Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Raven

Fortescue Metals Group Limited

science+design

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Rev No.	Author	Approved for Issue	Date
Draft	SK/JS/LA	BT	Feb-12

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Acknowledgements

Ecoscape wishes to acknowledge the assistance of the following Fortescue Metals Group Limited personnel in relation the Western Hub surveys:

- Todd Edwards, for coordinating the field survey logistics
- Shaun Grein, project manager
- Shadi Sayadi and the Bonnie Doon camp crew for accommodation and meals, and helping out with the myriad day-to-day issues that occur during field surveys.

Executive Summary

Ecoscape was engaged by Fortescue Metals Group Limited (Fortescue) to undertake Level 1 Flora and Vegetation and Level 1 Fauna assessments, and target conservation significant flora and fauna species survey of exploration tenements including E47/1523 (known as 'Raven') approximately 70 km northwest of Tom Price in the Pilbara region of Western Australia.

The assessments included background 'desktop' research and a reconnaissance (field) survey to verify the accuracy of the background research. Targeted searches for conservation significant flora and fauna species and significant ecological communities were also conducted.

The desktop assessment of the biological environment identified:

- there is one Threatened Ecological Community (TEC) in the Hamersley subregion (*'Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)', however the DEC database search did not identify it as occurring within 15 km of the study area
- there are 29 Priority Ecological Communities (PECs) in the Pilbara Region, with the most likely to occur in the vicinity being the 'Brockman Iron cracking clay communities of the Hamersley Range' and '*Triodia* sp. Robe River assemblages of mesas of the Robe Valley'
- there were two Threatened Flora (TF) and 51 Priority Listed Flora (PF) species identified from the DEC database search request of the Western Hub area and 15 km buffer; none of which have been recorded by the DEC from within the study area
- there were seven Threatened and Priority listed Fauna species identified from the DEC database search of the Western Hub area and 20 km buffer, none of which have been recorded from within the study area
- three Threatened and eight Migratory Fauna species were identified by the EPBC Protected Matters Search Tool as potentially occurring in the study area and 10 km buffer
- a search of the *NatureMap* database and previous fauna survey reports indicates four additional Priority Fauna species that may be expected to occur in the study area
- the fauna species of highest conservation significance that are likely to occur in the study area are Northern Quoll (*Dasyurus hallucatus*, Endangered), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*, Vulnerable), Pilbara Olive Python (*Liasis olivaceus barroni*, Vulnerable), and a blind snake (*Ramphotyphlops ganei*, Priority 1 - DEC).

The flora and vegetation field survey to verify the findings of the desktop assessment was undertaken in July 2011 by four assessors over 2.5 days (55 person hours) and identified:

- a total of 117 taxa of vascular flora were recorded within the study area from relevé sites and opportunistic observations. Species richness cannot be assessed with confidence because a Level 1 survey does not necessarily include intensive floristic sampling. The seasonal conditions were considered excellent.

- no TF gazetted under the Government of Western Australia's *Wildlife Conservation Act* (1950) or listed as Threatened pursuant to Schedule 1 of the *EPBC Act* (1999) were recorded from the study area, however the presence of the two most likely TF species (*Lepidium catapycnon* and *Thryptomene wittweri*) cannot be discounted as the usual habitat was largely inaccessible during the survey
- two PF species were recorded:
  - *Goodenia nuda* (P2) from one population
  - *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (P3) from three locations where it was abundant in a drainage line
- a species of *Josephinia* was collected and is awaiting verification as a previously uncollected species and application of a new phrase name; it currently has no conservation status however it is likely to be listed as a PF in the future
- 10 different vegetation types were recorded from 15 relevès, none of which have conservation significance
- two of these vegetation types had a degree of local significance, however do not have conservation significance:
  - The **ChAmSf** (*Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* open woodland) and **EAmTw2** (*Eucalyptus leucophloia* subsp. *leucophloia* open woodland) vegetation types are associated with hills and include hilltops and as such may be analogous to the 'Hilltop floras, Hamersley Range' *vulnerable* 'Ecosystem at Risk'
- vegetation condition ranged from Good to Excellent depending of the density of weeds, impacts from grazing and effects of fire.

The fauna field survey to verify findings of the desktop assessment and target conservation-significant species was undertaken in July-August 2011 and identified:

- four habitat types identified, corresponding to creeklines/drainage lines on lower slopes and valley floors; Spinifex grassland on slopes; sheltered gorges and gullies; and exposed upper slopes, clifflines and ridges
- habitats were in good to excellent condition throughout the study area except for recently burnt areas. Habitat quality for species of interest was limited by the absence of permanent water sources
- a total of 46 vertebrate species recorded (three mammals, seven reptiles, 36 birds), of which one was Priority listed (*P4*) by DEC, and one *Migratory* listed by the *EPBC* Act
- a total of 15 fauna species of conservation significance are either known or considered likely to be present in the study area, six of which would be likely to suffer little or no impact from the proposed mining activity.

1.0 Introduction

1.1 Project Overview

Ecoscape was commissioned by Fortescue Metals Group Limited (Fortescue) to undertake a Level 1 Flora and Vegetation assessment and Level 1 Fauna assessment and targeted conservation significant flora and fauna species surveys of the Raven study area.

1.1.1 STUDY AREA LOCATION

The Raven exploration area (the study area) is in the Shire of Ashburton, approximately 60 km north-west of Tom Price in the Pilbara region of Western Australia.

The Raven exploration tenement E47/1523 areas are shown in **Figure 1**. This survey was conducted in concert with surveys of a number of exploration areas within the Fortescue Western Hub project area, also shown on **Figure 1**.

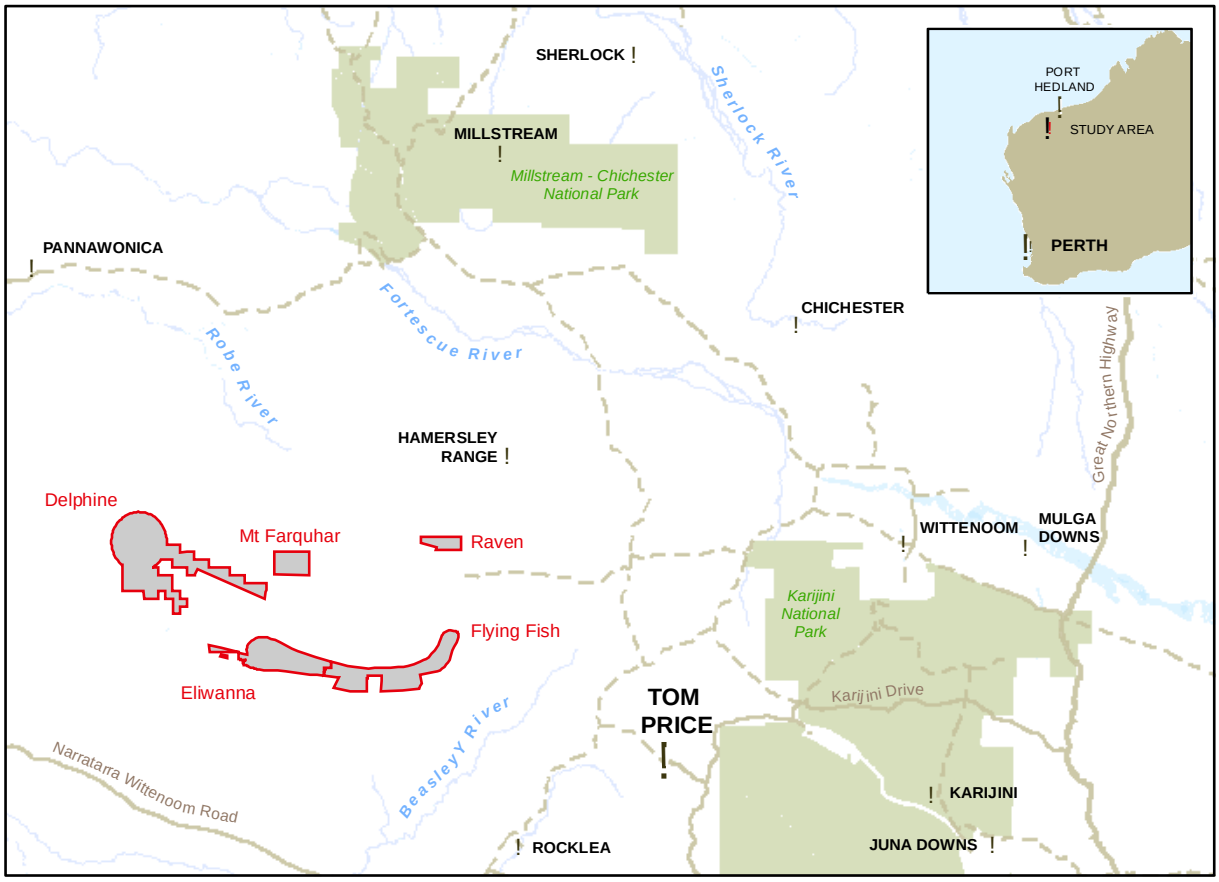

Figure 1: Study area locations

1.2 Project Objectives

The Level 1 Flora and Vegetation assessment and targeted conservation significant flora species searches were undertaken to be compliant with:

- Environmental Protection Authority (EPA) *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessments in Western Australia* (2004a)
- *Terrestrial Biological Surveys as an Element of Biodiversity Protection Position Statement No.* 3 (EPA 2002).

The flora and vegetation assessment involved:

- a background research or 'desktop' study at the locality scale involving a search of all sources of literature, data and map-based information;
- a reconnaissance survey to verify the accuracy of the background study (desktop assessment), to further delineate and characterise the flora and range of vegetation units present within the study area and to identify potential impacts. This involved a survey by qualified botanists to undertake selective, low intensity sampling of the flora and vegetation, including mapping of vegetation units and condition at an appropriate scale
- a targeted survey for conservation significant species and ecological communities.

The Level 1 Fauna assessment and targeted conservation significant fauna species searches were undertaken to be compliant with:

- EPA *Guidance Statement No.56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (2004b)
- *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA & DEC 2010)
- *Environment Protection and Biodiversity Conservation Act 1999* referral guidelines for the endangered northern quoll, *Dasyurus hallucatus*, EPBC Act policy statement 3.25 (Department of Sustainability, Environment, Water, Population and Community (DSEWPaC) 2011).

The fauna assessment involved:

- a background research or 'desktop' study at the locality scale involving a search of all sources of literature, data and map-based information;
- a reconnaissance survey to verify the accuracy of the background study (desktop assessment), to further delineate and characterise the fauna and faunal assemblages present within the study area and to identify potential impacts. This involved a survey by qualified zoologists to undertake selective, low intensity sampling of the fauna and faunal assemblages, and to provide habitat descriptions and habitat maps of the study area; and
- a targeted survey for conservation significant fauna species and their habitats.

1.3 Previous Surveys

Previous surveys in the Pilbara, reviewed to reference flora and vegetation information, include:

- Ecoscape (2012a) *Level 1 Vegetation, Flora and Fauna Assessment, and Target Conservation Significant Flora and Fauna Survey: Delphine,* Unpublished report for Fortescue Metals Group Ltd
- Ecoscape (2012b) *Level 1 Vegetation, Flora and Fauna Assessment, and Target Conservation Significant Flora and Fauna Survey: Flying Fish,* Unpublished report for Fortescue Metals Group Ltd
- Ecoscape (2012c) *Level 1 Vegetation, Flora and Fauna Assessment, and Target Conservation Significant Flora and Fauna Survey: Mt Farguhar,* Unpublished report for Fortescue Metals Group Ltd
- Ecoscape (2011) *Pilbara Iron Ore Project – Blacksmith Flora and Vegetation Survey,* Unpublished report for Flinders Mines Ltd
- Ecoscape (2010a) *Level Two Flora and Vegetation Assessment, Firetail Mining Area*, Unpublished report for Fortescue Metals Group Ltd
- ENV Australia (2010) Solomon Project: Kings Flora and Vegetation Assessment, Unpublished report for Fortescue Metals Group Ltd
- Coffey Environments (2010) *Flora and Vegetation Assessment, Solomon Project and Investigator*, Unpublished report for Fortescue Metals Group Ltd
- Coffey Environments (2010) *Flora and Vegetation Assessment, Solomon Rail Project Volume 1*, Unpublished report for Fortescue Metals Group Ltd.

Previous fauna surveys pertaining to the central and western Hamersley subregion of the Pilbara include:

- Bamford MJ (2002) *Karratha to Tom Price Highway: Karratha to Nanutarra-Munjina Road Section. Assessment of Fauna values and results of Fauna Survey May 2002*. Unpublished report commissioned by Gutteridge, Haskins and Davey Pty Ltd; Appendix D of Main Roads Western Australia (2003) Karratha – Tom Price Road, Karratha to Nanutarra-Munjina Rd Section, Consultative Environmental Review (Assessment No. 1244)
- Biota Environmental Sciences (2009) *Hope Downs IV Northern Quoll Position Paper*, Unpublished report for Rio Tinto Iron Ore on behalf of Hamersley HMS
- Coffey Environments (2008) *Level 2 Terrestrial Vertebrate Fauna Assessment for the Solomon Project*, Unpublished report for Fortescue Metals Group Ltd
- Ecologia (2010) *Fortescue Metals Group Ltd Solomon Project: Kings Area Vertebrate Fauna Assessment*, Unpublished report for Fortescue Metals Group Ltd
- Ecoscape (2011) *Level 1 Vertebrate Fauna Assessment – Rail Options*. Unpublished report for Flinders Mines Ltd

- Ecoscape (2011) *Pilbara Iron Ore Project – Blacksmith Vertebrate Fauna and Short Range Endemic Survey,* Unpublished report for Flinders Mines Ltd
- Ecoscape (2010b) *Solomon Project – Rail Re-alignment Fauna Assessment*, Unpublished report for Fortescue Metals Group Ltd
- Ecoscape (2010c) *Solomon Project – Rail Camp Sites 1, 2 and 3, Fauna Assessment*, Unpublished report for Fortescue Metals Group Ltd
- Ecoscape (2010d) *Vertebrate Fauna and Fauna Habitat Assessment for the Firetail Project*, Unpublished report for Fortescue Metals Group Ltd
- Morgan D, Ebner B, and Beatty S (2009) *Fishes in groundwater dependent pools of the Fortescue and Yule Rivers; Pilbara, Western Australia*. Centre for Fish and Fisheries Research, Murdoch University
- Muir BG (ed) (1983) *A Fauna Survey of the Hamersley Range National Park, Western Australia, 1980*, National Parks Authority of Western Australia, Bulletin No 1

2.0 Existing Environment

2.1 Physical Environment

2.1.1 CLIMATE

The Pilbara region experiences an arid climate, which is influenced by two air masses, the Indian tropical maritime air moving in from the west or north-west, and the tropical continental air from the inland. During the warmer part of the year, there is a hot low-pressure system over the region resulting in clear skies and very high temperatures from November to February with average maximum temperatures generally between 35°C and 40°C. During the winter months the average maximum temperature generally falls to between 22°C and 30°C, the range of which is generally greater in inland areas away from the moderating effects of onshore winds common in coastal areas (Australian Government 2009a).

The Pilbara lies south of the area normally penetrated by the northwest monsoon in the summer months, and is only occasionally influenced by weather systems of the westerly circulation in the winter months. Rainfall is therefore low and variable. The majority of rainfall occurs between December and March, as the result of moist tropical storms and cyclones originating in the north, with a pronounced dry period between August and November (Australian Government 2009a).

Figure 2 outlines monthly rainfall and temperature averages for the Wittenoom Bureau of Meteorology (BoM) site, approximately 90 km to the east and derived from data collected between 1950 and 2011. Weather data for the 12 months prior to the survey, also included in **Figure 3,** is derived from Wittenoom (for rainfall) and Paraburdoo Airport (for temperature) (BoM 2011). Paraburdoo Airport is located approximately 110 km south-south-east of Raven.

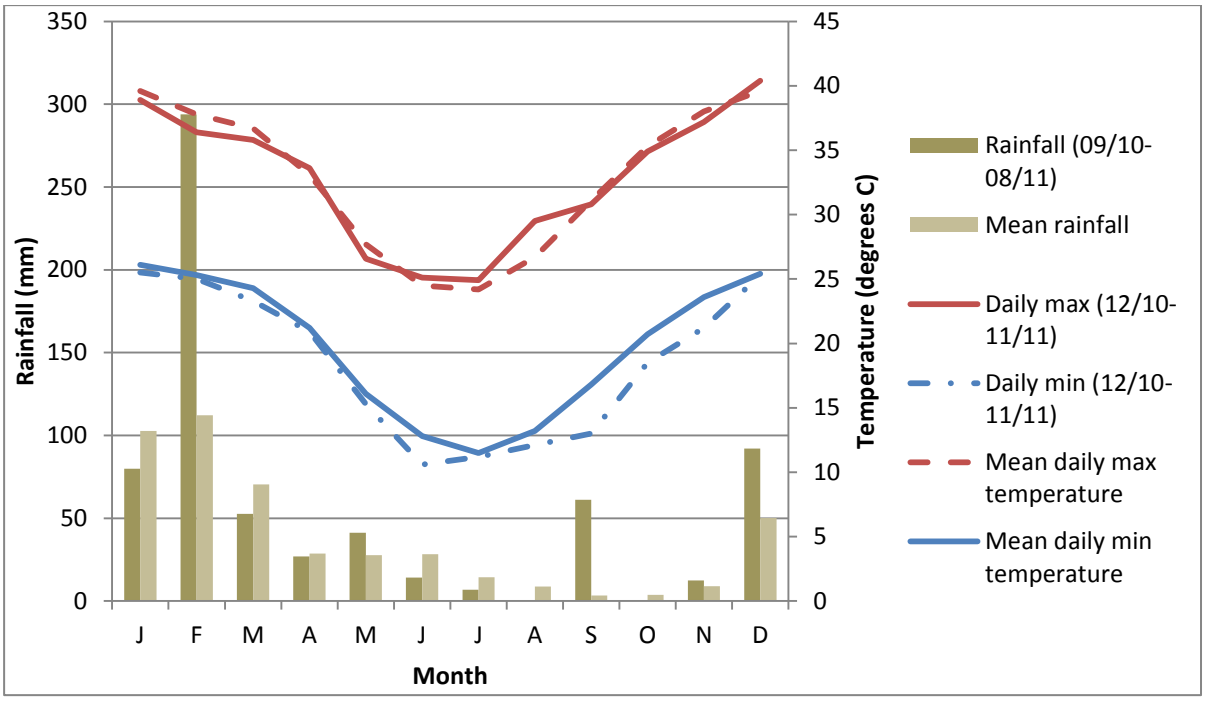

Figure 2: Monthly rainfall, and daily maxima and minima for Wittenoom BoM site (1950-2011) and Paraburdoo Airport (2011) (BoM 2011)

2.1.2 GEOLOGY

Table 1 lists the geological units that occur in the Raven study area (Thorne & Tyler 1997).

Table 1: Geological units occurring within the study area.

Unit	Description
Ahs	Mount McCrae Shale and Mount Sylvia Formation: pelite, chert, and banded iron formation
Czc	Colluvium - partly consolidated quartz and rock fragments in silt and sand matris; old valley-fill deposits, locally derived
PLHb	Brockman Iron Formation: banded iron-formation, chert, and pelite
Qa	Alluvium - unconsolidated silt, sand, and gravel; in drainage channels and adjacent floodplains

2.1.3 LAND SYSTEMS

The Department of Agriculture, as part of the rangeland resource surveys, has comprehensively described and mapped the biophysical resources of the Pilbara region, together with an evaluation of the condition of the soils and vegetation throughout (Van Vreeswyk *et al.* 2004). As part of this process an inventory of land types, land systems and land units with particular use capabilities, habitats or conservation values were established to assist in land use planning. According to this mapping, the following land systems (grouped according to land type on the basis of a combination of landform, soil, vegetation, and drainage characteristics) occur within the study area (**Table 2**).

Table 2: Descriptions of land types and systems occurring in the Raven study area (Van Vreeswyk *et al.* 2004)

Unit	Description
Land type 1	**Hills and ranges with spinifex grasslands**
Newman land system	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.
Land type 8	**Stony plains with spinifex grasslands**
Boolgeeda land system	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.
Land type 17	**River plains with grassy woodlands and shrublands, and tussock grasslands**
River land system	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.

The extent of the land systems outlined above within the Raven study area is indicated in **Map 1**, and their regional extent is provided in **Table 3**.

Table 3: Extent of land systems within the Raven study area and regional representation

Land System	Extent within study area (km2)	Proportion of study area (%)	Pilbara extent (km2)	Pilbara extent (%)
Newman Land System	12.94	50.70%	14580	0.09%
Boolgeeda Land System	12.46	48.80%	7748	0.16%
River Land System	0.13	0.50%	4088	0.00%

2.1.4 DRAINAGE

The Robe River is the most significant drainage line of the study area and dissects the eastern side of the study area, with another minor tributary near the western edge, both flowing in a northern direction (**Map 1**). In the Raven study area, the Robe River is considered to be a minor drainage line. There are also several other minor drainage lines within the Raven study area.

2.2 Biological Environment

2.2.1 BIOGEOGRAPHIC REGION

The Central Pilbara study area is located within the Pilbara biogeographic region as defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Australian Government 2009b). Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna. The Pilbara biogeographic region includes four major components; the Hamersley, Fortescue Plains, Chichester and Roebourne subregions (Thackway & Cresswell 1995). The study area is located entirely within the Hamersley subregion described in the 2002 Biodiversity Audit of Western Australia's 53 Biogeographical Subregions (McKenzie, May & McKenna 2003) as:

> *Mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils in valley floors, and* Eucalyptus leucophloia *over* Triodia brizoides *on skeletal soils of*

the ranges. The climate is semi-desert tropical, average 300mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon. Drainage into either the Fortescue to the north, the Ashburton to the south, or the Robe to the west.

2.2.2 FLORA

2.2.2.1 Conservation Significant Flora Species

Conservation significant flora species, for the purposes of this report, are those that are listed as Threatened Flora (TF) and Priority Flora (PF).

TF species are listed by the DEC, with some given additional legislative protection by being listed listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (Australian Government).

TF species were previously known in Western Australian as Declared Rare Flora (DRF), however the definition has recently been aligned with the Commonwealth category of TF. Flora species are classified as TF or listed as Priority Flora (PF) where populations are geographically restricted or threatened by local processes. The DEC enforces regulations under Government of Western Australia's *Wildlife Conservation Act (WC Act)* (1950) to conserve TF (termed 'rare flora' in the *WC Act*) and protect significant populations. Rare flora species are gazetted under Sub-section 2 of Section 23F of the *WC Act*, thereby making it an offence to remove or damage rare flora without Ministerial approval.

Definitions of the Commonwealth (Department of Sustainability, Environment, Water, Population and Communities, DSEWPaC) categories are also provided in **Table 17** in **Appendix One**. Not all DEC-listed TF species are listed under the *EPBC Act*.

Flora species may also be listed by the DEC as PF where populations are geographically restricted or threatened by local processes.

There are six DEC categories covering TF and PF species (DEC 2011a), which are outlined in **Table 18** in **Appendix One**.

PF for Western Australia are regularly reviewed by the DEC whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in **Table 18**.

DEC Database Search

The DEC Threatened Flora database search identifies TF and PF data from validated populations of TF and some PF from the Threatened Flora Database (DEFL), specimens in the Western Australian

Herbarium (WAHERB) and the DEC Declared Rare Flora and Priority Flora Database (Access database). Combined, TF and PF species are referred to as *conservation significant flora* species.

Fifty three conservation significant vascular flora taxa (species, subspecies and varieties) were identified from the DEC Threatened Flora database search as occurring within 15 km of the combined Western Hub and Central Pilbara (Mt Macleod West) study areas (**Table 21** in **Appendix Two**).

Two TF taxa, *Lepidium catapycnon* and *Thryptomene wittweri,* were identified by the DEC database search, along with 12 P1 taxa, nine P2 taxa, 26 P3 taxa and four P4 taxa.

The DEC Threatened Flora database search does not identify other *significant flora* species, described in *Guidance Statement No. 51* (EPA 2004a) as including keystone or relictual species, those having anomalous features, range extremities, range extensions, population outliers, restricted subtaxa and hybrids, local endemics or poorly reserved species.

The conservation significant flora species identified by the DEC database search request that have been recorded nearest to the Raven study area are:

- *Eremophila magnifica* subsp. *velutina*; one record from approximately 6 km to the south-west and one record from approximately 8 km to the south-east
- *Gymnanthera cunninghamii*; one record from approximately 2 km to the southy-west
- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301); two records from approximately 4-6 km to the south
- *Iotasperma sessilifolium*; one record from approximately 4 km to the south
- *Ptilotus subspinescens*; one record from approximately 10 km to the south-east
- *Rhynchosia bungarensis***;** one record from approximately 15 km to the north-east
- *Spartothamnella puberula*; one record from approximately 8k m to the south-east
- *Swainsona* sp. Hamersley Station (A.A. Mitchell 196); one record from approximately 7 to the south.

Map 2 illustrates the locations of species closest to the study area.

The DEC Threatened Flora database search does not identify other *significant flora* species, described in *Guidance Statement No. 51* (EPA 2004a) as including keystone or relictual species, those having anomalous features, range extremities, range extensions, population outliers, restricted subtaxa and hybrids, local endemics or poorly reserved species.

Expert taxonomic advice from the Western Australian Herbarium (WAH) was sought when collected plant specimens are suspected to meet one of these criteria.

Protected Matters Search

A review of the DSEWPaC online databases (Protected Matters Search Tool and Species Profile and Threats Database) was also conducted to identify any additional threatened flora with Commonwealth protection nearby. The results of the Protected Matters Search are reproduced in **Appendix Three**.

2.2.2.2 Introduced Species

Declared Plants are listed under the *Agriculture and Related Resources Protection Act 1976* (Government of Western Australia 1976) and require a degree of control, depending on their rating in the district they are encountered (Government of Western Australia 2009).

Plants declared as *P1* prohibit movement of plants or seeds, including prohibiting the movement of contaminated machinery and produce. *P2 Declared Plants* require eradication of the infestation until no plants remain, *P3 Declared Plants* require control preventing spread of seed or plant pars within and from the property, including destroying plants and preventing seed set, and *P4 Declared Plants* are required to be controlled to prevent the spread of the infestation, including destroying plants and preventing seed set.

Introduced species (weeds) are commonly recorded, particularly in disturbed areas including those targeted for grazing by introduced species, including cattle. . Plants are regarded as introduced if they are listed as such on FloraBase (Western Australian Herbarium 1998–).

Commonly occurring introduced species recorded from the Hamersley Range area include:

- Bipinnate Beggartick, **Bidens bipinnata*
- Buffel Grass, **Cenchrus ciliaris*
- Kapok Bush, **Aerva javanica*
- Mimosa Bush, **Vachellia farnesiana*
- Ruby Dock, **Acetosa vesicaria*
- Spiked Malvastrum, **Malvastrum americanum*
- Ulcardo Melon, **Cucumis melo* subsp. *agrestis*.

2.2.3 VEGETATION

2.2.3.1 Beard's Vegetation Mapping

John Beard and associates conducted a systematic survey of native vegetation during the 1970s, and described the vegetation systems in Western Australian at a scale of 1:250 000 in the south-west of Western Australia and at a scale of 1:1 000 000 in the less developed areas of the state. The vegetation survey of Western Australia maps and explanatory memoirs (1974-1981) are credited to J.S. Beard (or Beard with various co-authors).

Beard's vegetation maps attempted to depict the native vegetation as it was presumed to be at the time of settlement, and is known as the pre-European vegetation type and extent and has since been developed in digital form by Shepherd *et al.* (2002).

One broad vegetation association based on Shepherd *et al.* (2002) occurs in the study area; vegetation association 82 - Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana.*

The extent of the broad vegetation association occurring within the study area is displayed in **Map 3**.

2.2.3.2 Threatened and Priority Ecological Communities

Threatened Ecological Communities (TECs) are categorised at both State level (DEC 2010) and Commonwealth level (Australian Government 1999), while Priority Ecological Communities (PECs) are classed at State level (DEC 2010). The status of the State and Commonwealth ratings are summarised in **Table 19** and **Table 20**, Appendix One.

According to the list of TECs on the Department of Environment and Conservation (DEC) TEC database endorsed by the Minister for the Environment (DEC 2010), there are two State-listed TECs within the Pilbara bioregion:

1. The *vulnerable 'Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)'. This TEC is described as grassland plains dominated by the perennial *Themeda* (kangaroo grass) and many annual herbs and grasses.
2. The *endangered '*Ethel Gorge aquifer stygobiont community'.

Of these, only the *Themeda* grassland TEC is located within the Hamersley (PIL3) IBRA subregion (Kendrick 2002).

There are no Commonwealth-listed TECs within the Pilbara bioregion (Australian Government 2010).

There are 29 PECs listed as occurring in the Pilbara bioregion (DEC 2010). Whilst exact locations of these are unknown, the PECs most likely to occur in and near the study area are:

- The *P1* 'Brockman Iron cracking clay communities of the Hamersley Range'. Rare tussock grassland dominated by *Astrebla lappacea* in the Hamersley Range, on the Newman land system. Tussock grassland on cracking clays- derived in valley floors, depositional floors. This is a rare community and the landform is rare. Known from near West Angeles, Newman, Tom Price and boundary of Hamersley and Brockman Stations.
- The *P3* '*Triodia* sp. Robe River assemblages of mesas of the Robe Valley'. *Triodia* sp. Robe River (MET 12,369) is apparently geographically restricted to the extreme south western end of the Hamersley Range where it is known from an area extending from the Fortescue River south east to the Beasley River. The majority of occurrences have been recorded from the Robe River valley south to Duck Creek. These occurrences are typically restricted to mesas and

cordillo landforms where the plant assemblages are dominated by or contain *Triodia* sp. Robe River. The community is a mosaic of plant assemblages and is not contained in any reserves.

Communities identified from the DEC and Protected Matters database searches were specifically targeted during the vegetation survey, according to potential areas of shared landform, geological and habitat characteristics within the study area. Any vegetation types encountered during the field surveys exhibiting floristic or structural affinities with identified TECs/PECs, based upon available descriptions, were highlighted for further analysis.

DEC Database Search

The DEC Ecological Communities database search (search reference number 04-0711EC), conducted using a 15 km buffer, identified that the study area occurs within the administrative buffers of the '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)' TEC.

The DEC Ecological Communities database search does not identify other *significant vegetation* described in *Guidance Statement No. 51* (EPA 2004a), including scare vegetation types, communities including unusual species or a novel combination of species, vegetation acting as a refuge or key habitat for threatened species, vegetation representative of a range of a unit, or vegetation having a restricted distribution.

Map 2 displays the locations of the TECs identified from the DEC database search.

2.2.3.3 Ecosystems at Risk

'Ecosystems at Risk' were identified by regional ecologists and others as part of the then Department of Conservation and Land Management's (CALM, now DEC) *Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (CALM 2002). These ecosystems do not have any legislative protection.

'Ecosystems at Risk' identified from the Hamersley subregion (PIL3) of the Pilbara bioregion that may occur in or near the study area include:

- the *vulnerable* 'Grove/inter-grove mulga, eastern Hamersley Range' ecosystem, threatened by grazing, weeds and hydrological change
- the *vulnerable* 'Valley floor mulga' ecosystem, threatened by grazing, weeds, fire and hydrological change
- the *endangered* 'Lower-slope mulga' ecosystem, threatened by fire
- the *vulnerable* 'Hill-top floras, Hamersley Range' ecosystem, threatened by fire
- the *vulnerable* 'All major ephemeral water courses' ecosystem, threatened by grazing and weeds
- the 'Other stygofauna associated with aquifers near mining below water table' ecosystem, threatened by mine dewatering.

