

**DULCIE SAND EXTRACTION  
CLEARING PERMIT (AREA PERMIT) APPLICATION  
SUPPORTING DOCUMENTATION**

PREPARED FOR:

**DULCIE OPERATIONS**

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## DULCIE SAND EXTRACTION CLEARING PERMIT SUPPORT DOCUMENT

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# 1. SITE INFORMATION

## 1.1 BACKGROUND INFORMATION

This Clearing Permit (Area Permit) Application supporting document for Dulcie Sand Extraction supports the application for a native vegetation clearing permit for proposed sand extraction activities on tenement M 77/1267. The proposed sand extraction operation will supply sand for construction purposes at the nearby Dulcie Heap Leach project on M 77/1246 and M 77/1250.

A clearing permit (purpose permit) CPS 5344/1 was granted in 2013 for the initial sand extraction operations at the site. CPS 5344/1 permit lapsed on 31 July 2018 after completion of all approved clearing. Figure 1 shows regrowth of vegetation within the previous extraction area. This new application is within the boundaries of the previous permit and seeks approval for additional clearing to extend the sand extraction operations.



**Figure 1: Existing Clearing and Revegetation in the Application Area**

### 1.1.1 Location

The clearing permit application area (application area) is 40 km by bitumen and gravel road from Marvel Loch, 70 km from the regional centre of Southern Cross and 450 km east of Perth. The project location is shown in Figure 2.

### 1.1.2 Tenure

The application area is located on Mining Lease M 77/1267. This tenement is held by the proponents. An extract of the DMIRS tenement register confirming the ownership is attached in Appendix 1.



Figure 2: Location Plan

## 1.2 REGIONAL SETTING

The application area is located in the Yilgarn District of Western Australia. Grazing, cereal cropping, exploration and mining are major land uses in the region whilst tourism is a growing industry. The main regional centre is Southern Cross, 70 km to the north. The smaller town of Marvel Loch is 40 km to the north (Figure 2). Both these towns can be accessed via bitumen and dirt roads.

The project area has a semi-arid climate with hot dry summers and cools to mild winters. The average annual rainfall is about 280 mm with about half falling from May to August with the passage of cold fronts. On average, pan evaporation is an order of magnitude greater than rainfall and exceeds rainfall in every month of the year. The average minimum temperature is approximately 11°C and the average maximum temperature is approximately 25°C.

The regional geology of the project area lies within the Southern Cross Greenstone Belt which is a belt of variably metamorphosed Archaean rocks comprising mafic and ultramafic volcanics, sedimentary rocks, and more restricted felsic volcanics (Bagas 1994). The belt extends discontinuously for approximately 400 km, from north of Southern Cross to Ravensthorpe. The eastern margin of the greenstone belt is in contact with a large domal structure formed by gneissic and granitic rocks with a steeply outward dipping foliation.

## 1.3 TOPOGRAPHY AND LAND FORMS

Dulcie falls within the Avon Botanical District of WA according to Beard (1990). This is divided into two subregions with the project area occurring within the Avon Wheatbelt 1 (AW1) subregion (Beecham, 2001), which is characterised by an undulating landscape with low relief. There is no connected drainage and salt lake chains occur as remnants of ancient drainage systems that now only function in very wet years.

On a local scale, the project is situated on Vacant Crown Land, within an area of very open shrub mallee on a low relief sandplain approximately 400 metres above sea level. A line of low hills forming part of the Parker Range lies immediately to the east and a very flat playa lake system to the northeast.

## 1.4 SOILS

Soils of the Dulcie project area are of the upland section of the typical wheatbelt “catena” of soil type, including dissected lateritic uplands with yellow sands and duplex sands over gravel. Within the application area soils are yellow sands (Figure 1).

## 1.5 HYDROLOGY

### 1.5.1 Surface Hydrology

The application area lies within the Avon Wheatbelt 1 subregion of WA which is an area of active drainage and characterised by an undulating landscape with low relief. There is no connected drainage. Salt lake chains occur as remnants of ancient drainage systems that now only function in very wet years.

There are no visually distinct watercourses and no wetland environments within the application area.

### 1.5.2 Hydrogeology

An initial assessment of the groundwater in the Dulcie region was undertaken by Rockwater (2010). In the general vicinity of the project there are few bores recorded in the Department of Water and Environmental Regulation (DWER) WIN database. They include two dry bores drilled in granite as part of a State Government drought-relief programme (Nos.3 and 6); eight bores at the Yilgarn Star mine; and a salt-water well at Cheritons Find. The groundwater in all these bores is recorded as having salinities in the range of 120,000 to 210,000 TDS.

In the Dulcie area the deeper mineralised zones, the BIF, transitional rocks at the base of weathering, and cross-cutting fracture zones are all potential groundwater aquifers. A number of deep exploration drill holes have been recorded as being “wet”. Most of the water in these holes was intersected near the base of joint weathering at about 60 metres depth. Analyses of two samples from one of these holes are shown in Table 1 below.

A bore at Olga Rocks was used in the mid 1980’s by Thames Mining for a small heap leach operation about 1.5 km to the south. The groundwater salinity reported by Thames Mining was approximately 90,000 ppm TDS. The bore was pumped at a rate of about 350,000 kL/year. The standing water level is at 2.2 m below ground level (mBGL). Analyses of two samples taken from the Olga Rocks bore are shown in Table 1.

**Table 1: Analyses of Groundwater in the Dulcie Project Area (AMMTEC, 2010)**

Analyte	Unit	Drill hole DLRC1004 (at 96 m)	Drill hole DRLC1006 (at 102 m)	Olga Rocks bore (Black Drum)	Olga Rocks bore (Blue Drum)
Ca	ppm	681	1245	1189	1132
K	ppm	201	255	291	295
Mg	ppm	2205	1766	3572	3252
Na	ppm	13073	13300	20600	20390
CO <sub>3</sub>	ppm	170	130	100	175
Cl	ppm	22068	25879	38286	39350
SO <sub>4</sub>	ppm	2632	2393	4434	4605
TDS	ppm	46410	53365	80365	81390
pH		6.92	6.83	6.48	7.10
Conductivity	µS/cm	55.7	63.0	87.4	88.4
SG	g/cm <sup>3</sup>	1.0228	1.0273	1.0435	1.0423

There are no surface water bodies within the application area. No surface water quality data is available for the application area but the DWER WINS database contains a single record of surface water from a site on Emu Fence Road 20 km west of Dulcie which was saline with a TDS of 57,200 ppm.

## 1.6 VEGETATION AND FLORA

The application area is within the Avon Wheatbelt P1 subregion of the Avon Wheatbelt Interim Biogeographical Regionalisation for Australia (IBRA) bioregion. Although this bioregion is characterised by intensive clearing for agriculture, the application area is located at the eastern edge of the bioregion, approximately 10 km from the limit of intensive clearing (Figure 2).

A level 1 flora and vegetation survey in accordance with Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) of the proposed project area was undertaken in June 2012. A total of 96 species in 41 genera and 12 families were recorded and no introduced species were recorded. The vegetation throughout the application area is considered to be in good to very good health. The survey report is attached as Appendix 2 (Botanica 2012a).

As most plants were in flower during the time of surveying and 95% of flora species could be identified, it is considered that the survey gave a good indication of the full range of annual and seasonal species present in the vegetation communities of the project area.



## 1.7 VEGETATION

The clearing permit area is entirely within the Pre-European Beard vegetation association 552 (DPIRD 006 dataset) in the Parker bioregion. As shown in Table 2, over 97% of the pre-European extent of this association within the bioregion remains (DBCA 2019).

**Table 2: Extent of Beard Vegetation Associations (Parker Bioregion)**

Vegetation Association	Pre-European extent (ha)	Current extent (ha)	Pre-European extent remaining (%)	% of Current extent within DBCA-managed lands	Vegetation Description (Beard, 1990)
Parker 552	11,607.85	11264.18	97.04	0.00	Shrublands; <i>Casuarina acutivalvis</i> & <i>Calothamnus</i> (also <i>Melaleuca</i> ) thicket on greenstone hills

Botanica (Appendix 2) mapped a total of seven vegetation communities in their 2012 survey of the sand extraction area and haulage route. Only one of these occurs in the application area (Figure 3). Table 3 describes each vegetation community that was mapped. Mapped areas in Table 3 have been updated from Appendix 2 to account for clearing since 2012. None of the communities resemble any of the Threatened Ecological Communities (TECs) listed by DCCEEW or DBCA (Botanica 2012a).

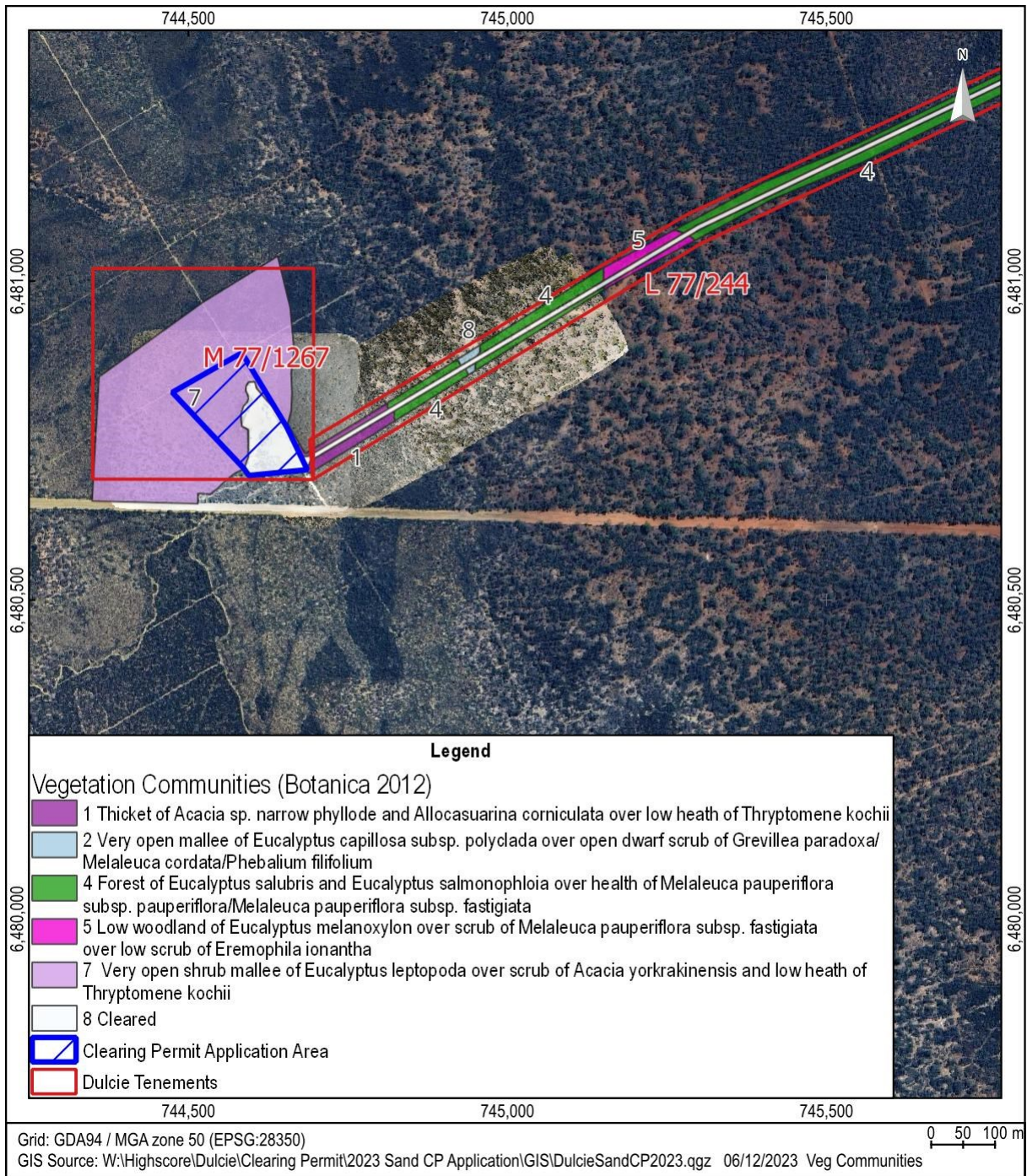
The vegetation communities described are well represented in the Yilgarn region and therefore are not thought to be regionally and locally significant.

The application area is located within the mapped buffer of a Priority 3 Parker Range vegetation complexes Ecological Community, however none of the vegetation communities that characterise this PEC were found in the application area or the survey area. It is located approximately 5 km west of the Jilbadji Nature Reserve, which is declared in Environmental Protection (Environmentally Sensitive Areas) Notice 2005, Government Gazette No. 55 as an Environmentally Sensitive Area.

**Table 3: Vegetation Communities of the Survey Area**

Code	Vegetation Community Description	Area Mapped in Survey (ha)	Area in Clearing Permit Application Area (ha)
1	Thicket of <i>Acacia</i> sp. narrow phyllode and <i>Allocasuarina corniculata</i> over low heath of <i>Thryptomene kochii</i> .	0.5	0.0
2	Very open mallee of <i>Eucalyptus capillosa</i> subsp. <i>polyclada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> / <i>Melaleuca cordata</i> / <i>Phebalium filifolium</i> .	0.3	0.0
3	Low woodland of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i> .	0.2	0.0
4	Forest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> .	2.8	0.0

Code	Vegetation Community Description	Area Mapped in Survey (ha)	Area in Clearing Permit Application Area (ha)
5	Low woodland of <i>Eucalyptus melanoxyton</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i> .	0.4	0.0
6	Open mallee of <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i> .	0.2	0.0
7	Very open shrub mallee of <i>Eucalyptus leptopoda</i> over scrub of <i>Acacia yorkkrakensis</i> and low heath of <i>Thryptomene kochii</i> .	8.5	1.2
Cleared	Cleared and regrowth on recently cleared areas.	NA	0.8
Total		12.86	2.0



**Figure 3: Mapped Vegetation Communities (Botanica 2012a)**

## 1.8 FLORA

The following searches were undertaken in 2012 to identify known locations of conservation significant flora in and surrounding the application area (Appendix 2):

- Declared Rare and Priority Flora Database (DEC).
- Western Australian Herbarium Specimen Database.

The database searches in 2012 identified 12 priority flora species and one declared rare flora species recorded within 20 km of the application area. Based on these results, Botanica (2012a) assessed three priority species as

potentially occurring in the clearing permit application area, as they occur in similar habitats and vegetation communities as those identified during the flora survey (Table 4). These are *Notisia intonsa* (Priority 3), *Hakea pendens* (Priority 3) and *Grevillea lissopleura* (Priority 1). The accepted name of *Notisia intonsa* has changed since the 2012 Botanica report, which refers to it as *Gnephosis intonsa*. Priority status of *Notisia intonsa* and *Hakea pendens* have also been reduced to the current P3 from P1 and P2 respectively in 2012.

