Small: None	Large: None
Cracks:	Moderate	Caves:	None	Crevices: None
Cliffs :	Common	Suitability for bats:	Nil	
Ground Cover:	+% Leaf litter, - Woody Debris, 40% Bare Ground.			

Vegetation

Hummock Grassland of *Triodia basedowii* with patches of *Eucalyptus leucophloia*, *Corymbia deserticola, Acacia* and *Hakea* species.

Vegetation Condition: Excellent

Fire Age: Old

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

Habitat Assessment - HA 6

Broad Fauna Habitat: Low Hill (Breakaway)

UTM Co-ordinates 50 774756 Easting, 7527102 Northing

Habitat Value: Moderate

Total Area of Habitat: 13748.79 ha

Proportion of Project Area: 20.3%

Habitat Structure and Microhabitats

Aspect:	Hill	Exfoliating Slabs:	Rare	
Soils:	Ironstone	Surface rocks:	Small: Common	Large: Rare
Boulders:	None	Tree Hollows:	Small: None	Large: None
Cracks:	Moderate	Caves:	None	Crevices: None
Cliffs :	Moderate	Suitability for bats:	Nil	
Ground Cover:	1% Leaf litter, - Woody Debris, 29% Bare Ground.			

Vegetation

Hummock Grassland of *Triodia basedowii* with patches of *Eucalyptus leucophloia*, *Corymbia deserticola, Acacia* and *Hakea* species.

Vegetation Condition: Excellent

Fire Age: Old

Other Relevant Information: Suitable for Western Pebble-mound Mouse

Habitat Assessment - HA 7

Broad Fauna Habitat: Drainage Line

UTM Co-ordinates 50 773653 Easting, 7525150 Northing

Habitat Value: Moderate

Total Area of Habitat: 8647.72 ha
Proportion of Project Area:
12.8%

Habitat Structure and Microhabitats

Aspect:	SW	Exfoliating Slabs:	None	
Soils:	Ironestone	Surface rocks:	Small: Common	Large: None
Boulders:	None	Tree Hollows:	Small: Moderate	Large: None
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	5% Leaf litter, 5% Woody Debris, 50% Bare Ground.			

Vegetation

Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* and *Acacia anuera* over *Acacia pruinocarpa* and *Acacia tetragonophylla* over *Triodia* and *Themeda* species.
Vegetation Condition: Excellent
Fire Age: Old

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

Disturbances- Weeds

Habitat Assessment - HA 8

Broad Fauna Habitat: Low Hill

UTM Co-ordinates 50 761892 Easting, 7526922 Northing

Habitat Value: Low

Total Area of Habitat: 13748.79 ha

Proportion of Project Area: 20.3%

Habitat Structure and Microhabitats

Aspect:	S	Exfoliating Slabs:	None	
Soils:	Ironstone	Surface rocks:	Small: Common	Large: Rare
Boulders:	None	Tree Hollows:	Small: None	Large: None
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	0% Leaf litter, 5% Woody Debris, 40% Bare Ground.			

Vegetation

Low Woodland of *Acacia aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla* and *Acacia xiphophylla* over species of *Triodia* and *Aristida*.
Vegetation Condition: Pristine
Fire Age: Old

Other Relevant Information: Suitable for Western Pebble-mound Mouse

Habitat Assessment - HA 9

Broad Fauna Habitat: Drainage Line

UTM Co-ordinates 50 769644 Easting, 7524264 Northing

Habitat Value: Moderate

Total Area of Habitat: 8647.72 ha
Proportion of Project Area: 12.8%

Habitat Structure and Microhabitats

Aspect:	Depression	Exfoliating Slabs:	None	
Soils:	River Sand	Surface rocks:	Small: Common	Large: Rare
Boulders:	None	Tree Hollows:	Small: Common	Large: Moderate
Cracks:	None	Caves:	None	Crevices: None
Cliffs :	None	Suitability for bats:	Nil	
Ground Cover:	10% Leaf litter, 20% Woody Debris, 30% Bare Ground.			

Vegetation

Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* and *Acacia anuera* over *Acacia pruinocarpa* and *Acacia tetragonophylla* over *Triodia* and *Themeda* species.
Vegetation Condition: Excellent
Fire Age: Old

Other Relevant Information: Unsuitable for Western Pebble-mound Mouse

APPENDIX E

BAT RECORDING DETAILS

CHRISTMAS CREEK TERRESTRIAL VERTEBRATE FAUNA AND FAUNA HABITAT ASSESSMENT

APPENDIX E

AnaBat Locations

Date	AnaBat Code	Easting	Northing	Species Recorded
20 March	AnaBat 1 (AB1)	773606	7524849	*Chaerephon jobensis* *Nyctophilus geoffroyi* *Scotorepens greyii*
21 March	AnaBat 2 (AB2)	762446	7527298	*Chalinolobus gouldii* *Nyctophilus geoffroyi* *Scotorepens greyii* *Vespadelus finlaysoni*
22 March	AnaBat 3 (AB3)	791104	7521330	*Chalinolobus gouldii* *Vespadelus finlaysoni*
29 July	AnaBat 4 (AB4)	795868	7519230	*Chaerephon jobensis* *Chalinolobus gouldii* *Nyctophilus daedalus* *Saccolaimus flaviventris* *Scotorepens greyii* *Vespadelus finlaysoni*
30 July	AnaBat 5 (AB5)	791988	7525278	*Vespadelus finlaysoni*
31 July	AnaBat 6 (AB6)	774391	7522901	*Chaerephon jobensis* *Chalinolobus gouldii* *Nyctophilus geoffroyi* *Scotorepens greyii* *Vespadelus finlaysoni*