2.2.3.4 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems that are dependent on groundwater for their survival at some stage or stages of their lifecycle, however groundwater use cannot be equated with groundwater dependence (Eamus 2009). Generally GDEs in the Pilbara are associated with drainage.

Phreatophytic species are those that have greater water use than can be provided from the surface soil profile. Phreatophytic species can be obligate phreatophytes (ie wetland species dependent on freely available water) or facultative phreatophytes (dependent on groundwater for part of their lifecycle and/or in times of drought (eg Maunsell Australia Pty Ltd 2006)).

Several species found in riparian areas are considered to be facultative phreatophytes, including *Eucalyptus camaldulensis* and *E. victrix*. However there is some debate regarding groundwater dependence of *E. victrix*, with various studies considering that it is not dependent on groundwater, and is at most only weakly phreatophytic (eg Resource and Environmental Management Pty Ltd 2007).

For the purposes of this report, the presence of any facultative phreatophyte (in the Eliwanna area; *E. camaldulensis* subsp. *refulgens* and *E. victrix*) is considered to indicate a GDE.

Melaleuca argentea is considered by some (eg Astron Environmental Services 2008) to be an obligate phreatophyte (dependent on groundwater), however others (eg Grierson 2010) consider this species to be dependent on surface water, rather than groundwater. As it is generally associated with wetter areas, it is reasonable to consider it to be dependent on freely available water. *Melaleuca argentea*, and other obligate phreatophytes including rushes and sedges associated with wetlands (eg *Typha domingensis* and *Cyperus vaginatus*), are vulnerable to changes in surface hydrology.

Other species associated with drainage lines (eg *Acacia citrinoviridis* and *Eucalyptus xerothermica*) are more efficient at extracting water from the soil surface profile and are not considered to be dependent on groundwater (Astron Environmental Services 2008)).

2.2.3.5 Sheet Flow Dependent Communities

Mulga (*Acacia aneura* sens lat) often occurs as a grove – intergrove formation on valley floors and floodplains. Regeneration of these groves are generally considered to be dependent on sheet water flow in times of heavy rain (eg Muller 2005).

Mulga is the common name for *Acacia aneura*. Until recently there were 12 varieties of *Acacia aneura* in Western Australia. Following a revision of this group, a number of distinct species are now recognized. The common name 'Mulga', for the purposes of this report, includes the closely-related *Acacia aneura* var. *intermedia, A. aptaneura, A. ayersiana, A. brachystachya, A. caesaneura, A. catenulata* subsp. *catenulata, A. craspedocarpa, A. fuscaneura, A. incurvaneura, A. macraneura, A.*

minyura, A. pteraneura, A. ramulosa and *A. sibirica*. Seven of these occur in the Pilbara bioregion, of which *Acacia aptaneura* is the most common and widespread. The common name, 'Mulga', is still applicable to the newly recognised species.

2.2.4 FAUNA

The conservation status of fauna species is assessed under Commonwealth and State Acts being the *EPBC act (1999)* and the Western Australian *WC Act* (1950). The significance levels for fauna used in the *EPBC Act* (1999) are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). *EPBC Act (1999)* categories are listed in **Appendix One**.

The Western Australian *WC Act* (1950) uses a set of Schedules but also classifies species using some of the IUCN categories. DEC Schedules, which provide special protection to listed fauna under the *WC Act* (1950) and definitions are shown in **Appendix One**.

In Western Australia, the DEC has produced a supplementary list of Priority Fauna, listed using priority codes, which are species that are not considered *Threatened* under *the WC Act* but for which the DEC considers there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. DEC Priority categories definitions are shown in **Appendix One**. It is important to recognise that such Priority Lists have no statutory standing, but are used to assist the DEC when considering which fauna are most in need of more surveys or other investigations, in order to establish their status in the wild.

The Priority Fauna List for Western Australia includes taxa organised by priority codes that either:

- have recently been removed from the schedule of threatened fauna
- have a restricted range, are uncommon or are declining in range and/or abundance, but which do not meet the criteria for inclusion on the schedule of threatened fauna
- have been nominated for consideration for the schedule of threatened fauna and for which there is insufficient information for the advisory committee to make an assessment of their status
- are worthy of inclusion on such a list, as determined by the DEC.

The Priority Fauna List for Western Australia is reviewed by the DEC whenever new information on relevant taxa becomes available. Taxa are removed from the list by the DEC as they cease to meet the requirements identified above. In addition to these conservation levels, species that have been introduced are indicated.

Vertebrate taxonomy in this report follows the WAM checklists last updated 6 Oct 2009, except for birds where the classification and sequence follows Christidis and Boles (2008).

DEC Database Search

A search of the DEC Threatened, Priority or other specially protected fauna database was conducted for an area comprising the Western Hub study areas with a buffer of 20 km. There were eight conservation significant fauna species identified through DEC database searches as known to occur within this area (**Table 4**):

- Long-tailed Dunnart (*Sminthopsis longicaudata*)– *P4*
- Ghost Bat (*Macroderma gigas*) – *P4*
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - *VU*
- Skink *(Notoscincus butleri)* – *P4*
- Blind Snake *(Ramphotyphlops ganei)* – *P1*
- Australian Bustard (*Ardeotis australis*)– *P4*
- Bush Stone-curlew (*Burhinus grallarius)* – *P4*

EPBC Protected Matters Search Tool

Results of the *Protected Matters Search Tool* (PMST, Australian Government 2011a) were obtained for each of the Western Hub study areas (Delphine, Mt Farquhar, Raven, and Eliwanna/Flying Fish) using a buffer of 10 km around each. Three *Threatened Species* of fauna were listed as potentially occurring in each of the study areas (**Table 4**, EPBC status *EN* and *VU*; EPBC protected Matters report M or L):

- Northern Quoll (*Dasyurus hallucatus*) - EN
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - VU
- Pilbara Olive Python (*Liasis olivaceus barroni*) - VU.

The PMST results also list *Migratory, Listed Marine*, and *Invasive* species. Migratory and/or marine species identified as potentially occurring in all of the study areas include (**Table 4**):

- Fork-tailed Swift (*Apus pacificus)* - M
- Great Egret (*Ardea modesta* (=*alba*)*)* - M
- Cattle Egret (*Ardea ibis*) - M
- White-bellied Sea-Eagle (*Haliaeetus leucogaster)* – M and L
- Rainbow Bee-eater (*Merops ornatus*) - M
- Oriental Plover (*Charadrius veredus)* - M.

NatureMap and other resources

A search of DEC's online *NatureMap* database (DEC 2011b) identified 199 faunal taxa as occurring in a polygon containing all of the Western Hub study areas (fewer species, as subspecies and synonyms are often listed separately) (**Appendix Four**). In addition to species identified by the DEC threatened and priority search and PMST, a number of further taxa of conservation significance were listed as known to occur in this area (**Table 4**):

- Short-tailed Mouse (*Leggadina lakedownensis*) – P4

- Western Pebble-mound Mouse (*Pseudomys chapmani*) – P4
- Bush Stone-curlew (*Burhinus grallarius*) – *P4*
- Long-tailed Dunnart (*Sminthopsis longicaudata*)– *P4*

Kendrick (2002) provides a summary of biodiversity values for the Hamersley subregion (IBRA PIL3). **Table 4** includes species mentioned by Kendrick, regardless of Schedule and Priority status, that are recorded from the western Hamersley Range.

The remaining species listed in **Table 4** are those of conservation significance (DEC *P3* or *P4*) that have been reported in other fauna surveys of areas in the western Hamersley Range. A more complete listing of the expected vertebrate fauna expected in the study area is given in **Table 24** (**Appendix Eight**).

Table 4: Conservation significant fauna species as determined by database searches.

Family	Common Name	Species	EPBC status	WCA status	DEC status	DEC **Threatened fauna database**	EPBC Protected Matters report	Hamersley (Kendrick)
Terapontidae	Fortescue Grunter	*Leiopotherapon aheneus*			*P 4*			+
Dasyuridae	Northern Quoll	*Dasyurus hallucatus*	*E N*	*S 1*	*T*		L	+
	Long-tailed Dunnart	*Sminthopsis longicaudata*			*P 4*	+		+
Macropodidae	Spectacled Hare-wallaby	*Lagorchestes conspicillatus leichardti*			*P 3*			
Megadermatidae	Ghost Bat	*Macroderma gigas*			*P 4*	+		+
Hipposideridae	Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*	*V U*	*S 1*	*T*	+	L	+
Muridae	Short-tailed Mouse	*Leggadina lakedownensis*			*P 4*			
	Western Pebble-mound Mouse	*Pseudomys chapmani*			*P 4*			+
Scincidae	Blue-tailed Skink	*Lerista zietzi*						+
	Soil-crevice Skink	*Notoscincus butleri*			*P 4*	+		
Typhlopidae	Blind Snake	*Ramphotyphlops ganei*			*P 1*	+		+
	Blind Snake	*Ramphotyphlops pilbarensis*						+
Pythonidae	Pilbara Olive Python	*Liasis olivaceus barroni*	*V U*	*S 1*				+
Apodidae	Fork-tailed Swift	*Apus pacificus*	*M*				M	
Ardeidae	Great Egret	*Ardea modesta* (=*alba*)	*M*				M	
	Cattle Egret	*Ardea ibis*	*M*				M	
Accipitridae	White-bellied Sea-eagle	*Haliaeetus leucogaster*	*M*				L	
Falconidae	Grey Falcon	*Falco hypoleucos*			*P 4*			
	Peregrine Falcon	*Falco peregrinus*	*M*	*S 4*				+
Otididae	Australian Bustard	*Ardeotis australis*			*P 4*	+		
Burhinidae	Bush Stone-curlew	*Burhinus grallarius*			*P 4*	+		+
Charadriidae	Oriental Plover	*Charadrius veredus*	*M*				M	
Meropidae	Rainbow Bee-eater	*Merops ornatus*	*M*				M	
Estrildidae	Star Finch (western)	*Neochmia ruficauda subclarescens*			*P 4*			

Abbreviations (EPBC status) *EN*, endangered; *VU*, vulnerable; *M*, migratory; (WCA Status) *S1*, Schedule 1 'rare or likely to become extinct'; *S4*, Schedule 4 'other specially protected fauna'; (DEC status) *T*, 'rare or likely to become extinct'; *P1*, Priority 1 'Taxa with few, poorly known populations on threatened lands'; *P4*, Priority 4 'Taxa in need of monitoring'; (EPBC Protected Matters report) L, 'Species or species habitat likely to occur'; M, 'Species or species habitat may occur'; (other columns) +, listed as present.

3.0 Methods

3.1 Flora and Vegetation

The Level 1 flora and vegetation assessment was undertaken to be compliant with Environmental Protection Authority (EPA) *Guidance Statement No. 51* (2004a) and *Position Statement No.* 3 (EPA 2002).

Level 1 surveys incorporate background research and a reconnaissance survey, and are often used to identify preliminary information that may be of assistance when preparing for a more intensive and detailed survey.

In addition to the Level 1 survey, targeted searches for conservation significant flora species were also conducted.

The data collected during the field survey was used to:

- describe and map the broad vegetation types of the study area to indicate the distribution and relative abundance of each vegetation unit and to help define units of particular conservation value
- identify vascular flora taxa of particular conservation significance
- identify significant infestations of introduced plant species and occurrences of Declared Plants.

The vegetation was described and mapped using relevés recorded in characteristic areas of each vegetation type, as assessed in the field. The data recorded from each relevé included physical characteristics of the environment (habitat). Up to five dominant and characteristic species from each of the traditional three strata (upper, mid and ground, including cover class for each stratum), along with each species' maximum height and cover were recorded.

Targeted and opportunistic searches for conservation significant flora species, targeting Threatened Flora (TF) and Priority 1 (P1) and Priority 2 (P2) taxa, were also undertaken.

3.1.1 FIELD SURVEYS

The flora and vegetation field survey was conducted by Lyn Atkins (flora collecting licence SL009324), Stephen Kern (flora collecting licence SL009477), Hayley Hughes (flora collecting licence SL009379) and Richard Daniel (flora collecting licence SL009247) over 2.5 days, during July 2011.

3.1.1.1 Vegetation Descriptions

Vegetation was described from each of the relevés using the height and estimated cover of dominant and characteristic species of each stratum, based on the National Vegetation Inventory System (NVIS, National Heritage Trust 2003) (**Table 5**), recorded at Level V. Up to three species per stratum were recorded from each stratum (upper, mid and ground) from each relevé.

The vegetation condition of the relevés were assessed using a rating scale that was based on a scale devised by Trudgen (1991), which the DEC has previously advised as the most appropriate for assessing vegetation condition in the Pilbara region (Coffey Environments 2007). This rating scale is outlined in **Table 6**. The vegetation condition of the study area was assessed by extrapolating the value recorded for each relevé and applying the condition to the vegetation type in the vicinity.

1.1.1 TIMING OF SURVEYS

The Level 1 survey of the Raven study area was conducted during winter (July), when the majority of ephemeral species are generally flowering. Season conditions in 2011 were considered to be excellent. Rainfall in the season December 2010 – June 2011 was 607.9 mm, which is 139.9% of the December – July long-term mean of 434.5 mm (**Figure 3**).

The timing of the field survey, in July, was not ideal to identify all species, particularly grasses. However many conservation significant shrub and herb taxa are known to flower during this period, providing negligible limitations in terms of identifying these.

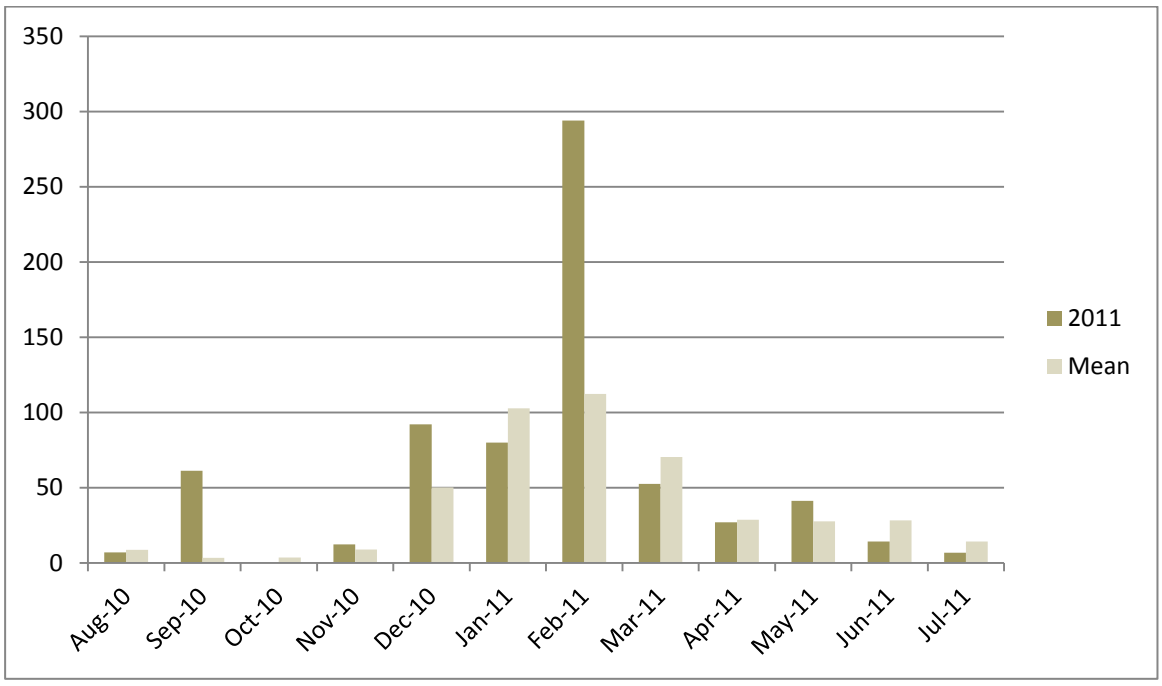

Figure 3: Monthly rainfall totals for the Wittenoom BoM site for the periods preceding the survey (August 2010 – July 2011) (BoM 2011)

Table 5: NVIS structural formation terminology (terrestrial vegetation) (National Heritage Trust 2003)

	Cover Characteristics							
	Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	**Height Ranges (m)**	**Structural Formation Classes**						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	mallee trees
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrubs
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrubs
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grasses
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rushes
herb	<0.5,>0.5	closed herbland	herbland	open herbland	sparse herbland	isolated herbs	isolated clumps of herbs	herbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	ferns
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyte-land	sparse bryophyte-land	isolated bryophytes	isolated clumps of bryophytes	bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichens
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vines

Table 6: Vegetation condition rating scale (Trudgen 1991)

Condition Rating	Description
E=Excellent	Pristine or nearly so; no obvious signs of damage caused by activities of European man.
VG= Very Good	Some relatively slight signs of damage caused by activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Ursinia anthemoides* or **Briza* spp., or occasional vehicle tracks.
G=Good	More obvious signs of damage caused by activities of European man, including some obvious signs of impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Ehrharta* spp.
P=Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some aggressive ones such as **Ehrharta* spp.
VP=Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species.
D=Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; ie areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

3.1.1.2 Relevé Data

The botanical survey involved the sampling of relevés (unmarked areas with the vegetation described as if it occurred within a 50 m x 50 m area, which is the standard quadrat size used in the Pilbara for botanical surveys), with the following parameters recorded at each relevé site:

- MGA coordinates recorded in GDA 94 datum using a hand-held Global Positioning System (GPS), to an accuracy usually within 5 m
- vegetation description based on the height and estimated cover of dominant and characteristic species and strata
- description of landform and habitat
- broad description of surface soil type and stony surface mantle
- evidence of grazing, mining exploration activities, weed invasion, frequent fires etc. Fire effects were only considered a negative impact if they were caused by repeated burning, eg for pastoral purposes.

Representative photographs of the vegetation at each site were taken using a digital camera.

Voucher specimens of dominant and characteristic taxa were only collected when the assessors could not identify the species with certainty in the field. Specimens collected were dried and treated in accordance with the requirements of the WAH. These voucher specimens were identified by Ecoscape and ME Trudgen, using appropriate publications, and/or comparison with pressed specimens housed at the WAH.

3.1.1.3 Conservation Significant Flora

No systematic grid search of the study area was undertaken for conservation significant flora species. However, targeted searches of areas identified from the DEC database search were conducted, including slopes, hilltops (where accessible), rock piles and drainage lines were undertaken. Opportunistic searches were also conducted when moving between relevé sites.

Where possible, the space between surveyors was 20-30 m in order to widen the search area.

3.1.1.4 Introduced Flora

Opportunistic observation of significant infestations of introduced species (weeds) and presence of Declared Plants were recorded from the study area.

3.1.2 BOTANICAL LIMITATIONS

Table 7: Botanical limitations.

Possible Limitations	Constraints (Yes/No); Significant, Moderate or Negligible	Comments
Competency/experience of the consultant botanist	No constraints	Lead survey staff have relevant recent experience surveying in the Pilbara region.
Proportion of the flora identified	No constraints	The survey was conducted as a Level 1 reconnaissance survey, with no floristic quadrats recorded. All dominant species used to identify vegetation characteristics were identified. The survey included a targeted search for conservation significant flora species. All potential TF and PF flora were identified.
Sources of information (historic/recent or new data)	Negligible	Raven is close to other surveyed areas, including the Flinders Mines Blacksmith tenement and Fortescue's Serenity exploration area. Ecoscape has surveyed both of these areas.
Proportion of the task achieved and further work that may need to be undertaken	Negligible	The reconnaissance survey was conducted at sufficient detail to identify major flora and vegetation attributes in preparation for a more detailed survey. Inaccessible areas would require more intensive surveys for conservation significant flora species.
Timing/weather/season/cycle	Negligible	The timing of the field survey and weather were optimal to identify plant species with above average rainfall prior to the survey, which was conducted in July 2011.
Intensity of survey	Negligible	The study area was surveyed at sufficient intensity to describe the dominant flora and vegetation types of the area in preparation for a more intensive (Level 2) survey. Accessible areas were sufficiently surveyed to identify the presence of most conservation significant flora species.
Completeness (eg was relevant area fully surveyed)	Moderate	Much of the area was not accessible by vehicle. Where possible, areas were accessed by walking however the central-west portion was assessed from a distance and aerial image interpretation due to the time required to access this area, which was not available for a reconnaissance survey. Despite this, sufficient areas were groundtruthed to enable identification of major vegetation types.
Resources (eg degree of expertise available for plant identification)	No constraints	The survey did not record floristic quadrats. Dominant and characteristic species were all identified.
Remoteness and/or access problems	Moderate	Access to all areas other than the western side was difficult, with only a barely trafficable track accessing the eastern side. Approximately one quarter of the study area was assessed by viewing from a distance and aerial imagery interpretation; this area has not adequately searched for conservation significant flora, however vegetation type assessment is considered adequate for a Level 1 survey. A Level 2 survey would require a significant amount of walking to adequately survey the area to the degree required.
Availability of contextual (eg bioregional) information for the study area	Negligible	Raven is in the central Hamersley Range (although towards the western side). There is adequate regional data in relation to the study area.

3.2 Fauna

The fauna assessment methodology used was developed to comply with Ecoscape's interpretation of the requirements of a Level 1 survey based upon the EPA's *Guidance for the Assessment of Environmental Factors No 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western* Australia (2004a), and *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA & DEC 2010). The targeted trapping for Northern Quoll considered the *EPBC Act 1999 referral guidelines for the endangered northern quoll* (DSEWPaC 2011).

3.2.1 FIELD SURVEY

The fauna and habitat field survey was conducted by John Scanlon (Senior Environmental Scientist) and Claudia McHarrie (Graduate Environmental Scientist) over 11 days in late July/early August 2011, under DEC Regulation 17 fauna licence SF008134.

The fauna assessment comprised a reconnaissance survey of the study area combined with targeted trapping for Northern Quoll. The reconnaissance aspect of the survey was used to verify the applicability of background desktop studies, familiarise survey personnel with the study area and provide habitat assessments and habitat maps. Timing of the targeted survey is consistent with DSEWPaC survey guidelines for Northern Quoll (May-August inclusive, primarily to avoid disturbance during the reproductive period).

Techniques used in the reconnaissance survey include:

- bird censusing using both visual and auditory techniques
- spotlighting significant habitat i.e. gorges, caves and creeks
- trail cameras set in likely areas of fauna activity for conservation significant fauna species
- leaf litter raking, rock pile and fallen log hand searching
- identification of scats, bones, tracks, diggings and burrows and the analysis of predator scats.

Opportunistic observations

Opportunistic observations were made during the day whilst driving and walking the study area. Searches are conducted by two personnel during the survey period. Searches were focussed on potential conservation significant fauna species habitats, including rocky gorges, hilltops and cave areas, creeklines, spoil heaps and water holes. Opportunistic searches also comprise spotlighting along roads and on water holes. Photography was used to record observations, allowing subsequent identification of animals and tracks not determinable in the field.

Bird Census

Bird censuses were undertaken each day at sunrise and sunset. Each census requires the observer to remain in one place for a duration of 20 minutes, recording the number of bird species and number of individuals of each species, in the immediate surrounding area, based on sightings and calls. Census points were undertaken in all habitat types, including Spinifex grasslands, creeklines, water

holes and hilltops. Birds observed or heard, while travelling around the site or checking traps were also recorded in a species list.

Trail Cameras

Three trail cameras were set up in positions chosen to maximise the likelihood of capturing fauna movement, at entrances to small caves (**Map 7**). Bait was scattered in front of cameras to increase the likelihood of attracting fauna. Cameras were set up to record still images or video, from 6pm (sunset) to 6am (sunrise). These were operational for two nights during the survey.

Targeted Northern Quoll Trapping

Twenty cage traps were set in areas of potential Northern Quoll habitat within the study site (**Map 7**). These locations included rocky gorges, small caves, and creeklines. Traps were placed in protected areas, covered with either a hessian bag or Spinifex, to provide shade. Traps remained in place for three nights and were checked early each morning. Bait was replaced when required. Bait used was universal type as specified in the DSEWPaC guidelines.

Field survey effort for Raven is indicated in **Table 8**.

Table 8: Survey effort, Raven

Technique	Survey Effort
Cage traps	60 nights
Trail cameras	6 nights
Bird census	8 x 20 minutes
Spotlighting	4 person hours
Hand searching	30 person hours

3.2.2 TAXONOMY AND NOMENCLATURE

Taxonomy and nomenclature for fauna species used in this report follows that of the Western Australian Museum, except for bats, which follow Armstrong and Reardon (2006) and birds which follow Christidis and Boles(2008).

Table 9 lists the references used. Ecoscape has presumed that the identifications referred to in the Appendices or in reports used to provide local and regional comparative data were correct and has only corrected records where the nomenclature was obviously incorrect.

Table 9: References used for species identification.

Reference	Identification
Menkhorst and Knight (2011)	Mammals
Armstrong and Reardon (2006)	Bats
WA Museum field guides	Reptiles
Christidis and Boles (2008)	Birds

3.2.3 FAUNA SURVEY LIMITATIONS

Table 10: Limitations of fauna survey

Possible Limitations	Constraints (Yes/No): Significant, Moderate or Negligible	Comment
Competency/experience of the consultant conducting the survey	No Constraint	All field survey staff have relevant recent experience surveying in the Pilbara region. Senior staff have extensive experience with species identification over all fauna assemblages
Scope	Yes, Negligible	Scope as Level 1 survey, not including invertebrates or attempting to inventory all species present; access to all habitat types was unconstrained.
Proportion of fauna identified, recorded and/or collected	Yes, Negligible	No vertebrate species collected, nearly all vertebrate fauna observed identified
Proportion of the task achieved and further work that may need to be undertaken	Yes, Moderate	Reconnaissance and targeted surveys were adequate to identify and map likely habitats for conservation significant species, but not to determine their actual presence, distribution or abundance
Timing/weather/season/cycle	Yes, Negligible	Survey conducted in July-August suitable for mammals, but not most reptiles or some birds that would be more active or only present in warmer/wetter conditions
Intensity of survey (eg In retrospect was the intensity adequate?)	No Constraint	Intensity judged to be adequate for level of survey
Disturbances which affected results of the survey	Yes, Moderate	Unusually poor climatic conditions in recent years have probably reduced abundance of some target species. Exploration activity (clearing tracks) has caused localised habitat degradation but probably not further altered the fauna assemblage to a significant extent, and also improved access
Sources of information	Yes, Negligible	Most relevant information sources readily available
Completeness (eg Was relevant area fully surveyed?)	Yes, Moderate	Limited access by tracks, some potentially important locations not accessed (middle valley)
Resources (eg Degree of expertise available for identification)	No Constraint	Adequate resources available
Remoteness and/or access problems	Yes, Moderate	Some areas unable to be accessed due to distance from tracks and difficult landscape.
Availability of contextual (eg bioregional) information for the survey area	Yes, Negligible	Physical environmental information not limiting. Flora and vegetation context provided by concurrent survey included in this report. Previous fauna surveys conducted in the same IBRA subregion allowed species inventory to be predicted, but some relevant taxonomic revisions and survey results are not currently available

4.0 Results

4.1 Flora and Vegetation

4.1.1 FLORA

4.1.1.1 Conservation Significant Flora Species

***Environmental Protection and Biodiversity Conservation Act* 1999**

No plant taxon recorded in the study area is listed as Threatened pursuant to Schedule 1 of the *EPBC Act* (1999).

***Wildlife Conservation Act* 1950**

No plant taxon recorded in the survey is gazetted as a Threatened Flora pursuant to Subsection 2 of Section 23F of the *WC Act* (1950).

Priority Flora

The Priority Flora recorded from the study area are listed below in **Table 11** shown on **Map 4**. Threatened and Priority Flora Report Forms are included in **Appendix Six**, and a brief description of each taxa is given below.

Table 11: Coordinates for Priority Flora species

Species	Cons. Code	GDA mE	GDA mN
Eremophila magnifica subsp. *velutina*	P3	522938	7542691
Goodenia nuda	P4	522849	7542605
Goodenia nuda	P4	530170	7540360
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	528761	7541448
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	528881	7541289
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	530085	7540296

***Eremophila magnifica* subsp. *velutina* (P3)**

Eremophila magnifica is a very distinctive species to 1.5 m tall with purple flowers, its leaves smell of nutmeg when crushed. *Eremophila magnifica* subsp. *magnifica* has glabrous leaves (with ciliate leaf margins) whilst *E. magnifica* subsp. *velutina* (**Plate 1** and **Plate 2**) has a velvety leaf surface. *Eremophila magnifica* subsp. *velutina* is known from 12 herbarium records, all of which come from the Hamersley Range. Within the study area, a single *Eremophila magnifica* subsp. *velutina* individual recorded from rocky habitats of the **EAmTw2** vegetation type, which is typical for this taxon although it has generally been recorded from high hills rather than rocky knolls.

Plate 1: *Eremophila magnifica* subsp. *velutina* flowers and foliage

Plate 2: *Eremophila magnifica* subsp. *velutina* form

Goodenia nuda (P4)

Goodenia nuda is an erect herb to 0.5 m with yellow flowers (**Plate 3**). It is known predominantly from the Pilbara bioregion with most of the 21 herbarium records coming from the Hamersley Range, largely associated with valley floors. Within the Raven study area, *Goodenia nuda* was recorded from two populations.

Plate 3: *Goodenia nuda* flowers

***Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (P3)**

Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) is an upright shrub to 2.5 m tall with red flowers (**Plate 4** and **Plate 5**). It is known from drainage lines and gorges of the Hamersley Range, with eight herbarium records. Within the study area *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) was recorded from three populations in drainage lines, typically as a dominant species of the shrub stratum.

Plate 4: Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) form

Plate 5: Indigofera sp. Bungaroo Creek (S.van Leeuwen 4301) flowers and foliage

Other Significant Species

This assessment did not include a detailed floristic survey, with only dominant and characteristic species and conservation significant flora species recorded.

Two undescribed ('phrase name') taxa, *Gompholobium* sp. Pilbara (N.F. Norris 908) and *Sida* sp. spiciform panicles (E. Leyland s.n. 14/8/90), were recorded in addition to the undescribed PF listed above. Both species are widespread across the Hamersley Range and unlikely to be of conservation significance.

A species of *Josephinia* was collected from the **EAmTw2** vegetation type where a single plant was observed. Pilbara taxonomist M.E. Trudgen has confirmed that it is a new species. It will shortly be given a 'phrase name' and submitted to the Western Australian Herbarium, after which it is likely to be listed as a PF. This taxon has also been collected from Fortescue's CPP project area and Flinders Mines Blacksmith tenement, to the east of the Raven study area.

Species Range Extension

All of the dominant and characteristic species recorded during this assessment were within their usual extents. All conservation significant species were also within their known extents.

4.1.1.2 Introduced Flora

No Declared Plants were recorded during the survey.

No significant infestations of introduced species were recorded during the survey.

Bidens bipinnata* (Bipinnate Beggartick), **Malvastrum americanum* (Spiked Malvastrum) and **Portulaca oleracea* (Purslane) were recorded from the larger drainage lines of the study area (Map** 4). Locations of all introduced flora records are listed in **Table 12**.