A Naturemap search (Appendix 3) was undertaken in November 2023 for a 20-km radius to compare with and update the 2012 results. The new search returned 31 species. These comprise 10 of the species from the 2012 database search and 21 new additions. One of the species returned in the 2012 result is no longer listed as a priority species, two others are still priority listed but are now not listed as occurring in the search area.

**Table 4: Conservation Significant Flora Recorded and with the Potential to Occur within the Dulcie Tenements Source: Botanica (2012a)**

Scientific Name	Conservation Category	Description and Habitat	Recorded in Clearing Permit Area
<i>Notisia intonsa</i>	P3	Prostrate to ascending annual herb, 1 – 4 cm high. Yellow and brown flowers from September to October. It occurs on red/brown clays and stony saline loams.	No
<i>Grevillea lissopleura</i>	P1	Erect shrub, 50 – 120 cm high. Flowers in August. It occurs on stony loam on banded ironstone ridges.	No
<i>Hakea pendens</i>	P3	Shrub, 2 – 3 m high and 2.5 – 3.1 m wide. Pink and white flowers in September. It occurs on stony loams and ironstone ridges.	No

DBCA has no records of priority flora in the clearing permit application area and the nearest record is of a priority species approximately two kilometres to the east. No declared rare or priority species were found during the survey of the application area (Botanica 2012a). Botanica (2012b) recorded *Hakea pendens* 2,000 m east of the application area and *Grevillea lissopleura* 2,300 m east of the application area in a survey of the adjacent Dulcie project tenements.

## 1.9 FAUNA

In July 2009 a level 1 survey according to the EPA (2004b) Guidance Statement 56 was undertaken by Terrestrial Ecosystems (2009) for the Dulcie area to assess the condition of the fauna habitat and to search for active Mallee Fowl mounds and other evidence of conservation significant species (Appendix 4). The survey covered the area of the Dulcie laterite project mining leases (approximately 370 ha). The survey did not specifically cover the clearing permit application area, which extends 2 km west of the surveyed area, but is sufficiently general in scope to provide guidance on fauna habitat likely to occur there.

A Naturemap search was undertaken in November 2023 for a 20-km radius to compare with and update the 2009 results. The new search returned 5 conservation significant species. Four of these were considered in the 2009 assessment. The additional species is an invertebrate *Aganippe castellum* (Tree-stem Trapdoor spider) listed as Priority 4. The habitat in the application area does not resemble the described critical habitat for this species, which is: Flood prone depressions or flats which support myrtaceous shrub communities. In particular, those areas

supporting Broombush (*Melaleuca uncinata*) and Sheoaks (such as *Allocasuarina acutivalvis*) in sandy loam soils (Avon Catchment Council 2007).

The Naturemap search also identified the application area as within the potential range of the Arid Bronze Azure Butterflies host ant and the medium priority survey area for Night Parrots. Review of the survey guidelines for both species indicates surveys are not required for either species due to lack of suitable habitat (Salmon Gums for the ant or Spinifex for the Night Parrot). The 2009 fauna survey results are therefore considered still applicable for current assessments.

Terrestrial Ecosystems (2009) identified the following five habitat types in the Dulcie area:

- Allocasuarina shrubland that is often quite dense to about 2.5 m.
- Open Eucalypt woodland with little understorey.
- Eucalypt woodland over Melaleuca that can be quite dense, but with little vegetation at ground level.
- Acacia shrubland to about 2.5 m.
- Disturbed areas that have been previously mined or subject to exploration activity.

The vegetation communities identified by Botanica (2012a) in the clearing permit application area are consistent with the habitats identified by Terrestrial Ecosystems (2009) indicating that there are no additional habitat types in clearing permit application area.

The land systems, vegetation and habitats of the clearing permit application area are common and widely represented in the region and do not provide any important ecological linkage or fauna movement corridors (Terrestrial Ecosystems 2009).

Predictions of the fauna likely to occur in the clearing permit application area are based upon an assessment of the habitats within the region. The habitat of the clearing permit application area will only be suitable for a subset of the species listed in Table 5 as having the potential to occur in the Dulcie area.

Conservation significant fauna species are those listed as protected under the Federal EPBC Act and/or Western Australia's BC Act, due to their status as rare, threatened, vulnerable or migratory species or listed as Priority Species by DBCA. Priority species are not specially protected by legislation but are species for which DBCA consider there is some concern or requirement for monitoring.

According to Terrestrial Ecosystems (2009), 12 protected and 10 priority species have the potential to occur in the Dulcie area. These species and their likelihood of being present in the project area based on their known ranges and habitat preferences are listed in Table 5.

Terrestrial ecosystems concluded that it is unlikely that Red-tailed Phascogales (*Phascogale calura*), Western Brush Wallabies (*Macropus irma*), Western Spiny-tailed Skinks (*Egernia stokesii badia*), Carpet Pythons (*Morelia spilota imbricata*), Womas (*Aspidites ramsayi*), Lake Cronin Snakes (*Paroplocephalus atriceps*), Malleefowl (*Leipoa ocellata*), Slender-billed Thornbills (*Acanthiza iredalei iredalei*), Major Mitchell's Cockatoos (*Cacatua leadbeateri*), Hooded Plovers (*Charadrius rubricollis rubricollis*), Crested Shrike-tits (*Falcunculus frontatus leucogaster*) and Bush Stone-curlews (*Burhinus grallarius*) inhabit the Dulcie area.

There is a low possibility that the Chuditch (*Dasyurus geoffroii*) and Carpet Python (*Morelia spilota imbricata*) are in the general area and there is also a possibility that the Dulcie area contains Shy Heathwrens (*Hylacola cauta whitlocki*), Crested Bellbirds (*Oreoica gutturalis gutturalis*), Western Rosellas (*Platycercus icterotis xanthogenys*) and Greater Long-eared Bats (*Nyctophilus timoriensis*).

Table 5: Potential Conservation Significant Fauna of the Dulcie Area

Species	Common Name	Conservation Status			Habitat and Description	Likelihood of Occurrence
		EPBC Act	BC Act	DBCA		
<b>Mammals</b>						
<i>Dasyurus geoffroii</i>	Chuditch	Vulnerable	Schedule 1		Wooded areas.	Possible.
<i>Phascogale calura</i>	Red-tailed Phascogale	Endangered	Schedule 1		Woodlands with hollow-containing eucalypts.	Unlikely.
<i>Notamacropus irma</i>	Western Brush Wallaby			Priority 4	Woodland with thickets and open flats.	Unlikely.
<i>Nyctophilus (timoriensis) sp. 1</i>	Greater Long-eared Bat			Priority 4	Woodlands. Roost in hollows or under loose bark.	Potentially.
<b>Reptiles</b>						
<i>Egernia stokesii badia</i>	Western Spiny-tailed Skink		Schedule 1		York Gum ( <i>Eucalyptus loxophleba</i> ) woodland.	Unlikely.
<i>Morelia spilota imbricata</i>	Carpet Python		Schedule 4		Wide range of habitats in temperate areas.	Highly Unlikely.
<i>Aspidites ramsayi</i>	Woma (southwestern)		Schedule 4		Grasslands and open heath on sandplains and dunes.	Highly Unlikely.
<i>Paroplocephalus atriceps</i>	Lake Cronin Snake			Priority 3	Not well-known, possibly arboreal.	Unlikely.
<b>Birds</b>						
<i>Leipoa ocellata</i>	Malleefowl	Vulnerable	Schedule 1		Mallee woodland on sandy soils.	Unlikely.
<i>Zanda latirostris</i>	Carnaby's Black-Cockatoo	Endangered	Schedule 1		Eucalypt woodland. Nests in hollows.	Infrequently.

Species	Common Name	Conservation Status			Habitat and Description	Likelihood of Occurrence
		EPBC Act	BC Act	DBCA		
<i>Platycercus icterotis xanthogenys (Mallee)</i>	Western Rosella		Schedule 1		Eucalypt woodland.	Potentially.
<i>Acanthiza iredalei iredalei</i>	Slender-billed Thornbill (western)	Vulnerable			Chenopod shrublands.	Unlikely.
<i>Merops ornatus</i>	Rainbow Bee-eater	Migratory			Creeks, sandy areas.	Likely.
<i>Apus pacificus</i>	Fork-tailed Swift	Migratory			Overfly any habitat.	Infrequently (may overfly).
<i>Falco peregrinus</i>	Peregrine Falcon		Schedule 4		Nest on cliffs, open pits.	Likely.
<i>Cacatua leadbeateri</i>	Major Mitchell' Cockatoo		Schedule 4		Mallee scrub and dry woodlands.	Unlikely.
<i>Hylacola cauta whilocki</i>	Shy Heathwren			Priority 4	Woodland with a dense heath understory.	Potentially.
<i>Oreoica gutturalis gutturalis</i>	Crested Bellbird			Priority 4	Temperate and arid zone woodlands.	Potentially.
<i>Charadrius rubicollis rubicollis</i>	Hooded Plover (western subspecies)			Priority 4	Southern coastal beaches and inland salt lakes.	Unlikely.
<i>Falcunculus frontatus leucogaster</i>	Crested Shrike-tit (south-western subspecies)			Priority 4	Eucalypt forest and woodlands.	Unlikely.

Species	Common Name	Conservation Status			Habitat and Description	Likelihood of Occurrence
		EPBC Act	BC Act	DBCA		
<i>Burhinus grallarius</i>	Bush Stone-curlew			Priority 4	Lightly wooded plains.	Unlikely.
<i>Calamanthus campestris montanellus</i>	Rufous Fieldwren			Priority 4	Scattered shrubs over sandplain.	Likely.
<i>Pomatostomus superciliosus ashbyi</i>	White-browed Babbler			Priority 4	Eucalypt forest and woodlands.	Likely.



Four species, the Rainbow Bee-eater (*Merops ornatus*), Peregrine Falcon (*Falco peregrinus*), Rufous Fieldwren (*Calamanthus campestris montanellus*) and White-browed Babbler (*Pomatostomus superciliosus ashbyi*) were assessed as likely to occur in the general area. Carnaby's Black Cockatoos (*Zanda latirostris*) may infrequently inhabit the Dulcie area, though this is unlikely and Fork-tailed swifts (*Apus pacificus*) might occasionally overfly the area.

The land systems, vegetation and fauna habitats of the application area and surrounding survey area are common and widely represented in the region. The application area does not contain any important ecological linkage habitats or fauna movement corridors. Clearing within these habitats is unlikely to have a significant impact on the conservation status of fauna species of conservation significance given the large local areas of similar habitat which will be retained. The potential impact of the project on species with a moderate to high likelihood of occurring in the clearing permit application area is discussed in the paragraphs below. Section 4.4.1 of Terrestrial Ecosystems, 2009 (Appendix 4) describes the potential impact of vegetation clearing on all conservation-significant and priority species.

The Rainbow Bee-eater (*Merops ornatus*), Peregrine Falcon (*Falco peregrinus*), Rufous Fieldwren (*Calamanthus campestris montanellus*) and White-browed Babbler (*Pomatostomus superciliosus ashbyi*) were the four species assessed as being likely to occur in the general project area. The Shy Heathwren (*Hylacola cauta whitlocki*), Crested Bellbirds (*Oreoica gutturalis gutturalis*), Western Rosella (*Platycercus icterotis xanthogenys*) and Greater Long-eared Bat (*Nyctophilus timoriensis*) were assessed as potentially occurring in the Dulcie area. Terrestrial Ecosystems (2009) assessed that the impact of the proposed clearing on these species is not likely to be significant because the proposed area represents a small fraction of locally available habitat for these species. Once clearing commences, if there are any individuals of these species affected, they will move to adjacent habitat.

The Chuditch (*Dasyurus geoffroii*) inhabits the region around Dulcie at low population densities. Terrestrial Ecosystems (2009) assessed the impact of proposed vegetation clearing on the overall conservation status of this species as low due to the abundance of suitable habitat in the surrounding area.

The Fork-tailed Swift (*Apus pacificus*) and Carnaby's Black Cockatoos (*Zanda latirostris*) may be infrequent visitors to the Dulcie project area. Suitable habitat for both of these species is abundant in the surrounding area and Terrestrial Ecosystems assessed the impact of mining operations on these species as low for this reason. Terrestrial Ecosystems did not find any chewed nuts or flowers in the survey area which are characteristic signs of Carnaby's Black Cockatoos. They also note that the distribution of this species has contracted and that they are not likely to be seen as far east as Dulcie in the foreseeable future.

Since the habitats present in the clearing permit application area are common on both a local and regional scale, it is unlikely that the loss of 2 ha of habitat will adversely impact the conservation status of any species.

## **2. PROPOSED CLEARING**

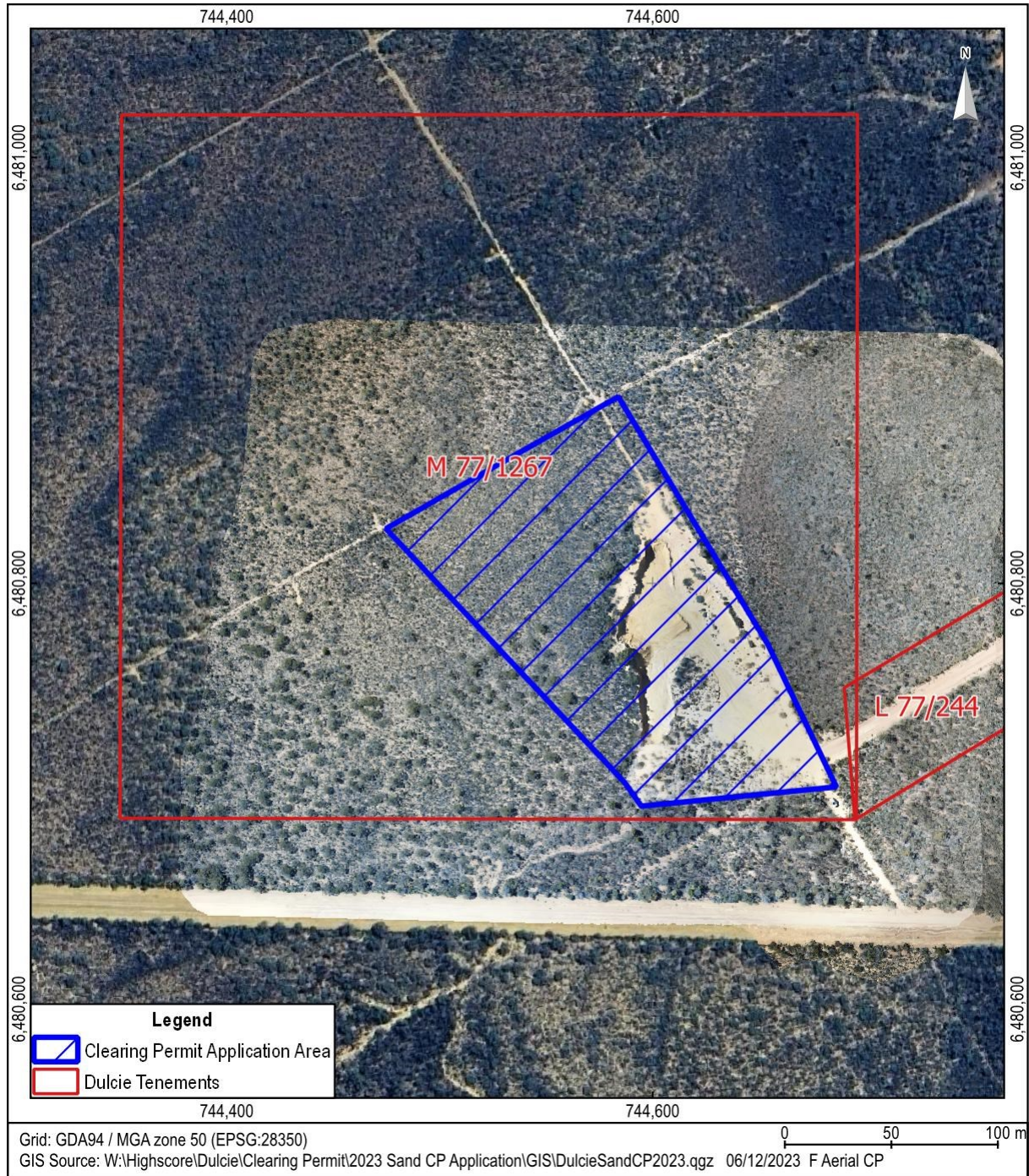
### **2.1 PROPOSED EXTRACTION OPERATION**

The proposed sand extraction operation will supply sand for construction at the nearby Dulcie Heap Leach project on M 77/1246 and M 77/1250. The initial operation will comprise extraction of 20,000 t of sand to a maximum depth of 4 m over a period of 5 to 10 years. The extracted material will be hauled 1.5 km to the Dulcie Heap Leach Project. The completed pit will be battered to maximum slopes of 10° and rehabilitation will take place progressively as sand extraction is completed. No blasting will be required.