Date	AnaBat Code	Easting	Northing	Species Recorded
1 August	AnaBat 7 (AB7)	790647	7522947	*Vespadelus finlaysoni*
2 August	AnaBat 8 (AB8)	791931	7524816	*Chaerephon jobensis* *Saccolaimus flaviventris* *Scotorepens greyii* *Vespadelus finlaysoni*
3 August	AnaBat 9 (AB9)	760571	7524672	*Chaerephon jobensis* *Chalinolobus gouldii* *Nyctophilus geoffroyi* *Saccolaimus flaviventris* *Scotorepens greyii* *Taphozous georgianus* *Vespadelus finlaysoni*
4 August	AnaBat 10 (AB10)	772634	7524747	*Chalinolobus gouldii* *Nyctophilus geoffroyi* *Saccolaimus flaviventris* *Scotorepens greyii* *Vespadelus finlaysoni*

World Geodetric System 1984 (WGS84), Zone 50K

APPENDIX F

CONSERVATION SIGNIFICANT FAUNA SPECIES RECORDED WITHIN THE VICINITY OF THE STUDY AREA

CHRISTMAS CREEK VERTEBRATE FAUNA AND FAUNA HABITAT ASSESSMENT

APPENDIX F

CONSERVATION SIGNIFICANT FAUNA SPECIES PREVIOUSLY RECORDED WITHIN THE VICINITY OF THE STUDY AREA

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
REPTILES				
Ramphotyphlops ganei (blind snake sp.)	P1	Little is known of the habitat requirements of *Ramphotyphlops ganei*, with most records occurring in habitats with rocky or stony soils (Wilson and Swan 2010). There are few records of the species in the Pilbara, making it one of the rarest reptiles for the region, however given the preference for rocky stony soils, it should occur broadly across the region.	Limited records of this species make habitat relevance hard to assess. There are 28 records on Naturemap through much of the Pilbara, but there no records during recent surveys in the vicinity of Christmas Creek surveys (Biota 2005, Davis *et al*. 2005, ATA Environmental 2006, ecologica 2011). There was a recent record at Jimblebar by Outback Ecology (2009) in an alluvial floodplain, which is not thought to be the preferred substrate for this species. The rocky substrate of the Low Hill habitat type and the Alluvial Plain habitat type may provide suitable habitat for this species. This species has been previously recorded within 40 km of the project area in 2009 (DEC 2011c), but there have been no records at Christmas Creek despite several surveys.	Possible
Pilbara Olive Python (*Liasis olivaceus barroni*)	VU,S1	Pilbara Olive Pythons are found in a range of habitats, including drier areas of woodland, escarpments, rocky gorges, gullies and around watercourses (Pearson 1993, Wilson and Swan 2010). This species is usually in close	The Drainage Line and its associated Alluvial Plain provide suitable habitat for this species as it contains surface water surrounded by cover. One specimen was recorded opportunistically while crossing the road in an	Recorded