Table 12: Coordinates of introduced flora species

Species	GDA mE	GDA mN
**Bidens bipinnata*	528881	7541289
**Malvastrum americanum*	528881	7541289
**Portulaca oleracea*	528995	7541440

4.1.1.3 Flora Inventory

As this survey did not include recording of floristic quadrats, a complete flora inventory was not recorded, and therefore species richness cannot be assessed with confidence.

A total of 117 dominant and characteristic vascular flora taxa were recorded from relevé sites and opportunistic observations (**Appendix Seven**). Of these, two were of conservation significance (**Table 11**) and three were introduced (**Table 12**).

4.1.2 VEGETATION

4.1.2.1 Vegetation Types

The following 10 vegetation types were recorded from the Raven study area. The extents of each of these vegetation types are shown in **Table 13** and **Map 5**. Data for the Raven relevé sites is presented in **Appendix Five**.

Table 13: Extents of each vegetation type in the study area

Code	Vegetation Type	Relevé	Area (ha)	Proportion
CdAaTw	*Corymbia deserticola* subsp. *deserticola*, *Eucalyptus leucophloia* subsp. *leucophloia* and *C. hamersleyana* open woodland over *Acacia atkinsiana*, *A. trudgeniana* and *A. exilis* sparse shrubland over *Triodia wiseana* hummock grassland	4a, 8	331.54	12.99
ChAiTw	*Corymbia hamersleyana* open woodland over *Acacia inaequilatera*, *A. elachantha* and *A. ancistrocarpa* open shrubland over *Triodia wiseana* hummock grassland	11	106.43	4.17

Code	Vegetation Type	Relevé	Area (ha)	Proportion
ChAmSf	*Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia monticola*, *Senna glutinosa* subsp. *glutinosa* and *Mirbelia viminalis* open shrubland over *Schizachyrium fragile* and *Triodia wiseana* open grassland/hummock grassland	4	15.74	0.62
ChAtCp	*Corymbia hamersleyana* open woodland over *Acacia tumida* var. *pilbarensis*, *A. pyrifolia* var. *pyrifolia* and *Indigofera* sp. Bungaroo Creek (S. Van Leeuwen 4301) sparse shrubland over *Cymbopogon procerus*, *Triodia epactia* and *Tephrosia rosea* var. *glabrior* sparse tussock grassland/.hummock grassland/ shrubland	3	48.23	1.89
ChSgTe	*Corymbia hamersleyana* and *Hakea chordophylla* open woodland over *Senna glutinosa* subsp. *x luerssenii*, *S. artemisioides* subsp. *oligophylla* and *Acacia bivenosa* sparse shrubland over *Triodia epactia* and *T. wiseana* hummock grassland	1, 2	191.88	7.52
EgAaTe	*Eucalyptus gamophylla*, *Corymbia deserticola* subsp. *deserticola* and *Hakea lorea* subsp. *lorea* open mallee woodland/ woodland over *Acacia atkinsiana*, *Senna glutinosa* subsp. *x luerssenii* and *A. bivenosa* sparse shrubland over *Triodia epactia* hummock grassland	5	492.35	19.29
ElAmTw[1]	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* open woodland over *Acacia maitlandii* open shrubland over *Triodia wiseana* and *A. hilliana* hummock grassland/ sparse shrubs	1a, 7	238.22	9.33
ElAmTw[2]	*Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia maitlandii*, *A. monticola* and *A. bivenosa* sparse shrubland over *Triodia wiseana* hummock grassland	3a, 6, 9	1080.82	42.35
ElTw	*Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Triodia wiseana* and *T.* aff. *melvillei* hummock grassland with *Acacia bivenosa*, *A. maitlandii* and *Senna glutinosa* subsp. *pruinosa* isolated shrubs	2a	12.53	0.49
ExAtTt	*Eucalyptus xerothermica* and *Corymbia hamersleyana* woodland over *Acacia tumida* var. *pilbarensis*, *A. pyrifolia* var. *pyrifolia* and *Gastrolobium grandiflorum* sparse shrubland over *Themeda triandra*, *Triodia epactia* and *Triodia wiseana* tussock grassland/hummock grassland	10	34.63	1.36
TOTAL			**2552.37**	**100.00**

Vegetation codes are formulated using initials for dominant and characteristic species in each strata, following Fortescue's *Flora and Vegetation Guidelines* (2011) and subsequent instructions

CdAaTw

Vegetation type description: *Corymbia deserticola* subsp. *deserticola*, *Eucalyptus leucophloia* subsp. *leucophloia* and *C. hamersleyana* open woodland over *Acacia atkinsiana*, *A. trudgeniana*, *A. exilis* and *Senna glutinosa* subsp. *glutinosa* sparse shrubland over *Triodia wiseana* hummock grassland. Other common species included *Eriachne pulchella* subsp. *dominii*, *Fimbristylis simulans* and *Schizachyrium fragile*.

This vegetation type occurred on valley floors of the Boolgeeda land system and was assessed from two relevés. The vegetation condition of the relevés were Very good. **Plate 6** illustrates the **CdAaTw** vegetation type.

Plate 6: CdAaTw vegetation type (relevé RAV11R08)

ChAiTw

Vegetation type description: *Corymbia hamersleyana* open woodland over *Acacia inaequilatera*, *A. elachantha*, *A. ancistrocarpa* and *A. cowleana* open shrubland over *Triodia wiseana* hummock grassland. Other common species included *Scaevola parviflora* subsp. *pilbarae* and *Schizachyrium fragile*.

This vegetation type occurred on valley floors of the Boolgeeda land system and was assessed from one relevé. The vegetation condition of the relevé was Very good. **Plate 14** illustrates the **ChAiTw** vegetation type.

Plate 7: ChAiTw vegetation type (relevé RAV11R11)

ChAmSf

Vegetation type description: *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia monticola*, *Senna glutinosa* subsp. *glutinosa* and *Mirbelia viminalis* open shrubland over *Schizachyrium fragile* and *Triodia wiseana* open grassland/hummock grassland. Other common species included *Clerodendrum floribundum* var. *angustifolium, Bulbostylis barbata*, *Eriachne ciliata*, *E. mucronata*, *Fimbristylis simulans* and *Keraudrenia velutina* subsp. *elliptica.*

This vegetation type occurred on the hill slopes of the Newman land system and was assessed from one relevé. The vegetation condition of the relevé was Very good. **Plate 12** illustrates the **ChAmSf** vegetation type.

Plate 8: ChAmSf vegetation type (relevé RAV11R04)

ChAtCp

Vegetation type description: *Corymbia hamersleyana* open woodland over *Acacia tumida* var. *pilbarensis, A. pyrifolia* var. *pyrifolia* and I*ndigofera* sp. Bungaroo Creek (S. Van Leeuwen 4301) sparse shrubland over *Cymbopogon procerus, Triodia epactia* and *Tephrosia rosea* var. *glabrior* sparse tussock grassland/.hummock grassland/ shrubland. Other common species included *Themeda triandra* and *Sida* sp. Spiciform Panicles (E. Leyland s.n. 14/8/90).

This vegetation type occurred on wide drainage channels and was assessed from one relevé. The vegetation condition of the relevé was Very good. **Plate 9** illustrates the **ChAtCp** vegetation type.

Plate 9: ChAtCp vegetation type (relevé RAV11R03)

ChSgTe

Vegetation type description: *Corymbia hamersleyana* and *Hakea chordophylla* open woodland over *Senna glutinosa* subsp. *x luerssenii*, *S. artemisioides* subsp. *oligophylla* and *Acacia bivenosa* sparse shrubland over *Triodia epactia* and *T. wiseana* hummock grassland. Other common species included *Aristida contorta*, *Bonamia rosea*, *Eriachne pulchella* subsp. *dominii*, *Ptilotus rotundifolius* and *Schizachyrium fragile*.

This vegetation type occurred on valley floors of the Boolgeeda land system and was assessed from two relevés. The vegetation condition of the relevés were Very good. **Plate 10** illustrates the **ChSgTe** vegetation type.

Plate 10: ChSgTe vegetation type (relevé RAV11R02)

EgAaTe

Vegetation type description: *Eucalyptus gamophylla*, *Corymbia deserticola* subsp. *deserticola* and *Hakea lorea* subsp. *lorea* open mallee woodland/ woodland over *Acacia atkinsiana*, *Senna glutinosa* subsp. *x luerssenii*, *A. bivenosa* and *A. ancistrocarpa* sparse shrubland over *Triodia epactia* hummock grassland.

This vegetation type occurred on valley floors of the Boolgeeda land system and was assessed from one relevé. The vegetation condition of the relevé was Very good. **Plate 11** illustrates the **EgAaTe** vegetation type.

Plate 11: EgAaTe vegetation type (relevé RAV11R05)

ElAmTw[1]

Vegetation type description: *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* open woodland over *Acacia maitlandii* open shrubland over *Triodia wiseana* hummock grassland with *A. hilliana* sparse shrubs. Other common species included *Eriachne pulchella* subsp. *dominii*, *Keraudrenia nephrosperma* and *Schizachyrium fragile*.

This vegetation type occurred on low hills/ footslopes and was assessed from two relevés. The vegetation condition of the relevés were Very good. **Plate 12** illustrates the **ElAmTw[1]** vegetation type.

Plate 12: ElAmTw[1] vegetation type (relevé RAV11R07)

ElAmTw^2

Vegetation type description: *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia maitlandii*, *A. monticola* and *A. bivenosa* sparse shrubland over *Triodia wiseana* hummock grassland. Other common species included *Cymbopogon ambiguus*, *Eriachne ciliata*, *E. mucronata*, *E. pulchella* subsp. *dominii*, *Oldenlandia crouchiana*, *Ptilotus calostachyus* and *Schizachyrium fragile*.

This vegetation type occurred on the Newman land system and was assessed from three relevés. The vegetation condition of the relevés were Very good to Excellent. **Plate 13** illustrates the **ElAmTw^2** vegetation type.

Plate 13: ElAmTw2 vegetation type (relevé RAV11R09)

ElTw

Vegetation type description: *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Triodia wiseana* and *T.* aff. *melvillei* hummock grassland with *Acacia bivenosa*, *A. maitlandii* and *Senna glutinosa* subsp. *pruinosa* scattered shrubs.

This vegetation type occurred on lower slopes and was assessed from one relevé. The vegetation condition of the relevé was Very good. **Plate 14** illustrates the **ElTw** vegetation type.

Plate 14: ElTw vegetation type (relevé RAV1102a)

ExAtTt

Vegetation type description: *Eucalyptus xerothermica* and *Corymbia hamersleyana* woodland over *Acacia tumida* var. *pilbarensis*, *A. pyrifolia* var. *pyrifolia* and *Gastrolobium grandiflorum* sparse shrubland over *Themeda triandra*, *Triodia epactia* and *Triodia wiseana* tussock grassland/ hummock grassland. *Digitaria brownii* was also characteristic of this vegetation type.

This vegetation type was associated with drainage lines on the Boolgeeda land system and was assessed from one relevé. The vegetation condition of the relevé was Good. **Plate 15** illustrates the **ExAtTt** vegetation type.

Plate 15: ExAtTt vegetation type (relevé RAV11R10)

4.1.2.2 Conservation Significance of Vegetation Types

Threatened or Priority Ecological Communities

No vegetation assessed as being, or likely to be considered, as a TEC or PEC were recorded from the Raven study area.

An ESA corresponding with the administrative boundaries of the '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)' TEC (as currently interpreted) slightly overlaps the southern edge of the Raven study area. A grassland assessment, focusing on delineating the boundaries of the TEC, was conducted during the same field survey period (Ecoscape 2011), and has determined that the grassland within this ESA is dominated by *Astrebla* spp., and corresponds with the 'Brockman Iron cracking clay communities of the Hamersley Range' PEC, and not the TEC.

As the southern boundary of the Raven study area largely corresponds with a tall, steep escarpment (the southern edge of the Hamersley Range), and the drainage in study area is towards the north, development of the study area is unlikely to impact on known TECs or PECs.

'Ecosystems at Risk'

'Ecosystems at Risk' do not have any statutory protection. They were identified by regional ecologists and others as part of the then Department of Conservation and Land Management's (CALM, now DEC) *Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (CALM 2002).

The DEC considers 'Hilltop floras, Hamersley Range' as a *vulnerable* 'Ecosystem at Risk' due to frequent fires preventing regeneration and deliberate burning (Kendrick 2002). Whilst the tallest hilltops were not assessed during the field survey, none are particularly high and they are unlikely to have vegetation different to that found on the slopes. Whilst not conclusive, it is unlikely that 'Hilltop flora, Hamersley Range' occurs in the study area.

Resource areas within the study area have not been identified, however most iron ore resources in the local area are associated with valley floors. Therefore future development is unlikely to directly impact on hilltops, however indirect impacts may include habitat fragmentation, changes to fire regimes and dust.

'All major ephemeral water courses' is also identified as an 'Ecosystem at Risk' in Kendrick (2002). The Robe River is the most significant ephemeral water course of the study area with several smaller tributaries. However, within the study area all water courses are minor to mid-range, dominated by *Corymbia hamersleyana* and *Eucalyptus xerothermica*.

Other nearby 'Ecosystems at Risk' listed in Kendrick (2002) include 'Valley floor Mulga', and 'Lower slopes Mulga'. Mulga (*Acacia aneura* sens lat) was not recorded within the study area.

Therefore, it is considered that none of the listed 'Ecosystems at Risk' occur in the study area.

Groundwater Dependent Ecosystems

Ecosystems including *Eucalyptus camaldulensis* and *Eucalyptus victrix* are facultative phreatophytes so at least partly groundwater dependent, *Melaleuca* spp. are potential phreatophytes or surface water dependent species. Neither of these *Eucalyptus* spp. nor any *Melaleuca* spp., were recorded during the surveys. Water courses were dominated by *Corymbia hamersleyana* and *Eucalyptus xerothermica*, which are not considered to be groundwater dependent (eg Astron Environmental Services 2008).

Sheet Flow Dependent Communities

Grove – intergrove Mulga (*Acacia aptaneura*) is considered to be dependent on surface water flows to regenerate. Mulga groves were not identified from the study area.

Other Measures of Vegetation Type Significance

In EPA *Guidance Statement No. 51* (2004a), the EPA list several reasons why vegetation may be considered to be significant in addition to its listing as a TEC or PEC or because the extent is below a minimum threshold. These reasons, which may apply at a number of scales but are not defined in detail, include:

- scarcity
- unusual species
- novel combinations of species
- role as a refuge
- role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species
- being representative of the range of a unit (particularly a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extension or isolated outliers of the main range)
- restricted distribution.

None of the above listed measures of vegetation significance were identified from the study area. Locally significant vegetation, unless it is a TEC, do not have any form of statutory protection.

1.1.2 VEGETATION CONDITION

Relevés were recorded in areas that were typical of the targeted vegetation type. The vegetation condition (Trudgen 1991) was recorded for the relevé and extrapolated to each vegetation type.

The extents and proportion of each vegetation condition rating category is shown in **Table 14**. **Error! Reference source not found.** shows vegetation condition in the study area.

Table 14: Vegetation Condition (Trudgen 1991)

Condition Rating	Excellent	Very good	Good	Poor	Very poor	Degraded
Extent (ha)	1080.82	1436.92	34.63	0	0	0
Proportion (%)	42.35	56.30	1.36	0	0	0

4.2 Fauna

4.2.1 HABITAT TYPES

Four habitat types were identified and given codes for ease of mapping (i.e. R1 for Raven habitat type 1). Each habitat type was mapped and delineated based on the following types:

- R1 - creeklines/drainage lines on lower slopes and valley floors (**Plate 16**)
- R2 - open shrubland or open woodland over Spinifex grassland on slopes (**Plate 17**)
- R3 - sheltered gorges/gullies (**Plate 18**)
- R4 - exposed upper slopes, clifflines and ridges (**Plate 19**).

The condition of all habitats was excellent, with no evidence of recent fire, and abundant fresh growth of *Triodia* spp. and *Acacia* spp. No surface water was recorded and all drainage appears to be ephemeral, although waterholes accessible to animals may exist in some gullies (based on presence of Euros).

The habitats were mapped based on landscape position, vegetation and soil type and are shown on . The majority of the study area is made up of habitat types R2 and R4 which are comprised of either the Boolgeeda or Newman land systems (**Plate 17** and **Plate 18**). **Table 15** shows the amount of each habitat type within the study area and the percentage extent.

Table 15: Amount and percentage proportion of each habitat type within the study area

Habitat Type	Area (ha)	Proportion of study area (%)
R1 – creeklines/drainage lines on lower slopes and valley floors	1393	54.6
R2 – open shrubland or open woodland over spinifex grasslands on slopes	1061	41.6
R3 – sheltered gorges/gullies	35	1.4
R4 – exposed upper slopes, clifflines and ridges	63	2.5
Total	**2552**	

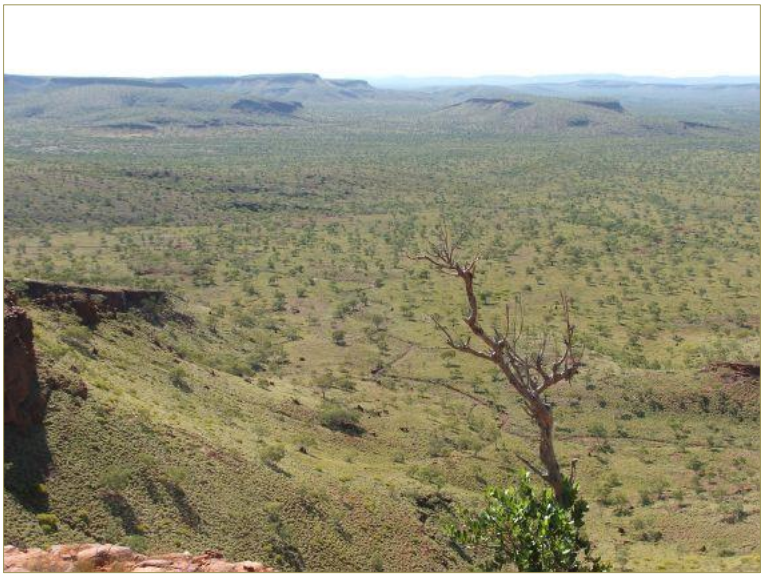

Plate 16: Habitat Type R1

Plate 17: Habitat Type R2

Plate 18: Habitat Type R3. Provides shelter in close proximity to foraging grounds

Plate 19: Habitat R4 showing steep cliffs and caves providing shelter

4.2.2 OPPORTUNISTIC OBSERVATIONS

Additional bird species were recorded opportunistically at other times and locations in and adjacent to the Raven study area, bringing the total to 35. Observed numbers of the additional species were

mostly low (1-4), consistent with low actual numbers or difficulty in detection, with the exception of Painted Finch, which was sighted in groups of about four individuals on three occasions. A pair of Rainbow Bee-eaters (EPBC *migratory*) was the only conservation-listed species recorded, however this is a widespread and common species. Other notable records were pairs of Red-capped Robin, Black-chinned Honeyeater, Chiming Wedgebill and Black-tailed Treecreeper (uncommonly recorded in other Hamersley Range surveys), and the presence of Western Bowerbird (one sighted during census, one calling male at a separate site) which is an indicator of high-quality (potential Northern Quoll denning) habitat.

Scats of Euro were observed commonly, mostly associated with overhangs and small caves, but none appeared to be fresh. This species is dependent on frequent access to water, so may only be able to use the area discontinuously after rainfall events, as we found no evidence of permanent waterholes.

Raptor pellets were found in a high overhang, but the only identifiable prey remains were from grasshoppers, and the pellets are attributed to Australian Kestrel (one individual of which was seen subsequently in the same valley). Brown Falcons were also present (three individuals close to a nest, likely a breeding pair with well-grown juvenile), and a Whistling Kite. The survey area may also be used for foraging and/or breeding by other raptors which have larger ranges and would occur there less frequently. Feathers found in the open among Spinifex at the western edge of the study area included a partial wing of a male Rufous Whistler, and grey and white wing feathers from another bird. This suggests the same site was used at least twice by a predator, either a raptor or possibly a cat.

Two inactive mounds of Pebble-mound Mouse (DEC P4) were located near the trapping sites, one of them with entrance hole only partly blocked, which indicates recent activity (Anstee 1996).

Other species recorded include Emu (one old but identifiable bone fragment, proximal tarsometatarsus, in an overhang near a bowerbird sighting; possibly transported as a prospective bower decoration), and an active roost of Common Sheathtail Bats (20 – 30 individuals estimated; photo) in a relatively large and deep (~8 m), warm and humid cave. Next to the rear wall of the same cave, the posterior part of a juvenile Central Bluetongue Skink was found (skin with bones of pelvic region and hindlimbs). This remnant, at least several months old, is consistent with prey remains left by either a Northern Quoll (EPBC EN) or, more likely, a Ghost Bat (DEC P4) which typically eat vertebrate prey head-first while suspended in a roost cave.

Reptile activity was low due to the relatively cool and drying conditions, with only a few species observed active (or rather, basking). Relatively few sandy or dusty surfaces suitable for track preservation were observed, and most seem to have been erased by strong winds shortly before this survey.

Using these methods, 46 vertebrate species were recorded (three mammals, seven reptiles, 36 birds) and are listed in **Table 23** (**Appendix Eight**).

4.2.3 BIRD CENSUS

Twenty-one species of birds were identified by sight or call during eight sessions of bird census over four days, the number of individuals ranging from one (five species) to 13. Eight or more individuals were recorded in the following species, which are thus regarded as common and conspicuous at the site:

- Zebra Finch (13),
- Rufous Whistler (11),
- Budgerigar (10),
- Diamond Dove (9),
- Striated Pardalote (9),
- Yellow-throated Miner (8)
- Variegated Fairy-wren (8).

No bird species of known conservation significance were recorded in the census sessions.

4.2.4 TRAIL CAMERAS

Trail cameras were set at three locations in front of low overhangs and caves, but did not obtain any identifiable images of fauna. **Table 16** lists the co-ordinates for the locations of each camera.

Table 16: Camera co-ordinates in meters (GDA94 MGA zone 50)

Item	Easting	Northing
Trail Camera	522438	7542919
Trail Camera	522441	7542885
Trail Camera	522401	7542793

4.2.5 TRAPPING

No captures of any species were made in 60 trap nights at Raven. Due to the necessity of daily access, trapping was restricted to a relatively small section in the north-west part of the study area, whereas better potential habitat was identified in the south-east.

5.0 Discussion

5.1 Flora and Vegetation

5.1.1 FLORA OF CONSERVATION SIGNIFICANCE

A total of 117 taxa of vascular flora were recorded within the study area from relevé sites and opportunistic observations (**Appendix Seven**). Species richness cannot be assessed with confidence because a Level 1 survey does not necessarily include intensive floristic sampling. The seasonal conditions were considered excellent.

Two TF species listed under the Commonwealth *EPBC Act* (1999) as *vulnerable* and *WC Act* (1950), *Lepidium catapycnon* and *Thryptomene wittweri,* were identified from the DEC database search request as occurring close to the study area. Neither were located during the field assessment. Both are known to occur high in the landscape, in areas that were mostly inaccessible during the field survey. Therefore, although it is unlikely that they occur in the study area, the landform and habitat of both occur, and their occurrence cannot be discounted without intensive survey.

Priority-listed flora species do not have specific protection, however the DEC expects that the proponent of any clearing that will impact on these species demonstrates that they have taken appropriate action to minimise impacts.

There were three PF (*Eremophila magnifica* subsp. *velutina, Goodenia nuda* and *Indigofera* sp. Bungaroo Creek) recorded within the study area.

Eremophila magnifica subsp. *velutina* (P3) was recorded from one population on a rocky knoll. It has also been found in similar situations in other recent surveys (Flying Fish, Ecoscape 2012d)), and may occur sparsely within the study area.

Goodenia nuda (P4) was recorded from two populations. This species is widespread across surrounding areas and it is likely to occur at low density across the study area.

Indigofera sp. Bungaroo Creek (P3) was recorded from three locations where it was abundant around a drainage line. It is likely that these three records represent a single, extensive population associated with the **ChAtCp** vegetation type.

Fifty-two conservation significant flora taxa (TF and PF) were identified by the DEC database search, with none identified as having previously been recorded within the study area. It is considered that the majority would have identifiable (if present) due to survey timing (coinciding with the majority of species' flowering periods) and *excellent* seasonal conditions. However, as a result of the broad scale nature of this survey across a large area it is not possible to rule out the possibility of additional conservation significant flora occurring within the study area.

Impacts on these species cannot be determined until resource and infrastructure areas are identified.

1.1.2.1 Conservation Significant Flora Risk Assessment

This assessment of the Eliwanna study area was a Level 1 survey according to EPA *Guidance Statement No. 51* (2004a) and *Position Statement No.* 3 (EPA 2002), and was conducted as a reconnaissance survey with targeted searches for conservation significant flora. Due to the size of the study area, restricted access to some areas due to lack of tracks, steep terrain and time constraints, and the nature of the survey (reconnaissance), it was not possible to search the entire study area for conservation significant flora.

A risk assessment, identifying the likelihood of conservation significant species occurring on the Raven study area is included in **Table 25**, **Appendix Nine**. The likelihood of a species occurring in the study area is based on the following attributes, as listed on FloraBase (WAH 2011a; 2011b) and tailored to Pilbara populations, including recent information from recent nearby surveys. The attributes were:

- the broad soil type usually associated with the species
- the broad landform usually associated with the species
- the usual vegetation (characteristic species) with which the species is usually associated
- the species having previously been recorded from nearby (approximately 50 km).

The likelihood rating is assigned using the following categories:

- Does occur (ie it was recorded within the study area)
- Almost certain: it is expected to occur within the study area (but was not recorded)
- Likely: it will probably occur within the study area
- Unlikely: it could occur but is not expected
- None (Rare): none of the attributes of soil, landform and associated vegetation that are characteristic of the species occur in the study area, nor has it been previously recorded nearby. Therefore it almost certainly does not occur within the study area.

The conservation significant flora most likely to occur in the study area but not recorded during the survey are:

- *Sida* sp. Hamersley Range (K. Newbey 10692) (P1)
- *Vigna* sp. central (M.E. Trudgen 1626), based largely upon its occurrence in similar valleys in Serenity (Ecoscape *in prep*.)
- *Ptilotus subspinescens* (P3)
- *Acacia bromilowiana* (P4)
- *Eremophila magnifica* subsp. *magnifica* (P4)
- *Ptilotus mollis* (P4)

- *Rhynchosia bungarensis* (P4).

It is not possible to determine the consequence of future impacts on these species as resource and infrastructure areas are unknown.

5.1.2 UNDESCRIBED SPECIES

The *Josephinia* sp. collected from the Raven study area is a new undescribed species and is likely to be listed as a PF when given a phrase name. Ecoscape has collected this species from four locations in the Hamersley Range (the Raven study area, two in the Serenity area of Fortescue's CPP, and the Flinders Mines Blacksmith tenement, adjacent to Serenity). Malcolm Trudgen is in the process of formal lodgement with the Herbarium, including the documentation required to formally recognise it as a new species. Currently, the proposed phrase name is *Josephinia* sp. Mt Sheila.

5.1.3 INTRODUCED SPECIES

No introduced species recorded from the Raven study area is recognised under the *Agriculture and Related Resources Protection Act 1976* as a Declared Plant.

There were no significant infestations of introduced species.

Three introduced flora species, **Bidens bipinnata* (Bipinnate Beggartick), **Malvastrum americanum* (Spiked Malvastrum), **Portulaca oleracea* (Purslane) were recorded from the study area. Infestations of these weeds were restricted to drainage lines.

5.1.4 VEGETATION CONSERVATION SIGNFICANCE

Ten vegetation types were recorded from the Raven study area, none of which match the descriptions of any recognised TEC or PEC.

No 'Ecosystems at Risk' Risk' (CALM 2002) were identified from the Raven study area, however it is possible (but unlikely) that vegetation considered to represent the *vulnerable* 'Hilltop floras, Hamersley Range' may occur in the study area. The **ChAmSf** and **EAmTw2** vegetation types are associated with hills and include hilltops. These vegetation types were recorded to be in Very good to Excellent condition and as such may have conservation value.

All of the other vegetation types recorded in the study area are considered to be relatively widespread and well represented in the broader region.

5.1.5 VEGETATION CONDITION

The vegetation condition of the Raven study area, assessed using the Trudgen (1991) Vegetation Condition Rating Scale, ranged from Good to Excellent depending of the density of weeds, impacts from grazing and effects of fire.

Most of the area is in Very good or Excellent condition (98.65%), with only 1.36% being in Good condition. The area considered in Good condition is associated with the drainage channel through the study area, and appears to be accessed by cattle (although none were observed during the field survey), leading to weed introduction and trampling.

5.2 Fauna and Habitat

5.2.1 CONSERVATION-SIGNIFICANT AND OTHER SPECIALLY PROTECTED FAUNA

Habitat requirements, documented or potential presence at the Eliwanna study area are discussed for each listed species. Species and common names are followed by abbreviations denoting conservation status (described in **Appendix One**), as listed in **Table 18.** Potential impacting processes (not all relevant in any particular case) include:

- mortality during clearing
- mortality during operations
- habitat loss leading to reduction in population size
- habitat loss leading to population fragmentation
- hydrological change (affecting habitat)
- habitat degradation due to weed invasion
- impact of disturbance, light and/or pollutants on habitat quality
- changes in abundance of predators and/or competitors, including introduced species
- changes in fire regime.

FISH

Leipoptherapon aheneus* (Fortescue Grunter) DEC *P4

The Fortescue Grunter (Terapontidae) is endemic to the Pilbara region of Western Australia (Allen, Midgley & Allen 2002). The species has only been recorded from permanent water along the Fortescue, Robe and Ashburton drainage systems (Beesley 2006). It occurs in slow to fast flowing streams and pools, and feeds on small crustaceans and juvenile fish, growing to a maximum length of 13 cm. When in suitable numbers the species displays schooling behaviour presumably as a defence mechanism (Morgan, Ebner & Beatty 2009).

The study area is in the upper reaches of the Robe drainage, but this species is unlikely to occur. It is possible that Fortescue Grunter could move into the study area after cyclonic activity and flooding links permanent water bodies via drainage systems, but persistence would be unlikely as there are no permanent flowing watercourses. No impact is likely.

MAMMALS

Dasyurus hallucatus* (Northern Quoll) EPBC *EN*, WCA *EN

The Northern Quoll (Dasyuridae) is a medium-sized carnivorous marsupial, occurring in a variety of habitats across its range. Rocky areas provide prime habitat as they offer shelter and protection

from predators and weather (Hill & Ward 2010). Northern Quoll are opportunistic foragers, feeding on a wide range of prey including beetles, grasshoppers, spiders, scorpions and centipedes, vertebrates up to the size of the Common Brushtail Possum, and also fruit, nectar, carrion and human refuse, switching dietary resources according to season and availability (Hill & Ward 2010). Mating occurs in late June and a single litter of up to eight young are born in July or August, with lactation ceasing in April (Schmitt *et al.* 1989). Reproductive maturity occurs at 11 months; males usually die within weeks after mating, and most females do not survive more than one breeding season. Body size, home range size and survival rate vary between rocky and savannah habitats, but Pilbara populations have not been well studied. Potential denning / shelter habitat (considered critical for quoll survival) occurs in the study area in the form of rocky gorges, gullies and escarpments associated with *Corymbia* woodland, boulder fields, termite mounds, and small caves. Foraging or dispersal habitat is considered to include any areas of predominantly native vegetation up to 2 km from denning habitat (DSEWPaC 2011).