Each extraction operation will occur over 5 to 10 days with pit rehabilitation being completed progressively after each stage.

### **2.2 LOCATION OF CLEARING**

This clearing permit application requests approval to clear up to 2 ha of native vegetation at the location shown in Figure 4. The clearing of native vegetation will be kept to the minimum required for the project. Existing roads and cleared areas will be utilised where possible. The existing access and haul route will be utilised and will not require additional clearing. Temporary topsoil and vegetation stockpiles for each stage will be located in the footprint of previous or subsequent stages so no additional clearing is required specifically for stockpiles. Only the clearing immediately required for each 5 to 10 day extraction campaign will be carried out at the start of each campaign. Areas cleared for previous sand extraction (0.8 ha) have been included in the application area to ensure regrowth may be cleared if necessary, as 10 years has now passed since the initial clearing for sand extraction at the site commenced.



**Figure 4: Clearing Permit Application Area over Aerial Photograph**

### 3. ASSESSMENT OF CLEARING PRINCIPLES

#### 3.1 NATIVE VEGETATION CLEARING PRINCIPLES

Clearing applications are assessed against 10 principles outlined in Schedule 5 of the *Environmental Protection Act 1986* (EP Act) (Table 6). These principles aim to ensure that all potential impacts resulting from the removal of native vegetation can be assessed in an integrated way and apply to all lands throughout Western Australia. The principles address the four main environmental areas of biodiversity significance, land degradation, conservation estate and ground and surface water quality.

The following sections provide an assessment of the impacts of the proposed clearing against the clearing principles. Where relevant, reference is made to the *Biodiversity Conservation Act 2016* (BC Act) and the federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

**Table 6: Native Vegetation Clearing Principles**

Environmental Area	Clearing Principle
Biodiversity Significance	
a.	Native vegetation should not be cleared if it comprises a high level of biological diversity.
b.	Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.
c.	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.
d.	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.
e.	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.
f.	Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.
Land Degradation	
g.	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.
Conservation Estate	
h.	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.
Ground and Surface Water Quality	
i.	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.
j.	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

#### 3.2 BIODIVERSITY SIGNIFICANCE

##### 3.2.1 Biological Diversity

**Clearing Principle (a):** Native vegetation should not be cleared if it comprises a high level of biological diversity.

A level 1 flora and vegetation survey in accordance with Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) of the proposed project area was undertaken in June 2012 (Appendix 2, Botanica 2012a). A total of 96 species in 41 genera and 12 families were recorded and no introduced species were recorded. The vegetation throughout the application area is considered to be in good to very good health.

The vegetation community described within the application area is well represented in the Yilgarn region and not thought to be locally or regionally significant. No threatened or priority flora has been recorded within the application area. The application area is within the buffer zone of the Priority 3 Parker Range vegetation complexes Ecological Community, but the none of the vegetation communities that characterise this PEC were found in the application area or surrounding surveyed areas.

A fauna survey (Appendix 4) of the broader Dulcie area found that the habitats identified in the area are abundant throughout the bioregion and are therefore unlikely to support a higher level of biodiversity than surrounding areas.

### 3.2.2 Significant Fauna Habitat

**Clearing Principle (b):** Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

A fauna survey (Appendix 4) of the broader Dulcie area found that the habitats identified in the area are abundant throughout the bioregion and are therefore unlikely to support a higher level of biodiversity than surrounding areas. Nine conservation significant fauna species were identified as possibly occurring within the application area, but it is not considered significant habitat for any of them.

### 3.2.3 Rare Flora

**Clearing Principle (c):** Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

No Threatened plant taxa pursuant to the BC Act or the EPBC Act have been recorded within the application area.

### 3.2.4 Threatened Ecological Communities

**Clearing Principle (d):** Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a Threatened Ecological Community (TEC).

No TECs pursuant to the BC Act or the EPBC Act occur within the application area.

### 3.2.5 Remnant Vegetation

**Clearing Principle (e):** Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

The vegetation within the application has been mapped as Beard vegetation association 552: Shrublands; *Casuarina acutivalvus* and *Calothamnus* (also *Melalueca*) thicket on greenstone hills.

This vegetation association is still largely intact in the Parker Bioregion with 11,607.85 ha (97.04% of pre-European extent) still remaining. The additional clearing of 2 ha for the project represents a fraction of a percent (0.02%) of the extant vegetation association and is not anticipated to have any significant impact.

### 3.2.6 Watercourse and Wetland Environments

**Clearing Principle (f):** Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

The proposed clearing is expected to have no impact on watercourse and wetland environments due to the lack of such environments near the proposed area of clearing.

### 3.3 LAND DEGRADATION

**Clearing Principle (g):** Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Beecham (2001) describes the Avon Wheatbelt 1 subregion as an ancient, gently undulating peneplain of low relief. There is no connected drainage and salt lake chains occur as remnants of ancient drainage systems that now only function in very wet years. The sandy soils, flat relief and climatic conditions in the clearing permit application area are indicative of low erosion potential.

The water table in the clearing permit application area is sufficiently deep (60 m) so that clearing of vegetation will not cause a major rise in the water table to result in soil salinity.

Rehabilitation including revegetation of cleared areas will be commenced following completion of sand extraction activities minimising the duration of the impacts of clearing. In the context of the low erodability of the land system and surrounding intact vegetation, the small scale of disturbance from the proposed clearing is not anticipated to increase land degradation.

### 3.4 CONSERVATION ESTATE

**Clearing Principle (h):** Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation areas.

There are no conservation reserves within to the clearing permit application area. The nearest conservation estate is Jilbadji Nature Reserve, approximately five kilometres east of the clearing permit application area. The proposed clearing is not expected to have any impact on Jilbadji Nature Reserve.

### 3.5 GROUND AND SURFACE WATER QUALITY

#### 3.5.1 Quality of Surface or Underground Water

**Clearing Principle (i):** Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

The proposed clearing is not anticipated to impact upon the water quality of groundwater or surface water resources. There are no Public Drinking Water Source Areas near the application area and no watercourses or surface water bodies within the application area. The depth of the water table in the application area (greater than 60 m) means the impact of vegetation removal on groundwater levels will not be significant.

#### 3.5.2 Flooding Potential

**Clearing Principle (j):** Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Within the clearing permit application area, surface runoff occurs only during and immediately following significant rainfall. There are no watercourses near the clearing permit application area. Some minor localised increase in surface runoff may occur where vegetation is cleared, however, the impact is unlikely to be detectable in the context of the range of the natural variability of runoff. The total area of clearing is small, so changes in runoff are likely to be undetectable at the first significant water courses downstream.

Overall the proposed clearing will have no detectable impact on flooding.

## 4. MANAGEMENT AND MITIGATION MEASURES

The operator will ensure compliance with all conditions of clearing including timing; extent of clearing; management and mitigation measures; and commitments associated with clearing permits, mine approvals and rehabilitation. Audits of the site before, during and after clearing will be carried out to verify compliance with designs, internal approval conditions and area of land actually cleared.

All clearing and rehabilitation will be recorded and reported annually.

All clearing will be reported in the AER submitted to DEMIRS and in an annual clearing permit report.

All efforts will be taken to minimise clearing and to progressively rehabilitate disturbed areas so that the biological diversity of the area is not significantly impacted. Management strategies to achieve this include:

- Use of existing roads, tracks and disturbed areas where practicable.
- Implementation of a procedure to record the amount of clearing undertaken and report the cumulative total.
- Cleaning of machinery and equipment prior to entering site to minimise weed introduction and spread.
- Clearly delineating clearing areas with survey pegs and flagging tape.
- Stockpiling topsoil and vegetation and respreading at completion to assist revegetation by providing a local seed source.
- Establishment of a weed management programme if weeds occur.
- Establishing vegetation on bare surfaces on completion of mining activities.
- Hydrocarbons will not be stored in, nor will refuelling take place in the application area.
- Progressive rehabilitation of completed surfaces to minimise active areas exposed.



## 5. REFERENCES

- AMMTEC. 2010. Heap Leach Amenable Testwork for Southern Cross Goldfields. Dulcie Project, Report No. A 12313.
- Avon Catchment Council. 2007. Tree-Stem Trapdoor Spider (*Aganippe Castellum*) Conservation Plan 2008-2013 (Final Draft). 2007.
- Bagas, L. 1994. Cheritons Find 1: 100 000 Geological Series. Geological Survey of Western Australia.
- Beard, J. S. 1990. Plant Life of Western Australia. Kangaroo Press, Kenhurst.
- Beecham. 2001. A Biodiversity Audit of Western Australia's 53 Biogeographical Region in 2002-Avon Wheatbelt 1 subregion. Department of Conservation and Land Management.
- Botanica. 2012a. Level 1 Flora and Vegetation Survey (Tenements: P77/3602, M77/669 and E77/1937). Unpublished report prepared for Richard Read & Associates. July 2012.
- Botanica. 2012b. Level 2 Flora & Vegetation Survey of the Dulcie Project. Unpublished report prepared for Richard Read & Associates. June 2012.
- DBCA, (Department of Biodiversity, Conservation and Attractions). 2019. 2018 Statewide Vegetation Statistics Incorporating the CAR Reserve Analysis (Full Report). Current as of March 2019.
- DPIRD, (Department of Primary Industries and Development). 2021. Pre-European Vegetation (DPIRD-006).
- EPA. 2004a. Guidance for the Assessment of Environmental Factors Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Environmental Protection Authority, Western Australia.
- EPA. 2004b. Guidance for the Assessment of Environmental Factors Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Environmental Protection Authority, Western Australia.
- Rockwater. 2010. Parker Range project: Dulcie laterite gold deposit. Initial assessment of groundwater availability. Unpublished report for Southern Cross Goldfields.
- Terrestrial Ecosystems. 2009. Level 1 Fauna Risk Assessment for Southern Cross Goldfields Dulcie Project Area. Unpublished report prepared for Southern Cross Goldfields Ltd. November 2009

## APPENDICES

## **APPENDIX 1: TENEMENT OWNERSHIP M 77/1267**

# MINING TENEMENT DETAILS REPORT

DISCLAIMER: This is not the official Register referred to in Reg. 84C of the Mining Regulations 1981.

## MINING LEASE 77/1267

### Tenement Summary

<b>Identifier :</b> M 77/1267	<b>District :</b> YILGARN M.F.
<b>Current Area :</b> 11.43500 HA	<b>Status :</b> Live
<b>Mark Out :</b> 04/09/2012 14:45:00	<b>Received :</b> 05/09/2012 13:44:01
<b>Term Granted :</b> 21 Years	<b>Lodging Office :</b> ONLINE
<b>Commence :</b> 20/12/2012	<b>Expiry :</b> 19/12/2033
<b>Purpose :</b>	<b>Death :</b>

### OWNERSHIP DETAILS

#### Current Holders

Name and Address	Shares
RICHARD READ AND ASSOCIATES PTY LTD (ACN:008951531) EVELINE READ, 33 FARRIN STREET, ATTADALE, WA, 6156, xxxxxx@optusnet.com.au, xxxxxxxx226	50
HIGHSCORE PTY LTD HIGHSCORE PTY LTD DTC, PO BOX 20, SOUTHERN CROSS, WA, 6426, xxxxxxxxxxxxxxxx@gmail.com, xxxxxxxx588	50
<b>Total Shares:</b>	<b>100</b>

#### Holder Changes

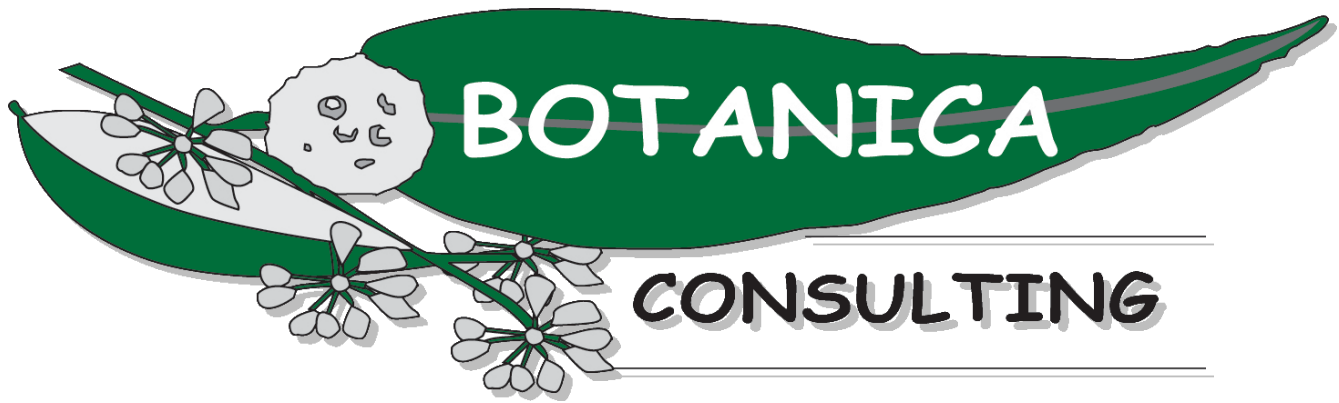
Dealing	Status Date	From (Shares)	To (Shares)
Deemed Transfer 406630	Registered 24/09/2012 15:00:00	SOUTHERN CROSS GOLDFIELDS LTD (100)	HIGHSCORE PTY LTD (50)
Deemed Transfer 406631	Registered 24/09/2012 15:00:00	SOUTHERN CROSS GOLDFIELDS LTD (50)	RICHARD READ & ASSOCIATES PTY LTD (50)
A to A (Name) 587075	Recorded 25/09/2020 08:30:00	RICHARD READ & ASSOCIATES PTY LTD (50)	RICHARD READ AND ASSOCIATES PTY LTD (50)

#### Applicants on Receival

Name and Address	Shares
SOUTHERN CROSS GOLDFIELDS LTD C/- AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, PO BOX 1434, WANGARA, WA, 6947	100
<b>Total Shares:</b>	<b>100</b>

End of Search

**APPENDIX 2: LEVEL 1 FLORA AND VEGETATION SURVEY  
(TENEMENTS: P77/3602, M77/669 AND E77/1937) (BOTANICA  
2012)**



# Level 2 Flora & Vegetation Survey of the Dulcie Project

(Tenements M771246, M77/1250, M77/581, L77/266 & P77/4016)

**Prepared For Richard Read & Associates**

Final

June 2012



**Prepared by:**  
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An internal quality review process has been implemented to each project task undertaken by BC. Each document and its contents is carefully reviewed by core members of the Consultancy team and signed off at Director Level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

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## Executive summary

Botanica Consulting was commissioned by Richard Read and Associates to undertake a Level 2 flora and vegetation survey of the Dulcie Project. The Dulcie Project is located approximately 103km northeast of Hyden and 64km southeast of Southern Cross. The Level 2 flora survey was conducted from the 6<sup>th</sup> to the 8<sup>th</sup> of July 2009 and covered an area of approximately 373ha. Fifteen quadrats were established in the survey area. These quadrats were re-surveyed in spring on the 24<sup>th</sup> of November 2011. In addition a Level 1 flora and vegetation survey in a further 20 hectare area for a proposed water pipeline was also surveyed.