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		proximity to water and rock outcrops that attract suitable sized prey species (Pearson 2003). Microhabitat preferences of the Pilbara Olive Python can often be under rock piles, on top of rocks or under Spinifex (Tutt *et al*. 2004). The species is considered stable and in sizable numbers at some known sites (Pearson 2003).	area adjacent to a Drainage line.	
BIRDS				
Fork-tailed Swift (*Apus pacificus*)	Mi	The Fork-tailed Swift is a summer migrant to Australia usually during the months of October-April. The Fork-tailed Swift is an aerial species which forages high above the tree canopy and rarely lower so is independent of terrestrial habitats. It usually occurs in flocks of up to 2000 and is often seen accompanying Tree Martins and Masked Wood swallows (Johnstone and Storr 1998).	As this species forages high in the airspace it is reasonably independent of the habitats within the project area. This species will only be found in the project area on an infrequent basis particularly in November for the Pilbara (Johnstone and Storr 1998). There are no previous records of this species in the vicinity of the project area.	Possible
Cattle Egret (*Ardea ibis*)	Mi	The Cattle Egret occurs in the wetter parts of Western Australia, in particular the Kimberley and the south-west. The species inhabits short grass, in particular damp pastures and wetlands, usually in the company of cattle and occasionally other livestock. In Western Australia it is an irregular visitor, occurring mostly in autumn, and is not thought to breed regularly (Johnstone and Storr 1998).	Despite the limited records in the vicinity of the project area this species is well known for the Pilbara region. The Drainage Line habitat and the associated Alluvial Plains, with its thick grasses provides suitable habitat for this species especially when surface water is present.	Likely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Eastern Great Egret (*Ardea modesta*)	Mi	The Eastern Great Egret occurs in the Kimberley, Pilbara, and on the west coast from the Murchison River south, throughout the south-west, and east to Cape Arid (Johnstone and Storr 1998). It inhabits mostly shallow fresh lakes, pools in rivers, lagoons, lignum swamps, clay pans and samphire flats, large dams and sewage ponds (Johnstone and Storr 1998). It also inhabits shallow saltwater habitat such as mangrove creeks, tidal pools, samphire swamps and salt work ponds. It breeds colonially at wooded swamps and river pools, nesting in various riparian trees (Johnstone and Storr 1998).	The Drainage Line and Marsh habitat type provides suitable foraging and breeding habitat for this species but only when surface water is present. One individual was recorded within the Christmas Creek study area during a previous survey (Biota 2005).	Likely
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Mi	The White-bellied Sea Eagle is distributed along the coast, islands and estuaries of WA but not the lower west and south-west or far east (Johnstone and Storr 1998). They feed on fish, sea snakes and nesting seabirds. White-bellied Sea- Eagles are known to breed almost wholly on islands or near coastal areas (Johnstone and Storr 1998). Nests are usually placed on high ground such as rock pinnacles, rigid shrubs or in tall trees (Simpson and Day 2004) almost usually on offshore islands (Johnstone and Storr 1998).	The Drainage Line and Marsh habitat of the project area contains surface water that may provide foraging habitat for this species. However this species is know from more marine or coastal habitats in Western Australia and only infrequently will venture inland. This bird has previously been recorded in the Fortescue Marsh (Bamford 2010).	Possible
Grey Falcon (*Falco hypoleucos*)	P4	The Grey Falcon is generally regarded as a rare bird in Australia, although it occurs on the Fortescue River and has been recorded within the Packsaddle Range. (Johnstone and Storr 1998). They are a difficult species to study, having a strongly transient nature. The Grey Falcon nests in River Gum and Coolabah trees and feeds mostly on birds (Johnstone and Storr 1998).	Possible nesting habitat occurs for this species in the large trees found in the Riverine habitat of the project area. This species has been previously recorded within the project area (Bamford 2005, 2010) and within 40 km of the project area (DEC 2011c).	Likely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Peregrine Falcon (*Falco peregrinus*)	S4	The Peregrine Falcon is uncommon but wide-ranging across Australia. They occur mainly along coastal cliffs, rivers and ranges as well as wooded watercourses and lakes. The Peregrine Falcon nests primarily on cliffs, granite outcrops and quarries, and feed mostly on birds (Johnstone and Storr 1998).	The drainage Line habitat of the project area provides suitable habitat for this species. Prey items are abundant and this species may forage across all parts of the project area as part of a wider home range. The Low Hills present in the project area lacked the high cliffs preferred by this species for its nesting positions. This species has been previously recorded in close proximity to the project area (DEC 2011c, Biota 2005, Bamford 2005, 2010).	Likely
Australian Bustard (*Ardeotis australis*)	P4	The Australian Bustard is typically widespread and nomadic, but locally scarce. This species is distributed across most of Western Australia, although is most prevalent in grasslands, especially tussock grasses, arid scrub and dry open woodlands (Morcombe 2000). The abundance of this species varies according to habitat and season, in particular the abundance of grasshoppers. Habitat loss has led to a decline in this species in the Pilbara (Johnstone and Storr 1998).	The Stony Plains in the project area are ideal habitats for the Australian Bustard. Nine individuals were recorded in this habitat type during the survey. This species has been previously recorded within 40 km of the project area (DEC 2011c, ecologia 2011, Biota 2005, Bamford 2005, 2010).	Recorded
Bush Stone-curlew (*Burhinus grallarius*)	P4	The Bush Stone-curlew inhabits dry open woodlands with groundcover of small sparse shrubs, grass or litter of twigs. It tends to avoids dense forest, closed-canopy habitats (Morcombe 2000). The species generally occurs near a watercourse or swamp (Geering *et al.* 2007). Bush Stone-curlews are locally rare because of predation by	The Alluvial and Stony Plains, specifically those adjacent to the Drainage Line habitats are the preferred habitat for this species because it provides denser vegetation cover for daytime shelter (Johnstone and Storr 1998). This species has been previously recorded within 40 km of the project area (Bamford 2011, DEC 2011c, , ecologia	Likely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		foxes - the main concern for their regional decline (Johnstone and Storr 1998).	2011).	
Oriental Plover (*Charadrius veredus*)	Mi	The Oriental Plover occurs in the Kimberley and in the north-eastern interior at Lake Gregory and on the north-west coastal plains (Johnstone and Storr 1998). It is found on sparsely vegetated plains including Samphire, Spinifex plains (particularly after fire), as well as beaches and tidal flats (Johnstone and Storr 1998). This species often feeds on insects (Johnstone and Storr 1998).	The Stoney Plains and Low Hills of the project area contain large areas of Spinifex that provide suitable foraging habitat for this species. However previous records of this species in the vicinity of the project area are lacking.	Possible
Wood Sandpiper (*Tringa glareola*)	Mi	The Wood Sandpiper is a summer non-breeding migratory shorebird that occurs along the coast and inland regions of Western Australia. It primarily inhabits freshwater wetlands and rarely inter-tidal mudflats (Geering *et al.* 2007).	The Marsh and Drainage Line habitat of the project area contains freshwater wetlands which is a suitable habitat for this species. This species has been previously recorded in the Marsh habitat of the project area (Bamford 2010).	Likely
Common Greenshank (*Tringa nebularia*)	Mi	The Common Greenshank is a non-breeding migratory shorebird, common along most of the coast of Western Australia (Geering *et al.* 2007). It inhabits intertidal mudflats, as well as fresh and saltwater wetlands of the coast or inland (Geering *et al.* 2007).	The Marsh and Drainage Line habitat of the project area contains freshwater wetlands which is a suitable habitat for this species. This species has been previously recorded in the Marsh habitat of the project area (Bamford 2010).	Likely
Night Parrot (*Pezoporus occidentalis*)	EN, S1	The Night Parrot (*Pezoporus occidentalis*) is a very cryptic bird species, with few records since the 1880s, although it is thought to persist inland. It inhabits inland plains, around sparsely wooded spinifex near water (Johnstone and Storr 1998). Most recently, a confirmed live sighting of the Night Parrot was reported from the	Very little is known about the biological requirements of this species. From what is known this species may be found near large Spinifex hummocks close to water, possibly with a greater likelihood of detection during hot and prolonged dry periods (Bamford 2010). If present this species may be located near surface water of the	Highly Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		proposed Fortescue Metals Group rail corridor at Minga Well near the Fortescue Marsh (Bamford 2010).	Fotescue Marsh. At least seven surveys for the Night Parrot have been conducted in the Fortescue Marsh, with only one confirmed record from 2005 at Minga Well about 60 km west of Christmas Creek (Bamford 2010).	
Rainbow Bee-eater (*Merops ornatus*)	Mi	The Rainbow Bee-eater is a common and widespread species in Western Australia, except in the drier interior of the State and the far south-west. It occurs in lightly wooded, often sandy country, preferring areas near water. The Rainbow Bee-eater feeds on airborne insects, and nests throughout its range in Western Australia in burrows excavated in sandy ground or banks, often at the margins of roads and tracks (Johnstone and Storr 1998).	All of the habitat types provide suitable foraging habitat for this species. The Alluvial Plains particularly those adjacent to the Drainage Line habitat type have soft substrates which are suitable as nesting sites, particularly in exposed river banks. This species was recorded in the Stoney Plain, Alluvial Plain and Drainage Line habitat during the survey.	Recorded
Western Star Finch (*Neochmia ruficauda subclarescens*)	P4	The Western Star Finch is confined to the Pilbara region of Western Australia (Pizzey and Knight 2007). The species occurs in grasslands with sparse vegetation, and feeds mainly on grass seeds and some small insects (Johnstone and Storr 2004). Like most finches this species needs regular water, so is likely to occur near permanent water for most of the season then disperse out to a wider area during and after the wet season when ephemeral pools have water.	The Marsh, Drainage Lines and the associated Alluvial Plains of the project area provide suitable habitat for this species. This species was opportunistically recorded in the Drainage Line habitat during the survey. Westerm Star Finches have previously been recorded in the vicinity of the project area (Bamford 2005).	Recorded