Pilbara Quoll populations are considered to be already fragmented and to have been in decline since the mid-1980s, with the precise causes unknown (Threatened Species Scientific Committee (TSSC) 2005). The major threat to future survival of the species overall (O'Donnell, Webb & Shine 2010) is the lethally toxic Cane Toad *Chaunus* (or *Bufo*) *marinus*, which has already been implicated in rapid population declines in Queensland and the Northern Territory, is now expanding its range westwards into Western Australia, and is likely to become established in parts of the Pilbara within 15 years (Sutherst, Floyd & Maywald 1996; TSSC 2005). Recent models (Kearney et al. 2008) imply that toads will eventually occupy parts of the western Hamersley Range (Department of Environment, Water, Heritage & the Arts 2010). Any areas of Northern Quoll habitat that cannot be occupied by the toad will act as refugia and may be critical to survival of the species.

Biota (2009) analysed distribution records of Northern Quoll across the Pilbara in terms of Land Systems (Van Vreeswyk *et al.* 2004) and results of trapping surveys. Considering the total area of each land system, those with five or more records can be ranked as follows: Wona (55 per 1000 km^2), Robe (36), River (20), Capricorn (19), Horseflat (5.6), Calcrete (3.5), Macroy (2.9), Rocklea (2.1), McKay (1.2), Boolgeeda (0.65) and Newman (0.48). Despite low density, Rocklea represents a high proportion of records (49 of 219) because of its large area. Most surveys using Elliott traps in the Hamersley Range (where Newman and Boolgeeda predominate) recorded no Northern Quolls, whereas there were few null trapping results in the Chichester subregion (Biota Environmental Sciences 2009).

Predicting the impact on Northern Quoll populations of toads and other disturbance, including that of mining, will need to take into account the availability of water and effects of climate change, particularly through the frequency and intensity of cyclones. While there is no evidence that Northern Quoll currently occur in the study area, it does occur at scattered localities in the Hamersley IBRA subregion, and the short generations, large litter sizes and large home ranges of this

species mean that population density and occupancy of habitat may fluctuate greatly between years, and sites that are occupied only occasionally may still be critical for long-term survival in the region. Although there appear to be no permanent water sources, potential denning habitat exists in the study area in the form of sheltered and vegetated gullies (e.g. sites occupied by Western Bower Bird), so some impact is possible.

Sminthopsis longicaudata* (Long-tailed Dunnart) DEC *P4

This species is found in rocky areas of central Western Australia and a few sites in central southern Northern Territory. In Western Australia it is found in the Pilbara, Murchison, northeastern Goldfields, Ashburton, and Gibson Desert regions (Pavey 2006). It is a rare species that is patchily distributed, but at times it can be locally common (Burbidge et al. 2009). It is found in rocky scree and plateau areas, generally with little vegetation or of Spinifex hummock grassland, shrubs, and open woodland (Burbidge et al. 2009). This species is nocturnal, and its diet includes a variety of invertebrates. Females in captivity give birth to up to five young between the months of October and December (Pavey 2006). There appear to be no major threats to this species. In the range within central Australia this species is affected by the spread of exotic buffel grass, which increases frequency and intensity of fires, and this is also likely to be an issue in parts of Western Australia (IUCN Red List 2011).

There are records of this species a few kilometers south of the study area (DEC & Western Australian Museum 2011) and suitable habitat exists, so there is potential for it to live within the site and for some impact to occur.

Lagorchestes conspicillatus leichardti* (Spectacled Hare-wallaby - mainland) DEC *P3

The Spectacled Hare Wallaby (Macropodidae) has declined dramatically in Western Australia; it is now extremely rare and reduced to a few isolated populations in the Pilbara and Kimberley regions (Department of Conservation and Land Management 1999; Wildlife Australia 1996). This species occupies a wide variety of habitat types including open forests, open woodland, tall shrublands, tussock grasslands and hummock grasslands. In the drier southern parts of its range, it commonly occupies spinifex (*Triodia* spp.) sandplains interspersed with low shrubs and a diversity of either soft grasses, sedges or herb species. Threats probably include introduced predators (foxes in southern parts of the range and possibly cats) and competitors, the pastoral industry (particularly sheep in the Pilbara and cattle in the south-west Kimberley and possibly MacDonnell Ranges) and changes in fire regimes (central Australia).

The only record of this species in the central Hamersley Ranges (DEC & Western Australian Museum 2011) dates from 1966, and it is unlikely that a population still occurs in the subregion. No impact is likely.

Macroderma gigas* (Ghost Bat) DEC *P4

Regional populations of Australia's only carnivorous bat (Megadermatidae) are centred on maternity roosts that are genetically isolated from each other, and only 10 such sites are known to exist (Worthington-Wilmer et al. 1994). Populations are known to disperse in the non-breeding (dry) season (GJ Toop 1979; G J Toop 1985). The persisting arid zone regional population in the Pilbara is also geographically isolated, being separated from extant northern Australian populations and the historical central Australian populations by extensive sandy deserts, and should be further assessed to determine its specific status. The central Australian population is considered to be extinct and the Pilbara population is considered vulnerable.

This bat forages by gleaning, eating large insects, frogs, lizards, small birds and mammals. Tideman *et al*. (1985) reported Ghost Bats in the Northern Territory foraged, on average, 1.9 km from their day roost, with a mean foraging area of 61 ha. They detect prey using eyes and ears rather than using echolocation, changing vantage points about every 15 minutes during foraging periods, with a mean distance of 360 m between them. They are obligate troglodytes, and survival is critically dependent on finding natural roosts in caves, crevices, deep overhangs, and artificial roosts such as abandoned mines (Hall *et al.* 1997). Threats include disturbance and loss of roosting sites due to mining, tourism and internal dereliction of mines through aging of timber supports, and collision with barbed wire fences (Hall *et al.* 1997). In recent times population declines could be attributable to competition for prey with foxes, feral cats, and prey lost through habitat modification by fire and livestock (Environment Australia 1999).

There are several records within 20 km, and a partly eaten lizard found in a cave on this survey indicates recent presence in the study area. Some impact from mining activity is therefore possible.

Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) WCA *VU

The Pilbara population of the Orange Leaf-nosed Bat (Hipposideridae) is subject to current taxonomic research and may be recognised as a distinct species from northern populations. It is a moderate-sized bat with short, bright orange fur, relatively small ears and a fleshy noseleaf structure surrounding the nostrils. It appears to be divided into three discrete subpopulations (eastern Pilbara mines and granite, Hamersley Range, Upper Gascoyne), separated by relatively flat areas that impede gene flow such as the Fortescue and Ashburton valley. It is unlikely that the Pilbara Leaf-nosed Bat disperses through the desert or occupies habitat there. Many records of the species in the region are of bats in flight or roadkills, so the number of distinct roosts is not known. The Pilbara Leaf-nosed Bat is restricted to caves and mine adits (horizontal shafts) with stable, warm and humid microclimates because of its poor ability to thermoregulate and retain water. The roost is usually over pools of water in deeper mines, or deep within the mine or cave structure in an area that maintains elevated temperature and humidity. Thus, the roosting site is often at depth in mines; in small crevices within caves, usually those ascending between sedimentary rock layers; and with associated groundwater seeps (eg at Barlee Range; K.N. Armstrong 2001). Simple vertical shafts are not used and shallow caves beneath mesa bluffs are also unlikely roost sites.

Foraging in the Pilbara has been observed in *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (eg near Marble Bar, Bamboo Creek, Lalla Rookh and Copper Hills), over small watercourses amongst granite boulder terrain and around nearby koppies, over pools and low shrubs in ironstone gorges, and above low shrubs and around pools in gravelly watercourses with *Melaleuca leucodendron*, such as in Barlee Range Nature Reserve (K.N. Armstrong 2001; Churchill, Helman & Hall 1988). Typically, the Pilbara Leaf-nosed Bat flies low in the open spaces in watercourses and gorges, and over *Triodia* grassland, sometimes within centimetres of the ground, but up to 2–3 m in height. This species is very sensitive to even slight human disturbances i.e. barbed wire fences. If subject to continual human interference it may completely abandon a roost. It often shares roosts with the Ghost Bat (*Macroderma gigas*), Finlayson's Cave Bat (*Vespadelus finlaysoni*), Common Sheath-tailed Bat (*Taphzous georgianus*), and possibly Hill's Sheath-tailed Bat (*Taphozous hilli*) in some parts of its range. Any management strategy that benefits the Pilbara Leaf-nosed Bat is also likely to benefit these species (DSEWPaC 2011).

There are records from the eastern and western Hamersley but none from the central section, and no indication of deep horizontal caves providing suitable roosts was observed in this survey. No impact is likely.

Leggadina lakedownensis* (Northern Short-tailed Mouse, Lakeland Downs Mouse) DEC *P4

This native rodent (Muridae) is a nocturnal species found in areas of open tussock and hummock grassland, *Acacia* shrubland, and savanna woodland, on alluvial clay or sandy soils. Females give birth to two litters annually. Litters contain up to four young and the gestation period lasts about 30 days. The population is rare and scattered on the mainland with large annual fluctuations that may not correlate with environmental fluctuations or seasonality (Moro & Kutt 2008). No major or general threats have been identified (IUCN Red List 2011).

There are NatureMap (DEC & Western Australian Museum 2011) records of this species a few kilometers south of the study area, so it may also occur on the site, most likely in the eastern part (Robe River valley) where open woodland / *Acacia* shrubland / tussock and hummock grassland vegetation on sandy soils (**Map 5**) represents suitable habitat. Given the patchy and fluctuating population, any impact would be very difficult to measure but some may occur.

Pseudomys chapmani* (Western Pebble-mound Mouse) DEC *P4

This native rodent (Muridae) is sparsely distributed within abundant habitat, preferring gentle slopes of rocky ranges sparsely vegetated by *Triodia* grasses, *Senna, Acacia* and *Ptilotus* species. Animals live in small family groups in burrows below mounds of pebbles. Females can produce several litters of four young annually. There appear to be no major threats to this species. The reasons for its elimination from the southern portion of its range are unclear, but may have been related to

predation by feral cats and foxes. Mining may be a very localized threat (Anstee, Roberts & O'Shea 1997) but this would not affect the overall population size (IUCN Red List 2011).

Inactive mounds in the study area indicate recent presence. Suitable habitat for this species is extremely abundant and practically continuous (comprising tops as well as lower slopes of hills) throughout the Pilbara, so no significant impact is likely.

BIRDS

Apus pacificus* (Fork-tailed Swift) EPBC *M

A non-breeding visitor to all states and territories of Australia, this swift (Apodidae) feeds on flying insects and is almost exclusively aerial in habits, flying from less than 1 m to at least 300 m above ground and probably much higher. In Australia they mostly occur over dry and open inland plains, but also over a wide variety of land and marine habitats. Some birds have been sighted in Western Australia arriving from Indonesia between October and November. Flocks have been recorded near Broome on southward passage across the continent. In north and north-west Western Australia, most birds have departed by the end of April. There are no significant threats to the Fork-tailed Swift in Australia (DSEWPaC 2011).

Swifts were not observed on this survey but there are numerous records from the central Hamersley and it would certainly occur in the study area. No impact is likely to occur because of the bird's nomadic aerial habits.

Ardea modesta* (Eastern Great Egret) EPBC *M

Eastern Great Egrets (Ardeidae; listed by DEC as *Ardea alba modesta*) are widespread in Australia, occurring in a wide range of wetland habitats and breeding (November to April, depending on rainfall) in colonies in wooded and shrubby swamps. They feed on a wide range of invertebrates and small vertebrates including birds, reptiles and small mammals. The species undertakes some regular seasonal movements, mostly to and from breeding colonies, and towards the coast in the dry season. Regional differences in reporting rates suggest that individuals migrate north to winter in tropical northern Australia, consistent with changes in the availability of suitable wetland habitat. Regular migration to locations outside of Australia is suspected but not confirmed. Threats include loss and/or degradation of foraging and especially breeding habitat through alteration of water flows, drainage and/or clearing of wetlands for development, frequent burning of wetland vegetation used as nest sites, salinisation, and invasion by exotic plants or fishes (DSEWPaC 2011).

There are few records of Great Egret in the Hamersley IBRA subregion relative to nearby subregions; it was not recorded during this survey, and no suitable wetland habitat is present in the study area although some would exist after sufficient rainfall. It is unlikely that activity on the study site would have any impact on this species.

Ardea ibis* (Cattle Egret) EPBC *M

The Cattle Egret (Ardeidae) is a relatively recent colonist of Australia (from 1948) from Asia, and occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands; it remains extremely rare in arid and semi-arid regions. In the Pilbara there are only a few records, from Fortescue Marsh, and Ophthalmia Dam near Newman (eastern Hamersley range), and no breeding is reported in this area. They feed mainly on grasshoppers, but also other insects and small vertebrates. Migration occurs to and from breeding colonies in Australia, but movements are poorly known in north and Western Australia. There are few threats in Australia, other than predation by feral cats while nesting (DSEWPaC 2011)).

Cattle Egrets have not been recorded within 200 km of the study site and are unlikely to occur. No impact is likely.

Haliaeetus leucogaster*(White-bellied Sea-eagle) EPBC *M

The White-bellied Sea-eagle is a large raptor (Accipitridae) distributed mainly along coastlines, offshore islands and large inland waterways, with breeding only in limited areas of its range. It also occurs around freshwater swamps, lakes, reservoirs etc, and feeds on a wide variety of fish, crustaceans, and terrestrial vertebrates including carrion. It is common and widespread in much of southern Asia, but has declined in some areas including Australia. The main threats are loss of habitat due to land development, and the disturbance of nesting pairs by human activity (DSEWPaC 2011).

Sea-eagles are recorded along the Fortescue River but are not known to extend into the Hamersley range, and are unlikely to occur near the study site. No impact is expected.

Falco hypoleucos* (Grey Falcon) DEC *P4

The Grey Falcon is the rarest of Australia's six falcon species (Falconidae). It is sparsely distributed throughout the arid zone and is even less common in mesic areas (most coastal sightings occurring in drought years). It feeds on a wide variety of birds, but most often on ground-feeding parrots and pigeons, as well as some snakes, lizards, and grasshoppers. Grey Falcons use the nests of crows, kites or eagles, most often placed in upper branches of emergent eucalypts, often on a tree-lined watercourse. Eggs are laid between July and October (Olsen & Olsen 1986). There are scattered records through most parts of WA including the Pilbara, but none within 100 km of the study site (DEC & Western Australian Museum 2011).

Suitable foraging and nesting habitat exists at the study site, as shown by the presence of Kestrel and Wedge-tailed Eagle. However, this species would be present sporadically, if at all, and no impact is likely.

Falco peregrinus* (Peregrine Falcon) WCA *S4

This species (Falconidae) is uncommon but wide-ranging throughout Australia, preferring areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land. Ledges, cliff faces,

large tree hollows and spouts, or abandoned nests of other raptors are used for nesting. Individual Peregrines are occasionally sighted throughout the region and may use the study area as part of a larger foraging range. Abundant cliffs and other nesting raptors indicate that suitable conditions for nesting occur on the site, but significant impact is unlikely.

Ardeotis australis* (Australian Bustard) DEC *P4

A large, omnivorous, partly nocturnal bird of plains, grasslands and woodlands, the Bustard (Otididae) is nomadic, so numbers fluctuate depending on the availability of food with seasons and following irregular rainfall. Food includes leaves, buds, seeds, fruit, frogs, lizards and invertebrates. It has disappeared from much of southern Australia due to hunting pressure, but remains common in the north. Their presence also indicates healthy populations of insects and small animals. Threats include human hunting, introduced predators (especially foxes), and thickening of vegetation due to overgrazing or lack of fire. As ground nesters, they are particularly vulnerable to fire in the nesting season.

No bustards were detected in this survey but they are likely to occur in the study area as they are fairly common throughout the region. Some increased mortality and reduction in foraging range can be expected as a result of mining, but impact is likely to be minor.

Burhinus grallarius* (Bush Stone-curlew) DEC *P4

While this bird (Burhinidae) is found in all mainland states, it is sparsely distributed and continues to decline. Roosting and nesting sites are usually in grassy woodlands with a low, sparse grassy or herb understorey. Nests are usually beside a fallen log, which probably makes it harder for foxes to find. Curlews prefer a sparse understorey so they can see predators while foraging for insects. Branches on the ground are essential for the bird's camouflage, and it is unlikely to attempt nesting without it (Department of Sustainability and Environment (Victoria) 2002). This species occurs across much of Australia preferring lightly wooded country near thickets or long grass that act as daytime shelter. They are usually seen in pairs, although in the breeding season, small flocks gather. Historically this species was widely distributed throughout much of Western Australia but is now considered rare with an estimated population of 15,000 individuals (Garnett & Crowley 2000). The Bush Stone-curlew is ground dwelling and non-migratory and is therefore susceptible to predation from fox and feral cat.

There is a record from a few kilometres to the south and this species is likely to occur on the site, especially in the Robe River valley (eastern part of the study area). Clearing of shrubland/woodland habitat along this river valley could therefore have some impact.

Charadrius veredus* (Oriental Plover) EPBC *M

This species (Charadriidae) breeds in Mongolia and adjacent parts of Manchuria and Siberia, and it is thought that the entire global population spends the non-breeding season (September to March) in northern Australia, in both coastal and inland areas. Most records are along the north-western

coast, between Exmouth Gulf and Derby in Western Australia. Immediately after arriving, Oriental Plovers spend a few weeks in coastal habitats before dispersing further inland to flat, open, semi-arid or arid grasslands, particularly locations with short, sparse grass interspersed with hard, bare ground, such as claypans, dry paddocks, lawns, cattle camps, or recently burnt grasslands. It is not considered globally threatened (DSEWPaC 2011).

No suitable habitat appears to exist in the study area currently, but temporarily attractive conditions would exist after fires. No impact is likely.

Merops ornatus* (Rainbow Bee-eater) EPBC *M

The Rainbow Bee-eater (Meropidae) is widespread throughout most of Australia, does not depend on any particular habitat or vegetation type for feeding or breeding, and is considered to require no particular habitat protection. Disturbance to areas utilised by the Rainbow Bee-eater, such as sand banks of creeks and drainage lines used to burrow to create nesting chambers between September and February, may have some impact on the breeding success of this species. However, historical disturbance does not represent a major issue to this species and it is common in cleared and semi-cleared habitats (DSEWPaC 2011). Disturbance and predation of nests by Cane Toads may have an impact on Bee-eater breeding success in areas of high toad density (*ibid*.), but is unlikely to be significant on a regional scale.

A pair of Bee-eaters was seen in the northeastern part of the study area (Robe River valley), and suitable conditions for breeding may exist along banks of dry watercourses. Establishment of toads is unlikely due to lack of surface water through most of the year, and disturbance due to mining is likely to have only temporary impact if any.

Neochmia ruficauda subclarescens* (Star Finch (western)) DEC *P4

Star Finches (Estrildidae) live in grasslands and eucalypt woodland close to water, where they feed on seeds. Birds tend to be resident in large flocks during the dry season, and disperse to breed during the wet season. The western subspecies has three sub-populations: Shark Bay to Pilbara; Fitzroy River valley, West Kimberley; and Gibb River to Gulf of Carpentaria. The Cape York subspecies (*N. r. clarescens*) is claimed to be endangered, but is not listed by federal or state statutes as it has been recognized as a separate subspecies for only a few years; the southern or eastern subspecies *N. r. ruficauda* is listed by EPBC as *EN* and is critically endangered, possibly extinct. The main threat is overgrazing of grasslands near water; it may also require mosaic burning to maintain food supply.

There are scattered records of this species through the Hamersley, though it was not recorded in any of the recent survey reports consulted. It was not recorded in this survey and is unlikely to occur in the study area during the dry season due to the lack of water. Wet season surveys would be required to determine any potential impact on breeding sites.

REPTILES

Notoscincus butleri* (Lined Soil-crevice Skink) DEC *P4

This species of skink was originally described from Dampier, then reported from the Harding River dam (Lake Poongkaliyarra; Storr, Smith & Johnstone 1999). It is now also known from numerous localities in the western Hamersley Range (DEC & Western Australian Museum 2011), where it is associated with rocky and spinifex-dominated areas near creek and river margins (Wilson & Swan 2008).

This species was not recorded in the survey and is unlikely to occur due to the lack of water for most of the year. Suitable habitat apparently does not exist on the site and no impact is likely.

Ramphotyphlops ganei* (Blind Snake) DEC *P1

This species (Typhlopidae) occurs at widely scattered sites in the Pilbara, including the eastern and western Hamersley, Fortescue valley, and Chichester range. It appears to be associated with moist areas such as gorges, gullies and floodplains, though there is a record from sandy soil with spinifex (Western Australian Museum record cited by Ecologia 2010). Like most other typhlopids it is believed to feed on eggs, larvae and pupae of ants, and individuals are likely to mostly inhabit topsoil, termitaria and ant nests.

This species may occur in the study area, especially in sheltered gullies such as the locations where Western Bowerbirds were sighted (these are also considered as potential Northern Quoll habitat). Impact on this species would be very difficult to measure but would be minimized by avoiding disturbance to such gully sites.

Liasis olivaceus barroni* (Pilbara Olive Python) EPBC *VU*, WCA *VU

The subspecies (Pythonidae) is restricted to ranges within the Pilbara region of north-western Western Australia, such as the Hamersley Range, and islands of the Dampier Archipelago. They are most often seen at night and are generally found around rocky areas, rocky outcrops and cliffs, but they also shelter in logs, flood debris, caves, tree hollows and thick vegetation. They are mostly found close to permanent waterholes, not because they need to drink frequently but because their prey does. Juvenile Olive Pythons feed on small reptiles and (probably) frogs, as well as small mammals, shifting to birds and medium-sized mammals (eg Quolls, Rock-wallabies) as adults, which may grow to at least 4 m. Individuals may be sedentary (with a discrete home range associated with water) for most of the year, but can move several kilometres through rocky hills in some seasons, eg during June and July males may travel long distances to locate females for breeding (D. Pearson 2003; Wilson & Swan 2008).

Potential threats to the Pilbara Olive Python are thought to include loss of suitable prey species (eg due to Fox in coastal areas), and accidental or deliberate killing of individual snakes by people (Pearson 2003). Cane Toads may also cause the death of some individual young snakes. However, the continued abundance of the same species in the Queensland Gulf Country indicates that neither

direct human action (associated with the long-established mining and pastoral industries there), nor Cane Toads constitute a major threat to survival where toads have been present for over two decades.

Since the Pilbara subspecies was first listed as threatened in Western Australia, many more locality records have accumulated (nine reported by (L Smith 1981), (17 by Pearson 1993) and it has been considered "*Not threatened, or likely to be. Shouldn't be on list, common and widespread*" (Kendrick 2002). It is known to occur at 17 locations within the Pilbara (Pearson 1993)). Four populations occur at Pannawonica, Millstream, Tom Price and Burrup Peninsula (Pearson 2003). Kendrick (2002) reported this species as common and wide-spread in the Pilbara and one that should not be listed as threatened or declining. The species is considered stable and in sizable numbers at some known sites (Pearson 2003).

No signs of this species were detected in this survey, but it is likely to be present, with individuals possibly moving seasonally between the river valley and sheltered gorges. Feeding opportunities may be limited by the lack of permanent water, but the presence of Euro, Rock Rats and other mammals indicates that resources to support Olive Pythons currently exist. Increased traffic, clearing and excavation along the river valley could have a significant impact on the local population.

AMPHIBIANS

***Chaunus marinus* (Cane Toad)**

Cane Toads (formerly *Bufo marinus*) would have a severe impact on some vertebrate populations if they were to become established in the area, and there is a possibility that this could occur. 'Toad-busting' and biological control are not considered likely to prevent continued range expansion, and the focus now is on 'protecting our most vulnerable native species on a local scale' (DSEWPaC 2011). Toads are likely to become established in parts of the Pilbara within a decade, and if this occurs during the period of mining operation, container and vehicle transport associated with the mine could create opportunities for their introduction to the study area. Even though it is likely toads could not become established if introduced to the area in its natural state, due to lack of permanent waterholes, high evaporation rates, and temperature extremes (cf. Kearney et al. 2008), there is a risk that the presence of mine infrastructure and increased use of water on site would create more favourable conditions for their breeding and survival. The incremental risk (set against risks arising from existing development and tourism) must be considered quite low, but is subject to uncertainty, and strategies to prevent incidental toad transport should be developed and implemented.

5.2.2 EXTENT AND VULNERABILITY OF SIGNIFICANT HABITATS

Of the four habitats identified above (**Section 4.2.1**), the most restricted and potentially significant is R3 – sheltered gullies or gorges, which could provide habitat for Northern Quolls, Pilbara Olive Pythons and *Ramphotyphlops ganei* if they were present. Western Bowerbirds were observed at two locations in gullies, and though not itself a conservation-significant species, Ecoscape consider this to

be an indicator of relatively high-quality habitat. The significance of this habitat on Raven is reduced by the apparent absence of available water during the dry season, though there may be small rockholes or seeps that were not detected, and there are some humid caves within gullies that provide habitat for bats, including Ghost Bats (presence inferred from feeding traces). The gully or gorge habitats in the Raven area are located as pockets within habitat R4 (exposed upper slopes and clifflines) and are likely to suffer little direct disturbance from mining activity concentrating on valley floors.

Also potentially important for some significant species is habitat R1 – creeklines and drainage lines on lower slopes and valley floors, and adjacent areas of woodland/shrubland and tussock grassland which occur in the upper Robe River valley. This is the most likely habitat, including potential breeding habitat, for Rainbow Bee-eater (observed to be present), Bush Stone-curlew, Bustard, and Northern Short-tailed Mouse. During the Wet season this might also provide breeding habitat for Star Finch. This habitat is likely to be largely disturbed or destroyed within the tenement as a result of mining activity, however the fauna species that could be affected remain widely distributed and are currently at a lower level of conservation concern.

Habitats R2 and R4 are more open areas on lower and upper slopes with hard Spinifex and scattered trees, together with exposed clifflines. The slopes provide habitat for Pebble-mound Mouse and Long-tailed Dunnart, and clifflines are potential nesting areas for Peregrine Falcon, however similar habitats are very extensive and connected throughout the region so that little impact is likely to occur.

5.2.3 FAUNA CONCLUSIONS

The three species of highest importance based on their listing in both the WC Act and The EPBC Act are as follows;

- Northern Quoll (*Dasyurus hallucatus*) - EN
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - VU
- Pilbara Olive Python (*Liasis olivaceus barroni*) - VU.

None of these were recorded through the level 1 survey or the targeted Northern Quoll survey undertaken in July-August 2011. There is habitat present for each of these species within the study area, habitat is defined by the Northern Quoll referral guidelines and SPRAT sheet information from the DSEWPaC web pages.

The bird species listed under the EPBC Act as Migratory are all possible transient visitors to the study area and would likely to not be significantly impacted by disturbance. There is little or no information for the remainder of the conservation significant fauna species, other than the Western Pebble-mound mouse which is well represented by NatureMap records. Detailed level 2 survey using

a range of trapping and survey techniques is required to determine the presence of these species within the study area.