No Declared Rare Flora/Threatened Flora pursuant to Subsection 2 of Section 23F of the *Wildlife Conservation Act (1950)*, *Environment Protection and Biodiversity Conservation Act 1999* and listed by the Department of Environment and Conservation were identified within the survey area. Two Priority Flora species, *Grevillea lissopleura* (P1) and *Hakea pendens* (P2) were recorded within the survey area.

Eleven broad vegetation communities were identified within the survey area;

- Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii*,
- Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*,
- Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala*,
- Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within historically cleared gravel pit,
- Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii*,
- Forrest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over heath of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata*,
- Low woodland of *Eucalyptus melanoxydon* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha*,
- Open mallee of *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata*,
- Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides*,
- Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii*, and
- Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii*.

These vegetation communities were represented by a total of 27 Families, 51 Genera and 112 Species.

With a few exceptions allocations of quadrats to different vegetation communities using PATN analysis supported delineations of vegetation communities made in the field. The compositions of the upper storey species in the two vegetation communities containing *Eucalyptus* species were found to be similar. The species composition of the remaining vegetation communities differed from one another with the exception of two Thicket of *Allocasuarina campestris/Allocasuarina helmsii* over heath of *Baeckea elderiana* quadrats which shared more common species with the Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii* quadrats. This intermixing of seemingly different communities (as determined in the field) suggests that there was a level of homogeneity between the *Eucalyptus* vegetation communities and between the *Acacia* and *Allocasuarina* vegetation communities within the survey area.

None of the vegetation communities have National Environmental Significance as defined by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. No Threatened Ecological Communities pursuant to Commonwealth legislation or listed by the Department of Environment and Conservation were recorded within the survey area. The survey area is however located within the Priority 3 Ecological Community known as the *Parker Range vegetation complexes*. It is also located approximately 2km west of the Jilbadji Nature Reserve, which is listed on the Register of National Estate by the Department of Sustainability, Environment, Water, Population and Communities. Areas listed on the Register of National Estate are not formally protected under the *Environment Protection and Biodiversity Conservation Act 1999*. The Jilbadji Nature Reserve is also listed by the Department of Environment and Conservation as an Environmentally Sensitive Area.

The entire Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora/Melaleuca hamata/Melaleuca teuthidoides* vegetation community (2.5ha) located within the northern extremity of the proposed water pipeline occurs within a drainage line, which is also listed as an Environmentally Sensitive Area. The entire survey area is located within a Schedule 1 Area, as described in Regulation 6 and Schedule 1, clause 4 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Based on Keighery's vegetation health rating scale (1994), nine of the eleven vegetation communities within the area surveyed by BC were classed as being in 'very good' health. One vegetation community was classed as "good" and one vegetation community was classed as having a "degraded" health condition. Two introduced species, *Centaurea melitensis* and *Dittrichia graveolens*, were recorded in the survey area. Neither of these species are classified as Declared Plants, by the Department of Agriculture and Food of Western Australia.

## 1 Introduction

### 1.1 Project Description

Botanica Consulting (BC) was commissioned by Richard Read and Associates to conduct a Level 2 and Level 1 flora and vegetation survey within the Dulcie Project, located approximately 103km northeast of Hyden and 64km southeast of Southern Cross. The survey area is located within Tenements L77/226, P77/4016, M77/581, M77/1246, and M77/1250 (Figure 1).

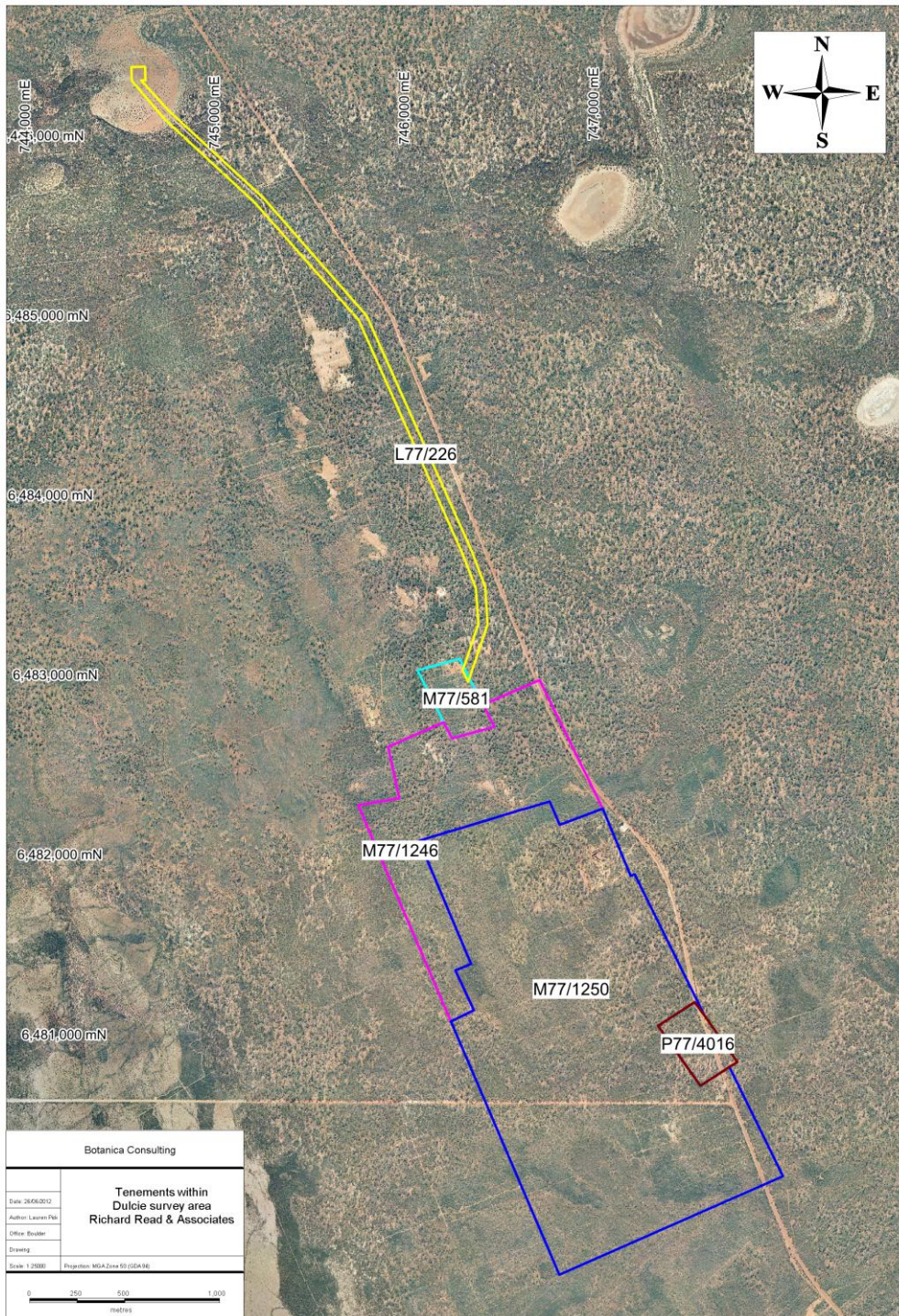


Figure 1: Tenements within the Dulcie survey area

The survey area is shown in Figure 2 and Appendix 2. The aim of the survey was to produce a vegetation map (Appendix 4) and species list (Appendix 9), as well as to document and map locations of any Declared Rare or Priority listed flora species identified within the survey area, which covers an area of approximately 393ha.

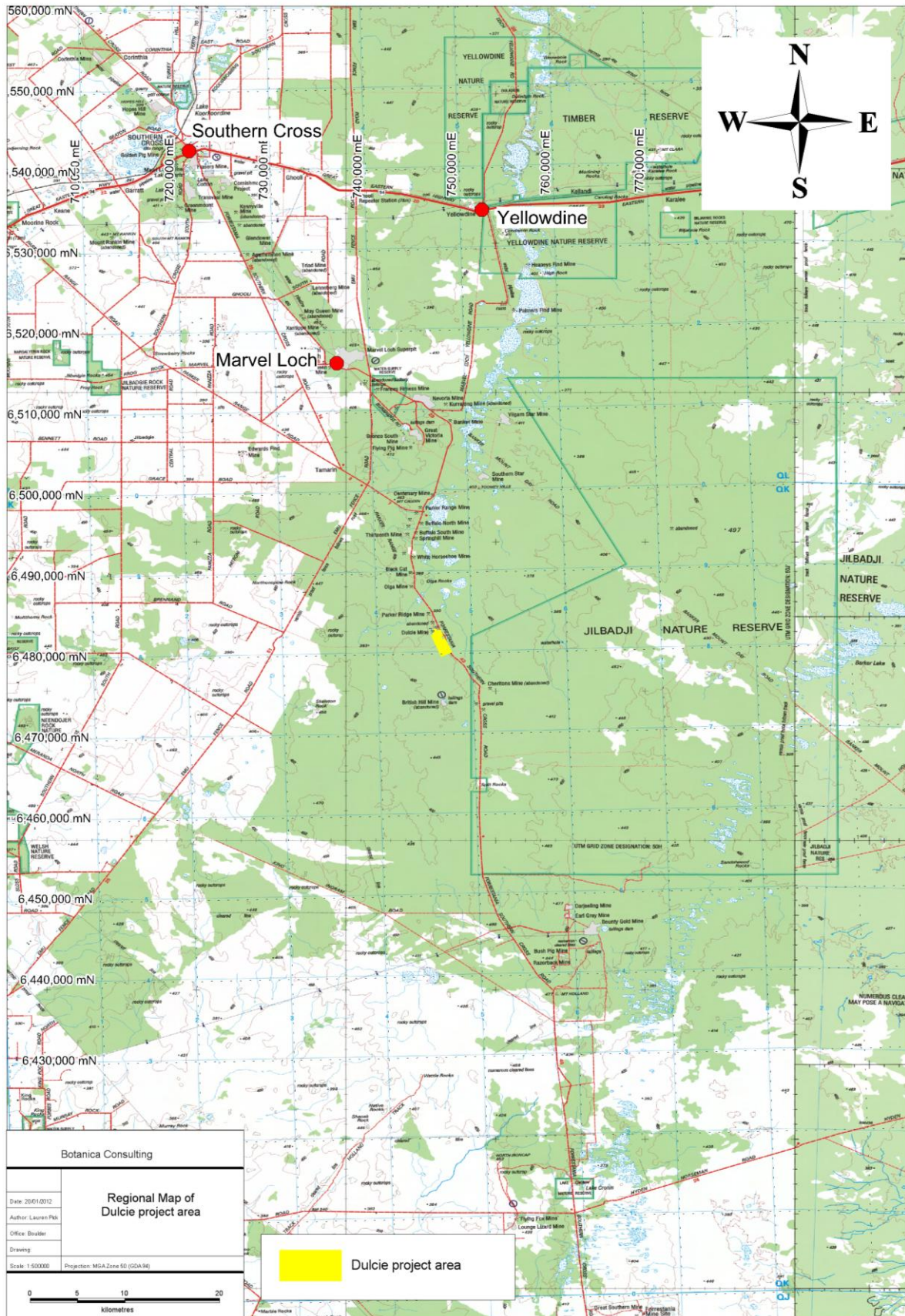


Figure 2: Regional map of the Dulcie survey area

## 1.2 Previous relevant flora surveys

### **Rare Flora search and Vegetation Survey at British Hill Mine, Polaris Metals, 2004**

In 2004 Paul Armstrong and Associates was commissioned by ENVIRON on behalf of Polaris Metals NL to undertake a threatened flora search and vegetation survey of three mining prospects in the vicinity of the abandoned British Hill mine located approximately 5.5km south of the Dulcie project area. No Declared Rare Flora (DRF) and two Priority Flora species were identified during the survey, *Drummondita wilsonii* (P1) and *Stylidium sejunctum* (P2). Two vegetation communities were identified, *Eucalyptus eremophila* subsp. *eremophila* and *E. calycogona* subsp. *calycogona* open Mallee and *Allocasuarina/Melaleuca uncinata* thicket.

### **Flora and Vegetation of the Eastern Goldfields Ranges, Parker Range, November 1997, N**

#### **Gibson & M N Lyons**

A study of the flora and plant communities of the Parker Range greenstone belt recorded 254 taxa in the spring of 1994. The study encompassed a 25km radius of the Dulcie project area. Ten weed species were identified and further weeds are considered likely to occur in the area surveyed. The flora list included new populations of eight rare or poorly known taxa. Of the five species apparently endemic to the Parker range greenstone belt, two were collected for the first time.