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
MAMMALS				
Mulgara sp. (*Dasycercus sp.*)	[VU,P4]	Refer also to the Discussion. Brush-tailed Mulgara has recently been reviewed and has had its name changed from *Dasycercus cristicauda* (it is listed as Vulnerable under the *EPBC Act* and as Schedule 1 [WC Act] as *Dasycercus cristicauda*) to *Dasycercus blythi*. Currently the name *Dasycercus blythi* is only listed as Priority 4 by the DEC, with any updates yet to be made to the EPBC Act (*pers comm.* S. Peacock DSEWPaC). This species is found in central Western Australia in sandy regions, living in burrows (van Dyck and Strahan 2008). The Crest-tailed Mulgara was recently verified (by genetic analysis) as occurring just outside the Pilbara bioregion, about 100 km southeast of Newman (Phoenix Environmental Sciences 2011).	There are previously unconfirmed reports of Mulgara from the vicinity of Cloudbreak airstrip (ATA Environmental 2006), and unconfirmed reports of diggings, scats and tracks along the Stage B rail corridor on sandplain habitat (Biota Environmental Sciences 2005). Based on these past observations, the Mulgara could possibly occur in the study area, but the lack of a confirmed record makes it difficult to judge the likelihood of occurrence. Mulgara have been previously recorded within 40 km of the project area (DEC 2011c).	Possible
Northern Quoll (*Dasyurus hallucatus*)	EN, S1	The Northern Quoll occurs mainly in areas of open eucalypt woodland within 200 km of the coast, although it has been recorded in a range of vegetation types, and is known to den in rock crevices and rock piles. It favors rocky areas, taking refuge in rock crevices, and utilises gullies and drainage lines (van Dyck and Strahan 2008). The Northern Quoll may be locally common, but its former range has retracted considerably (van Dyck and Strahan 2008). The Northern Quoll also has a relatively large home range with males utilizing areas of up to 153 ha, however this likely to be an underestimate (Oakwood 2002). The	The Drainage Line habitat types may provide suitable foraging habitat for this species. Northern Quoll scats were recorded from Mt Nicholas to the west of Christmas Creek (Biota 2005) and a single individual was recorded at Nullangine/Cloudbreak in 1980 (DEC 2011c). A targeted survey involving trapping did not obtain any evidence of populations of Northern Quoll on Christmas Creek (ENV. Australia 2011c). Due to previous records within the vicinity of the study area it is possible that the Northern Quoll could occupy areas within the study area.	Possible

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		maximum distances recorded for movement between successive dens on successive days is 1.85 km for a male and 1.21km for a female (Oakwood 2002).		
Greater Bilby (*Macrotis lagotis*)	VU,S1	The Greater Bilby has gone from being a widespread and common species to being confined to sparse desert populations in the eastern Pilbara and south to Warburton (Menkhorst and Knight 2004). The presence of the Greater Bilby is characterized by its feeding habits, evident from the numerous scattered excavations up to 25 cm deep it leaves behind, from which soil has been scattered on all sides (Menkhorst and Knight 2004). It is a burrowing species, and prefers sandy substrates.	The sandy substrates preferred by this species are only present in the Marsh and Alluvial Plain habitat type. There have been reports of diggings produced by Bilbys near the Cloud Break mine (ATA Environmental 2006) but none have been recorded in the vicinity of the study area.	Possible
Ghost Bat (*Macroderma gigas*)	P4	The Ghost Bat (*Macroderma gigas*) occurs in a wide variety of habitats, and requires an undisturbed cave, deep fissure or disused mine shaft in which to roost. It is patchily distributed across Australia, and is sensitive to disturbance. Colonies range in size from 400-1000 individuals (van Dyck and Strahan 2008). The Ghost Bat inhabits areas of open woodland (Churchill 2008).	There are no suitable roost sites for this species within the project area. If suitable roosting sites are located near the project area this species can be expected to forage over all habitat types within a radius of about 2 km from the roost (Churchill 2008). This species has been previously recorded within 40 km of the project area (DEC 2011c).	Possible