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Maps

436000 446000 456000 466000 476000 486000 496000 506000 516000 526000 536000 546000

7550000 7540000 7530000 7520000 7510000 7500000 7490000

RED HILL CREEK
ROBE RIVER
SERPENTINE CREEK
DUCK CREEK
CAVES CREEK
PINARRA CREEK
BOOLGEEDA CREEK
Mt Brockman Rd
Duck Creek Rd

Delphine
Mt Farquhar
Raven
Eliwanna
Flying Fish

Legend

River; Creek

Roads
- Sealed Roads
- Unsealed Roads
- Western Hub Survey Areas

DAFWA Land Systems
- BGD - Boolgeeda Land System - Stony lower slopes and plains below hill systems; not degraded or eroded.
- BNY - Bonney Land System - Low rounded hills and undulating stony plains supporting soft spinifex grasslands.
- BRO - Brockman Land System - Alluvial plains with cracking clay soils supporting tussock grasslands.
- CPN - Capricorn Land System - Rugged hills and ridges on sedimentary rocks; poorly accessible, not degraded or eroded.
- DOR - Dollar Land System - Stony plains supporting acacia shrublands.
- HOY - Hooley Land System - Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands.
- JUR - Jurrawarrina Land System - Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.
- KLN - Kooline Land System - Rough, red shale hills and saline drainage floors; stony short grass forb pastures in poor to good condition; moderate erosion on drainage floors.
- MCK - McKay Land System - Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands.
- NEW - Newman Land System - Rugged ironstone ridges, plateaux and mountains; hard spinifex pastures in good to excellent condition; no erosion.
- PAR - Paraburdoo Land System - Stony drainage floors and gilgai plains developed from basalt; snakewood with stony chenopod pastures in poor to fair condition; moderate erosion on drainage floors.
- PLA - Platform Land System - Dissected slopes and raised plains supporting hard spinifex grasslands.
- PRA - Prairie Land System - Undulating stony plains and granite hills supporting acacia-eremophila-cassia shrublands and minor soft spinifex grasslands
- RIV - River Land System - Flood plains and terraces flanking major rivers and creeks; little pasture degradation or erosion.
- ROB - Robe Land System - Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands.
- ROC - Rocklea Land System - Rugged basalt hills and dissected plateaux; poorly accessible, not degraded or eroded.
- TAB - Table Land System - Low calcrete plateaux, mesas and lower plains supporting mulga and cassia shrublands and minor spinifex grasslands.
- WNM - Wannamunna Land System - Hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally eucalypt woodlands)
- WON - Wona Land System - Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands

GDA 1994 MGA Zone 50

Map 1

Aug 2011

Western Hub Flora and Fauna Surveys

Land Systems

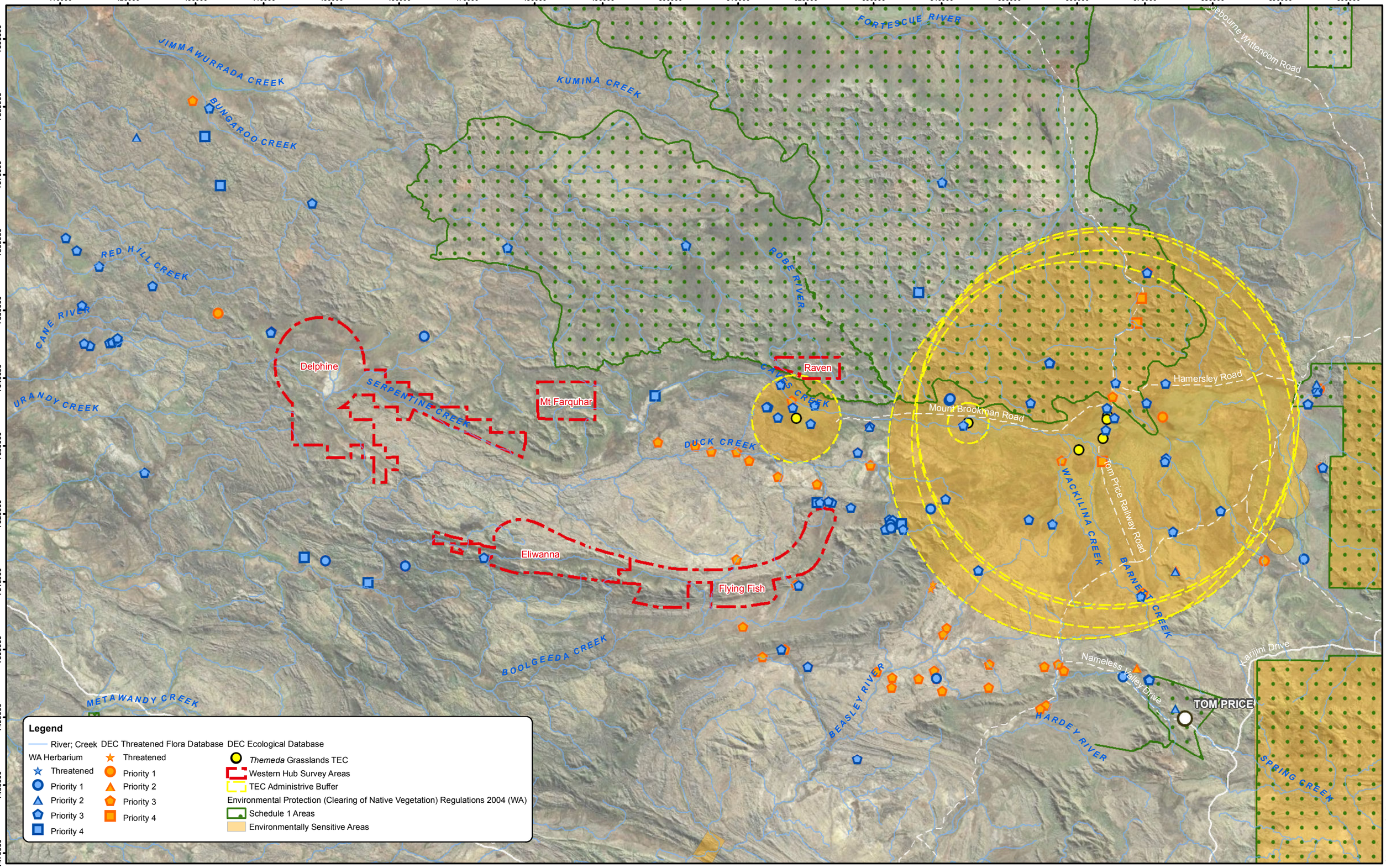
prepared for FORTESCUE METALS GROUP

0 5 10 15 20 Kms

1:300,000 @ A3

Project No. 2668-11

ecoscape



Map 2

Aug 2011

Western Hub Flora and Fauna Surveys

DEC Database Search Results and Environmental Protection (Clearing of Native Vegetation) Regulation Areas

prepared for FORTESCUE METALS GROUP

0 5 10 15 20 Kms

1:500,000 @ A3

Project No. 2668-11

ecoscape

436000 446000 456000 466000 476000 486000 496000 506000 516000 526000 536000 546000

7550000 7540000 7530000 7520000 7510000 7500000 7490000

RED HILL CREEK
ROBE RIVER
SERPENTINE CREEK
CAVES CREEK
DUCK CREEK
PINARRA CREEK
BOOLGEEDA CREEK
BEASLEY RIVER
Mt Brockman Rd
Duck Creek Rd

Delphine
Mt Farquhar
Raven
Eliwanna
Flying Fish

82 565 569 18 175 178 29 567 103 157 580 588 568 181

Legend

River; Creek

Roads

Sealed Roads
Unsealed Roads
Western Hub Survey Areas

Pre-European Vegetation (DEC 2006)

Vegetation Association

18 : Low woodland; mulga (*Acacia aneura*)
29 : Sparse low woodland; mulga, discontinuous in scattered groups
82 : Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*
103 : Hummock grasslands, shrub steppe; snakewood over soft spinifex and *Triodia wiseana*
157 : Hummock grasslands, grass steppe; hard spinifex, *Triodia wiseana*
175 : Short bunch grassland - savanna/grass plain (Pilbara)
178 : Hummock grasslands, grass steppe; hard spinifex, *Triodia basedowii*
181 : Shrublands; mulga and snakewood scrub
565 : Hummock grasslands, low tree steppe; bloodwood over soft spinifex
567 : Hummock grasslands, shrub steppe; mulga and kanji over soft spinifex and *Triodia basedowii*
568 : Hummock grasslands, shrub steppe; mulga and snakewood over *Triodia wiseana*
569 : Hummock grasslands, low tree steppe; bloodwood over soft spinifex and *Triodia wiseana*
580 : Mosaic: Shrublands; eremophila and cassia dwarf scrub / Hummock grasslands, grass steppe; hard spinifex (*Triodia wiseana*)

GDA 1994 MGA Zone 50

Map 3

Aug 2011

Western Hub Flora and Fauna Surveys

Vegetation Associations

prepared for FORTESCUE METALS GROUP

0 5 10 15 20 Kms

1:300,000 @ A3

Project No. 2668-11

ecoscape

522000 524000 526000 528000 530000 532000

7544000

7542000

7540000

7538000

Emv
Gn
IB Po
IB Bb
Ma
IB Gn
CAVES CREEK

Legend

Introduced Flora

Species

Bb *Bidens bipinnata* L.

Ma *Malvastrum americanum* (L.) Torr.

Po *Portulaca oleracea* L.

Conservation Significant Flora (CSF)

Species

Emv *Eremophila magnifica* subsp. *velutina* Chinnock (P3)

Gn *Goodenia nuda* E.Pritz. (P4)

IB *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (P3)

River; Creek

Raven Survey Area

Vegetation Types containing CSF

Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)

Overview Map

Delphine
Mt Farquhar
Raven
Flying Fish
Eliwanna

GDA 1994 MGA Zone 50

Imagery supplied by FMG

Map 4

Aug 2011

Western Hub Flora and Fauna Surveys

Conservation Significant and Introduced Flora

prepared for FORTESCUE METALS GROUP

0 0.5 1 1.5 2 Kilometers

1:30,000 @ A3

Project No. 2668-11

ecoscape

522000 524000 526000 528000 530000

7544000 7542000 7540000 7538000

RAV11R04a RAV11R02a RAV11R03a RAV11R01a RAV11R08 RAV11R09 RAV11R07 RAV11R10 RAV11R11 RAV11R06 RAV11R05 RAV11R04 RAV11R01 RAV11R02 RAV11R03

ElTw CdAaTw ElAmTw2 ElAmTw1 EgAaTe ChAiTw ExAtTt ChAmSf ChSgTe ChAtCp

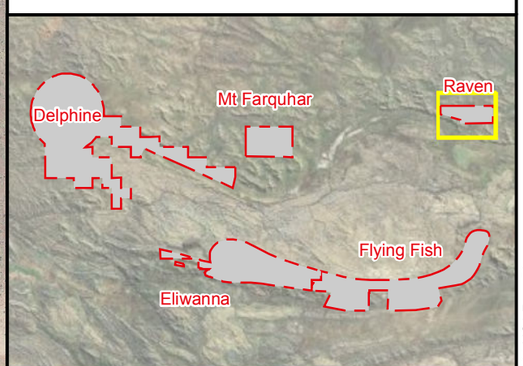
CAVES CREEK

Legend

- Releves
- River; Creek
- Raven Survey Area

Vegetation Type

- CdAaTw: *Corymbia deserticola* subsp. *deserticola, Eucalyptus leucophloia* subsp. *leucophloia* and *C. hamersleyana* open woodland over *Acacia atkinsiana, A. trudgeniana* and *A. exilis* sparse shrubland over *Triodia wiseana* hummock grassland
- ChAiTw: *Corymbia hamersleyana* open woodland over *Acacia inaequilatera, A. elachantha* and *A. ancistrocarpa* open shrubland over *Triodia wiseana* hummock grassland
- ChAmSf: *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia monticola, Senna glutinosa* subsp. *glutinosa* and *Mirbelia viminalis* open shrubland over *Schizachyrium fragile* and *Triodia wiseana* open grassland/hummock grassland
- ChAtCp: *Corymbia hamersleyana* open woodland over *Acacia tumida* var. *pilbarensis, A. pyrifolia* var. *pyrifolia* and *Indigofera* sp. Bungaroo Creek (S. Van Leeuwen 4301) sparse shrubland over *Cymbopogon procerus, Triodia epactia* and *Tephrosia rosea* var. *glabrior* sparse tussock grassland/ hummock grassland/ shrubland
- ChSgTe: *Corymbia hamersleyana* and *Hakea chordophylla* open woodland over *Senna glutinosa* subsp. x *luerssenii, S. artemisioides* subsp. *oligophylla* and *Acacia bivenosa* sparse shrubland over *Triodia epactia* and *Triodia wiseana* hummock grassland
- EgAaTe: *Eucalyptus gamophylla, Corymbia deserticola* subsp. *deserticola* and *Hakea lorea* subsp. *lorea* open mallee woodland/ woodland over *Acacia atkinsiana, Senna glutinosa* subsp. x *luerssenii* and *Acacia bivenosa* sparse shrubland over *Triodia epactia* hummock grassland
- ElAmTw1: *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* open woodland over *Acacia maitlandii* open shrubland over *Triodia wiseana* hummock grassland with *Acacia hilliana* sparse shrubs
- ElAmTw2: *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia maitlandii, A. monticola* and *A. bivenosa* sparse shrubland over *Triodia wiseana* hummock grassland
- ElTw: *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Triodia wiseana* and *Triodia* aff. *melvillei* hummock grassland with *Acacia bivenosa, Acacia maitlandii* and *Senna glutinosa* subsp. *pruinosa* isolated shrubs
- ExAtTt: *Eucalyptus xerothermica* and *Corymbia hamersleyana* woodland over *Acacia tumida* var. *pilbarensis, A. pyrifolia* var. *pyrifolia* and *Gastrolobium grandiflorum* sparse shrubland over *Themeda triandra, Triodia epactia* and *Triodia wiseana* tussock grassland/hummock grassland



Overview Map

GDA 1994 MGA Zone 50

Imagery supplied by FMG

Map 5

Aug 2011

Western Hub Flora and Fauna Surveys

Vegetation Types

prepared for FORTESCUE METALS GROUP

0 0.5 1 1.5 2 Kilometers

1:32,000 @ A3

Project No. 2668-11

ecoscape

522000 524000 526000 528000 530000 532000

7544000
7542000
7540000
7538000

RAV11R04a
RAV11R02a
RAV11R03a
RAV11R08
RAV11R09
RAV11R07
RAV11R10
RAV11R11
RAV11R06
RAV11R01a
RAV11R05
RAV11R04
RAV11R01
RAV11R02
RAV11R03

CAVES CREEK

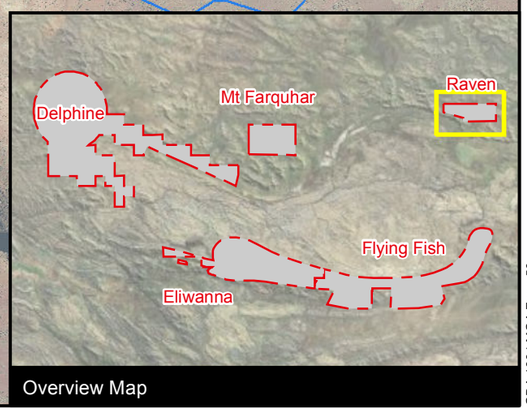
Legend

River; Creek

Raven Survey Area

Releves
Vegetation Condition (Trudgen (1991) Scale)
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded

Mapping
Vegetation Condition (Trudgen (1991) Scale)
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded



GDA 1994 MGA Zone 50

Imagery supplied by FMG

Map 6

Aug 2011

Western Hub Flora and Fauna Surveys

Vegetation Condition

prepared for FORTESCUE METALS GROUP

0 0.5 1 1.5 2 Kilometers

1:30,000 @ A3

Project No. 2668-11

ecoscape

521000 522000 523000 524000 525000 526000 527000 528000 529000 530000 531000

7544000 7543000 7542000 7541000 7540000 7539000 7538000

see Enlargement

Legend

- Trail Camera Location
- Bird Census Point
- Cage Trap Locations
- Search Track
- Raven Study Area
- Northern Quoll Critical Habitat

Fauna Habitat Types

- R1: creekline/drainage lines on lower slopes and valley floors
- R2: open shrubland/open woodland over Spinifex grassland on slopes
- R3: sheltered gorges/gullies
- R4: exposed upper slopes, clifflines and ridges

Enlargement

0 50 100 150 200 250 m

Overview Map

Delphine
Mt Farquhar
Raven
Flying Fish
Eliwanna

GDA 1994 MGA Zone 50

Imagery supplied by FMG

Map 7

Oct 2011

Western Hub Flora and Fauna Surveys

Fauna Habitat Types, Critical Habitats and Locations of Cage Traps, Trail Cameras and Bird Census Points

prepared for Fortescue Metals Group Ltd

0 0.4 0.8 1.2 1.6 Km

1:26,938 @ A3

Project No. 2668-11

ecoscape

Appendix One: Definitions and Criteria

Table 17: *EPBC Act* categories for flora (Australian Government 1999)

EPBC Act Category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish;
	(ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 18: DEC conservation codes for flora and fauna (DEC 2011a)

Conservation Codes for Western Australian Flora and Fauna
T: Schedule 1 under the *Wildlife Conservation Act 1950*
• **Threatened Fauna** (Fauna that is rare or is likely to become extinct) • **Threatened Flora** (Declared Rare Flora – Extant) Taxa* that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X: Schedule 2 under the *Wildlife Conservation Act 1950*
• **Presumed Extinct Fauna** • **Presumed Extinct Flora** (Declared Rare Flora – Extinct) Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
1A: Schedule 3 under the *Wildlife Conservation Act 1950*
• **Birds protected under an international agreement** Birds that are subject to an agreement between governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.
S: Schedule 4 under the *Wildlife Conservation Act 1950*
• **Other specially protected fauna** Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.
Threatened fauna and flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria. **CR:** Critically Endangered – considered to be facing an extremely high risk of extinction in the wild. **EN**: Endangered – considered to be facing a very high risk of extinction in the wild. **VU:** Vulnerable – considered to be facing a high risk of extinction in the wild.
Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora and Priority Fauna Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Taxa that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These taxa require regular monitoring. Conservation Dependent species are placed in Priority 5.
1: Priority One: Poorly-known taxa
Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
2: Priority Two: Poorly-known taxa
Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
3: Priority Three: Poorly-known taxa

Conservation Codes for Western Australian Flora and Fauna
Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4: Priority Four: Rare, Near Threatened and other taxa in need of monitoring
(a) **Rare.** Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. (b) **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5: Priority Five: Conservation Dependent taxa
Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

Table 19: DEC definitions and criteria for TECs and PECs (DEC 2010)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

Criteria	Definition
	B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):

Criteria	Definition
	A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.
Priority Ecological Communities	
Priority One	*Poorly known ecological communities* Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	*Poorly known ecological communities* Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	*Poorly known ecological communities* i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. i. Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. ii. Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened

Criteria	Definition
	within five years.

Table 20: *EPBC Act* categories for TECs (Australian Government 2011b)

EPBC Act Category	Definition
Critically Endangered (CR)	An ecological community that is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	An ecological community that is not critically endangered, and is facing a very high risk of extinction in the wild in the new future.
Vulnerable (VU)	An ecological community that is not critically endangered or endangered, and is facing a high risk of extinction in the medium-term future.

Appendix Two: DEC Database Search Results (Flora)

Table 21: DEC database search results (Flora)

Species	Habit	Flowering	Landform\Soil	Vegetation Type
T				
Lepidium catapycnon	Open, woody perennial, herb or shrub, 0.2-0.3 m high, stems zigzag	Oct	Skeletal soils, hillsides	*Triodia wiseana* hummock grassland. With *Acacia bivenosa, A. inaequilatera, A. pruinocarpa, A. pyrifolia, Triodia* sp. Shovelanna Hill.
Thryptomene wittweri	Spreading or rounded shrub, 0.5–1.5(–2.1) m high	Apr/Jul/ Aug	Skeletal red stony soils. Breakaways, stony creek beds	
P1				
Bothriochloa decipiens var. *cloncurrensis*	-	-	-	-
Calotis squamigera	Procumbent annual, herb, to 0.21 m high	Jul	Pebbly loam	
Eragrostis sp. Mt Robinson (S.van Leeuwen 4109)	Tussock-forming perennial, grass-like or herb, to 0.3 m high	Sep	Red-brown skeletal soils, ironstone. Steep slopes, summits	
Eremophila sp. West Angelas (S. van Leeuwen 4086)	-	-	-	
Eremophila sp. Snowy Mountain (S. van. Leeuwen 3737)	-	-	-	
Eremophila spongiocarpa	Compact, succulent-leaved shrub, to 1 m high	May/Sep	Weakly saline alluvial plain on margins of marsh	
Eucalyptus lucens	Mallee, to 4.5 m high, bark smooth, white, sometimes slightly powdery; leaves glossy green		Ironstone rocky slopes and mountain tops, high in the landscape	
Genus sp. Hamersley Range hilltops (S van Leeuwen 4345)	Rounded shrub, to 0.4 m high	Oct	Skeletal, brown gritty soil over ironstone. Hill summit	Growing in VOSM of *Eucalyptus leucophloia* and *E. gamophylla* over LSB of *Senna pruinosa, Acacia bivenosa, A. maitlandii* and *A. pyrifolia* over ODSD of *A. marramamba* over MDHG of *Triodia* sp.
Sida sp. Hamersley Range (K. Newbey 10692)	-	-	-	n VOSM of *Eucalyptus gamophylla* and *E. xerothermica* with scattered emergent *E. leucophloia* over OLSB of *Acacia pyrifolia* (SVL 4375) and *Hakea lorea* over DHG of *Triodia* sp.
Tetratheca fordiana ms	Dwarf shrub, 0.3–0.4 m high	-	Shale pocket amongst ironstone	
Teucrium pilbaranum	Rounded shrub, to 0.4 m high	May/Sep	Clay. Crab hole plain in a river floodplain, margin of calcrete table	*Chrysopogon fallax* tussock grassland, Open woodland of *Eucalyptus victrix*, with a tussock grass understorey of *Eriachne benthamii*
Vittadinia sp. Coondewanna Flats (s. van Leeuwen 4684)	Tall daisy to 1 m , open canopy, in late flower and dehiscing fruit, cream/white flowers.	May/Sep	Clay loam soils	*Acacia* thicket over mixed grassland. Species dominating in area include: *Acacia aneura, Eucalyptus ?xerothermica, Themeda ?triandra*.

Species	Habit	Flowering	Landform\Soil	Vegetation Type
P2				
Adiantum capillus-veneris	Rhizomatous, perennial, herb (fern), 0.1-0.2 m high	-	Moist, sheltered sites in gorges and on cliff walls	
Cladium procerum	Densely tufted perennial, grass-like or herb (sedge), 2 m high	Nov	Perennial pools	
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	Low shrub 0.5 m tall with red or pinky flowers with long exerted stamens	May-Jul	Stony soil, slopes	
Oxalis sp. Pilbara (M.E. Trudgen 12725)	Small herb to 10 cm tall. Leaves green above, purple below	-	Red-brown pebbly/rocky loam amongst boulders	
Paspalidium retiglume	Tufted annual, grass-like or herb, 0.1–0.5 m high	Apr	Clay	
Pilbara trudgenii	Gnarled, aromatic shrub, to 1 m high	Sep.	Skeletal, red stony soil over ironstone. Hill summits, steep slopes, screes, cliff faces.	
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	Shrub, to 1 m high	Jul-Aug.	Skeletal, brown gritty soil over basalt. Summits of hills, steep hills	Growing in VOSM of *Eucalyptus kingsmillii* and *Eucalyptus* aff. *hamersleyana* over LSA of Acacia *hamersleyensis* over OLSD of *Ptilotus rotundifolius* over DHG of *Triodia* sp. (SVL 2476).
Spartothamnella puberula	Shrub, 0.35–1.5 m high	Sep-Nov	Rocky loam, sandy or skeletal soils, clay. Sandplains, hills	*Corymbia ferriticola* low woodland over *Petalostylis labicheoides* and *Acacia aneura* tall open shrubland over *Triodia pungens* and *T.* sp. Mt Ella hummock grassland and *Themeda triandra* open tussock grassland.
Vigna sp. central (M.E. Trudgen 1626)	50 m high x 50 m wide.	-	Sandy plain, Plain with thin sheet of sand (light orange / brown) over compacted hardpan and limestone rock, Claypan of fine cracking clays. Basalt hills in the immediate distance.	*Triodia epactia* hummock grassland over *Cenchrus ciliaris* very open tussock grassland, *Indigofera colutea / Vigna* sp Central / *Rhynchosia minima* low open shrubland. *Eucalyptus camaldulensis* and *Cenchrus ciliaris* association.
P3				
Acacia daweana	Spreading shrub, 0.3–1.5(–2) m high	Jul-Sep	Stony red loamy soils. Low rocky rises, along drainage lines	
Acacia subtiliformis	Spindly, slender, erect shrub, to 3.5 m high	Jun	On rocky calcrete plateau	
Calotis latiuscula	Erect herb, to 0.5 m high	Jun-Oct	Sand, loam. Rocky hillsides, floodplains, rocky creeks or river beds	
Dampiera anonyma ms	Multistemmed perennial, herb, to 0.5(-1) m high	Jun-Sep	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite. Hill summits, upper slopes	

Species	Habit	Flowering	Landform\Soil	Vegetation Type
Dampiera metallorum ms	Rounded, multistemmed perennial, herb, to 0.5 m high	Apr-Oct	Skeletal red-brown gravely soils over banded ironstone. Steep slopes and summits	
Eragrostis crateriformis	Annual, grass-like or herb, 0.17–0.42 m high	Jan-Jul	Clayey loam or clay. Creek banks, depressions	
Eragrostis surreyana	Tufted annual herb 5-8 (-13) cm high	May-Sep	Drainage line, red-brown clay	
Eremophila forrestii subsp. *viridis*	Much-branched shrub, ca 1 m high	Aug	Sandplain	
Eremophila magnifica subsp. *velutina*	Shrub, 0.5–1.5 m high	Aug-Sep	Skeletal soils over ironstone. Summits	
Fimbristylis sieberiana	Shortly rhizomatous, tufted perennial, grass-like or herb (sedge), 0.25–0.6 m high	May-Jun	Mud, skeletal soil pockets. Pool edges, sandstone cliffs	
Geijera salicifolia	Tree, 1.5–6 m high	Sep	Skeletal soils, stony soils. Massive rock scree, gorges	
Glycine falcata	Mat-forming perennial, herb, to 0.2 m high.Fl. blue, purple	May-Jul	Floodplains. Black clayey sand. Along drainage depressions in crabhole plains on river	
Gymnanthera cunninghamii	Erect shrub 1-2 m high	Jan-Dec	Sandy soils	
Indigofera gilesii subsp. *gilesii*	Shrub, to 1.5 m high	May/Aug	Pebbly loam amongst boulders & outcrops, hills	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Erect shrub to 2.3 m high, red-pink flowers	Jul-Oct	Creeks and gorges	
Iotasperma sessilifolium	Erect herb. Fl. pink.	-	Cracking clay, black loam. Edges of waterholes, plains	
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading annual, herb, 0.05–0.1 m high	Mar.	Cracking clay, basalt. Gently undulating plain with large surface rocks, flat crabholed plain	
Olearia mucronata	Densely branched, unpleasantly aromatic shrub, 0.6–1 m high. Fl. white, yellow	Aug-Jan	Schistose hills, along drainage channels	
Phyllanthus aridus	Erect, much-branched shrub, to 0.25 m high. Fl. cream, green	May–Jun	Sandstone, gravel, red sand	
Ptilotus subspinescens	Compact shrub, to 0.8 m high. Fl. pink, bases of screes	Sep–Oct	Gentle rocky slopes, screes and the bases of screes	
Rhagodia sp. Hamersley (M. Trudgen 17794)	Erect shrub	-	Floodplain / lower slopes	
Rostellularia adscendens var. *latifolia*	Herb or shrub, 0.1–0.3 m high	Apr-May	Ironstone soils. Near creeks, rocky hills	
Sida sp. Barlee Range (S van Leeuwen 1642)	Spreading shrub, to 0.5 m high	Aug	Skeletal red soils pockets. Steep slope	
Swainsona sp. Hamersley Station (A.A. Mitchell 196)	Prostrate annual, herb, to 0.1 m high	Mat	Flat crabholed plain.	Open *Eremophila maculata* shrubland over moderately dense herbs. Tussock grassland of *Astrebla pectinata*.

Species	Habit	Flowering	Landform\Soil	Vegetation Type
Triodia sp. Mt. Ella (ME Trudgen 12739)	Perennial, grass-like or herb, 0.4 m high	-	Light orange-brown, pebbly loam. Amongst rocks & outcrops, gully slopes	
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	Perennial hummock grass to 0.6 m high	-	Rocky hills and mesas	
P4				
Acacia bromilowiana	Tree or shrub, to 12 m high	Jul-Aug	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds	
Eremophila magnifica subsp. *magnifica*	Shrub, 0.5-1.5 m high	Aug-Nov	Skeletal soils over ironstone. Rocky screes	
Livistona alfredii	Tree-like monocot (palm) to 10 m high	Jun-Sep	Edges of permanent pools	
Rhynchosia bungarensis	Compact, prostrate shrub, to 0.5 m high	-	Pebbly, coarse sand, banks of flow line	

Appendix Three: EPBC Protected Matters Search Results

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

EPBC Act Protected Matters Report: Coordinates

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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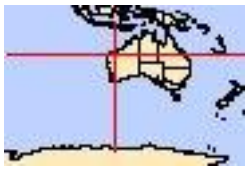

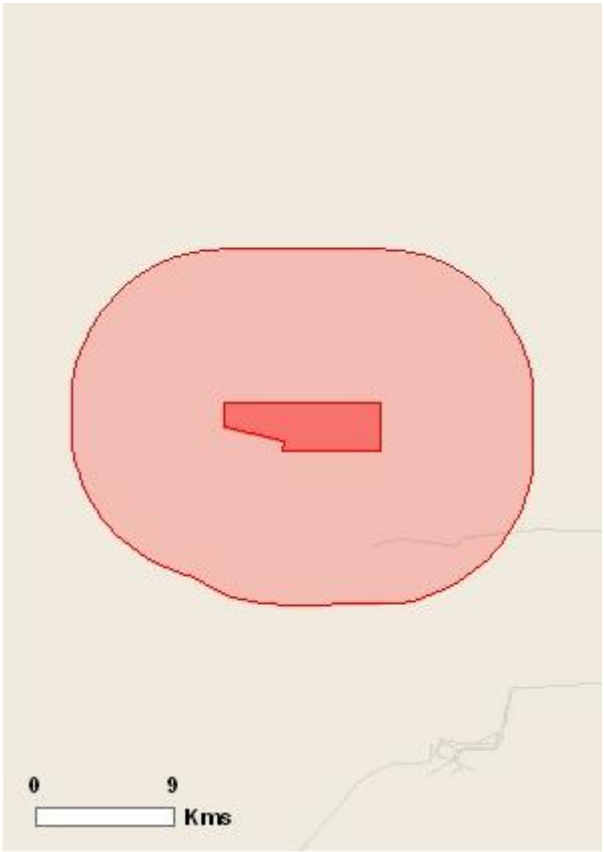

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 10.0Km

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance (Ramsar Wetlands):	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communitites:	None
Threatened Species:	4
Migratory Species:	8

Other Matters Protected by the EPBC Act

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

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

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	6
Whales and Other Cetaceans:	None

Critical Habitats:	None
Commonwealth Reserves:	None

Report Summary for Extra Information

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

Place on the RNE:	None
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	5
Nationally Important Wetlands:	None

Details

Matters of National Environmental Significance

Threatened Species		**[Resource Information]**
Name	Status	Type of Presence
MAMMALS		
Dasyurus hallucatus		
Northern Quoll [331]	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat likely to occur within area
PLANTS		
Lepidium catapycnon		
Hamersley Lepidium, Hamersley Catapycnon [9397]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
Liasis olivaceus barroni		
Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat may occur within area

Migratory Species		**[Resource Information]**
Name	Status	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus		

Rainbow Bee-eater [670]	Species or species habitat may occur within area
Migratory Wetlands Species	
Ardea alba	
Great Egret, White Egret [59541]	Species or species habitat may occur within area
Ardea ibis	
Cattle Egret [59542]	Species or species habitat may occur within area
Charadrius veredus	
Oriental Plover, Oriental Dotterel [882]	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

Name	Status	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat may occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area

Prosopis spp.
Mesquite, Algaroba [68407] Species or species habitat may occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:
- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:
- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:
- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

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

Coordinates

-22.216667 117.208246,-22.216667 117.3,-22.244655 117.3,-22.245002 117.24165,-22.239171 117.243328,-22.230401 117.208107,-22.216667 117.208246

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the

following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

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

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

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Appendix Four: NatureMap Fauna Search

NatureMap Species Report

Created By bruce turner on 30/06/2011

Kingdom Animalia
Current Names Only Yes
Species Group All Animals
Method 'By Polygon'