Six vegetation communities were defined from 61 sites spread across the range. The distribution of these community types appeared to be primarily controlled by edaphic factors including water holding capacity. Three of the floristic communities had some representation in conservation reserves, but four of the endemic taxa and three of the community types are not presently reserved. The flora and community types of the Parker Range are significantly different from the Bremer Range (100km south east) although the local underlying ecological gradients appear to be similar. It is suggested that the differences between the range systems is related to regional climatic gradients. There has been significant impact on the vegetation of this range as a result of mining and mineral exploration.

### **Parker Range Flora and Vegetation Survey, Cazaly Resources, 2008-2011**

BC was commissioned by Cazaly Resources to undertake multiple flora and vegetation surveys and targeted species searches within and around the proposed Parker Range Iron Ore project area located approximately 15km north-west of the Dulcie project area. This involved a series of field trips to the survey area from 2007 to 2010 and two regional surveys of the surrounding *Parker Range* Priority Ecological Community (PEC) in 2010. A total of 30 vegetation communities were described and mapped from the Survey area and surrounding *Parker Range* PEC covering a total area of 55,960ha.

Nine Priority flora species were identified during the survey, *Acacia concolorans* (P2), *Lepidosperma* sp. Parker Range (N. Gibson & M. Lyons 2094) (P1), *Lepidosperma* sp. Mt Caudan (N. Gibson & M. Lyons 2081) (P1), *Hakea pendens* (P2), *Banksia shanklandiorum* (P4), *Cryptandra crispula* (P3),

*Baeckea grandibracteata* subsp. Parker Range (P1), *Verticordia multiflora* subsp. *solox* (P2) and *Euryomyrtus leptospermoides* (P3). One DRF species, *Isopogon robustus* was identified along decomposing laterite ridges within the Parker Range PEC.

### **British Hill Flora and Vegetation Survey, Southern Cross Goldfields, 2010-2011**

Botanica Consulting was commissioned by Southern Cross Goldfields to undertake a Level 2 flora and vegetation survey of the British Hill survey area located approximately 5.5km south of the Dulcie survey area. The survey covered an area of approximately 1156ha, approximately 85ha of which was burned sandplain, leaving the total vegetated and surveyed area at 1071ha. On the 25th and 26th November 2010, fifteen quadrats were established in the British Hill survey area. These quadrats were monitored again on 6<sup>th</sup> April 2011.

No DRF were identified within the survey area however three Priority flora species, *Baeckea* sp. North Ironcap (R.J. Cranfield 10580) (P2), *Verticordia stenopetala* (P3) and *Drummondita wilsonii* (P1) were recorded during the survey. Six vegetation communities were identified within the survey area, *Eucalyptus salmonophloia*/E. *salubris* woodland over *Melaleuca* shrubland, *Eucalyptus capillosa* Mallee shrubland over *Allocasuarina acutivalvis* shrubland, *Allocasuarina* shrubland, *Eucalyptus eremophila* Mallee shrubland, *Eucalyptus burracoppinensis* Mallee shrubland and Rehabilitation vegetation.

No Threatened Ecological Communities (TEC) pursuant to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) or listed by the Department of Environment and Conservation (DEC) were recorded within the survey area. The survey area is however located within the *Parker Range vegetation complexes* PEC3 which covers an area of 55,960ha.

Based on Keighery's 1994 vegetation health rating scale, four of the six vegetation communities within the area surveyed by BC were rated as being in 'very good' health. The *Eucalyptus salmonophloia*/E. *salubris* woodland over *Melaleuca shrubland* was rated as in 'good' health. The rehabilitation vegetation community was rated as 'degraded'. No weed species were identified within the survey area.



## 2 Regional Biophysical Environment

The Dulcie project lies within the Wheatbelt Region of the South-Western Interzone of Western Australia in an area known as the Avon Botanical District. The Wheatbelt Region is further divided into subregions, based on the Interim Biogeographic Regionalisation of Australia (IBRA), with the Dulcie survey area located within the Avon Wheatbelt 1 (AW1) subregion (Beecham, 2001). The Dulcie project is also located within close proximity to the Coolgardie Region, occurring approximately 1km west of the Southern Cross subregion (COO2). A map of the survey area in relation to IBRA subregions is provided in Figure 3 below.

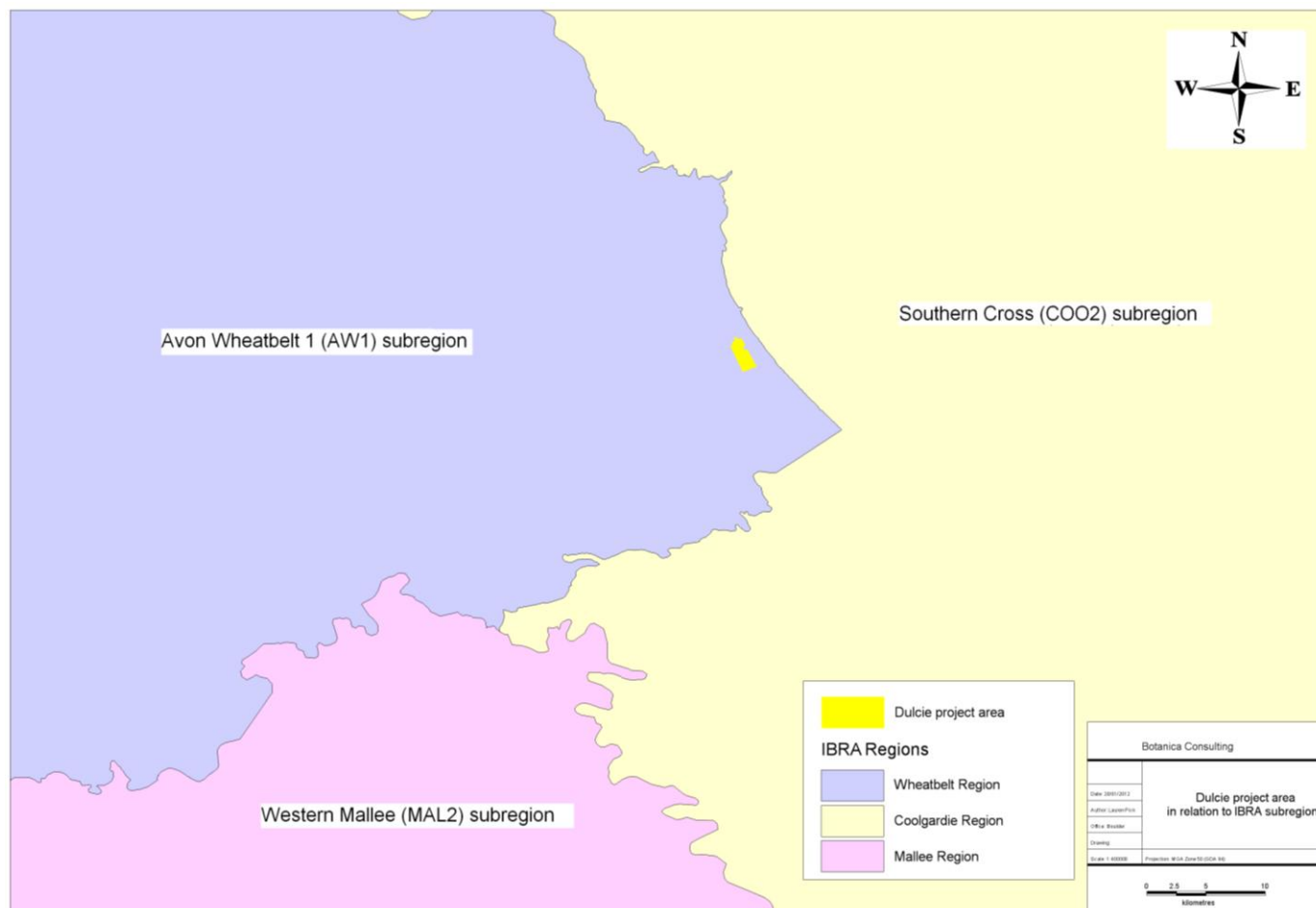


Figure 3: Map of the Dulcie project area in relation to IBRA subregions

### 2.1 Great Western Woodlands

The survey area is located within the Great Western Woodlands (approximately 17km east of the far western boundary). This area contains many endemic species and is therefore considered by The Wilderness Society of WA to be of global biological and conservation importance as one of the largest and healthiest temperate woodlands on Earth. The region covers almost 16 million hectares, 160,000 square kilometres, from the southern edge of the Western Australian Wheatbelt to the pastoral lands of the mulga country in the north, the inland deserts to the northeast, and the treeless Nullarbor Plain to the east (Figure 4).

The area provides an eastward connection between southwest forests and inland deserts (Gondwana Link) as well as linking the northwest passage to Shark Bay. The majority of the Great Western Woodlands is unallocated crown land (61.1%) with other interests including pastoral leases (20.4%), conservation reserves (15.4%) unallocated crown land ex pastoral managed by the Department of Environment and Conservation (DEC) (2%) and private land (approximately 1%) (Watson et al., 2008).

No specific management strategy applies to the Great Western Woodlands, rather an approach to conservation which occurs across all land tenures and when different stakeholders work together with biodiversity in mind. The central component of this approach is to identify and conserve key large-scale, long term ecological processes that drive connectivity between ecosystems and species. The Great Western Woodlands is however currently nominated to be listed as a national heritage property under the *EPBC Act 1999*. The Great Western Woodlands currently includes towns, highways, roads, railways, private property, Crown Reserves, agricultural activities and mining tenements.

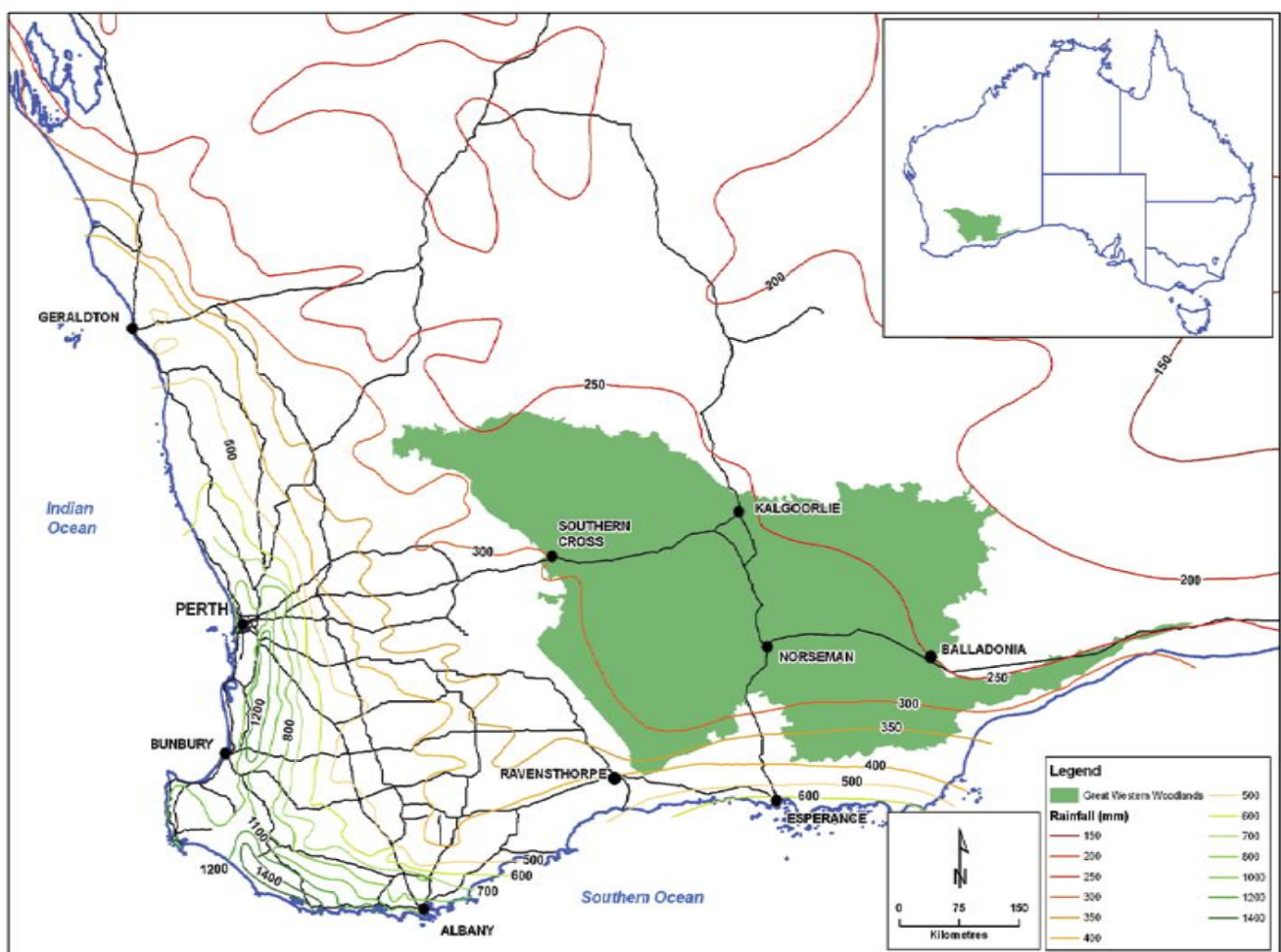


Figure 4: Location map of the Great Western Woodlands (DEC, 2010a)

## 2.2 Topography & Soils

The Avon Wheatbelt 1 subregion is an area of active drainage and is characterised by an undulating landscape with low relief, lateritic uplands and yellow sandplains. Proteaceous scrub-heaths, rich in endemics, on residual lateritic uplands and derived sandplains; mixed eucalypt, *Allocasuarina huegeliana* and Jam-York Gum woodlands on Quaternary alluvials and eluvials. Within this subregion is an ancient flat land surface with low relief with a gently undulating landscape. There is no connected drainage; salt lake chains occur as remnants of ancient drainage systems that now only function in very wet years. Lateritic uplands are dominated by yellow sandplain (Beecham, 2001).

## 2.3 Climate

The climate of the Avon Wheatbelt 1 subregion is characterised as being arid non-seasonal to semi-arid Mediterranean. The area receives approximately 250-300mm of rainfall per year with 7-8 dry months (Beard, 1990; Beecham, 2001). Rainfall data for the Youanmi Valley weather station (#12201) located approximately 34km from the survey area is displayed in Figure 5 (Bureau of Meteorology, BOM, 2012).