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	VU,S1	The Pilbara Leaf-nosed Bat requires deep caves or disused mine shafts in which to roost (van Dyck and Strahan 2008), at least in the dry season. These bats have been recorded in isolated populations in the Pilbara, and are present only where suitable roosting niches are available. They are generally sparsely distributed. The Pilbara Leaf-nosed Bat inhabits areas of open woodland (Churchill 2008).	There are no suitable roost sites for this species within the project area. If suitable roosting sites are located near the project area this species can be expected to forage over all habitat types (Churchill 2008). As part of the recent biodiversity survey of the Pilbara the Pilbara Leaf-nosed Bat was recorded in 17 of the 24 areas (71%) surveyed, including the Chichester Ranges suggesting there remains additional roost colonies to be discovered throughout the Pilbara (McKenzie and Bullen 2009). This bat can forage up to about 10-15 km from a roost (Bob Bullen in prep 2011) and it is therefore possible that the bat could fly into the study area from a roost located outside the study area. Much of the study area provides suitable foraging habitat	Possible
Short-tailed Mouse (*Leggadina lakedownensis*)	P4	The Short-tailed Mouse (*Leggadina lakedownensis*) occurs in a range of habitat types on seasonally inundated sandy-clay soils (van Dyck and Strahan 2008). In the Pilbara it occurs on stony hummock grassland (Menkhorst and Knight 2004). It is generally rare, with scattered populations, and very little is known of its biology (van Dyck and Strahan 2008).	The Stoney Plains of the project area provide suitable habitat for this species, however the clay pans and sandy clay depressions favored by this species are absent. This species has been previously recorded in the project area (Biota 2005) and within 40 km of the project area (DEC 2011c).	Likely
Western Pebble-mound Mouse (*Pseudomys chapmani*)	P4	The Western Pebble-mound Mouse is restricted to the Pilbara, where it is recognized as an endemic species. Abandoned mounds to the east of its current range indicate a decline in distribution (Menkhorst and Knight	The Low Hill habitat type provides suitable habitat for this species. There were no pebble mounds recorded during the survey although three mounds were recorded in the project area during a recent survey (ENV 2011).	Likely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		2004). Abandoned mounds in disturbed areas suggest that the species is under threat by grazing and mining activities. The construction of extensive pebble mounds, built from small stones, which typically cover areas from 0.5-9.0 square metres, is characteristic of this species. Mounds are restricted to suitable-class stones, and are usually found on gentle slopes and spurs.	This species has been previously recorded within 40 km of the project area (DEC 2011c, Bamford 2005, Biota 2005).	

[#]Australian Geocentric 1994 (GDA94) Zone 50K

KEY:

En	Listed as Endangered under the EPBC Act 1999.
Vu	Listed as Vulnerable under the EPBC Act 1999.
Mi	Listed as Migratory under the EPBC Act 1999.
S	Listed as Scheduled under the WC Act 1950.
P	Listed as Priority by the DEC.
Recorded	Recorded during the field survey or site reconnaissance.
Likely	Suitable habitat is present in the project area and the project area is in the species' known distribution.
Possible	Limited or no suitable habitat is present in project area but is nearby. The species has good dispersal abilities and is known from the general area.
Unlikely	No suitable habitat is present in project area but is nearby, the species has poor dispersal abilities, but is known from the general area; or suitable habitat is present, however the project area is outside of the species' known distribution.
Highly Unlikely	The species has poor dispersal abilities, no suitable habitat is present, and the species is uncommon; or the species is thought to be locally extinct.

APPENDIX G

LOCATION OF CONSERVATION SIGNIFICANT SPECIES WITHIN STUDY AREA

CHRISTMAS CREEK VERTEBRATE FAUNA AND FAUNA HABITAT ASSESSMENT

APPENDIX G

LOCATION OF CONSERVATION SIGNIFICANT SPECIES WITHIN STUDY AREA

Species	Easting	Northing	Mound activity	Source
Australian Bustard	796732	7518471		Present study
	773653	7525150		Present study
	789734	7520049		Present study
	773011	7525150		Present study
	764690	7522976		Present study
Western Star Finch	782229	7513606		Present study
	781693	7517584		Present study
Rainbow Bee-eater	796732	7518471		Present study
	795569	7519064		Present study
	795944	7518923		Present study
	773653	7525150		Present study
	769644	7524264		Present study
Pilbara Olive Python	795868	7519215		Present study
Western Pebble-mound Mouse	793625	7524788	Active	Appendix C
Western Pebble-mound Mouse	774681	7527795	Active	Appendix C
Western Pebble-mound Mouse	763255	7527583	Inactive	Appendix C
Western Pebble-mound Mouse	790990	7522288	Inactive	Appendix C
Western Pebble-mound Mouse	790810	7522026	Inactive	Appendix C
Western Pebble-mound Mouse	763266	7527594	Inactive	Appendix C
Western Pebble-mound Mouse	791713	7525655	Inactive	Appendix C
Western Pebble-mound Mouse	791558	7525592	Inactive	Appendix C
Western Pebble-mound Mouse	792852	7525368	Inactive	Appendix C
Western Pebble-mound Mouse	794174	7524401	Inactive	Appendix C
Western Pebble-mound Mouse	794255	7524333	Inactive	Appendix C
Western Pebble-mound Mouse	763559	7527267	Inactive	Appendix C
Western Pebble-mound Mouse	763877	7527173	Inactive	Appendix C
Western Pebble-mound Mouse	764011	7527171	Inactive	Appendix C
Western Pebble-mound Mouse	764103	7527125	Inactive	Appendix C
Western Pebble-mound Mouse	764165	7527135	Inactive	Appendix C
Western Pebble-mound Mouse	764154	7527091	Inactive	Appendix C
Western Pebble-mound Mouse	764237	7527145	Inactive	Appendix C
Western Pebble-mound Mouse	764309	7527110	Inactive	Appendix C
Western Pebble-mound Mouse	764499	7526775	Inactive	Appendix C
Western Pebble-mound Mouse	790995	7521446	Inactive	Appendix C
Western Pebble-mound Mouse	764273	7526834	Inactive	Appendix C
Western Pebble-mound Mouse	763965	7526884	Inactive	Appendix C
Western Pebble-mound Mouse	791329	7523845	Inactive	Appendix C
Western Pebble-mound Mouse	792413	7525586	Inactive	Appendix C
Western Pebble-mound Mouse	791163	7522684	Inactive	Appendix C
Western Pebble-mound Mouse	763211	7527384	Inactive	Appendix C
Western Pebble-mound Mouse	791376	7525817	Inactive	Appendix C