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill (Inland Thornbill))*			
3.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
4.	25332	*Acanthophis wellsi (Pilbara Death Adder)*			
5.	25536	*Accipiter fasciatus (Brown Goshawk)*			
6.	24283	*Accipiter fasciatus subsp. didimus*			
7.	30833	*Amphibolurus longirostris*			
8.	24539	*Amytornis striatus subsp. striatus*		P4	
9.	24540	*Amytornis striatus subsp. whitei*			
10.	25448	*Antaresia stimsoni (Stimson's Python)*			
11.	24285	*Aquila audax (Wedge-tailed Eagle)*			
12.	24341	*Ardea pacifica (White-necked Heron)*			
13.	24610	*Ardeotis australis (Australian Bustard)*		P4	
14.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
15.	24352	*Artamus cinereus subsp. melanops*			
16.	24355	*Artamus minor (Little Woodswallow)*			
17.	24356	*Artamus personatus (Masked Woodswallow)*			
18.	25331	*Brachyurophis approximans*			
19.	24359	*Burhinus grallarius (Bush Stone-curlew)*		P4	
20.	25715	*Cacatua roseicapilla (Galah)*			
21.	24726	*Cacatua roseicapilla subsp. roseicapilla*			
22.	25716	*Cacatua sanguinea (Little Corella)*			
23.	24039	*Canis lupus subsp. dingo (Dingo)*	Y		
24.	25015	*Carlia munda*			
25.	24181	*Chaerephon jobensis (Northern Freetail-bat)*			
26.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
27.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
28.	24833	*Cincloramphus cruralis (Brown Songlark)*			
29.	24834	*Cincloramphus mathewsi (Rufous Songlark)*			
30.	24395	*Climacteris melanura subsp. wellsi*			
31.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
32.	24611	*Colluricincla harmonica subsp. brunnea*			
33.	24613	*Colluricincla harmonica subsp. rufiventris*			
34.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
35.	24362	*Coracina novaehollandiae subsp. novaehollandiae*			
36.	24363	*Coracina novaehollandiae subsp. subpallida*			
37.	24416	*Corvus bennetti (Little Crow)*			
38.	25593	*Corvus orru (Torresian Crow)*			
39.	24418	*Corvus orru subsp. cecilae (Western Crow)*			
40.	25701	*Coturnix ypsilophora (Brown Quail)*			
41.	24672	*Coturnix ypsilophora subsp. cervina*			
42.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
43.	25595	*Cracticus tibicen (Australian Magpie)*			
44.	24423	*Cracticus tibicen subsp. tibicen (Black-backed Magpie)*			
45.	25596	*Cracticus torquatus (Grey Butcherbird)*			
46.	30893	*Cryptoblepharus buchananii*			
47.	30892	*Cryptoblepharus ustulatus*			
48.	24865	*Ctenophorus caudicinctus subsp. caudicinctus*			
49.	24874	*Ctenophorus isolepis subsp. citrinus*			
50.	24876	*Ctenophorus isolepis subsp. isolepis*			
51.	24889	*Ctenophorus scutulatus*			
52.	25036	*Ctenotus duricola*			
53.	25041	*Ctenotus grandis subsp. grandis*			
54.	25043	*Ctenotus grandis subsp. titan*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
55.	25045	*Ctenotus helenae*			
56.	25054	*Ctenotus mimetes*			
57.	25060	*Ctenotus pantherinus subsp. acripes*			
58.	25064	*Ctenotus pantherinus subsp. ocellifer*			
59.	25070	*Ctenotus robustus*			
60.	25072	*Ctenotus rubicundus*			
61.	25071	*Ctenotus rutilans*			
62.	25073	*Ctenotus saxatilis (Rock Ctenotus)*			
63.	25074	*Ctenotus schomburgkii*			
64.	25075	*Ctenotus severus*			
65.	24435	*Cuculus pallidus (Pallid Cuckoo)*			
66.	25090	*Cyclodomorphus melanops subsp. melanops*			
67.	25375	*Cyclorana maini (Sheep Frog)*			
68.	25547	*Dacelo leachii (Blue-winged Kookaburra)*			
69.	24998	*Delma elegans*			
70.	25001	*Delma nasuta*			
71.	25002	*Delma pax*			
72.	25004	*Delma tincta*			
73.	25295	*Demansia psammophis subsp. cupreiceps*			
74.	25297	*Demansia rufescens (Rufous Whipsnake)*			
75.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
76.	24441	*Dicaeum hirundinaceum subsp. hirundinaceum*			
77.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
78.	24944	*Diplodactylus savagei*			
79.	24899	*Diporiphora valens*			
80.	25094	*Egernia formosa*			
81.	24631	*Emblema pictum (Painted Finch)*			
82.	24570	*Epthianura tricolor (Crimson Chat)*			
83.	24257	*Equus asinus (Donkey)*	Y		
84.	25109	*Eremiascincus richardsonii (Broad-banded Sand Swimmer)*			
85.	24837	*Eremiornis carteri (Spinifex-bird)*			
86.	24368	*Eurostopodus argus (Spotted Nightjar)*			
87.	25621	*Falco berigora (Brown Falcon)*			
88.	24471	*Falco berigora subsp. berigora*			
89.	25622	*Falco cenchroides (Australian Kestrel)*			
90.	24472	*Falco cenchroides subsp. cenchroides*			
91.	24474	*Falco longipennis subsp. longipennis*			
92.	24041	*Felis catus (Cat)*	Y		
93.	24956	*Gehyra pilbara*			
94.	24958	*Gehyra punctata*			
95.	24959	*Gehyra variegata*			
96.	24401	*Geopelia cuneata (Diamond Dove)*			
97.	25585	*Geopelia striata (Peaceful Dove)*			
98.	24403	*Geopelia striata subsp. placida*			
99.	24404	*Geophaps plumifera (Spinifex Pigeon)*			
100.	25530	*Gerygone fusca (Western Gerygone)*			
101.	24271	*Gerygone fusca subsp. fusca*			
102.	24443	*Grallina cyanoleuca (Magpie-lark)*			
103.	24296	*Hamirostra isura (Square-tailed Kite)*			
104.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
105.	24962	*Heteronotia spelea (Desert Cave Gecko)*			
106.	24492	*Hirundo nigricans subsp. nigricans*			
107.	24572	*Lacustroica whitei (Grey Honeyeater)*			
108.	24367	*Lalage tricolor (White-winged Triller)*			
109.	24217	*Leggadina lakedownensis (Short-tailed Mouse)*		P4	
110.	25135	*Lerista flammicauda*			
111.	25155	*Lerista muelleri*			
112.	25005	*Lialis burtonis*			
113.	24575	*Lichenostomus keartlandi (Grey-headed Honeyeater)*			
114.	24578	*Lichenostomus penicillatus (White-plumed Honeyeater)*			
115.	24581	*Lichenostomus virescens (Singing Honeyeater)*			
116.	25661	*Lichmera indistincta (Brown Honeyeater)*			
117.	24582	*Lichmera indistincta subsp. indistincta*			
118.	30933	*Lucasium stenodactylum*			
119.	30934	*Lucasium wombeyi*			
120.	24180	*Macroderma gigas (Ghost Bat)*		P4	
121.	25489	*Macropus robustus*			
122.	24135	*Macropus robustus subsp. erubescens (Euro, Biggada)*			
123.	24136	*Macropus rufus (Red Kangaroo, Marlu)*			
124.	25651	*Malurus lamberti (Variegated Fairy-wren)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
125.	24544	*Malurus lamberti subsp. assimilis*			
126.	24548	*Malurus leucopterus subsp. leucopterus*		T	
127.	24583	*Manorina flavigula (Yellow-throated Miner)*			
128.	24736	*Melopsittacus undulatus (Budgerigar)*			
129.	25184	*Menetia greyii*			
130.	25187	*Menetia surda subsp. surda*			
131.	24598	*Merops ornatus (Rainbow Bee-eater)*			
132.	24302	*Mirafra javanica subsp. horsfieldii*			
133.	25193	*Morethia ruficauda subsp. exquisita*			
134.	24182	*Mormopterus beccarii (Beccari's Freetail-bat)*			
135.	24223	*Mus musculus (House Mouse)*	Y		
136.	24972	*Nephrurus wheeleri subsp. cinctus*			
137.	24095	*Ningaui timealeyi (Pilbara Ningaui)*			
138.	24819	*Ninox connivens subsp. connivens (Barking Owl)*			
139.	25196	*Notoscincus butleri*		P4	
140.	25197	*Notoscincus ornatus subsp. ornatus*			
141.	24742	*Nymphicus hollandicus (Cockatiel)*			
142.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
143.	24976	*Oedura marmorata (Marbled Velvet Gecko)*			
144.	24618	*Oreoica gutturalis (Crested Bellbird)*			
145.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
146.	24624	*Pachycephala rufiventris subsp. rufiventris*			
147.	24627	*Pardalotus rubricatus (Red-browed Pardalote)*			
148.	25682	*Pardalotus striatus (Striated Pardalote)*			
149.	24629	*Pardalotus striatus subsp. uropygialis*			
150.	24658	*Petroica cucullata (Hooded Robin)*			
151.	24409	*Phaps chalcoptera (Common Bronzewing)*			
152.	24101	*Planigale ingrami (Long-tailed Planigale)*			
153.	25721	*Platycercus zonarius (Australian Ringneck (Ring-necked Parrot))*			
154.	24751	*Platycercus zonarius subsp. zonarius*			
155.	24905	*Pogona minor subsp. minima (Dwarf Bearded Dragon)*		T	
156.	24907	*Pogona minor subsp. minor*			
157.	25706	*Pomatostomus temporalis (Grey-crowned Babbler)*			
158.	24684	*Pomatostomus temporalis subsp. rubeculus*			
159.	24106	*Pseudantechinus woolleyae (Woolley's Pseudantechinus)*			
160.	25261	*Pseudechis australis (Mulga Snake)*			
161.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse)*		P4	
162.	24235	*Pseudomys desertor (Desert Mouse)*			
163.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
164.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
165.	25432	*Pseudophryne douglasi (Gorge Toadlet)*			
166.	24757	*Ptilonorhynchus maculatus subsp. guttatus (Western Bowerbird)*			
167.	25009	*Pygopus nigriceps*			
168.	25277	*Ramphotyphlops grypus*			
169.	25279	*Ramphotyphlops hamatus*			
170.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
171.	24454	*Rhipidura leucophrys subsp. leucophrys*			
172.	24982	*Rhynchoedura ornata (Beaked Gecko)*			
173.	24200	*Scotorepens greyii (Little Broad-nosed Bat)*			
174.	30948	*Smicrornis brevirostris (Weebill)*			
175.	24115	*Sminthopsis longicaudata (Long-tailed Dunnart)*		P4	
176.	24116	*Sminthopsis macroura (Stripe-faced Dunnart)*			
177.	24556	*Stipiturus ruficeps subsp. ruficeps*			
178.	24927	*Strophurus elderi*			
179.	24949	*Strophurus wellingtonae*			
180.	25307	*Suta punctata (Spotted Snake)*			
181.	24207	*Tachyglossus aculeatus (Echidna)*			
182.	30870	*Taeniopygia guttata (Zebra Finch)*			
183.	30871	*Taeniopygia guttata subsp. castanotis*			
184.	24175	*Taphozous georgianus (Common Sheathtail-bat)*			
185.	24176	*Taphozous hilli (Hill's Sheathtail-bat)*			
186.	25202	*Tiliqua multifasciata (Central Blue-tongue)*			
187.	24308	*Todiramphus pyrrhopygia (Red-backed Kingfisher)*			
188.	24851	*Turnix velox (Little Button-quail)*			
189.	30814	*Tympanocryptis cephalus (Pebble Dragon)*			
190.	25445	*Uperoleia russelli (Northwest Toadlet)*			
191.	25209	*Varanus acanthurus (Spiny-tailed Monitor)*			
192.	25210	*Varanus brevicauda (Short-tailed Pygmy Monitor)*			
193.	30825	*Varanus bushi (Pilbara Mulga Monitor)*			
194.	25212	*Varanus eremius (Pygmy Desert Monitor)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
195.	25224	*Varanus pilbarensis (Pilbara Rock Monitor)*			
196.	25227	*Varanus tristis subsp. tristis (Racehorse Monitor)*			
197.	25311	*Vermicella snelli*			
198.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			
199.	24248	*Zyzomys argurus (Common Rock-rat)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix Five: Relevé Data

Site	RAV11R01a	
Described by	LA	12/7/2011
MGA Zone	GDA94 50	521686mE 7541603mN
Landform	Moderate NE facing mid slope	
Soil	Red brown clay loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* open woodland over *Triodia wiseana* hummock grassland with *Acacia hilliana* and *Eriachne* sp. sparse shrubs and tussock grasses.	
Vegetation Condition	Very good	
Notes		
Photo		

Site	RAV11R02a	
Described by	LA	12/7/2011
MGA Zone	GDA94 50	522864mE 75112988mN
Landform	Very gentle north facing lower slope	
Soil	Red brown	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia bivenosa*, *Acacia maitlandii* and *Senna glutinosa* subsp. *pruinosa* isolated shrubs over *Triodia wiseana* and *Triodia* aff. *melvillei* hummock grassland.	
Vegetation Condition	Very good	
Notes		

Site	RAV11R02a
Photo	

Site	RAV11R03a	
Described by	LA	12/7/2011
MGA Zone	GDA94 50	522850mE 7542606mN
Landform	Moderate north facing lower slope	
Soil	Red brown clay loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia bivenosa*, *Ptilotus calostachyus* and *Senna symonii* sparse shrubland over *Triodia wiseana* hummock grassland with *Cymbopogon ambiguus*, *Eriachne* sp. and *Oldenlandia crouchiana* sparse tussock grasses and herbs.	
Vegetation Condition	Very good	
Notes	Includes slopes with dominant *Acacia monticola* in middle stratum	
Photo		

Site	RAV11R04a	
Described by	LA	12/7/2011
MGA Zone	GDA94 50	521696mE 7543049mN
Landform	Valley floor, flat	
Soil	Red brown	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. leucophloia, *Corymbia deserticola* subsp. *deserticola* and *Corymbia hamersleyana* open woodland over *Acacia bivenosa*, *A. tumida* subsp. *pilbarensis*, *A.*	

Site	RAV11R04a	
	tenuissima and *A. atkinsiana* sparse shrubland over *Triodia wiseana* hummock grassland.	
Vegetation Condition	Very good	
Notes		
Photo		
Site		
Described by	SK	20/7/2011
MGA Zone	GDA94 50	530283mE 7540452mN
Landform	Slightly undulating valley floor	
Soil	Red brown sandy loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus gamophylla*, *Corymbia hamersleyana* and *E. leucophloia* subsp. *leucophloia* open mallee woodland/ woodland over *Acacia bivenosa* and *A. exilis* sparse shrubland over *Triodia wiseana*, *T. epactia* hummock grassland with *Eriachne pulchella* subsp. *dominii* sparse tussock grasses.	
Vegetation Condition	Very good	
Notes	Forms a mosaic with *Corymbia hamersleyana* dominated vegetation	
Photo		

Site	RAV11R02	
Described by	SK	20/7/2011
MGA Zone	GDA94 50	530170mE 7540360mN
Landform	Valley floor	
Soil	Red brown loam	
Rock Type	Ironstone	

Site	RAV11R02	
Vegetation Description	*Corymbia hamersleyana* and *Hakea chordophylla* open woodland over *Senna artemisioides* subsp. *oligophylla*, *Acacia bivenosa* and *S. glutinosa* subsp. *x luerssenii* sparse shrubland over *Triodia epactia* and *T. wiseana* hummock grassland with *Aristida contorta*, *Schizachyrium fragile* and *Eriachne pulchella* subsp. *dominii* sparse tussock grasses.	
Vegetation Condition	Very good	
Notes		
Photo		
Site		
Described by	SK	20/7/2011
MGA Zone	GDA94 50	530085mE 7540296mN
Landform	Drainage line	
Soil	Red brown loam	
Rock Type	Ironstone	
Vegetation Description	*Corymbia hamersleyana* open woodland over *Acacia tumida* var. *pilbarensis*, *A. pyrifolia* var. *pyrifolia* and *Indigofera* sp. Bungaroo Creek (S. Van Leeuwen 4301) sparse shrubland over *Cymbopogon procerus*, *Triodia epactia*, *Tephrosia rosea* var. *glabrior* and *Themeda triandra* sparse grassland/ shrubland.	
Vegetation Condition	Very good	
Notes		
Photo		

Site	RAV11R04	
Described by	SK	20/7/2011
MGA Zone	GDA94 50	529602mE 7540359mN

Site	RAV11R04		
Landform	Moderate north facing lower slope		
Soil	Red brown sandy loam		
Rock Type	Ironstone		
Vegetation Description	*Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia monticola*, *Senna glutinosa* subsp. *glutinosa*, *Mirbelia viminalis* and *Clerodendrum floribundum* var. *angustifolium* open shrubland over *Schizachyrium fragile* and *Triodia wiseana* open grassland.		
Vegetation Condition	Very good		
Notes			
Photo			
Site			
Described by	SK	20/7/2011	
MGA Zone	GDA94 50	529292mE	7540671mN
Landform	Valley floor, flat		
Soil	Red brown loam		
Rock Type	Ironstone		
Vegetation Description	*Eucalyptus gamophylla*, *Corymbia deserticola* subsp. *deserticola* and *Hakea lorea* subsp. *lorea* open mallee woodland/ woodland over *Acacia atkinsiana*, *Senna glutinosa* subsp. *x luerssenii*, *Acacia bivenosa* and *A. ancistrocarpa* sparse shrubland over *Triodia epactia* hummock grassland.		
Vegetation Condition	Very good		
Notes			
Photo			

Site	RAV11R06	
Described by	SK	20/7/2011
MGA Zone	GDA94 50	528981mE 7541483mN
Landform	Very gentle SW facing lower slope	
Soil	Red brown loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia*, *Corymbia hamersleyana* and *C. ferriticola* open woodland over *Acacia maitlandii* and *A. monticola* sparse shrubland over *Triodia wiseana* hummock grassland with *Eriachne ciliata* and *Schizachyrium fragile* sparse tussock grasses.	
Vegetation Condition	Excellent	
Notes		
Photo		
Site		
Described by	SK	20/7/2011
MGA Zone	GDA94 50	527420mE 7541789mN
Landform	Gentle east facing lower slope	
Soil	Red brown loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* open woodland over *Acacia maitlandii* open shrubland over *Triodia wiseana* hummock grassland with *Acacia hilliana*, *Keraudrenia nephrosperma*, *Eriachne pulchella* subsp. *dominii* and *Schizachyrium fragile* sparse shrubs and tussock grasses.	
Vegetation Condition	Very good	
Notes		
Photo		

Site	RAV11R08	
Described by	SK	20/7/2011
MGA Zone	GDA94 50	526648mE 7542843mN
Landform	Very gentle sloping valley floor	
Soil	Red brown loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia*, *Corymbia deserticola* subsp. *deserticola* and *C. hamersleyana* open woodland over *Acacia trudgeniana, A. exilis, A. atkinsiana* and *Senna glutinosa* subsp. *glutinosa* sparse shrubland over *Triodia wiseana* hummock grassland with *Schizachyrium fragile*, *Fimbristylis simulans* and *Eriachne pulchella* subsp. *dominii* sparse tussock grasses and sedges.	
Vegetation Condition	Very good	
Notes		
Photo		
Site		
Described by	SK	20/7/2011
MGA Zone	GDA94 50	527404mE 7542473mN
Landform	Gentle SE facing upper slope	
Soil	Red brown rocky loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Acacia maitlandii* and *A. inaequilatera* sparse shrubland over *Triodia wiseana* hummock grassland with *Schizachyrium fragile* and *Eriachne mucronata* and *Eriachne pulchella* subsp. *dominii* sparse tussock grasses.	
Vegetation Condition	Excellent	
Notes		

Site	RAV11R08
Photo	

Site	RAV11R10	
Described by	SK	20/7/2011
MGA Zone	GDA94 50	527664mE 7541704mN
Landform	Drainage line	
Soil	Red brown clay loam	
Rock Type	Ironstone	
Vegetation Description	*Eucalyptus xerothermica* and *Corymbia hamersleyana* woodland over *Acacia tumida* var. *pilbarensis*, *A. pyrifolia* var. *pyrifolia* and *Gastrolobium grandiflorum* sparse shrubland over *Themeda triandra*, *Triodia epactia*, *Triodia wiseana* and *Digitaria brownii* grassland.	
Vegetation Condition	Good	
Notes		
Photo		
Site		
Described by	SK	20/7/2011
MGA Zone	GDA94 50	527863mE 7541704mN
Landform	Valley floor, flat	
Soil	Red brown loam	
Rock Type	Ironstone	
Vegetation Description	*Corymbia hamersleyana* open woodland over *Acacia inaequilatera*, *Acacia elachantha*, *A. ancistrocarpa* and *A. cowleana* open shrubland over *Triodia wiseana* hummock grassland.	
Vegetation Condition	Very good	
Notes		

Site	RAV11R10
Photo	

Appendix Six: Threatened and Priority Flora Report Forms

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Threatened and Priority Flora Report Form

Version 1.0 January 2010

Please complete as much of the form as possible, with emphasis on those sections bordered in black.

TAXON: Goodenia nuda **TPFL Pop. No:**

OBSERVATION DATE: 20/7/2011 **CONSERVATION STATUS:** P4 New population ☒

OBSERVER/S: S. Kern, R. Daniel **PHONE:** 94308955

ROLE: Botanists **ORGANISATION:** Ecoscape

DESCRIPTION OF LOCATION (Provide at least nearest town/named locality, and the distance and direction to that place):

Raven project area, Approximately 70km NW of Tom Price

Reserve No:

DEC DISTRICT: Pilbara **LGA:** Shire of Ashburton Land manager present: ☐

DATUM: GDA94 / MGA94 ☐ AGD84 / AMG84 ☐ WGS84 ☒ Unknown ☐

COORDINATES: (If UTM coords provided, **Zone** is also required) DecDegrees ☐ DegMinSec ☐ UTMs ☒

Lat / Northing: 7540360

Long / Easting: 530170

ZONE: 50

METHOD USED: GPS ☒ Differential GPS ☐ Map ☐

No. satellites: _____ Map used: _____

Boundary polygon captured: ☐ Map scale: _____

LAND TENURE:

Nature reserve ☐	Timber reserve ☐	Private property ☐	Rail reserve ☐	Shire road reserve ☐
National park ☐	State forest ☐	Pastoral lease ☒	MRWA road reserve ☐	Other Crown reserve ☐
Conservation park ☐	Water reserve ☐	UCL ☐	SLK/Pole _____ to _____	Specify other: Exploration Lease

AREA ASSESSMENT: Edge survey ☐ Partial survey ☒ Full survey ☐ Area observed (m²): _____

EFFORT: Time spent surveying (minutes): _____ No. of minutes spent / 100 m²: _____

POP'N COUNT ACCURACY: Actual ☐ Extrapolation ☐ Estimate ☒ Count method: _____ (Refer to field manual for list)

WHAT COUNTED: Plants ☒ Clumps ☐ Clonal stems ☐

TOTAL POP'N STRUCTURE:	**Mature:**	**Juveniles:**	**Seedlings:**	**Totals:**
Alive	2			
Dead				

Area of pop (m²): _____

Note: Pls record count as numbers (not percentages) for database.

QUADRATS PRESENT: No. _____ Size _____ Data attached ☐ Total area of quadrats (m²): _____

Summary Quad. Totals: Alive				

REPRODUCTIVE STATE: Clonal ☐ Vegetative ☐ Flowerbud ☐ Flower ☑

Immature fruit ☐ Fruit ☐ Dehisced fruit ☐ Percentage in flower: 100 %

CONDITION OF PLANTS: Healthy ☒ Moderate ☐ Poor ☐ Senescent ☐

COMMENT: herb, yellow flowers

THREATS - type, agent and supporting information: Eg clearing, too frequent fire, weed, disease. Refer to field manual for list of threats & agents. **Specify agent** where relevant. Rate current and potential threat impact: N=Nil, L=Low, M=Medium, H=High, E=Extreme Estimate time to potential impact: S=Short (<12mths), M=Medium (<5yrs), L=Long (5yrs+)	**Current impact (N-E)**	**Potential Impact (L-E)**	**Potential Threat Onset (S-L)**
• Clearing	N	H	M
•			
•			

Please return completed form to DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **Administrative Officer, Flora,** Species and Communities Branch.

Record entered by:_____ **Sheet No.:**_____ **Record Entered in Database** ☐

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Threatened and Priority Flora Report Form

Version 1.0 January 2010

HABITAT INFORMATION:

LANDFORM:
- Crest ☐
- Hill ☐
- Ridge ☐
- Outcrop ☐
- Slope ☐
- Flat ☑
- Open depression ☐
- Drainage line ☐
- Closed depression ☐
- Wetland ☐

ROCK TYPE:
- Granite ☐
- Dolerite ☐
- Laterite ☐
- Ironstone ☑
- Limestone ☐
- Quartz ☐

Specify other: _____

LOOSE ROCK: (on soil surface; eg gravel, quartz fields)
- 0-10% ☐
- 10-30% ☐
- 30-50% ☑
- 50-100% ☐

SOIL TYPE:
- Sand ☐
- Sandy loam ☐
- Loam ☑
- Clay loam ☐
- Light clay ☐
- Peat ☐

Specify other: _____

SOIL COLOUR:
- Red ☑
- Brown ☑
- Yellow ☐
- White ☐
- Grey ☐
- Black ☐

Specify other: _____

DRAINAGE:
- Well drained ☑
- Seasonally inundated ☐
- Permanently inundated ☐
- Tidal ☐

Specific **Landform** Element: _____
(Refer to field manual for additional values)

CONDITION OF SOIL: Dry ☑ Moist ☐ Waterlogged ☐ Inundated ☐

VEGETATION CLASSIFICATION*:

Eg: **1.** Banksia woodland (B. attenuata, B. ilicifolia); **2.** Open shrubland (Hibbertia sp., Acacia spp.) ; **3.** Isolated clumps of sedges (Mesomelaena tetragona)

1. _____
2. _____
3. _____
4. _____

ASSOCIATED SPECIES: _____

Other (non-dominant) spp _____

* Please record up to four of the most representative vegetation layers (with up to three dominant species in each layer). Structural Formations should follow 2009 *Australian Soil and Land Survey Field Handbook* guidelines – refer to field manual for further information and structural formation table.

CONDITION OF HABITAT: Pristine ☐ Excellent ☐ Very good ☑ Good ☐ Degraded ☐ Completely degraded ☐

COMMENT: _____

FIRE HISTORY: **Last Fire:** Season/Month: _____ Year: _____ **Fire Intensity:** High ☐ Medium ☐ Low ☐ No signs of fire ☐

FENCING: Not required ☐ Present ☐ Replace / repair ☐ Required ☐ Length req'd: _____

ROADSIDE MARKERS: Not required ☒ Present ☐ Replace / reposition ☐ Required ☐ Quantity req'd: _____

OTHER COMMENTS: (Please include recommended management actions and/or implemented actions - include date. Also include details of additional data available, and how to locate it.)

SPECIMEN: Collectors No: RAVII-V10 WA Herb. ☑ Regional Herb. ☐ District Herb. ☐ Other: _____

ATTACHED: Map ☐ Mudmap ☐ Photo ☐ GIS data ☐ Field notes ☐ Other: _____

COPY SENT TO: Regional Office ☐ District Office ☐ Other:

Submitter of Record: Stephen Kern Role: Botanist Signed: Stephen Kern Date: 27/9/2011

Please return completed form to DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **Administrative Officer, Flora,** Species and Communities Branch.

Record entered by: _____ **Sheet No.:** _____ **Record Entered in Database** ☐

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Threatened and Priority Flora Report Form

Version 1.0 January 2010

Please complete as much of the form as possible, with emphasis on those sections bordered in black.

TAXON: Indigofera sp. Bungaroo Creek **TPFL Pop. No:**

OBSERVATION DATE: 20/7/2011 **CONSERVATION STATUS:** P3 New population ☒

OBSERVER/S: S. Kern, R. Daniel **PHONE:** 94308955

ROLE: Botanists **ORGANISATION:** Ecoscape

DESCRIPTION OF LOCATION (Provide at least nearest town/named locality, and the distance and direction to that place):

Raven project area, Approximately 70km NW of Tom Price

Reserve No:

DEC DISTRICT: Pilbara **LGA:** Shire of Ashburton Land manager present: ☐

DATUM:
GDA94 / MGA94 ☐
AGD84 / AMG84 ☐
WGS84 ☒
Unknown ☐

COORDINATES: (If UTM coords provided, **Zone** is also required)
DecDegrees ☐ DegMinSec ☐ UTMs ☒
Lat / Northing: 7541448
Long / Easting: 528761
ZONE: 50

METHOD USED:
GPS ☒ Differential GPS ☐ Map ☐
No. satellites: _____ Map used: _____
Boundary polygon captured: ☐ Map scale: _____

LAND TENURE:

Nature reserve ☐	Timber reserve ☐	Private property ☐	Rail reserve ☐	Shire road reserve ☐
National park ☐	State forest ☐	Pastoral lease ☒	MRWA road reserve ☐	Other Crown reserve ☐
Conservation park ☐	Water reserve ☐	UCL ☐	SLK/Pole _____ to _____	Specify other: Exploration Lease

AREA ASSESSMENT: Edge survey ☐ Partial survey ☒ Full survey ☐ Area observed (m²): _____

EFFORT: Time spent surveying (minutes): _____ No. of minutes spent / 100 m²: _____

POP'N COUNT ACCURACY: Actual ☐ Extrapolation ☐ Estimate ☒ Count method: _____
(Refer to field manual for list)

WHAT COUNTED: Plants ☒ Clumps ☐ Clonal stems ☐

TOTAL POP'N STRUCTURE:	**Mature:**	**Juveniles:**	**Seedlings:**	**Totals:**
Alive	100+			
Dead				

Area of pop (m²): _____

Note: Pls record count as numbers (not percentages) for database.

QUADRATS PRESENT: No. _____ Size _____ Data attached ☐ Total area of quadrats (m²): _____

Summary Quad. Totals: Alive				

REPRODUCTIVE STATE: Clonal ☐ Vegetative ☐ Flowerbud ☐ Flower ☑
Immature fruit ☐ Fruit ☐ Dehisced fruit ☐ Percentage in flower: 100 %

CONDITION OF PLANTS: Healthy ☒ Moderate ☐ Poor ☐ Senescent ☐

COMMENT: Erect shrub to 1.8m

THREATS - type, agent and supporting information: Eg clearing, too frequent fire, weed, disease. Refer to field manual for list of threats & agents. **Specify agent** where relevant. Rate current and potential threat impact: N=Nil, L=Low, M=Medium, H=High, E=Extreme Estimate time to potential impact: S=Short (<12mths), M=Medium (<5yrs), L=Long (5yrs+)	**Current impact (N-E)**	**Potential Impact (L-E)**	**Potential Threat Onset (S-L)**
• Clearing	N	H	M
•			
•			

Please return completed form to DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **Administrative Officer, Flora,** Species and Communities Branch.

Record entered by: _____ **Sheet No.:** _____ **Record Entered in Database** ☐

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HABITAT INFORMATION:

LANDFORM:
- Crest ☐
- Hill ☐
- Ridge ☐
- Outcrop ☐
- Slope ☐
- Flat ☐
- Open depression ☐
- Drainage line ☑
- Closed depression ☐
- Wetland ☐

ROCK TYPE:
- Granite ☐
- Dolerite ☐
- Laterite ☐
- Ironstone ☑
- Limestone ☐
- Quartz ☐

Specify other: _____

LOOSE ROCK: (on soil surface; eg gravel, quartz fields)
- 0-10% ☐
- 10-30% ☐
- 30-50% ☑
- 50-100% ☐

SOIL TYPE:
- Sand ☐
- Sandy loam ☑
- Loam ☐
- Clay loam ☐
- Light clay ☐
- Peat ☐

Specify other: _____

SOIL COLOUR:
- Red ☑
- Brown ☑
- Yellow ☐
- White ☐
- Grey ☐
- Black ☐

Specify other: _____

DRAINAGE:
- Well drained ☑
- Seasonally inundated ☐
- Permanently inundated ☐
- Tidal ☐

Specific **Landform** Element: _____
(Refer to field manual for additional values)

CONDITION OF SOIL: Dry ☑ Moist ☐ Waterlogged ☐ Inundated ☐

VEGETATION CLASSIFICATION*:
Eg: **1.** Banksia woodland (B. attenuata, B. ilicifolia); **2.** Open shrubland (Hibbertia sp., Acacia spp.) ; **3.** Isolated clumps of sedges (Mesomelaena tetragona)

1. _____
2. _____
3. _____
4. _____

ASSOCIATED SPECIES: Acacia humida, Cymbopogon procerus

Other (non-dominant) spp _____

* Please record up to four of the most representative vegetation layers (with up to three dominant species in each layer). Structural Formations should follow 2009 *Australian Soil and Land Survey Field Handbook* guidelines – refer to field manual for further information and structural formation table.

CONDITION OF HABITAT: Pristine ☐ Excellent ☑ Very good ☐ Good ☐ Degraded ☐ Completely degraded ☐

COMMENT: _____

FIRE HISTORY: **Last Fire:** Season/Month: _____ Year: _____ **Fire Intensity:** High ☐ Medium ☐ Low ☐ No signs of fire ☐

FENCING: Not required ☐ Present ☐ Replace / repair ☐ Required ☐ Length req'd: _____

ROADSIDE MARKERS: Not required ☒ Present ☐ Replace / reposition ☐ Required ☐ Quantity req'd: _____

OTHER COMMENTS: (Please include recommended management actions and/or implemented actions - include date. Also include details of additional data available, and how to locate it.)

SPECIMEN: Collectors No: _____ WA Herb. ☐ Regional Herb. ☐ District Herb. ☐ Other: _____

ATTACHED: Map ☐ Mudmap ☐ Photo ☐ GIS data ☐ Field notes ☐ Other: _____

COPY SENT TO: Regional Office ☐ District Office ☐ Other:

Submitter of Record: Stephen Kern Role: Botanist Signed: Stephen Kern Date: 27/9/2011

Please return completed form to DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **Administrative Officer, Flora,** Species and Communities Branch.