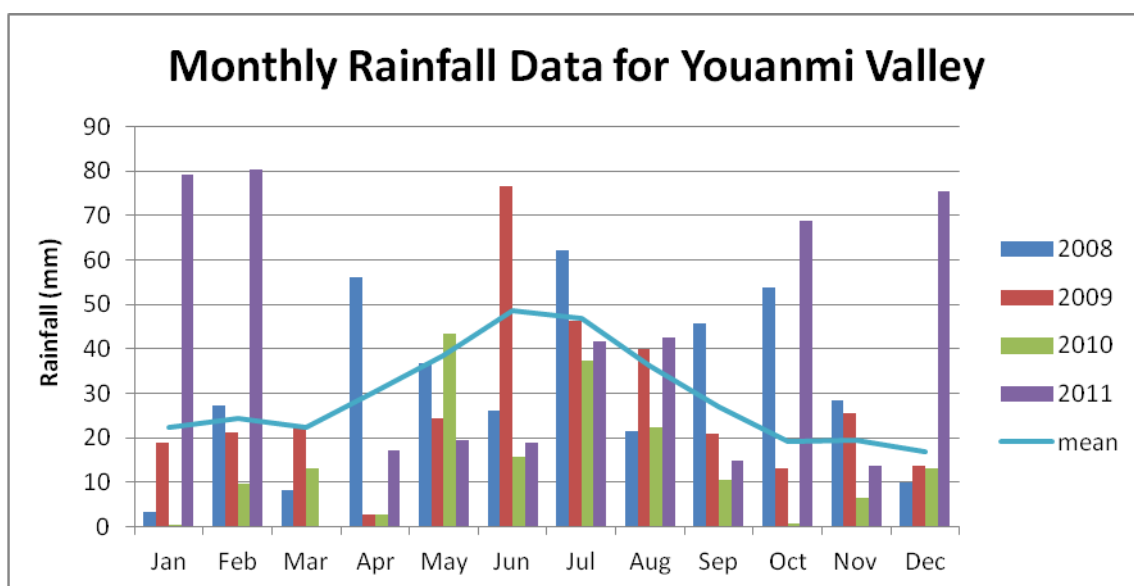


Figure 5: Monthly rainfall from January 2008 to December 2011 compared to the mean monthly rainfall (January 1966 to December 2011) for Youanmi Valley weather station (#12201)

## 2.4 Vegetation

The typical sequences of vegetation within the Avon Botanical District are scrub-heath on sandplain, *Acacia-Casuarina* thickets on ironstone gravels, woodlands of York gum (*Eucalyptus loxophleba*), Salmon Gum (*Eucalyptus salmonophloia*) and wandoo (*Eucalyptus wandoo*) on loams and halophytes on saline soils (Beard, 1990). The Avon Wheatbelt 1 subregion is an interface between the South-western forests and the transitional rainfall zone and provides habitat for many endemic plant species particularly of the *Grevillea*, *Hakea*, *Verticordia*, *Eucalyptus*, *Acacia*, *Dryandra*, *Verticordia*, *Lhotskya*, *Eriostemon*, *Wehlia*, *Baeckea*, *Melaleuca*, *Chamelaucium*, *Micromyrtus* and *Thryptomene* genera. Approximately 25% of the DRF in WA occurs in Eucalypt woodlands in this region. Rare features include plant communities of granite outcrops, gypsum dunes, and the Wongan Hills greenstone belt and associated laterite-capped mesas (ANRA, 2012).

## 2.5 Remnant Vegetation

The majority of ecosystems in the Avon Wheatbelt 1 subregion have been extensively cleared well below Comprehensiveness, Adequacy and Representativeness (CAR) thresholds (Beecham, 2001). Eucalypt woodlands in this area have been particularly disturbed with approximately only 3% of some of the woodlands still existing in the Avon Wheatbelt (WWF, 2005). According to a report on the Landscape Health of the IBRA bioregions, the Avon Wheatbelt has a continental landscape stress class of 1 as assessed by the Landscape Health report with 1 being the most stressed and 6 least stressed (Morgan, 2000).

The Department of Agriculture and Food WA GIS file (DAFWA, 2007) depicts that one pre-European vegetation association occurs within Dulcie survey area of the Avon Wheatbelt; Parker 1068. The extent of this association as described by the DAFWA is shown in Table 1.

**Table 1: Remaining Beard Vegetation Associations within Western Australia (DAFWA, 2007)**

Veg Association	Pre-European extent (ha)	Current extent (ha)	Pre-European extent remaining (%)	% of Current extent within DEC managed lands	Vegetation Description (Beard, 1990)
Parker 1068	32, 713.32	27, 708.26	84.70	6.63	Medium woodland; salmon gum, morrel, gimlet & <i>Eucalyptus sheathiana</i>

Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered “endangered”.

## 2.6 Land Use

The land uses of the Avon Wheatbelt 1 subregion are a mixture of cultivation (dryland agriculture and grazing), improved pastures, Unallocated Crown Land UCL and Crown reserves, conservation, rural residential and mining (Beecham, 2001).

## 2.7 Survey Objectives

The objectives of the survey undertaken were to:

- Compile a broad scale vegetation community flora map and species list of the survey area (Appendix 4);
- Document and map locations of any Declared Rare or Priority listed flora species recorded; (Appendix 1 and 4);
- Assess the regional and local conservation status of plant species and ecological communities within the survey area;
- Identify and map occurrences of any “Declared and Environmental” weeds within the survey area; and
- Provide plot based data as per Guidance Statement 51 (Environmental Protection Authority, EPA, 2004).

## 3 Survey Methodology

### 3.1 Desktop Assessment

Prior to the field survey, a combined search of the DEC’s Declared Rare and Priority Flora databases (DEC, 2011a) was undertaken and the results are provided in Appendix 1. These significant flora species were examined on the Western Australian Herbarium’s (WAHERB) web page prior to the survey to familiarise staff with their appearance.

Locations of DRF and Priority Flora species were overlaid on aerial photography of the area (Appendix 4). Vegetation descriptions and available images of the Priority Flora were also obtained from Florabase. A PEC and TEC database search was also completed prior to the survey (DEC, 2009).

Priority Flora and their respective vegetation types were targeted on foot specifically looking for the flora of conservation significance associated with that vegetation description. The sample locations and GPS coordinates of Priority Flora recorded during the survey are presented in Appendix 3.

Table 2 represents the definitions of Declared Rare and Priority ratings under the *Wildlife Conservation Act (1950)* as extracted from Florabase (WAHERB, 2012).

**Table 2: Definitions of Rare and Priority Flora Species (WAHERB, 2012)**

<b>T: Schedule 1 Threatened Flora under the <i>Wildlife Conservation Act 1950</i></b>
Taxa which 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.
<b>X: Declared Rare flora – Presumed Extinct Taxa</b>
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.
<b>1: Priority One – Poorly known Species</b>
Species 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. Species 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.
<b>2: Priority Two – Poorly Known Species</b>
Species 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. Species 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.
<b>3: Priority Three – Poorly known Species</b>
Species 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. Species 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.
<b>4: Priority Four – Rare, Near Threatened and other species in need of monitoring</b>
<ol style="list-style-type: none"> <li>1. Rare. Species 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 species are usually represented on conservation lands.</li> <li>2. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.</li> <li>3. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</li> </ol>
<b>5: Priority 5 – Conservation Dependent Species</b>
Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

### 3.2 Sampling and Analysis Methods

The Level 2 flora fieldwork was completed from the 6th to 8<sup>th</sup> July 2009 and again on the 24<sup>th</sup> November 2011 with the addition of a Level 1 flora survey of 20 hectares for a proposed pipeline on 23<sup>rd</sup> January 2012. The survey area was traversed by two people via four wheel drive, all terrain vehicles and on foot. Figure 6 & 7 provides maps showing GPS tracks of the areas traversed throughout the survey.

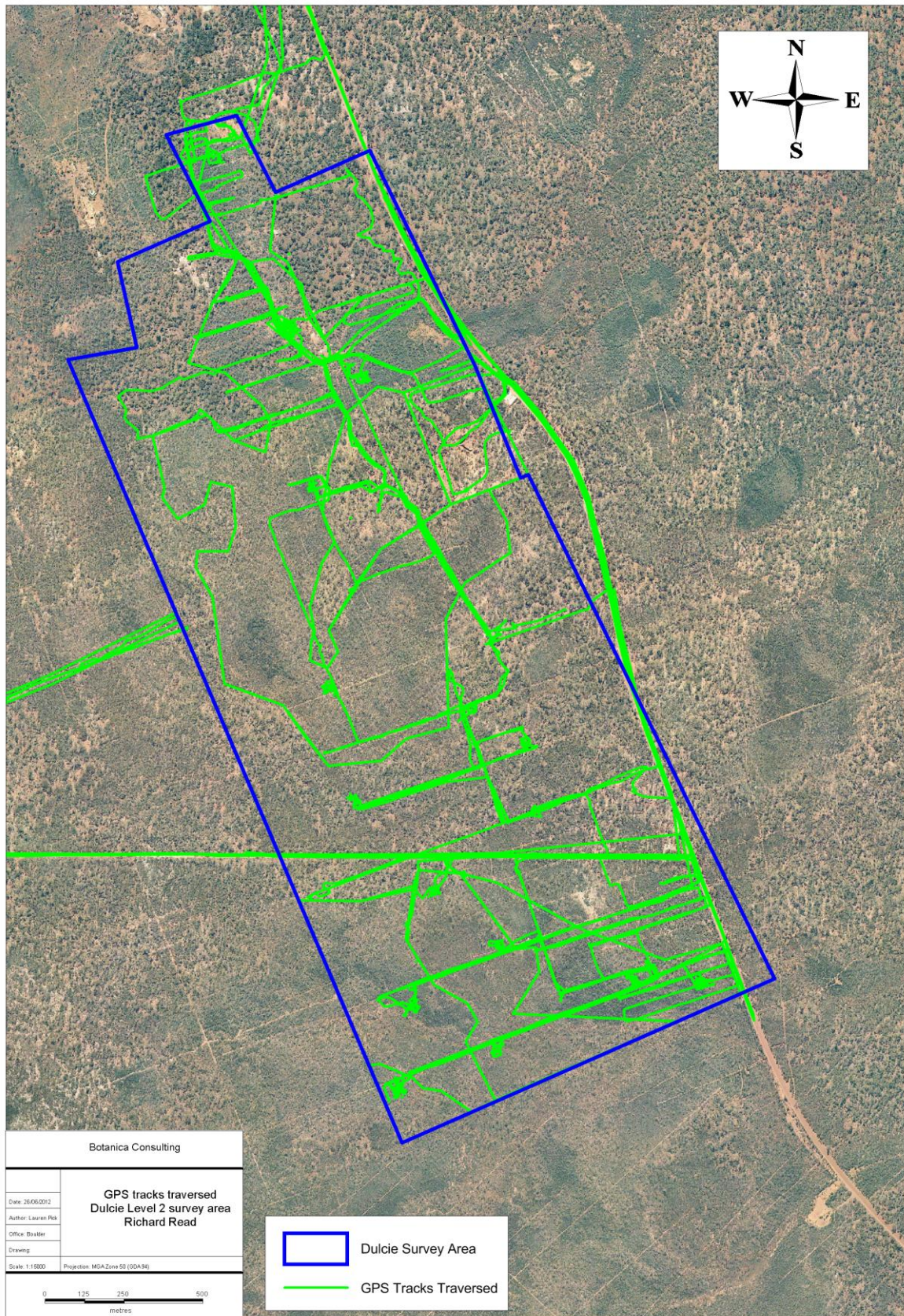
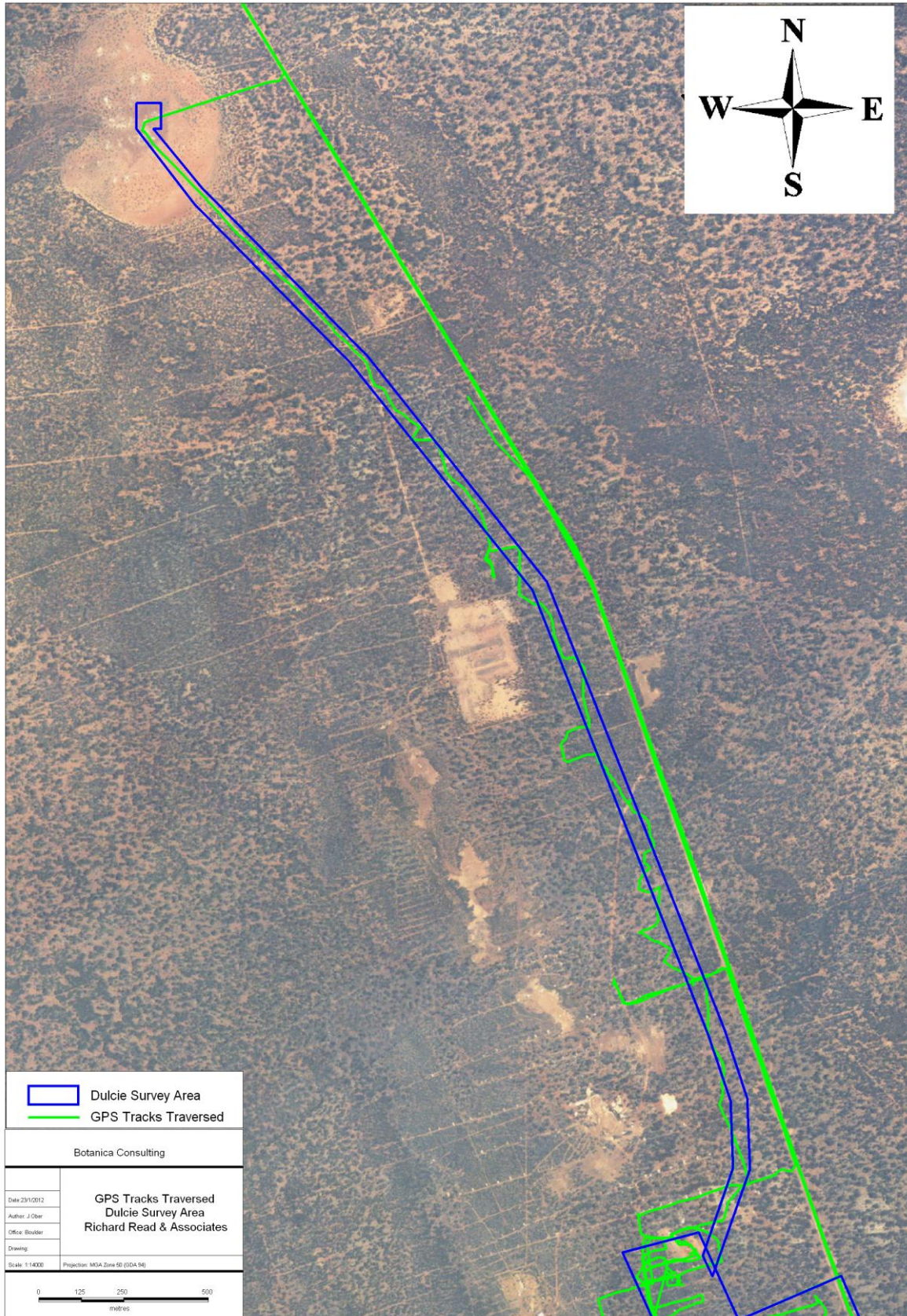


Figure 6: Map of GPS tracks traversed throughout the Dulcie project



**Figure 7: Map of GPS tracks traversed throughout the Dulcie proposed pipeline**



Prior to the commencement of field work, aerial photography was inspected and obvious differences in the vegetation assemblages were identified. The different vegetation communities identified were then inspected during the field survey to assess their validity. A handheld GPS unit was used to record the co-ordinates of the boundaries between existing vegetation communities.