Species	Easting	Northing	Mound activity	Source
Western Pebble-mound Mouse	792771	7525436	Inactive	Appendix C
Western Pebble-mound Mouse	791910	7525131	Inactive	Appendix C
Western Pebble-mound Mouse	794016	7524226	Inactive	Appendix C
Western Pebble-mound Mouse	792079	7525349	Inactive	Appendix C
Western Pebble-mound Mouse	763949	7527150	Inactive	Appendix C
Western Pebble-mound Mouse	764150	7526847	Inactive	Appendix C
Western Pebble-mound Mouse	763482	7526980	Inactive	Appendix C
Western Pebble-mound Mouse	792379	7525942	Inactive	Appendix C
Western Pebble-mound Mouse	792027	7524807	Inactive	Appendix C
Western Pebble-mound Mouse	790825	7522247	Inactive	Appendix C
Western Pebble-mound Mouse	791028	7522099	Inactive	Appendix C
Western Pebble-mound Mouse	791671	7525600	Inactive	Appendix C
Western Pebble-mound Mouse	791447	7525716	Inactive	Appendix C
Western Pebble-mound Mouse	791355	7525773	Inactive	Appendix C
Western Pebble-mound Mouse	791988	7525982	Inactive	Appendix C
Western Pebble-mound Mouse	792759	7525358	Inactive	Appendix C
Western Pebble-mound Mouse	792810	7525302	Inactive	Appendix C
Western Pebble-mound Mouse	792902	7525278	Inactive	Appendix C
Western Pebble-mound Mouse	793003	7525143	Active	Appendix C
Western Pebble-mound Mouse	794203	7524300	Inactive	Appendix C
Western Pebble-mound Mouse	794417	7524152	Inactive	Appendix C
Western Pebble-mound Mouse	794218	7524001	Inactive	Appendix C
Western Pebble-mound Mouse	794136	7524024	Inactive	Appendix C
Western Pebble-mound Mouse	793801	7524286	Active	Appendix C
Western Pebble-mound Mouse	793626	7524322	Active	Appendix C
Western Pebble-mound Mouse	793597	7524378	Inactive	Appendix C
Western Pebble-mound Mouse	793536	7524457	Active	Appendix C
Western Pebble-mound Mouse	792755	7525126	Inactive	Appendix C
Western Pebble-mound Mouse	763529	7527334	Inactive	Appendix C
Western Pebble-mound Mouse	764094	7527181	Inactive	Appendix C
Western Pebble-mound Mouse	764135	7527202	Inactive	Appendix C
Western Pebble-mound Mouse	764741	7527070	Inactive	Appendix C
Western Pebble-mound Mouse	764942	7526745	Inactive	Appendix C
Western Pebble-mound Mouse	764870	7526757	Inactive	Appendix C
Western Pebble-mound Mouse	764459	7526842	Inactive	Appendix C
Western Pebble-mound Mouse	791202	7522722	Inactive	Appendix C
Western Pebble-mound Mouse	791019	7522221	Active	Appendix C
Western Pebble-mound Mouse	790906	7522392	Active	Appendix C
Western Pebble-mound Mouse	792833	7525324	Active	Appendix C
Western Pebble-mound Mouse	792922	7525279	Inactive	Appendix C
Western Pebble-mound Mouse	793640	7524418	Active	Appendix C
Western Pebble-mound Mouse	793616	7524406	Inactive	Appendix C
Western Pebble-mound Mouse	792454	7525374	Inactive	Appendix C
Western Pebble-mound Mouse	762759	7527413	Inactive	Appendix C
Western Pebble-mound Mouse	764223	7527155	Inactive	Appendix C
Western Pebble-mound Mouse	764668	7526773	Inactive	Appendix C
Western Pebble-mound Mouse	774762	7527788	Active	Appendix C

World Geodetic System 1984 (WGS84), Zone 50K

Species	*Easting*	*Northing*	*Source*	*Date*
Australian Bustard	781977	7523256	Ecoscape (2009)	30/09/2008
Australian Bustard	795265	7522123	ENV.AUSTRALIA (2009)	22/01/2009
Australian Bustard	761531	7526664	ENV.AUSTRALIA (2009)	10/12/2008
Australian Bustard	783080	7521510	FMG - Cameron Newling	25/10/2011
Peregrine Falcon	795866	7519142	FMG	
Rainbow Bee-eater	792813	7522104	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	803291	7516799	Source – not given	
Western Pebble-mound Mouse	802926	7516638	Source – not given	
Western Pebble-mound Mouse	802681	7516607	Source – not given	
Western Pebble-mound Mouse	801682	7516607	Source – not given	
Western Pebble-mound Mouse	801655	7516563	Source – not given	
Western Pebble-mound Mouse	757431	7528081	Coffey	09/06/2008
Western Pebble-mound Mouse	757832	7527917	Coffey	09/06/2008
Western Pebble-mound Mouse	757845	7527932	Coffey	09/06/2008
Western Pebble-mound Mouse	757872	7527823	Coffey	09/06/2008
Western Pebble-mound Mouse	758240	7527641	Coffey	09/06/2008
Western Pebble-mound Mouse	758301	7527581	Coffey	09/06/2008
Western Pebble-mound Mouse	758402	7527651	Coffey	09/06/2008
Western Pebble-mound Mouse	761648	7526810	Coffey	09/06/2008
Western Pebble-mound Mouse	761790	7526799	Coffey	09/06/2008
Western Pebble-mound Mouse	763487	7525566	Coffey	09/06/2008
Western Pebble-mound Mouse	763499	7525748	Coffey	09/06/2008
Western Pebble-mound Mouse	764319	7525565	Coffey	09/06/2008
Western Pebble-mound Mouse	764595	7525438	Coffey	09/06/2008
Western Pebble-mound Mouse	764671	7525492	Coffey	09/06/2008
Western Pebble-mound Mouse	764879	7525380	Coffey	09/06/2008
Western Pebble-mound Mouse	765023	7525281	Coffey	09/06/2008
Western Pebble-mound Mouse	765197	7525284	Coffey	09/06/2008
Western Pebble-mound Mouse	765810	7525159	Coffey	09/06/2008
Western Pebble-mound Mouse	767525	7524906	Coffey	09/06/2008
Western Pebble-mound Mouse	768863	7524940	Coffey	09/06/2008
Western Pebble-mound Mouse	773860	7525183	Coffey	09/06/2008
Western Pebble-mound Mouse	774041	7525311	Coffey	09/06/2008
Western Pebble-mound Mouse	774264	7525135	Coffey	09/06/2008
Western Pebble-mound Mouse	774335	7525232	Coffey	09/06/2008
Western Pebble-mound Mouse	774359	7525259	Coffey	09/06/2008
Western Pebble-mound Mouse	774399	7525188	Coffey	09/06/2008
Western Pebble-mound Mouse	774667	7525108	Coffey	09/06/2008
Western Pebble-mound Mouse	774832	7524911	Coffey	09/06/2008
Western Pebble-mound Mouse	775164	7524824	Coffey	09/06/2008
Western Pebble-mound Mouse	779152	7519834	Coffey	09/06/2008