Record entered by: _____ **Sheet No.:** _____ **Record Entered in Database** ☐

Department of Environment and Conservation
Our environment, our future

Threatened and Priority Flora Report Form

Version 1.0 January 2010

Please complete as much of the form as possible, with emphasis on those sections bordered in black.

TAXON: Indigofera sp. Bungaroo Creek **TPFL Pop. No:**

OBSERVATION DATE: 20/7/2011 **CONSERVATION STATUS:** P 3 New population ☒

OBSERVER/S: S. Kern, R. Daniel **PHONE:** 94308955

ROLE: Botanists **ORGANISATION:** Ecoscape

DESCRIPTION OF LOCATION (Provide at least nearest town/named locality, and the distance and direction to that place):

Raven project area, Approximately 70km NW of Tom Price

Reserve No:

DEC DISTRICT: Pilbara **LGA:** Shire of Ashburton Land manager present: ☐

DATUM:
GDA94 / MGA94 ☐
AGD84 / AMG84 ☐
WGS84 ☒
Unknown ☐

COORDINATES: (If UTM coords provided, **Zone** is also required)
DecDegrees ☐ DegMinSec ☐ UTMs ☒

Lat / Northing: 7540296

Long / Easting: 530085

ZONE: 50

METHOD USED:
GPS ☒ Differential GPS ☐ Map ☐

No. satellites: _____ Map used: _____

Boundary polygon captured: ☐ Map scale: _____

LAND TENURE:

Nature reserve ☐	Timber reserve ☐	Private property ☐	Rail reserve ☐	Shire road reserve ☐
National park ☐	State forest ☐	Pastoral lease ☒	MRWA road reserve ☐	Other Crown reserve ☐
Conservation park ☐	Water reserve ☐	UCL ☐	SLK/Pole _____ to _____	Specify other: Exploration Lease

AREA ASSESSMENT: Edge survey ☐ Partial survey ☒ Full survey ☐ Area observed (m²): _____

EFFORT: Time spent surveying (minutes): _____ No. of minutes spent / 100 m²: _____

POP'N COUNT ACCURACY: Actual ☐ Extrapolation ☐ Estimate ☒ Count method: _____
(Refer to field manual for list)

WHAT COUNTED: Plants ☒ Clumps ☐ Clonal stems ☐

TOTAL POP'N STRUCTURE:	**Mature:**	**Juveniles:**	**Seedlings:**	**Totals:**
Alive	200+			
Dead				

Area of pop (m²): _____

Note: Pls record count as numbers (not percentages) for database.

QUADRATS PRESENT: No. _____ Size _____ Data attached ☐ Total area of quadrats (m²): _____

Summary Quad. Totals: Alive				

REPRODUCTIVE STATE: Clonal ☐ Vegetative ☐ Flowerbud ☐ Flower ☑
Immature fruit ☐ Fruit ☐ Dehisced fruit ☐ Percentage in flower: 100 %

CONDITION OF PLANTS: Healthy ☒ Moderate ☐ Poor ☐ Senescent ☐

COMMENT: Erect shrub to 1.8m

THREATS - type, agent and supporting information: Eg clearing, too frequent fire, weed, disease. Refer to field manual for list of threats & agents. **Specify agent** where relevant. Rate current and potential threat impact: N=Nil, L=Low, M=Medium, H=High, E=Extreme Estimate time to potential impact: S=Short (<12mths), M=Medium (<5yrs), L=Long (5yrs+)	**Current impact (N-E)**	**Potential Impact (L-E)**	**Potential Threat Onset (S-L)**
• Clearing	N	H	M
•			
•			

Please return completed form to DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

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Record entered by: _____ **Sheet No.:** _____ **Record Entered in Database** ☐

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Threatened and Priority Flora Report Form

Version 1.0 January 2010

HABITAT INFORMATION:

LANDFORM:
- Crest ☐
- Hill ☐
- Ridge ☐
- Outcrop ☐
- Slope ☐
- Flat ☐
- Open depression ☐
- Drainage line ☑
- Closed depression ☐
- Wetland ☐

ROCK TYPE:
- Granite ☐
- Dolerite ☐
- Laterite ☐
- Ironstone ☑
- Limestone ☐
- Quartz ☐

Specify other: _____

LOOSE ROCK: (on soil surface; eg gravel, quartz fields)
- 0-10% ☐
- 10-30% ☐
- 30-50% ☑
- 50-100% ☐

SOIL TYPE:
- Sand ☐
- Sandy loam ☑
- Loam ☐
- Clay loam ☐
- Light clay ☐
- Peat ☐

Specify other: _____

SOIL COLOUR:
- Red ☑
- Brown ☐
- Yellow ☐
- White ☐
- Grey ☐
- Black ☐

Specify other: _____

DRAINAGE:
- Well drained ☑
- Seasonally inundated ☐
- Permanently inundated ☐
- Tidal ☐

Specific **Landform** Element: _____
(Refer to field manual for additional values)

CONDITION OF SOIL: Dry ☑ Moist ☐ Waterlogged ☐ Inundated ☐

VEGETATION CLASSIFICATION*:

Eg: **1**. Banksia woodland (B. attenuata, B. ilicifolia); **2**. Open shrubland (Hibbertia sp., Acacia spp.) ; **3**. Isolated clumps of sedges (Mesomelaena tetragona)

1. _____
2. _____
3. _____
4. _____

ASSOCIATED SPECIES: Corymbia hamersleyana, Cymbopogon ~~procerus~~, Acacia tumida

Other (non-dominant) spp: _____

* Please record up to four of the most representative vegetation layers (with up to three dominant species in each layer). Structural Formations should follow 2009 *Australian Soil and Land Survey Field Handbook* guidelines – refer to field manual for further information and structural formation table.

CONDITION OF HABITAT: Pristine ☐ Excellent ☐ Very good ☐ Good ☐ Degraded ☐ Completely degraded ☐

COMMENT: _____

FIRE HISTORY: **Last Fire:** Season/Month: _____ Year: _____ **Fire Intensity:** High ☐ Medium ☐ Low ☐ No signs of fire ☐

FENCING: Not required ☐ Present ☐ Replace / repair ☐ Required ☐ Length req'd: _____

ROADSIDE MARKERS: Not required ☒ Present ☐ Replace / reposition ☐ Required ☐ Quantity req'd: _____

OTHER COMMENTS: (Please include recommended management actions and/or implemented actions - include date. Also include details of additional data available, and how to locate it.)

SPECIMEN: Collectors No: RAVII-v11 WA Herb. ☑ Regional Herb. ☐ District Herb. ☐ Other: _____

ATTACHED: Map ☐ Mudmap ☐ Photo ☐ GIS data ☐ Field notes ☐ Other: _____

COPY SENT TO: Regional Office ☐ District Office ☐ Other:

Submitter of Record: Stephen Kern Role: Botanist Signed: Stephen Kern Date: 27/9/2011

Please return completed form to DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **Administrative Officer, Flora,** Species and Communities Branch.

Record entered by: _____ **Sheet No.:** _____ **Record Entered in Database** ☐

Appendix Seven: Flora Species List

Table 22: Flora species list (dominant and characteristic species and opportunistic observations)

Family	Species	Introduced	Cons. Code
Amaranthaceae	*Gomphrena cunninghamii*		
	Ptilotus astrolasius		
	Ptilotus auriculifolius		
	Ptilotus calostachyus		
	Ptilotus exaltatus var. *exaltatus*		
	Ptilotus fusiformis		
	Ptilotus rotundifolius		
Araliaceae	*Trachymene oleracea* subsp. *oleracea*		
Asteraceae	**Bidens bipinnata*	X	
	Peripleura arida		
	Pterocaulon serrulatum		
	Pterocaulon sphacelatum		
Boraginaceae	*Trichodesma zeylanicum* var. *zeylanicum*		
Capparaceae	*Capparis umbonata*		
Caryophyllaceae	*Polycarpaea corymbosa* var. *corymbosa*		
	Polycarpaea holtzei		
	Polycarpaea longiflora		
Chenopodiaceae	*Dysphania rhadinostachya* subsp. *rhadinostachya*		
Cleomaceae	*Cleome viscosa*		
Convolvulaceae	*Bonamia rosea*		
	Duperreya commixta		
Cucurbitaceae	*Cucumis maderaspatanus*		
Cyperaceae	*Bulbostylis barbata*		
	Fimbristylis simulans		
Euphorbiaceae	*Euphorbia boophthona*		
Fabaceae	*Acacia adoxa* var. *adoxa*		
	Acacia ancistrocarpa		
	Acacia atkinsiana		
	Acacia bivenosa		
	Acacia cowaniana		
	Acacia dictyophleba		
	Acacia elachantha		
	Acacia exilis		
	Acacia hilliana		
	Acacia inaequilatera		
	Acacia maitlandii		
	Acacia monticola		
	Acacia pruinocarpa		
	Acacia pyrifolia var. *pyrifolia*		
	Acacia tenuissima		
	Acacia trudgeniana		

Family	Species	Introduced	Cons. Code
Fabaceae	*Acacia tumida* var. *pilbarensis*		
	Crotalaria medicaginea var. *neglecta*		
	Gastrolobium grandiflorum		
	Gompholobium sp. Pilbara (N.F. Norris 908)		
	Indigofera monophylla		
	Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)		P3
	Mirbelia viminalis		
	Senna artemisioides subsp. *oligophylla*		
	Senna glutinosa subsp. *glutinosa*		
	Senna glutinosa subsp. *pruinosa*		
	Senna glutinosa subsp. *x luerssenii*		
	Senna notabilis		
	Senna symonii		
	Swainsona formosa		
	Tephrosia rosea var. glabrior		
Goodeniaceae	*Dampiera candicans*		
	Goodenia cusackiana		
	Goodenia micrantha		
	Goodenia nuda		P4
	Goodenia stobbsiana		
	Scaevola parvifolia subsp. *pilbarae*		
	Scaevola spinescens		
Gyrostemonaceae	*Codonocarpus cotinifolius*		
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*		
Malvaceae	*Abutilon dioicum*		
	Gossypium australe (Burrup Peninsula form)		
	Gossypium robinsonii		
	Hibiscus coatesii		
	Keraudrenia nephrosperma		
	Keraudrenia velutina subsp. *elliptica*		
	**Malvastrum americanum*	X	
	Melhania oblongifolia		
	Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)		
	Waltheria virgata		
Molluginaceae	*Mollugo molluginea*		
Myrtaceae	*Corymbia deserticola* subsp. *deserticola*		
	Corymbia ferriticola		
	Corymbia hamersleyana		
	Eucalyptus gamophylla		
	Eucalyptus leucophloia subsp. *leucophloia*		
	Eucalyptus xerothermica		
Nyctaginaceae	*Boerhavia coccinea*		
Oleaceae	*Jasminum didymum* subsp. *lineare*		
Pedaliaceae	*Josephinia* sp.		

Family	Species	Introduced	Cons. Code
Phyllanthaceae	*Notoleptopus decaisnei* var. *orbicularis*		
Phyllanthaceae	*Phyllanthus erwinii*		
Poaceae	*Aristida contorta*		
	Aristida holathera var. *holathera*		
	Cymbopogon ambiguus		
	Cymbopogon procerus		
	Digitaria brownii		
	Eragrostis cumingii		
	Eragrostis eriopoda		
	Eriachne aristidea		
	Eriachne ciliata		
	Eriachne mucronata		
	Eriachne pulchella subsp. *dominii*		
	Eriachne tenuiculmis		
	Paraneurachne muelleri		
	Schizachyrium fragile		
	Setaria surgens		
	Themeda triandra		
	Triodia aff. *melvillei*		
	Triodia epactia		
	Triodia wiseana		
Polygalaceae	*Polygala* aff. *isingii*		
Portulacaceae	**Portulaca oleracea*	X	
Proteaceae	*Grevillea pyramidalis* subsp. *leucadendron*		
	Hakea chordophylla		
	Hakea lorea ssp. lorea		
Rubiaceae	*Oldenlandia crouchiana*		
Santalaceae	*Santalum lanceolatum*		
Sapindaceae	*Dodonaea lanceolata*		
Scrophulariaceae	*Eremophila magnifica* subsp. *velutina*		P3
Solanaceae	*Solanum sturtianum*		
Zygophyllaceae	*Tribulus hirsutus*		
	Tribulus macrocarpus		

Appendix Eight: Fauna species list and photographs

Table 23: List of Fauna species recorded at Raven by this survey

Family	Species	Common Name	Cons. status	Plate
Mammals				
Macropodidae	*Macropus robustus*	Euro, Biggada		
Emballonuridae	*Taphozous georgianus*	Common Sheathtail-bat		14
Muridae	*Pseudomys chapmani*	Western Pebble-mound Mouse	*P 4*	1 5
Reptiles				
Agamidae	*Ctenophorus caudicinctus*	Ringtailed Dragon		
	Pogona minor mitchelli	Northwest Bearded Dragon		16
Gekkonidae	*Heteronotia binoei*	Bynoe's Gecko		
Diplodactylidae	*Oedura marmorata*	Marbled Velvet Gecko		17
Scincidae	*Ctenotus duricola*	Pilbara Ctenotus		
	Morethia ruficauda exquisita	Fire-tailed Skink		
	Tiliqua multifasciata	Central Blue-tongue		17
Birds				
Casuariidae	*Dromaius novaehollandiae*	Emu		18
Columbidae	*Ocyphaps lophotes*	Crested Pigeon		
	Geophaps plumifera	Spinifex Pigeon		
	Geopelia cuneata	Diamond Dove		
Accipitridae	*Haliastur sphenurus*	Whistling Kite		
Falconidae	*Falco cenchroides*	Australian Kestrel		
	Falco berigora	Brown Falcon		19
Turnicidae	*Turnix velox*	Little Button-quail		
Cacatuidae	*Cacatua sanguinea*	Little Corella		
Psittacidae	*Melopsittacus undulatus*	Budgerigar		
Halcyonidae	*Dacelo leachii*	Blue-winged Kookaburra		
Meropidae	*Merops ornatus*	Rainbow Bee-eater	*M*	20
Climacteridae	*Climacteris melanura*	Black-tailed Treecreeper		
Ptilonorhynchidae	*Ptilonorhynchus guttatus*	Western Bowerbird		
Maluridae	*Malurus lamberti*	Variegated Fairy-wren		
Pardalotidae	*Pardalotus striatus*	Striated Pardalote		
Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater		
	Lichenostomus keartlandi	Grey-headed Honeyeater		
	Lichenostomus penicillatus	White-plumed Honeyeater		
	Manorina flavigula	Yellow-throated Miner		
	Melithreptus gularis	Black-chinned Honeyeater		
Eupetidae	*Psophodes occidentalis*	Chiming Wedgebill		
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		
	Lalage tricolor [sueurii]	White-winged Triller		
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler		
Artamidae	*Artamus cinereus*	Black-faced Woodswallow		
	Artamus minor	Little Woodswallow		
	Cracticus nigrogularis	Pied Butcherbird		
	Cracticus tibicen	Australian Magpie		
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail		
Corvidae	*Corvus orru*	Torresian Crow		
Petroicidae	*Petroica goodenovii*	Red-capped Robin		
Alaudidae	*Mirafra javanica horsfieldii*	Horsfield's (Singing) Bushlark		
Megaluridae	*Eremiornis carteri*	Spinifexbird		
Estrildidae	*Taeniopygia guttata*	Zebra Finch		
	Emblema pictum	Painted Finch		21

Plate 20: Lizards from Sheathtail Bat roost cave: posterior trunk and hindlimbs of Central Bluetongue (*Tiliqua occipitalis*) probably dropped by a Ghost Bat, and nearly complete shed skin of Marbled Velvet Gecko (*Oedura marmorata*)

Plate 21: Bird bone fragment from overhang in southeast corner of Raven, only consistent in size with Emu (*Dromaius novaehollandiae*)

Table 24: Vertebrate taxa known or potentially present in the study area

Family	Species	Common Name	EPBC status	WCA status	DEC status	DEC Threatened fauna database	EPBC Protected Matters report	Hamersley PIL3		Raven	Mt Farquhar	Eliwanna/FF	Delphine	Mt McLeod	Mt McL N-Map	Mesa A and G	Mesa J	WPIOP	Blacksmith	Karijini NP	Solomon	Solomon Rail	V. Kings	Firetail South	Firetail North	West Turner	Brockman Sync 4	Fortescue River
FISH																												
Anguillidae	*Anguilla bicolor*	Indian Short-finned Eel																										+
Clupeidae	*Nematalosa erebi*	Bony Bream															+											+
Gobiidae	*Glossogobius giurus*	Flathead Goby																										+
Melanotaeniidae	*Melanotaenia australis*	Western Rainbowfish											+				+				+		+					+
Plotosidae	*Neosilurus hyrtli*	Hyrtl's Tandan											+				+				+		+					
	Neosilurus sp.(**1**)	(Eel-tailed Catfish, Tandan)																										+
	Neoarius graeffei	Lesser Salmon Catfish																										+
Terapontidae	*Amniataba percoides*	Barred Grunter															+						+					+
	Leiopotherapon unicolor	Spangled Perch															+				+		+					+
	Leiopotherapon aheneus	Fortescue Grunter			*P 4*			+									+											+
	Unnamed sp.																											+
AMPHIBIANS																												
Hylidae	*Cyclorana maini*	Sheep Frog													+			5		79	13		+			1	14	
	Cyclorana platycephala	Water-holding Frog																		5								
	Litoria rubella	Little Red Tree Frog											+	1				84	2	c	1		+	2			1	
Myobatrachidae	*Pseudophryne douglasi*	Gorge Toadlet																+		4								
	Uperoleia glandulosa	Glandular Toadlet																	2				+	3				
	Uperoleia russelli	Northwest Toadlet													+			6			62		+				(+)	
	Uperoleia sp. (one of preceding)																			16								
Limnodynastidae	*Limnodynastes spenceri*	Desert Burrowing Frog																		1								
MAMMALS																												
Tachyglossidae	*Tachyglossus aculeatus*	Echidna													+	5				+			+	1				
Dasyuridae	*Dasykaluta rosamondae*	Kaluta													+		+	10	2	20	14		+	1		17	3	
	Dasyurus hallucatus	Northern Quoll	*E N*	*S 1*	*EN*	+	L	+								1	+	4	1		1		+	2	3		(+)	
	Ningaui timealeyi	Pilbara Ningaui													+	10		47	2	156	7		+		4	33	27	
	Planigale ingrami	Long-tailed Planigale													+			13		1	112				8	3		
	Planigale maculata	Common Planigale																		3	3				1			
	Planigale sp. (**2**)																	+	4					20			(+)	
	Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus																		1								
	Pseudantechinus roryi	Rory's Pseudantechinus																										
	Pseudantechinus woolleyae	Woolley's Pseudantechinus											1						1				+			2	(+)	
	Sminthopsis macroura	Stripe-faced Dunnart													+			6		25	101		+		5	7	(+)	
	Sminthopsis longicaudata	Long-tailed Dunnart			*P 4*	+		+							+			1									(+)	
	Sminthopsis ooldea	Ooldea Dunnart																		5								
Macropodidae	*Macropus robustus*	Euro, Biggada								+	+	1	3	+	+	13		46	1	+	+	+	+	14	10	27	5	
	Macropus rufus	Red Kangaroo, Marlu													+			5		+			+			3	n	

Family	Species	Common Name	EPBC status	WCA status	DEC status	DEC Threatened fauna database	EPBC Protected Matters report	Hamersley PIL3		Raven	Mt Farquhar	Eliwanna/FF	Delphine	Mt McLeod	Mt McL N-Map	Mesa A and G	Mesa J	WPIOP	Blacksmith	Karijini NP	Solomon	Solomon Rail	V. Kings	Firetail South	Firetail North	West Turner	Brockman Sync 4	Fortescue River
	Petrogale "penicillata"	Brush-tailed Rock-wallaby																		+								
	Petrogale rothschildi	Rothschild's Rock-wallaby																									(+)	
	Petrogale sp.	Rock-wallaby										4	2						1					1				
	Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby			P 3										+													
Phalangeridae	*Trichosurus vulpecula*	Brush-tailed Possum									1	1	1					+	1					2				
Megadermatidae	*Macroderma gigas*	Ghost Bat			P 4	+		+							+	+		2	+	+			+				(+)	
Hipposideridae	*Rhinonicteris aurantia*	Pilbara Leaf-nosed Bat	V U	S 1	VU	+	L	+										7										
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat																1		6	24		+	+	+	2		
	Taphozous georgianus	Common Sheathtail-bat								20					+		+	83		18	25		+	+	+	14	+	
	Taphozous hilli	Hill's Sheathtail-bat													+					46			+				(+)	
Molossidae	*Chaerephon jobensis*	Northern Freetail-bat														+		+		17	7		+					
	Mormopterus beccarii	Beccari's Freetail-bat													+					58	7		+	+	+			
	Mormopterus loriae cobourgiana	Western Little Freetail-bat																		+							+	
	Mormopterus sp.	South-western Freetail-bat																	+									
	Tadarida australis	White-striped Freetail-bat																3		1							+	
Vespertilionidae	*Nyctophilus bifax*	Northwestern Long-eared Bat																		1								
	Nyctophilus geoffroii	Lesser Long-eared Bat																		1								
	Nyctophilus gouldii	Gould's Long-eared Bat																		+								
	Nyctophilus arnhemensis	Arnhem Land Long-eared Bat																									?	
	Nyctophilus sp. indet.																				+		+					
	Chalinolobus gouldii	Gould's Wattled Bat													+	+		7	1	75	27		+	+	+	6	+	
	Chalinolobus morio	Chocolate Wattled Bat																								6		
	Scotorepens greyii	Little Broad-nosed Bat													+	+		5	1	34	25		+	+	+	2	+	
	Scotorepens balstoni	Inland Broad-nosed Bat																1										
	Vespadelus finlaysoni (**3**)	Finlayson's Cave Bat													+	+	+	70	1	39	27		+	+	+	50	+	
Muridae	*Leggadina lakedownensis*	Short-tailed Mouse			P 4	+									+												(+)	
	Mus musculus	House Mouse			Y										+			+		127	13		+			2	1	
	Notomys alexis	Spinifex Hopping-mouse									1			2						1								
	Pseudomys chapmani	Western Pebble-mound Mouse			P 4			+		2			2	2	+		(+)	9	+	15			+			12	1	
	Pseudomys delicatulus	Delicate Mouse														2		1										
	Pseudomys desertor	Desert Mouse													+			7	1		146		+	10	1	6	3	
	Pseudomys hermannsburgensis	Sandy Inland Mouse													+			49		62	156		+		3	23	2	
	Zyzomys argurus	Common Rock-rat										1			+	1		49	1	16			+	8	4	161	13	
Leporidae	*Oryctolagus cuniculus*	Rabbit			Y		L																					
Bovidae	*Bos taurus*	Cow									+	22	26	+				5		+	+		+					
Equidae	*Equus asinus*	Donkey			Y										+			1		+							n	
	Equus caballus	Horse										3	3														6	
Canidae	*Canis lupus dingo*	Dingo			Y						+	1		3	+	11		11	3	+	9	+	+	3	1	8	1	
	Canis lupus familiaris	Dog											4															

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	Vulpes vulpes	Fox			*Y*		M													+								
Felidae	*Felis catus*	Cat			*Y*		L					1	1	1				1	1	+	2	+	+	2	1	1	2	
REPTILES																												
Cheluidae	*Chelodina steindachneri*	Flat-shelled Turtle															+			2								
Agamidae	*Amphibolurus gilberti*	Gilbert's Dragon																		+								
	Amphibolurus longirostris	Long-nosed Dragon													+	1		11	3	vc	81		+	1		16	4	
	Caimanops amphiboluroides	Mulga Dragon																1		(2)		+						
	Ctenophorus caudicinctus	Ringtailed Dragon								1	2	2	+	10	+	17		48	6	vc	111		+	4	12	41	47	
	Ctenophorus isolepis	Military Dragon													+	8		45	2	7	64		+			8	31	
	Ctenophorus nuchalis	Central Netted Dragon														5		8										
	Ctenophorus reticulatus	Western Netted Dragon													+			+		3								
	Ctenophorus scutulatus	Lozenge-marked Dragon																+										
	Diporiphora valens	Pilbara Two-lined Dragon													+					6						4	5	
	Diporiphora winneckei	Blue-lined Dragon																		+							(?)	
	Pogona minor (**4**)	Western Bearded Dragon													+			2		mc			+			3	2	
	Pogona minor mitchelli	Northwest Bearded Dragon								1			+	5					3		41			1	3			
	Tympanocryptis cephalus	Pebble Dragon													+			+									(+)	
Gekkonidae	*Gehyra pilbara*	Pilbara Dtella													+				1	6	2		+				(+)	
	Gehyra punctata	Spotted Dtella													+			25	38	mc	1		+	2	2	1	4	
	Gehyra purpurascens	Purple Dtella																16					+					
	Gehyra variegata	Common Dtella											+		+			+		c	17		+	3	4	24	6	
	Heteronotia binoei	Bynoe's Prickly Gecko								1	1				+	9		44	9	mc	98		+	3	13	14	40	
	Heteronotia planiceps	North-west Prickly Gecko						+																				
	Heteronotia spelea	Desert Cave Gecko													+			2	2	2			+				(+)	
Carphodactylidae	*Underwoodisaurus seorsus* (**3**)	Pilbara Barking Gecko																	2				+	1	1			
	Nephrurus laevis pilbarensis	Pilbara Smooth Knobtail Gecko														2												
	Nephrurus wheeleri cinctus	Banded Knob-tailed gecko													+			1	2	mc	13		+	1			1	
Diplodactylidae	*Crenadactylus ocellatus*	Clawless gecko													+			2	1				+					
	Diplodactylus conspicillatus	Fat-tailed gecko													+	6		29	1	+	234		+			7	50	
	Diplodactylus mitchelli	Pilbara Stone Gecko																+										
	Diplodactylus savagei	Yellow-spotted Pilbara Gecko													+			14	1		2		+		1	2	5	
	Lucasium squarrosum (**3**)	Spotted Ground Gecko																		+								
	Lucasium stenodactylum	Sand-plain Gecko													+	6		7		4			+				140	
	Lucasium wombeyi	Pilbara Ground Gecko													+			2		(3)	49		+		5		21	
	Oedura marmorata	Marbled Velvet Gecko								2	2				+			5	17	3			+	1	1		(+)	
	Rhynchoedura ornata	Beaked Gecko													+	2		1		(2)						2	88	
	Strophurus elderi	Jewelled Gecko													+			6		1	4		+			3	8	
	Strophurus jeanae	Southern Phasmid Gecko																		(2)	26		+					
	Strophurus strophurus	Western Spiny-tail gecko																					+					
	Strophurus wellingtonae	Western Shield Spiny-tail Gecko									1				+				2	2	17		+	2	1	5	4	

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Pygopodidae	*Delma butleri*																		1					1				
	Delma elegans														+			2	1	(2)	2		+	1			(+)	
	Delma haroldi														+													
	Delma nasuta														+	3		6	1	7	6		+	3	2	6	16	
	Delma pax														+			6	1		14		+	8	2	1	6	
	Delma tincta														+			+		2			+			3	2	
	Lialis burtonis	Burton's Legless lizard												1	+	2		3	1	mc	10		+	1	2	4	10	
	Pygopus nigriceps	Hooded Scaly-foot													+	1		2		mc	12		+		3		2	
Scincidae	*Carlia munda*	Shaded-litter Rainbow Skink									3			1	+	5		8	7	11	268		+	5	16	7	14	
	Carlia triacantha	Rainbow Skink													+					1	80		+		2			
	Cryptoblepharus buchananii														+													
	Cryptoblepharus carnabyi (**3**)															4				6							3	
	Cryptoblepharus plagiocephalus (**3**)																			9						3	1	
	Cryptoblepharus ustulatus	Russet Snake-eyed Skink													+			1	1				+	2				
	Ctenotus duricola	Pilbara Ctenotus								1					+	4		16	1	c	111		+		14	3	19	
	Ctenotus grandis	Grand Ctenotus									1				+	2		24	23		234		+	12		1	22	
	Ctenotus hanloni	Nimble Ctenotus														10		8								4		
	Ctenotus helenae	Clay-soil Ctenotus													+	2		6		13	467		+	1	13	1		
	*Ctenotus "*aff. *helenae"*																	8									37	
	Ctenotus leonhardii	Leonhard's Ctenotus																			5		+					
	Ctenotus mimetes	Checker-sided Ctenotus																+										
	Ctenotus pantherinus	Leopard Ctenotus									1				+	8		36	4	15	330		+	2	16	27	40	
	Ctenotus piankai	Coarse Sands Ctenotus																		+							(?)	
	Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus						+																				
	Ctenotus aff. *robustus*														+			+									(+)	
	Ctenotus rubicundus	Ruddy Ctenotus												1	+			2		2				1		2	(+)	
	Ctenotus rutilans	Rusty-shouldered Ctenotus													+			+		uc	4		+				4	
	Ctenotus saxatilis	Rock Ctenotus											+	1	+	14		96	13	26	326		+	36	61	3	6	
	Ctenotus schomburgkii	Barred Wedge-snout Ctenotus													+			+		7						4	8	
	Ctenotus serventyi	Sandy-loam Ctenotus																+										
	Ctenotus severus	Stern Ctenotus																+										
	Ctenotus uber uber	Spotted Ctenotus																+										
	Cyclodomorphus melanops	Spinifex Slender Bluetongue													+			1	1	c	36		+	1	1	1	12	
	Egernia cygnitos (**3**)	West Pilbara Spiny-tail Skink																+										
	Egernia formosa	Goldfields Crevice-skink													+			+		2	1		+				3	
	Eremiascincus fasciolatus	Narrow-banded Sandswimmer													+				1		1		+					
	Eremiascincus isolepis	Northern Bar-lipped Skink																+										
	Eremiascincus richardsonii	Broad-banded Sandswimmer													+	1				uc							(+)	
	Eremiascincus sp. (=*musivus*?)																	+								1		
	Lerista bipes	Northwestern Sandslider														47		+										