At each sample point, the following information was recorded:

- GPS location;
- Photograph of vegetation;
- Dominant species;
- Collection and documentation of unknown plant specimens; and
- GPS location, photograph and collection of Threatened Flora if encountered.

Unknown specimens collected during the survey were identified with the aid of samples housed at the BC Herbarium and the Western Australian Herbarium.

### 3.2.1 20m x 20m Quadrat Sampling

Fifteen 20m x 20m quadrats were established within the Dulcie project in winter and resurveyed in spring 2011. The objective being to have at least three quadrats per vegetation community to capture the floristic variations within the survey area. Where a vegetation community was insufficiently large to accommodate three quadrats, the maximum number of quadrats that would fit within that specific community were established.

The quadrats were established by inserting metal pickets in each corner, and measuring the length of the resultant boundaries to verify the quadrats were 20m square. Following their establishment and boundary verification, the location of each quadrat was recorded by GPS, photographed and all vascular plants within the quadrat were recorded. This included recording of dominant taxa from the upper, middle and lower stratum, and sampling of all unknown taxa. Unknown taxa were identified using BC's own reference herbarium and relevant taxonomical keys. Data on topographical position, percentage litter, percentage bare ground, percentage surface rock (bedrock and surface deposits), and vegetation structure were collected from each quadrat.

### 3.2.2 Personnel involved

Jim Williams	-	Environmental Consultant/Botanist (Diploma of Horticulture)
Andrea Williams	-	Environmental Consultant (BSc Hons)
Lauren Pick	-	Environmental Consultant (BSc Conservation Biology)
Samantha Stapleton	-	Environmental Consultant (BSc Ecology)

### 3.2.3 Scientific licences

**Table 3: Scientific Licences of Botanica Staff coordinating the survey**

Licensed staff	Permit Number	Valid Until
Andrea Williams	SL009437	3-4-2012
Jim Williams	SL009438	3-4-2012
Lauren Pick	SL009439	3-4-2012

### 3.3 Data Analysis Tools

Once the survey was completed the data obtained was analysed to generate a vegetation map (Appendix 4 and 5). The statistical program PATN was used to complete a pattern analysis on the data obtained from the quadrats.

#### 3.3.1 PATN Analysis

PATN is a software package that aims to display patterns in complex data. The classifications are based upon a Bray-Curtis association matrix using a flexible UPGMA which standardises the data enabling the analysis to be completed. The PATN analysis was conducted on all perennial species present in each quadrat using a Flexible UPGMA and a beta value of -0.1. Species reconciliation eliminated those sterile species that could not be fully identified from the analysis.

### 3.4 Flora survey limitations and constraints

It is important to note that flora surveys will entail limitations notwithstanding careful planning and design. Potential limitations are listed in Table 4.

**Table 4: Limitations and constraints associated with the flora and vegetation survey.**

Variable	Impact on Survey outcomes
<b>Access problems</b>	The survey was conducted via 4WD, all terrain vehicle and on foot. However, where possible BC staff accessed majority of the areas via existing access tracks and on foot.
<b>Experience levels</b>	The BC personnel that conducted the survey were regarded as suitably qualified and experienced. <b>Coordinating Botanist:</b> Jim Williams <b>Field Staff:</b> Jim Williams, Andrea Williams, Lauren Pick and Samantha Stapleton <b>Data Interpretation:</b> Jim Williams, Lauren Pick & Samantha Stapleton
<b>Timing of survey, weather &amp; season</b>	In Accordance with EPA guidance statement 51 the flora and vegetation survey was conducted in two seasons. The most recent fieldwork was completed during the EPA's recommended time period (i.e., Spring) for detecting most ephemeral flora. However in Spring 2011 rainfall was below average in September and November, when the survey area was dry, but well above average in October.
<b>Sources of information</b>	BC were able to obtain information about the area from previous research conducted within the Parker Range PEC which enabled adequate background information about the region.
<b>Mapping reliability</b>	BC were able to obtain high quality ortho aerial images in order to reliably determine changes in vegetation within the survey area.
<b>Area disturbance</b>	The survey area has been subject to moderate disturbance from exploration activities and historical mining.
<b>Survey Intensity</b>	Survey intensity was high with a Level 2 quadrat based survey conducted in Winter and Spring. Prior to the quadrats being established a reconnaissance of the survey area was conducted in order to identify vegetation communities and any Priority Flora species. DEC listed threatened flora locations within the survey area were also visited in order to confirm their presence.
<b>Resources</b>	The DEC provided several resources including threatened flora information and previous

Variable	Impact on Survey outcomes
	reports which were used to complete the survey.
<b>Completeness</b>	In the opinion of BC the survey area was covered sufficiently in order to identify vegetation assemblages. Many of the plants during the winter survey were in flower due to the high rainfall received in the area and as a result majority of the flora species including annual species could be fully identified. Rainfall preceding the Spring survey however was low and there was minimal flowering material. It is estimated that approximately 85% of the flora within the survey area were able to be fully identified.
<b>Completeness</b>	The vegetation communities for this study were based on visual descriptions of locations in the field. The distribution of these vegetation communities outside the study area is not known, however vegetation communities identified were categorised via comparison to vegetation distributions throughout WA given on Australian Natural Resources Atlas (ANRA, 2012). Vegetation communities identified in the field were compared using PATN analysis to determine the degree of similarity/dissimilarity in species composition of vegetation communities throughout the survey area.

## 4 Results

### 4.1 Summary

Eleven broad vegetation communities were identified within the survey area,

1. Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii*,
2. Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*,
3. Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala*,
4. Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxal*/*Melaleuca cordata*/*Phebalium filifolium* within historically cleared gravel pit,
5. Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii*,
6. Forrest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over heath of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata*,
7. Low woodland of *Eucalyptus melanoxydon* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha*,
8. Open mallee of *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata*,
9. Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides*,
10. Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii*, and
11. Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii*.

These communities were represented by a total of 27 Families, 51 Genera and 112 Species. With a few exceptions allocations of quadrats to different vegetation communities using PATN analysis supported delineations of vegetation communities made in the field. The compositions of the upper storey species in the two vegetation communities containing *Eucalyptus* species were found to be similar. The species composition of the remaining vegetation communities differed from one another with the exception of two Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*

quadrats which shared more common species with the Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii* quadrats. This intermixing of seemingly different communities (as determined in the field) suggests that there was a level of homogeneity between the *Eucalyptus* vegetation communities and between the *Acacia* and *Allocasuarina* vegetation communities within the survey area.

No DRF/ Threatened Flora pursuant to Subsection 2 of Section 23F of the *Wildlife Conservation Act (1950)*, *EPBC Act 1999* and listed by the DEC were identified within the survey area. Two Priority Flora species, *Grevillea lissopleura* (P1) and *Hakea pendens* (P2) were identified within the survey area.

None of the vegetation communities have National Environmental Significance as defined by the *EPBC Act 1999*. There were no TEC as defined by the *EPBC Act 1999* or listed by the DEC within the survey area (DEC, 2009, DSEWPC, 2012). The survey area is however located within the buffer zone of a Priority 3 Ecological Community known as the *Parker Range vegetation complexes*. It is also located approximately 2km west of the Jilbadji Nature Reserve, which is managed by the DEC as a Class C Nature Reserve for the conservation of flora and fauna. The Jilbadji Nature Reserve is listed on the Register of National Estate (RNE) by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). RNE do not have formal protection under the *EPBC Act 1999* (DSEWPaC, 2012).

The Jilbadji Nature Reserve is also listed by the DEC as an Environmentally Sensitive Area (ESA). Appendix 2 provides a regional map of the survey area in relation to surrounding conservation areas. The entire Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides* vegetation community (2.5ha) located within the northern extremity of the proposed water pipeline occurs within a drainage line which is also listed as an ESA (Appendix 5). The entire survey area is located within a Schedule 1 Area, as described in Regulation 6 and Schedule 1, clause 4 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (Appendix 5).

Based on Keighery's vegetation health rating scale (1994), nine of the eleven vegetation communities within the area surveyed were rated as being in 'very good' health. A 'very good' health condition is defined as vegetation that has been altered due to obvious signs of disturbance, in this instance as a result of historic tracks, as well as current and historic drilling exploration. One vegetation community, Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides* was rated 'good'. A 'good' health condition is the structure affected multiple disturbances; however it retains its basic structure and has the ability to regenerate. The one remaining vegetation community, Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within an historically cleared gravel pit was rated as a 'degraded' health condition. This is defined as a vegetation structure which is severely disturbed; it has the ability to regenerate to a good condition; however it will requires intensive management.

Two introduced flora species were recorded during the survey; *Centaurea melitensis* and *Dittrichia graveolens*. According to the DAFWA neither of these species are listed as Declared Plants (DAFWA, 2011).

#### 4.2 Desktop Assessment

The results of the combined search of the DEC's Declared Rare and Priority Flora databases (DEC, 2011) revealed twelve Priority Flora species within 20km of the survey area (see Appendix 1). Six of these species have the potential to occur within the survey area as they occur in similar habitats and vegetation communities to those identified within the survey area. Table 5 identifies the DEC listed Priority Flora species potentially occurring within the survey area. Only two of these species were identified within the survey area; *Grevillea lissopleura* (P1) and *Hakea pendens* (P2). The other six species identified in the database search results occur in habitats and vegetation communities not found in the survey area and are therefore unlikely to occur in the survey area.

**Table 5: Priority Flora with the potential to occur within the survey area (DEC, 2011)**

Species	Conservation Code	Description (WAHERB 2012)
<i>Acacia concolorans</i>	P2	Intricate, sprawling or compact, pungent shrub, 0.1–0.5 m high. Fl. yellow, Jul–Aug. Red/brown loam, clay. Low lateritic hills, flats. Distribution: ER: COO; SW: AW, MAL.
<i>Gnephosis intonsa</i>	P1	Prostrate to ascending annual, herb, 0.01–0.04 m high. Fl. yellow, brown, Sep–Oct. Red/brown clay, stony saline loam. Distribution: ER: COO, MUR; SW: AW, ESP, MAL
<i>Grevillea lissopleura</i>	P1	Erect shrub, 0.5–1.2 m high. Fl. Aug. Stony loam on banded ironstone. On ridges. Distribution: ER: COO; SW: AW
<i>Hakea pendens</i>	P2	Shrub, 2–3 m high, 2.5–3.1 m wide. Fl. pink, white, Sep. Stony loam. Ironstone ridges. Distribution: ER: COO; SW: AW
<i>Eutaxia lasiocalyx</i>	P2	Low, spreading, multi-stemmed shrub, to 0.15 m high. Fl. yellow, Nov. Red sandy loam, laterite and quartz gravel. Gentle lower slopes. Distribution: ER: COO; SW: AW
<i>Lasiopetalum fitzgibbonii</i>	P3	Erect, spreading shrub, 0.3–1.5 m high. Fl. blue, purple, pink, Sep–Nov. Sand, clay loam, lateritic soils. Undulating plains, hills. Distribution: ER: COO; SW: ESP, MAL

### 4.3 Flora of Conservation Significance

No DRF/Threatened Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)*, *EPBC Act 1999* and as listed by the DEC (Atkins, 2010), were identified within the survey area. Two Priority flora, *Hakea pendens* (P2) and *Grevillea lissopleura* (P1) were recorded within the survey area. Both of these species were recorded within the Level 2 flora and vegetation survey area. No Priority Flora species were identified within the Dulcie proposed pipeline Level 1 survey. The GPS locations of these Priority Flora species are provided in Appendix 3. A map showing the location of Priority Flora species within the Level 2 flora and vegetation survey area is provided in Appendix 4.

#### 4.3.1 *Hakea pendens* (P2)

This species is described as a shrub, growing to an approximate height of 2–3 m high and a width of 2.5-3.1 m. It produces pink and white flowers in September and its preferred habitat is stony loam over ironstone ridges (WAHERB, 2012). An estimated 53 plants of this species were recorded at eleven locations within the survey area, which are listed in Appendix 3. It was identified within three of the vegetation communities; Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*, Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana* and Low woodland of *Eucalyptus salubris*/*Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii*. The nearest DEC known location of this species is approximately 4km north-west of the survey area.



Plate 1: Image of *Hakea pendens* (P2)

#### 4.3.2 *Grevillea lissopleura* (P1)

This species is described as an erect shrub approximately 0.5–1.2m high. It produces white or cream flowers in August and its preferred habitat is amongst low trees or tall (sclerophyll) shrubland, in rocky or stony soil (WAHERB, 2012). Four plants of this species were recorded at two locations within the survey area, which are listed in Appendix 3. It was identified within two of the vegetation communities; Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae* and Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*. The nearest DEC known location of this species is located approximately 1km east of the survey area.



Plate 2: Image of *Grevillea lissopleura* (P1)

## 5 Vegetation Communities

Eleven broad vegetation communities were identified within the survey area. These included:

1. Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii*;
2. Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*;
3. Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala*;
4. Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within historically cleared gravel pit;
5. Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii*;
6. Forrest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over heath of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata*;
7. Low woodland of *Eucalyptus melanoxyton* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha*;
8. Open mallee *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata*;
9. Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides*;
10. Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii*; and
11. Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii*.

These vegetation communities were represented by a total of 27 Families, 51 Genera and 112 Species (Appendix 9).



**Table 6: Summary of vegetation communities and their areas**

Vegetation Community	Area (ha)
Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	24
Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	119
Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i> / <i>Calytrix tetragona</i> / <i>Verticordia eriocephala</i>	1
Very open mallee of <i>Eucalyptus capillosa</i> subsp. <i>polyclada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> , <i>Melaleuca cordata</i> and <i>Phebalium filifolium</i> within an historically cleared gravel pit	2
Low woodland of <i>Eucalyptus salubris</i> / <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	204
Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> .	28
Low woodland of <i>Eucalyptus melanoxylon</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i>	7
Open mallee <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i>	1.5
Scrub of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca hamata</i> / <i>Melaleuca teuthidoides</i>	2.5
Open mallee of <i>Eucalyptus salubris</i> and <i>Eucalyptus calycogona</i> over open low scrub of <i>Acacia merrallii</i>	0.5
Open mallee of <i>Eucalyptus horistes</i> and <i>Eucalyptus oleosa</i> over heath of <i>Daviesia benthamii</i>	3.5
<b>Total Area</b>	<b>393</b>

## 5.1 Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii*

### 5.1.1 Flora

Flora recorded in the vegetation community was represented by 11 Families, 16 Genera and 21 Species (Appendix 9). Two quadrats were established in this vegetation community. Flora recorded in the quadrat survey was represented by 10 Families, 15 Genera and 20 Species (Appendix 11). No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

### 5.1.2 Vegetation

The flora recorded in this vegetation community was representative of Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii*. The species in the upper storey included *Eucalyptus loxophleba* subsp. *lissophloia* and *Acacia* sp. narrow phyllode.