Species	*Easting*	*Northing*	*Source*	*Date*
Western Pebble-mound Mouse	757845	7527932	Coffey	04/08/2008
Western Pebble-mound Mouse	757431	7528081	Coffey	04/08/2008
Western Pebble-mound Mouse	758240	7527641	Coffey	04/08/2008
Western Pebble-mound Mouse	758301	7527581	Coffey	04/08/2008
Western Pebble-mound Mouse	774664	7526750	Coffey	14/08/2008
Western Pebble-mound Mouse	774674	7526827	Coffey	14/08/2008
Western Pebble-mound Mouse	774715	7527002	Coffey	14/08/2008
Western Pebble-mound Mouse	774725	7527101	Coffey	14/08/2008
Western Pebble-mound Mouse	774792	7526884	Coffey	14/08/2008
Western Pebble-mound Mouse	774796	7526854	Coffey	14/08/2008
Western Pebble-mound Mouse	774815	7526856	Coffey	14/08/2008
Western Pebble-mound Mouse	774827	7526937	Coffey	14/08/2008
Western Pebble-mound Mouse	775060	7527210	Coffey	14/08/2008
Western Pebble-mound Mouse	775286	7527230	Coffey	14/08/2008
Western Pebble-mound Mouse	775320	7527430	Coffey	14/08/2008
Western Pebble-mound Mouse	775457	7527319	Coffey	14/08/2008
Western Pebble-mound Mouse	775606	7527259	Coffey	14/08/2008
Western Pebble-mound Mouse	775607	7527322	Coffey	14/08/2008
Western Pebble-mound Mouse	775610	7527278	Coffey	14/08/2008
Western Pebble-mound Mouse	775611	7527477	Coffey	14/08/2008
Western Pebble-mound Mouse	775622	7527381	Coffey	14/08/2008
Western Pebble-mound Mouse	775632	7527209	Coffey	14/08/2008
Western Pebble-mound Mouse	775632	7527279	Coffey	14/08/2008
Western Pebble-mound Mouse	775711	7527276	Coffey	14/08/2008
Western Pebble-mound Mouse	775712	7527250	Coffey	14/08/2008
Western Pebble-mound Mouse	775744	7526697	Coffey	14/08/2008
Western Pebble-mound Mouse	775761	7527382	Coffey	14/08/2008
Western Pebble-mound Mouse	775761	7527375	Coffey	14/08/2008
Western Pebble-mound Mouse	775769	7527341	Coffey	14/08/2008
Western Pebble-mound Mouse	775840	7527495	Coffey	14/08/2008
Western Pebble-mound Mouse	775863	7527498	Coffey	14/08/2008
Western Pebble-mound Mouse	775940	7525477	Coffey	14/08/2008
Western Pebble-mound Mouse	775941	7525532	Coffey	14/08/2008
Western Pebble-mound Mouse	776062	7525581	Coffey	14/08/2008
Western Pebble-mound Mouse	776062	7525548	Coffey	14/08/2008
Western Pebble-mound Mouse	776065	7525545	Coffey	14/08/2008
Western Pebble-mound Mouse	776073	7525688	Coffey	14/08/2008
Western Pebble-mound Mouse	776089	7525614	Coffey	14/08/2008
Western Pebble-mound Mouse	776092	7525716	Coffey	14/08/2008
Western Pebble-mound Mouse	776100	7525662	Coffey	14/08/2008
Western Pebble-mound Mouse	776103	7525740	Coffey	14/08/2008
Western Pebble-mound Mouse	776190	7525612	Coffey	14/08/2008
Western Pebble-mound Mouse	776201	7525754	Coffey	14/08/2008