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	Lerista clara																	2										
	Lerista sp.															4												
	Lerista flammicauda (incl. "*frosti*")	Pilbara Flame-tailed Slider													+			4	3	6						2		
	Lerista jacksoni	Jackson's Lerista																+						1		2		
	Lerista muelleri (3)	Wood-mulch Slider													+			6	5	1			+				5	
	Lerista rolfei	Rolfe's Slider																+										
	Lerista verhmens	Powerful Lerista													+			+			36		+					
	Lerista zietzi	Blue-tailed Skink						+										1			4		+	2	4			
	Menetia greyii	Common Dwarf Skink											+		+	4		5	3		42		+	8	4	2	11	
	Menetia surda	Western Dwarf Skink													+			+		uc						1	18	
	Morethia ruficauda exquisita	Fire-tailed Skink								1	4			1	+	1		10	5	mc	3		+		3	4	2	
	Notoscincus butleri	Lined Soil-crevice Skink			*P4*	+									+		+	+			1		+			1	2	
	Notoscincus ornatus	Ornate Soil-crevice Skink													+			4										
	Proablepharus reginae	Western Soil-crevice Skink													+					1	1		+					
	Tiliqua multifasciata	Central Blue-tongue								1					+			2	5	c	42		+	1		2	2	
Varanidae	*Varanus acanthurus*	Ridge-tailed Monitor													+			9	8	mc	102		+	2	13	4	7	
	Varanus brevicauda	Short-tailed Pygmy Monitor													+			9	3	mc	248		+			1	7	
	Varanus bushi	Pilbara Mulga Monitor													+			+			18	+	+	2		1		
	Varanus caudolineatus	Stripe-tailed Monitor													+					c								
	Varanus eremius	Pygmy Desert Monitor													+	2		6	4		91		+		1		8	
	Varanus giganteus	Perentie												1				3	1	(2)			+	1			1	
	Varanus gilleni	Pigmy Mulga Monitor																3									(+)	
	Varanus gouldii	Sand Monitor																		(1)								
	Varanus panoptes	Yellow-spotted Monitor																+	2	1+	21		+	1			2	
	Varanus pilbarensis	Pilbara Rock Monitor													+			+		3			+				1	
	Varanus tristis	Black-tailed Monitor													+			+	1	1	2		+	1	1	1	2	
	Varanus sp. (unidentified juv.)																				7							
Typhlopidae	*Ramphotyphlops ammodytes*														+			9		(1)	2		+			3		
	Ramphotyphlops "australis"																			+								
	Ramphotyphlops "bituberculatus"																			+								
	Ramphotyphlops ganei				*P1*	+		+							+			+	1				+					
	Ramphotyphlops grypus														+			10	5	mc	25		+	1	4	6	6	
	Ramphotyphlops hamatus														+			+		5								
	Ramphotyphlops pilbarensis							+							+			1			6		+		2		4	
	Ramphotyphlops waitii																			4								
Pythonidae	*Antaresia perthensis*	Pigmy Python													+			+		2			+	1			(+)	
	Antaresia stimsoni	Stimson's Python												1	+			+	4	(1)	64		+	1			(+)	
	Aspidites melanocephalus	Black-headed Python																	1	(1)	2		+	1				
	Liasis olivaceus barroni	Pilbara Olive Python	*V U*		*S1*	*VU*		+						(1)				3	1	2			+			1		
Elapidae	*Acanthophis wellsi*	Pilbara Death Adder													+	2		3		(1)			+	1		1	(+)	

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	Brachyurophis approximans	Pilbara Shovel-nosed Snake													+			2	1	5	34		+	1	5	1	4	
	Demansia psammophis	Yellow-faced Whipsnake													+	1		2		uc	5		+				2	
	Demansia rufescens	Rufous Whipsnake													+			+		c	20		+	3	1	2		
	Furina ornata	Moon Snake													+	1		5	1	3	12		+	1		1	2	
	Parasuta monachus	Monk Snake																2		mc	5		+			6	4	
	Pseudechis australis	Mulga Snake									+			1	+			1	1	c	45		+	1			1	
	Pseudonaja modesta	Ringed Brown Snake													+			1		2	7		+			1		
	Pseudonaja mengdeni (3)	Gwardar																		3	6		+		3	1	1	
	Suta fasciata	Desert Banded Snake																		mc	4		+			2	(+)	
	Suta punctata	Spotted Snake													+	1		+		(1)								
	Vermicella snelli	Pilbara Bandy Bandy																	1	(1)			+			1		
BIRDS																												
Casuariidae	*Dromaius novaehollandiae*	Emu								1					+	3		24	2	uc	1	+	+				2	
Phasianidae	*Coturnix pectoralis*	Stubble Quail																+			2				2			
	Coturnix ypsiliophora	Brown Quail													+			2			2		+	4				
Anatidae	*Cygnus atratus*	Black Swan																		s								
	Chenonetta jubata	Australian Wood Duck													+					s								
	Malacorhynchus membranaceus	Pink-eared Duck													+					s								
	Anas gracilis	Grey Teal													+					uc							5	
	Anas superciliosus	Pacific Black Duck													+			+		uc	2						3	
	Aythya australis	Hardhead													+					s								
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe													+			+		uc								
	Poliocephalus poliocephalus	Hoary-headed Grebe													+					uc								
Columbidae	*Phaps chalcoptera*	Common Bronzewing									1	1	1	1	+	1		11	2	mc	3		1	1	1	18	12	
	Phaps elegans	Brush Bronzewing														3												
	Phaps histrionica	Flock Bronzewing																		(+)								
	Ocyphaps lophotes	Crested Pigeon								1	1	10	+	55	+			223	1	mc	16	+	7	2		83	91	
	Geophaps plumifera	Spinifex Pigeon								2	4	16	5		+			320	1	mc	51		13	18	22	170	72	
	Geopelia cuneata	Diamond Dove								9	21	33	12	5	+	5		69	1	c	35		12		11	65	304	
	Geopelia striata	Peaceful Dove													+	1		15		uc	40	+	1	15	33	6		
Podargidae	*Podargus strigoides*	Tawny Frogmouth													+					s			+	1			1	
Eurostopodidae	*Eurostopodus argus*	Spotted Nightjar										1		1	+			12		c	45		+	1			8	
Aegothelidae	*Aegotheles cristatus*	Owlet Nightjar										4	1		+			1		s			+	2				
Apodidae	*Apus pacificus*	Fork-tailed Swift	*M*				M								+			+		mc			+					
Anhingidae	*Anhinga melanogaster*	Australasian Darter																		uc								
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant																		s	2				2			
	Phalacrocorax carbo	Great Cormorant																		s								
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican													+					(2)								
Ardeidae	*Ardea pacifica*	White-necked Heron												3	+			2		uc			+				2	

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	Ardea modesta (=*alba*)	Great Egret	*M*				M								+					s								
	Ardea ibis	Cattle Egret	*M*				M																					
	Egretta novaehollandiae	White-faced Heron											1		+	1		+	1	uc							6	
	Nycticorax caledonicus	Nankeen Night-heron																		uc								
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis													+			4		uc								
Accipitridae	*Elanus axillaris*	Black-shouldered Kite													+					uc	4		1			2		
	Lophoictinia isura	Square-tailed Kite													+					+			+					
	Hamirostra melanosternon	Black-breasted Buzzard																+		s								
	Haliaeetus leucogaster	White-bellied Sea-eagle	*M*				L																					
	Haliastur sphenurus	Whistling Kite								1				3	+			1		mc	1		+			2	2	
	Milvus migrans	Black Kite													+					mc								
	Accipiter fasciatus	Brown Goshawk													+	2		3	1	uc	2		+	2			1	
	Accipiter cirrocephalus	Collared Sparrowhawk													+			+		mc	1		+		1			
	Circus assimilis	Spotted Harrier												1	+			7		c						1	3	
	Aquila audax	Wedge-tailed Eagle										1	+	1	+			18	1	mc			+			4	3	
	Hieraeetus morphnoides	Little Eagle													+	2		+		uc						2	2	
	Pandion cristatus	Eastern Osprey																		(1)								
Falconidae	*Falco cenchroides*	Australian Kestrel								1		2	4		+	1		10	1	c	1		+	1		3	6	
	Falco berigora	Brown Falcon								3	1		6		+	1		21	1	c	5	+	3	2		17	9	
	Falco longipennis	Australian Hobby													+			1		uc		+	+			1	1	
	Falco hypoleucos	Grey Falcon			*P4*													1		+								
	Falco peregrinus	Peregrine Falcon	*M*	*S4*	*S*			+					1					+		uc								
Rallidae	*Gallirallus philippensis*	Buff-banded Rail																		(1)								
	Porzana tabuensis	Spotless Crake																		mc								
	Porzana fluminea	Spotted Crake																		(+)								
	Tribonyx ventralis	Black-tailed Native-hen																		s								
	Fulica atra	Eurasian Coot													+					s								
Otididae	*Ardeotis australis*	Australian Bustard			*P4*	+						1	10	2	+			23		mc		+	+			1	17	
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew			*P4*			+			1				+					s				1			1	
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt													+					(3)								
Charadriidae	*Charadrius veredus*	Oriental Plover	*M*				M																					
	Elseyornis melanops	Black-fronted Dotterel											2		+	1				mc							3	
	Erythrogonys cinctus	Red-kneed Dotterel																		(+)								
Turnicidae	*Turnix velox*	Little Button-quail								1		2	+		+			6	1	mc	4		1	2			3	
Scolopacidae	*Gallinago megala*	Swinhoe's Snipe	*M*												+													
	Numenius minutus	Little Curlew																1										
	Tringa glareola	Wood Sandpiper																		(2)								
	Actitis hypoleucos	Common Sandpiper													+					(1)								
	Calidris ferruginea	Curlew Sandpiper																		+								
Glareolidae	*Glareola maldivarum*	Oriental Pratincole	*M*				(M)																					

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Laridae	*Chlidonias hybrida*	Whiskered Tern																		(3)								
Cacatuidae	*Eolophus roseicapillus*	Galah									2	11	7	31	+	2		274	7	uc		+	+	4		39	42	
	Cacatua sanguinea	Little Corella								1	4		4	82	+	1		34		mc	5		+	12	5	35	63	
	Nymphicus hollandicus	Cockatiel												71	+	3		45		mc	10		+	12	10	2	79	
	Calyptorhynchus banksii	Red-tailed Black Cockatoo																		(+)								
Psittacidae	*Barnardius zonarius*	Australian Ringneck									3	7	3	7	+	1		26	6	c	52	+	7	15	19	64	58	
	Psephotus varius	Mulga Parrot																		(1)								
	Melopsittacus undulatus	Budgerigar								30	70	34	28	15	+	8		275		mc	104		46	20		6	266	
	Neopsephotus bourkii	Bourke's Parrot													+					uc								
Cuculidae	*Centropus phasianinus*	Pheasant Coucal													+			+			2		+		2			
	Chalcites osculans	Black-eared Cuckoo										1								(1)						1		
	Chalcites basalis	Horsfield's Bronze-Cuckoo													+	2		11		mc	30		4		6	8	3	
	Cacomantis pallidus	Pallid Cuckoo									1			1	+	2		10		mc	7		+		1	23	15	
Strigidae	*Ninox connivens*	Barking Owl																		1?								
	Ninox novaeseelandiae	Boobook Owl													+					uc	1		+	1				
Tytonidae	*Tyto javanica*	Eastern Barn Owl																		(2)							1	
Halcyonidae	*Dacelo leachii*	Blue-winged Kookaburra								1					+	1		5		mc	29		5	2	22		4	
	Todiramphus sanctus	Sacred Kingfisher											1		+	1		+	1	mc	73		+	2	72			
	Todiramphus pyrrhopygia	Red-backed Kingfisher												1	+			8		mc			+	1		4	15	
Meropidae	*Merops ornatus*	Rainbow Bee-eater	*M*				M			2	4	18	7	2	+	5		109	10	c	53	+	7	26	12	30	32	
Climacteridae	*Climacteris melanura*	Black-tailed Treecreeper								2	2			1	+					mc	2						1	
Ptilonorhynchidae	*Ptilonorhynchus guttatus*	Western Bowerbird								2	12				+			2	2	uc	21		2	2	1	1	16	
Maluridae	*Malurus leucopterus* (**4**)	White-winged Fairy-wren										4	+		+			13	1	uc	17		15			24	36	
	Malurus lamberti	Variegated Fairy-wren								8	21				+	4		96	3	c	136	+	46	21	31	236	147	
	Stipiturus ruficeps	Rufous-crowned Emu-wren													+	2		2		uc						25	21	
	Amytornis striatus (**4**)	Striated Grasswren													+	2		4			12		5		6	17	6	
	Amytornis striatus whitei	Striated Grasswren													+			+		r								
Acanthizidae	*Sericornis magnirostris*	Large-billed Scrubwren																		+								
	Calamanthus campestris	Rufous Fieldwren													+													
	Pyrrholaemus brunneus	Redthroat													+					s								
	Smicrornis brevirostris	Weebill									5	1	+	1	+	1		78	8	mc	261		69	11	37	370	431	
	Gerygone fusca fusca	Western Gerygone													+	4		5		c	2		+	2		15	3	
	Acanthiza robustirostris	Slaty-backed Thornbill													+					s								
	Acanthiza uropygialis	Chestnut-rumped Thornbill													+					c						31	18	
	Acanthiza apicalis	Broad-tailed (Inland) Thornbill													+				+	mc						34	3	
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill										4	3		+				1	s		+		4				
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote													+	2		5	2	mc	30		4		7	4	21	
	Pardalotus striatus	Striated Pardalote								9	1	2	+	27	+	1		3	1	c	12		1		2	10	21	
Meliphagidae	*Certhionyx variegates*	Pied Honeyeater										6	+		+					s			+			1		
	Lichenostomus virescens	Singing Honeyeater								6	4	52	13	4	+			259	3	mc	107	+	20	5	1	98	277	

Family	Species	Common Name	EPBC status	WCA status	DEC status	DEC Threatened fauna database	EPBC Protected Matters report	Hamersley PIL3		Raven	Mt Farquhar	Eliwanna/FF	Delphine	Mt McLeod	Mt McL N-Map	Mesa A and G	Mesa J	WPIOP	Blacksmith	Karijini NP	Solomon	Solomon Rail	V. Kings	Firetail South	Firetail North	West Turner	Brockman Sync 4	Fortescue River
	Lichenostomus keartlandi	Grey-headed Honeyeater								3	33	5	2		+	3		148	3	mc	90		5	26	22	41	26	
	Lichenostomus plumulus	Grey-fronted Honeyeater													+			2		+								
	Lichenostomus penicillatus	White-plumed Honeyeater								4		6	8		+	1		96	1	c	97	+	1	9	85	20	3	
	Purnella albifrons	White-fronted Honeyeater																5		uc							3	
	Manorina flavigula	Yellow-throated Miner								8	3	26	11	10	+			139	15	mc	73		9	26	12	36	188	
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater													+			40	1	c	6		+	9	1	46	133	
	Conopophila whitei	Grey Honeyeater													+			2		uc						1		
	Sugomel niger	Black Honeyeater													+	6		12		mc			+					
	Ephthianura tricolor	Crimson Chat													+			11		mc							16	
	Ephthianura aurifrons	Orange Chat																		(+)								
	Lichmera indistincta	Brown Honeyeater									5				+	4		131	1	mc	10		2	2		46	27	
	Melithreptus gularis	Black-chinned Honeyeater								2					+			3		mc	3		+	2			1	
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler										11	8		+	1		14	1	uc	30		5	3	23	145	23	
	Pomatostomus superciliosus	White-browed Babbler													+												5	
Eupetidae	*Cinclosoma castaneothorax*	Chestnut-breasted Quail-thrush													+			1									3	
	Psophodes occidentalis	Chiming Wedgebill								2	1				+													
Neosittidae	*Daphoenositta chruysoptera*	Varied Sittella													+					mc	7							
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike								4	11	11	27	10	+	3		23		c	44	+	9	4	10	25	55	
	Coracina maxima	Ground Cuckoo-shrike													+					s			+			2	8	
	Lalage tricolor [sueurii]	White-winged Triller								1	3		5	1	+	1		4		c	21		1		4	1	43	
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler								11	9	3	7	11	+	2		20	2	c	119	+	13	4	65	56	76	
	Colluricincla harmonica	Grey Shrike-thrush									8	1	4	1	+			14	5	mc	126		30	12	63	47	37	
	Oreoica gutturalis	Crested Bellbird										4	+		+	2		91	3	mc	71		21	6	16	58	36	
Artamidae	*Artamus personatus*	Masked Woodswallow													+			1118	1	uc			+			3		
	Artamus cinereus	Black-faced Woodswallow								2	5			9	+	1		51	4	mc	36		4	8		95	88	
	Artamus minor	Little Woodswallow								4	5	19	4		+	2		10		mc	10		2	23	4	12	24	
	Cracticus torquatus	Grey Butcherbird												1	+			1	1	mc	7		+	4	4	6	21	
	Cracticus nigrogularis	Pied Butcherbird								6	1	1	+	2	+	2		27	3	mc	35		2	12	8	36	43	
	Cracticus tibicen	Australian Magpie								3		13	9	1	+			17	3	mc	7	+	2			9	11	
Rhipiduridae	*Rhipidura fuliginosa*	Grey Fantail													+	1				s						7		
	Rhipidura leucophrys	Willie Wagtail								3	11	16	7	4	+	5		108	4	mc	37		3	10	15	89	97	
Corvidae	*Corvus bennetti*	Little Crow													+			4		(+)		+	+	2		2		
	Corvus orru	Torresian Crow								6	3	6	6	6	+	2		59	3	mc	12	+	1	6	1	75	36	
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark									1	2	6	4	+	1		22	2	mc	9	+	+	8	6	24	23	
Petroicidae	*Petroica goodenovii*	Red-capped Robin								2					+			+		mc						3	4	
	Melanodryas cucullata	Hooded Robin									1	6	2		+			16	2	mc	8		2	1		16	10	
	Poecilodryas superciliosa	White-browed Robin																		+								
Alaudidae	*Mirafra javanica horsfieldii*	Horsfield's (Singing) Bushlark								1	1				+			+		s								
Acrocephalidae	*Acrocephalus australis*	Australian Reed-warbler																		s								
Megaluridae	*Cincloramphus mathewsi*	Rufous Songlark													+	1		2		mc	8		+				16	

Family	Species	Common Name	EPBC status	WCA status	DEC status	DEC Threatened fauna database	EPBC Protected Matters report	Hamersley PIL3		Raven	Mt Farquhar	Eliwanna/FF	Delphine	Mt McLeod	Mt McL N-Map	Mesa A and G	Mesa J	WPIOP	Blacksmith	Karijini NP	Solomon	Solomon Rail	V. Kings	Firetail South	Firetail North	West Turner	Brockman Sync 4	Fortescue River
	Cincloramphus cruralis	Brown Songlark													+			3		uc			+			3	2	
	Eremiornis carteri	Spinifexbird								2		5	2		+	3		14	3	mc	71		8	8	2	13	19	
Hirundinidae	*Hirundo neoxena*	Welcome Swallow																+										
	Petrochelidon ariel	Fairy Martin													+	2				(+)			+				1	
	Petrochelidon nigricans	Tree Martin													+			1		c	9		+				2	
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird													+	1		1		mc	30		+		21	6	8	
Estrildidae	*Taeniopygia guttata*	Zebra Finch								33	15		4	235	+	6		309	20+	vc	67	+	7	32	6	817	2051	
	Neochmia ruficauda subclarescens	Star Finch (western)			P4										+					c								
	Emblema pictum	Painted Finch								12	4	20	+		+	10		35		c	88		12	6	2	139	282	
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit													+			1		s							7	

Notes to Table:

(**1**) Morgan et al. (2009) consider *Neosilurus* sp. in Fortescue River as distinct from *N. hyrtlii* (type locality Fitzroy River, Qld)

(**2**) *Planigale* is represented by two undescribed species in the Pilbara, which have often been conflated with *P. ingrami* and *P. maculata* (Gibson & McKenzie 2009). [Unpublished names have been used in some Ecoscape reports in error]

(**3**) Some extralimital species records have been deleted (e.g. *Litoria spenceri*) or assigned to the similar (or similarly-named) species likely to be intended, if it is unique (e.g. Yellow-throated Honeyeater [Tasmanian endemic] => Yellow-throated Miner; *Vespadelus pumilus* [Eastern Forest Bat] scored as *V. finlaysoni*). In some cases this is not possible, e.g. former *Cryptoblepharus plagiocephalus* includes *C. ustulatus* and *C. buchanani* (Horner 2007); former *Lerista muelleri* includes *L. clara* and *L. verhmens* as well as *L. muelleri* sensu stricto (L A Smith & Adams 2007). Pilbara specimens previously identified as *Underwoodisaurus milii* (or *Nephrurus milii*) are now recognised as *Underwoodisaurus seorsus*, which 'may be of conservation concern' (Doughty & Oliver 2011); *Egernia cygnitos* is the western Pilbara species formerly included in *E. depressa* (Doughty, Kealley & Donnellan 2011). *Lucasium squarrosum* record retained, but likely to represent *L. wombeyi*.

(**4**) Mainland WA records of *Malurus leucopterus* are mostly identified as *M. leucopterus leuconotus* (blue with white wings), but the few records from the western Hamersley range on NatureMap (DEC & Western Australian Museum 2011) are identified as *M. leucopterus leucopterus*, the black-plumaged subspecies of Dirk Hartog Island. The Hamersley records come from fauna survey returns and the identifications are listed as 'certain'. A similar situation applies to two other conservation-listed subspecies. Peter Mawson (DEC; email 26 Aug 2011) states: "*Amytornis striatus striatus* – is restricted to the DEC Midwest and Goldfields regions. Any records from the Pilbara are most likely *Amytornis striatus whitei* (not threatened or Priority listed). *Malurus leucopterus leucopterus* – is restricted to Dirk Hartog Island, and so any Pilbara records should be *M. l. leuconotus*. *Pogona minor minima* – is restricted to the Abrolhos Islands and any records in the Pilbara are most likely *Pogona minor minor*."

Appendix Nine: Conservation Significant Flora Risk Assessment

Table 25: Conservation Significant Flora Risk Assessment Matrix

Species	Cons Code	Soil	Landform	Vegetation	Soil Type Present	Landform Present	Associated Vegetation Present	Known from Nearby	Likelihood of Occurring in Flying Fish
Lepidium catapycnon	T	Skeletal soils	Hillsides	*Eucalyptus leucophloia*, *Triodia* spp.	Y	Y	Y	N	Unlikely
Thryptomene wittweri	T	Skeletal red stony soils	Breakaways, stony creek beds	*Eucalyptus kingsmillii*	Y	Y	N	N	Unlikely
Bothriochloa decipiens var. *cloncurrensis*	P1	Clay, loam	Damp depression; clay plain	Mulga, *Eucalyptus camaldulensis*	N	N	N	N	None (rare)
Calotis squamigera	P1	Pebbly loam	Plain	Mulga, *Acacia xiphophylla*	N	N	N	N	None (rare)
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	P1	Red-brown skeletal soils, ironstone	Steep slopes, summits	*Eucalyptus kingsmillii*	Y	Y	N	N	Unlikely
Eremophila sp. West Angelas (S. van Leeuwen 4086)	P1	Banded ironstone	High hills; summits	*Eucalyptus kingsmillii*, Mulga	Y	N	N	N	Unlikely
Eremophila sp. Snowy Mountain (S. van. Leeuwen 3737)	P1	Ironstone	High hills; summits	*Eucalyptus leucophloia*	Y	N	Y	N	Unlikely
Eremophila spongiocarpa	P1	Weakly saline alluvium	Alluvial plain on margins of marsh	Samphire	N	N	N	N	None (rare)
Eucalyptus lucens	P1	Ironstone rocks	Rocky slopes and mountain tops, high in the landscape	*Eucalyptus kingsmillii*	Y	N	N	N	Unlikely
Genus sp. Hamersley Range hilltops (S van Leeuwen 4345)	P1	Skeletal, brown gritty soil over ironstone	Hill summit	*Eucalyptus leucophloia*, *Triodia* spp.	Y	Y	Y	N	Unlikely
Sida sp. Hamersley Range (K. Newbey 10692)	P1	Skeletal soil; ironstone	Hilltops, cliffs, scree	*Eucalyptus leucophloia* , *Eucalyptus gamophylla*	Y	Y	Y	Y	Likely
Tetratheca fordiana ms	P1	Shale pocket amongst ironstone	Midslope	*Eucalyptus kingsmillii*	Y	Y	N	N	Unlikely
Teucrium pilbaranum	P1	Clay	Crab hole plain in a river floodplain, margin of calcrete table	*Eucalyptus camaldulensis, Eucalyptus victrix, Chrysopogon fallax*	N	N	N	N	None (rare)
Vittadinia sp. Coondewanna Flats (s. van Leeuwen 4684)	P1	Clay loam soils	Plain	Mulga	N	N	N	N	None (rare)
Adiantum capillus-veneris	P2	Rocky	Moist, sheltered sites in gorges and on cliff walls	Unknown	N	N	N	N	None (rare)

Species	Cons Code	Soil	Landform	Vegetation	Soil Type Present	Landform Present	Associated Vegetation Present	Known from Nearby	Likelihood of Occurring in Flying Fish
Cladium procerum	P2	Loam, gravel	Perennial pools	Unknown	N	N	N	N	None (rare)
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	P2	Stony soil	Slopes, low in landscape	Mulga	Y	Y	N	N	None (rare)
Oxalis sp. Pilbara (M.E. Trudgen 12725)	P2	Red-brown pebbly/rocky loam amongst boulders	Gullies	*Acacia* spp, *Eucalyptus leucophloia*	Y	N	Y	N	Unlikely
Paspalidium retiglume	P2	Clay; cracking	Plain	Grassland/herbland	N	N	N	N	None (rare)
Pilbara trudgenii	P2	Skeletal, red stony soil over ironstone	Hill summits, steep slopes, screes, cliff faces	*Eucalyptus kingsmillii*	Y	Y	N	N	Unlikely
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	P2	Skeletal, brown gritty soil over basalt	Summits of hills, steep hills	*Eucalyptus kingsmillii*	Y	Y	N	N	Unlikely
Spartothamnella puberula	P2	Rocky loam, sandy or skeletal soils, clay	Gorge, gully	*Acacia* spp.	Y	N	N	Y	Unlikely
Vigna sp. central (M.E. Trudgen 1626)	P2	Sandy plain; sand over compacted hardpan and limestone rock; claypan of fine cracking clays	Plain, claypan (valleys in CPP)	*Triodia epactia*, Mulga, *Eucalyptus camaldulensis*	Y	Y	N	Y	Likely
Acacia daweana	P3	Stony red loamy soils	Low rocky rises, along drainage lines	*Acacia* spp, *Eucalyptus* spp.	Y	Y	Y	N	Unlikely
Acacia subtiliformis	P3	Rocky calcrete plateau	Plateau	*Triodia* spp.	N	N	Y	N	Unlikely
Calotis latiuscula	P3	Sand, loam	Plain	Mulga	N	N	N	N	None (rare)
Dampiera anonyma ms	P3	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite	Hill summits, upper slopes	*Eucalyptus kingsmillii, Acacia hamersleyana*	Y	N	N	Y	Unlikely
Dampiera metallorum ms	P3	Skeletal red-brown gravely soils over banded ironstone	Steep slopes and summits	*Eucalyptus kingsmillii*	Y	N	N	N	Unlikely
Eragrostis crateriformis	P3	Clayey loam or clay	Creek banks, depressions	*Triodia epactia, Eucalyptus victrix*	N	Y	N	N	Unlikely
Eragrostis surreyana	P3	Red-brown clay	Drainage line	*Eucalyptus victrix, Eucalyptus camaldulensis, Cyperus vaginatus*	N	N	N	N	None (rare)

Species	Cons Code	Soil	Landform	Vegetation	Soil Type Present	Landform Present	Associated Vegetation Present	Known from Nearby	Likelihood of Occurring in Flying Fish
Eremophila forrestii subsp. *viridis*	P3	Unknown	Sandplain	Unknown	U	N	N	N	None (rare)
Eremophila magnifica subsp. *velutina*	P3	Skeletal soils over ironstone	Summits	*Eucalyptus kingsmillii*	Y	Y	Y	Y	Does occur
Fimbristylis sieberiana	P3	Mud, skeletal soil pockets	Pool edges, sandstone cliffs	*Cyperus vaginatus*	N	N	N	N	None (rare)
Geijera salicifolia	P3	Skeletal soils, stony soils	Massive rock scree, gorges	Mulga	Y	Y	N	N	Unlikely
Glycine falcata	P3	Black clayey sand	Floodplains; depressions in crabhole plains on river	Grassland; *Eriachne* spp.	N	N	N	Y	None (rare)
Gymnanthera cunninghamii	P3	Sand, calcrete, clay loam	Drainage line	*Eucalyptus camaldulensis, Eucalyptus victrix, Acacia citrinoviridis*	Y	N	N	Y	Unlikely
Indigofera gilesii subsp. *gilesii*	P3	Pebbly loam amongst boulders & outcrops	Hills	*Eucalyptus leucophloia, Corymbia hamersleyana, Corymbia ferriticola*	Y	Y	N	N	Unlikely
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	Alluvium, skeletal ironstone	Creeks and gorges	Not given	Y	Y	Y	Y	Does occur
Iotasperma sessilifolium	P3	Cracking clay, black loam	Edges of waterholes, plains	Grassland, *Eriachne* spp., *Astrebla* spp., *Eucalyptus victrix*	N	N	N	Y	None (rare)
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	Cracking clay, basalt	Gently undulating plain with large surface rocks, flat crabholed plain	*Astrebla* grassland; Mulga	N	N	N	Y	None (rare)
Olearia mucronata	P3	Schist	Schistose hills, along drainage channels	Mulga; grassland	N	N	N	Y	None (rare)
Phyllanthus aridus	P3	Sandstone, gravel, red sand	Sandplain, hills	Coastal	N	N	N	N	None (rare)
Ptilotus subspinescens	P3	Rocky	Gentle rocky slopes, screes and the bases of screes	Unknown	Y	Y	U	Y	Likely
Rhagodia sp. Hamersley (M. Trudgen 17794)	P3	Clay loam, sand loam, colluvium	Floodplain / lower slopes	Mulga; *Triodia* grassland	Y	Y	N	Y	Unlikely
Rostellularia adscendens var. *latifolia*	P3	Ironstone soils	Near creeks, rocky hills	Mulga; *Eucalyptus kingsmillii*	Y	Y	N	Y	Unlikely
Sida sp. Barlee Range (S van Leeuwen 1642)	P3	Skeletal red soils pockets	Steep slope	*Ficus brachypoda, Corymbia ferriticola, Eucalyptus victrix, Eucalyptus kingsmillii*	Y	Y	N	Y	Unlikely
Swainsona sp. Hamersley Station (A.A. Mitchell 196)	P3	Clay loam (cracking)	Flat crabholed plain	*Astrebla* grassland; Mulga	N	N	N	Y	Unlikely

Species	Cons Code	Soil	Landform	Vegetation	Soil Type Present	Landform Present	Associated Vegetation Present	Known from Nearby	Likelihood of Occurring in Flying Fish
Triodia sp. Mt. Ella (ME Trudgen 12739)	P3	Light orange-brown, pebbly loam. Amongst rocks & outcrops, gully slopes	Hilltops, gorges, gullies	*Eucalyptus leucophloia, Corymbia ferriticola*, Mulga	N	Y	N	N	Unlikely
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	P3	Banded ironstone, Robe pisolite	Rocky hills and mesas	*Eucalyptus leucophloia, Acacia pruinocarpa, Acacia bivenosa, Acacia inaequilatera*	N	N	Y	Y	Unlikely
Acacia bromilowiana	P4	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt	Rocky hills, breakaways, scree slopes, gorges, creek beds	*Eucalyptus leucophloia, Eucalyptus kingsmillii, Corymbia ferriticola, Acacia hamersleyensis*	Y	Y	N	Y	Likely
Eremophila magnifica subsp. *magnifica*	P4	Skeletal soils over ironstone	Rocky screes	*Corymbia hamersleyana, Eucalyptus leucophloia, Eucalyptus kingsmillii*	Y	Y	Y	Y	Likely
Goodenia nuda	P4	Alluvium, loam, clay (various)	Adjacent to drainage, floodplain, hills	Various	Y	Y	Y	y	Does occur
Livistona alfredii	P4	Stony loam, limestone	Edges of permanent pools	*Eucalyptus camaldulensis , Eucalyptus victrix, Corymbia opaca*	N	N	N	Y	Unlikely
Ptilotus mollis	P4	Rocky	Stony hills and screes	*Eucalyptus leucophloia*, Mulga, *Triodia* spp.	Y	Y	N	Y	Likely
Rhynchosia bungarensis	P4	Pebbly, coarse sand	Banks of flow line	Various	Y	Y	Y	Y	Almost certain