Species	*Easting*	*Northing*	*Source*	*Date*
Western Pebble-mound Mouse	776201	7526634	Coffey	14/08/2008
Western Pebble-mound Mouse	776221	7526471	Coffey	14/08/2008
Western Pebble-mound Mouse	776230	7526504	Coffey	14/08/2008
Western Pebble-mound Mouse	776233	7526565	Coffey	14/08/2008
Western Pebble-mound Mouse	776238	7526550	Coffey	14/08/2008
Western Pebble-mound Mouse	776246	7526642	Coffey	14/08/2008
Western Pebble-mound Mouse	776265	7526640	Coffey	14/08/2008
Western Pebble-mound Mouse	776294	7526615	Coffey	14/08/2008
Western Pebble-mound Mouse	776342	7525881	Coffey	14/08/2008
Western Pebble-mound Mouse	776386	7525722	Coffey	14/08/2008
Western Pebble-mound Mouse	776443	7526421	Coffey	14/08/2008
Western Pebble-mound Mouse	776523	7526177	Coffey	14/08/2008
Western Pebble-mound Mouse	775885	7527201	Coffey	14/08/2008
Western Pebble-mound Mouse	775888	7527481	Coffey	14/08/2008
Western Pebble-mound Mouse	775887	7525703	Coffey	14/08/2008
Western Pebble-mound Mouse	774833	7524910	Coffey	05/09/2008
Western Pebble-mound Mouse	775166	7524821	Coffey	05/09/2008
Western Pebble-mound Mouse	775209	7524811	Coffey	05/09/2008
Western Pebble-mound Mouse	789011	7520240	Coffey	03/09/2008
Western Pebble-mound Mouse	789031	7520308	Coffey	03/09/2008
Western Pebble-mound Mouse	790701	7520114	Coffey	03/09/2008
Western Pebble-mound Mouse	789167	7520307	Coffey	03/09/2008
Western Pebble-mound Mouse	789518	7520275	Coffey	03/09/2008
Western Pebble-mound Mouse	775679	7525189	Coffey	03/09/2008
Western Pebble-mound Mouse	775667	7525404	Coffey	03/09/2008
Western Pebble-mound Mouse	775677	7525381	Coffey	03/09/2008
Western Pebble-mound Mouse	775666	7525511	Coffey	03/09/2008
Western Pebble-mound Mouse	775660	7525552	Coffey	03/09/2008
Western Pebble-mound Mouse	775636	7525593	Coffey	03/09/2008
Western Pebble-mound Mouse	775666	7525616	Coffey	03/09/2008
Western Pebble-mound Mouse	775635	7525393	Coffey	03/09/2008
Western Pebble-mound Mouse	775642	7525336	Coffey	03/09/2008
Western Pebble-mound Mouse	757431	7528081	Coffey	03/09/2008
Western Pebble-mound Mouse	757832	7527917	Coffey	03/09/2008
Western Pebble-mound Mouse	757845	7527932	Coffey	03/09/2008
Western Pebble-mound Mouse	757872	7527823	Coffey	03/09/2008
Western Pebble-mound Mouse	758240	7527641	Coffey	03/09/2008
Western Pebble-mound Mouse	758301	7527581	Coffey	03/09/2008
Western Pebble-mound Mouse	758816	7526967	Coffey	03/09/2008
Western Pebble-mound Mouse	758871	7526960	Coffey	03/09/2008
Western Pebble-mound Mouse	757783	7527615	Coffey	03/09/2008
Western Pebble-mound Mouse	758606	7527216	Coffey	03/09/2008
Western Pebble-mound Mouse	758743	7527012	Coffey	03/09/2008

Species	*Easting*	*Northing*	*Source*	*Date*
Western Pebble-mound Mouse	758746	7527080	Coffey	03/09/2008
Western Pebble-mound Mouse	786015	7523075	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	785960	7524014	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	787907	7523075	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	784477	7524804	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	782834	7524936	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	785578	7523029	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	785597	7523750	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	787909	7523089	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	783980	7525069	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	783968	7525494	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	784479	7524800	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	786389	7522657	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	787242	7524401	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	788379	7522592	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	787194	7522525	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	785186	7522679	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	785205	7522579	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	784791	7521676	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	784860	7521992	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	784639	7522200	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	786081	7522804	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	785595	7524058	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	787040	7523398	Ecoscape (2009)	30/09/2008
Western Pebble-mound Mouse	791991	7523234	Ecoscape (2009)	08/05/2009
Western Pebble-mound Mouse	781194	7526526	Ecoscape (2009)	08/05/2009
Western Pebble-mound Mouse	780602	7525504	Ecoscape (2009)	08/05/2009
Western Pebble-mound Mouse	781640	7525909	Ecoscape (2009)	08/05/2009
Western Pebble-mound Mouse	781469	7526420	Ecoscape (2009)	08/05/2009
Western Pebble-mound Mouse	779846	7526036	Ecoscape (2009)	08/05/2009
Western Pebble-mound Mouse	792405	7523873	ENV.AUSTRALIA (2009)	
Western Pebble-mound Mouse	795418	7521603	ENV.AUSTRALIA (2009)	
Western Pebble-mound Mouse	795298	7523028	ENV.AUSTRALIA (2009)	
Western Pebble-mound Mouse	793252	7521784	ENV.AUSTRALIA (2009)	
Western Pebble-mound Mouse	793345	7522637	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793367	7522417	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793651	7522011	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793527	7521690	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793027	7521341	ENV.AUSTRALIA (2009)	22/01/2009

Species	*Easting*	*Northing*	*Source*	*Date*
Western Pebble-mound Mouse	792329	7521604	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	792130	7521700	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	792938	7521701	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	792428	7523911	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	792397	7523193	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	795408	7523053	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	794287	7522304	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793658	7521459	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793841	7521239	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793675	7521381	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793403	7521068	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	792300	7522966	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	794805	7522870	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	793930	7521936	ENV.AUSTRALIA (2009)	22/01/2009
Western Pebble-mound Mouse	765846	7525158	ENV.AUSTRALIA (2009)	10/12/2008
Western Pebble-mound Mouse	786043	7525790	Coffey	13/09/2009
Western Pebble-mound Mouse	786815	7525846	Coffey	13/09/2009
Western Pebble-mound Mouse	786419	7526531	Coffey	13/09/2009
Western Pebble-mound Mouse	786481	7526565	Coffey	13/09/2009
Western Pebble-mound Mouse	789343	7520627	Coffey	12/09/2009
Western Pebble-mound Mouse	789343	7521000	Coffey	12/09/2009
Western Pebble-mound Mouse	789343	7521343	Coffey	12/09/2009
Western Pebble-mound Mouse	795448	7520652	Coffey	12/09/2009
Western Pebble-mound Mouse	794689	7520490	Coffey	12/09/2009
Western Pebble-mound Mouse	776443	7526419	Coffey	22/07/2010
Western Pebble-mound Mouse	776588	7525962	Coffey	22/07/2010
Western Pebble-mound Mouse	793636	7523997	Coffey	22/07/2010
Western Pebble-mound Mouse	793754	7523976	Coffey	22/07/2010
Ghost Bat (possible roost)	793092	7522353	ENV.AUSTRALIA (2009)	

World Geodetic System 1984 (WGS84), Zone 50K