The understorey species included *Thryptomene kochii*, *Leptospermum erubescens*, *Grevillea didymobotrya* subsp. *didymobotrya* and *Trymalium myrtillus* subsp. *myrtillus*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 7.

**Table 7: Vegetation assemblage for Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii* within the survey area (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	10-30%	<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>
Shrubs >2m	30-70%	<i>Acacia</i> sp. narrow phyllode
Shrubs 1.5 - 2m	30-70%	<i>Allocasuarina helmsii</i> <i>Leptospermum erubescens</i>
Shrubs 0.5 - 1m	30-70%	<i>Thryptomene kochii</i> <i>Grevillea paradoxa</i> <i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>
Shrubs 0 - 0.5m	30-70%	<i>Westringia cephalantha</i> var. <i>caterva</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the *Acacia* shrublands vegetation community according to the ANRA, which covers 9.5% of the State of Western Australia (ANRA, 2012).



**Plate 3: Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii* within the survey area**

## 5.2 Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*

### 5.2.1 Flora

Flora recorded in this vegetation community was represented by 17 Families, 30 Genera and 47 Species (Appendix 9). Six quadrats were established in this vegetation community. Flora recorded in the quadrat survey was represented by 12 Families, 23 Genera and 35 Species (Appendix 11). Two Priority Flora species, *Hakea pendens* (P2) and *Grevillea lissopleura* (P1), were identified in this vegetation community during the survey. One weed species *Centaurea melitensis* was recorded in this vegetation community. According to the DAFWA this species is not listed as a Declared Plant (DAFWA, 2012).

### 5.2.2 Vegetation

The flora recorded in this vegetation community was representative of Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana*. The species in the upper storey included *Eucalyptus loxophleba* subsp. *lissophloia*, *Allocasuarina campestris* and *Allocasuarina helmsii*. The understorey species included *Baeckea elderiana*, *Phebalium filifolium*, *Phebalium megaphyllum*, *Leptospermum erubescens*, *Grevillea didymobotrya* subsp. *didymobotrya*, *Calothamnus gilesii*, *Hibbertia eatoniae* and *Trymalium myrtillus* subsp. *myrtillus*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 8.

**Table 8: Vegetation assemblage for Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana* within the survey area (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	10-30%	<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>
Shrubs >2m	30-70%	<i>Allocasuarina campestris</i> <i>Allocasuarina helmsii</i>
Shrubs 1.5 - 2m	30-70%	<i>Acacia neurophylla</i> subsp. <i>neurophylla</i> <i>Grevillea paradoxa</i> <i>Baeckea elderiana</i>
Shrubs 0.5 - 1m	30-70%	<i>Phebalium filifolium</i> <i>Phebalium megaphyllum</i>
Shrubs 0 - 0.5m	30-70%	<i>Hibbertia eatoniae</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the *Casuarina* forests and woodlands vegetation community according to the ANRA, which covers 0.1% of the State of Western Australia (ANRA, 2012).



**Plate 4: Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana* within the survey area**

### **5.3 Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala***

#### **5.3.1 Flora**

Flora recorded in this vegetation community was represented by 10 Families, 14 Genera and 16 Species (Appendix 9). Only one quadrat was established in this vegetation community due to its small geographical size. Flora recorded in the quadrat survey was represented by 8 Families, 11 Genera and 11 Species (Appendix 11). Two Priority Flora species, *Hakea pendens* (P2) and *Grevillea lissopleura* (P1), were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

#### **5.3.2 Vegetation**

The flora recorded in this vegetation community was representative of Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala*. The species in the upper storey included *Allocasuarina campestris*. The understorey species included *Calothamnus gilesii*, *Hibbertia eatoniae*, *Calytrix tetragona* and *Verticordia eriocephala*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 9.

**Table 9: Vegetation assemblage for Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala* within the survey area (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Shrubs >2m	2-10%	<i>Allocasuarina campestris</i>
Shrubs 1.5 - 2m	2-10%	<i>Calothamnus gilesii</i>
Shrubs 0 - 0.5m	2-10%	<i>Hibbertia eatoniae</i> <i>Calytrix tetragona</i> <i>Verticordia eriocephala</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area however it has been disturbed by historical exploration and mining. This vegetation community is best represented by the *Casuarina* forests and woodlands vegetation community according to the ANRA, which covers 0.1% of the State of Western Australia (ANRA, 2012).



**Plate 5: Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala* within the survey area**

**5.4 Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within an historically cleared gravel pit**

**5.4.1 Flora**

Flora recorded in the vegetation community was represented by 7 Families, 9 Genera and 11 Species (Appendix 9). No quadrats were established in this vegetation community due to the high level of disturbance. No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community

**5.4.2 Vegetation**

The flora recorded in this vegetation community was representative of Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within historically cleared gravel pit. The species in the upper storey included *Eucalyptus capillosa* subsp. *polyclada*. The under-storey species included *Melaleuca cordata*, *Grevillea paradoxa*, *Westringia cephalantha* var. *caterva* and *Hibbertia eatoniae*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 10.

**Table 10: Vegetation assemblage for Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within historically cleared gravel pit within the survey area (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	2-10%	<i>Eucalyptus capillosa</i> subsp. <i>polyclada</i>
Shrubs 0.5 - 1m	10-30%	<i>Grevillea paradoxa</i> <i>Melaleuca cordata</i> <i>Phebalium filifolium</i>
Shrubs 0 - 0.5m	2-10%	<i>Westringia cephalantha</i> var. <i>caterva</i> <i>Hibbertia eatoniae</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area.

This vegetation community is best represented by the cleared/modified vegetation community according to the ANRA, which covers 7.3% of the State of Western Australia (ANRA, 2012).



**Plate 6: Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within historically cleared gravel pit within the survey area**

## **5.5 Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii***

### **5.5.1 Flora**

Flora recorded in this vegetation community was represented by 14 Families, 19 Genera and 39 Species (Appendix 9). Three quadrats were established in this vegetation community. Flora recorded in the quadrat survey was represented by 10 Families, 13 Genera and 21 Species (Appendix 11). One Priority Flora species, *Hakea pendens* (P2), were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

### **5.5.2 Vegetation**

The flora recorded in this vegetation community was representative of Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii*. The species in the upper storey included; *Eucalyptus salmonophloia* and *Eucalyptus salubris*. The under-storey species included; *Melaleuca pauperiflora* subsp. *pauperiflora*, *Dodonaea stenozyga*, *Acacia merrallii* and *Templetonia sulcata*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 11.

**Table 11: Vegetation assemblage for Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii* within the survey area (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Trees 5 - 15m	10-30%	<i>Eucalyptus salubris</i> <i>Eucalyptus salmonophloia</i>
Shrubs >2m	10-30%	<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>
Shrubs 0.5 - 1m	10-30%	<i>Dodonaea stenozyga</i> <i>Acacia erinacea</i> <i>Acacia merrallii</i> <i>Templetonia sulcata</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area.

This vegetation community is best represented by the *Eucalyptus* open woodlands vegetation community according to the ANRA, which covers 1.3% of the State of Western Australia (ANRA, 2012).



**Plate 7: Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii* within the survey area**



## 5.6 Forest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over health of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata*

### 5.6.1 Flora

Flora recorded in this vegetation community was represented by 11 Families, 17 Genera and 36 Species (Appendix 9). Three quadrats were established in this vegetation community. The flora recorded in this quadrat survey was represented by 9 Families, 13 Genera and 24 Species (Appendix 11). No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community

### 5.6.2 Vegetation

The flora recorded in this vegetation community was representative of Forest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over health of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata*. The species in the upper storey included *Eucalyptus salubris* and *Eucalyptus salmonophloia*. The under-storey species included *Melaleuca pauperiflora* subsp. *pauperiflora*, *Santalum acuminatum*, *Dodonaea stenozyga*, *Grevillea acuaria*, *Alyxia buxifolia*, *Eremophila ionantha*, *Exocarpos aphyllus* and *Acacia merrallii*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 12.

**Table 12: Vegetation assemblage for Forest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over health of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata* within the survey area (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	30-70% 10-30%	<i>Eucalyptus salubris</i> <i>Eucalyptus salmonophloia</i>
Shrubs 1.5-2m	30-70%	<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>
Shrubs 0 – 0.5m	2-10%	<i>Acacia deficiens</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the *Eucalyptus* open forest vegetation community according to the ANRA, which covers 0.8 % of the State of Western Australia (ANRA, 2012).



**Plate 8 Forest of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over health of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca pauperiflora* subsp. *fastigiata***

## **5.7 Low woodland of *Eucalyptus melanoxyton* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha***

### **5.7.1 Flora**

Flora recorded in this vegetation community was represented by 10 Families, 13 Genera and 20 Species (Appendix 9). No quadrats were established within this community as it occurred within the Level 1 flora and vegetation survey area; Dulcie proposed pipeline. No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

### **5.7.2 Vegetation**

The flora recorded in this vegetation community was representative of Low woodland *Eucalyptus Melanoxyton* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha*. The species in the upper storey included *Eucalyptus melanoxyton*, *Eucalyptus salubris* and *Eucalyptus oleosa*. The mid storey included *Melaleuca pauperiflora* subsp. *fastigiata*, *Exocarpos aphyllus*, *Acacia colletioides* and *Beyeria brevifolia*. The under storey included *Eremophila ionantha*, *Acacia merrallii*, *Templetonia sulcata*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 13.

**Table 13: Vegetation assemblage for Low woodland of *Eucalyptus melanoxyton* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha* E (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	10-30%	<i>Eucalyptus melanoxyton</i>
Shrubs 1.5-2m	10-30%	<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>
Shrubs 0-0.5m	2-10%	<i>Eremophila ionantha</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the *Eucalyptus* woodlands vegetation community according to the ANRA, which covers 3.5% of the State of Western Australia (ANRA, 2012).



**Plate 9: Low woodland of *Eucalyptus melanoxyton* over scrub of *Melaleuca pauperiflora* subsp. *fastigiata* over low scrub of *Eremophila ionantha***

## 5.8 Open mallee of *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata*

### 5.8.1 Flora

Flora recorded in this vegetation community was represented by 9 Families, 12 Genera and 15 Species (Appendix 9). No quadrats were established within this community as it occurred within the Level 1 flora and vegetation survey area; Dulcie proposed pipeline. No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

### 5.8.2 Vegetation

The flora recorded in this vegetation community was representative of Open mallee of *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata*. The species in the upper storey included; *Eucalyptus loxophleba* subsp. *lissophloia* and *Eucalyptus melanoxylon*. Mid-storey species included; *Melaleuca acuminata*, *Melaleuca hamata*, *Acacia hemiteles*, *Acacia* sp. narrow phyllode and *Eremophila oldfieldii* subsp. *angustifolia*. Understorey species included; *Hibbertia eatoniae*, *Beyeria brevifolia*, *Prostanthera grylloana* and *Microcybe multiflora*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 14.

**Table 14: Vegetation assemblage Open mallee of *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata* (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	10-30%	<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>
Shrubs 1.5-2m	10-30%	<i>Melaleuca acuminata</i> <i>Melaleuca hamata</i>
Shrubs 0 – 0.5m	2-10%	<i>Phebalium filifolium</i> <i>Hibbertia eatoniae</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the Mallee woodland and shrublands according to the ANRA, which covers 2% of the State of Western Australia (ANRA, 2012).



**Plate 10: Open mallee of *Eucalyptus loxophleba* subsp. *lissophloia* over scrub of *Melaleuca acuminata* and *Melaleuca hamata***

## **5.9 Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides***

### **5.9.1 Flora**

Flora recorded in this vegetation community was represented by 5 Families, 7 Genera and 7 Species (Appendix 9). No quadrats were established within this community as it occurred within the Level 1 flora and vegetation survey area; Dulcie proposed pipeline. No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

The entire Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides* vegetation community (2.5ha) located within the northern extremity of the proposed water pipeline occurs within a drainage line which is also listed as an ESA.

### **5.9.2 Vegetation**

The flora recorded in this vegetation community was representative of Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides*. The species in the upper storey included; *Melaleuca hamata* and *Melaleuca teuthidoides*. Understorey species included; *Tecticornia lylei*, *Daviesia benthamii*, and *Westringia cephalantha* var. *caterva*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 15.

**Table 15: Vegetation assemblage Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides* (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Shrub 1.5-2m	10-30%	<i>Melaleuca hamata</i> <i>Melaleuca teuthidoides</i>
Shrubs 0 – 0.5m	2-10%	<i>Tecticornia lylei</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the other shrublands vegetation community according to the ANRA, which covers 0.7% of the State of Western Australia (ANRA, 2012).



**Plate 11: Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides***

## **5.10 Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii***

### **5.10.1 Flora**

Flora recorded in this vegetation community was represented by 7 Families, 8 Genera and 12 Species (Appendix 9). No quadrats were established within this community as it occurred within the Level 1 flora and vegetation survey area; Dulcie proposed pipeline. No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

### 5.10.2 Vegetation

The flora recorded in this vegetation community was representative of Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii*. The species in the upper storey included; *Eucalyptus salubris* and *Eucalyptus calycogona*. Mid-storey species included; *Acacia merrallii*, *Trymalium myrtillus* subsp. *myrtillus*, *Eremophila oldfieldii* subsp. *angustifolia* and *Eremophila scoparia*. Understorey species included; *Templetonia sulcata*, *Acacia erinacea*, *Ptilotus holosericeus*, *Sclerolaena parviflora* and *Erymophyllum ramosum*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 16.

**Table 16: Vegetation assemblage Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii* (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	10-30%	<i>Eucalyptus salubris</i> <i>Eucalyptus calycogona</i>
Shrubs 1.5-2m	2-10%	<i>Acacia merrallii</i>
Shrubs 0 – 0.5m	2-10%	<i>Templetonia sulcata</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the Mallee woodlands and shrublands vegetation community according to the ANRA), which covers 2% of the State of Western Australia (ANRA, 2012).



**Plate 12: Open mallee of *Eucalyptus salubris* and *Eucalyptus calycogona* over open low scrub of *Acacia merrallii***

## 5.11 Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii*

### 5.11.1 Flora

Flora recorded in this vegetation community was represented by 11 Families, 14 Genera and 25 Species (Appendix 9). No quadrats were established within this community as it occurred within the Level 1 flora and vegetation survey area; Dulcie proposed pipeline. No Priority Flora species were identified in this vegetation community during the survey. No introduced species were recorded in this vegetation community.

### 5.11.2 Vegetation

The flora recorded in this vegetation community was representative Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii*. The species in the upper storey included; *Eucalyptus horistes*, *Eucalyptus oleosa*, *Eucalyptus salubris* and *Eucalyptus salmonophloia*. Mid storey species included *Melaleuca scalena*, *Melaleuca zeteticorum* and *Acacia collectioides*. Understorey species included *Daviesia benthamii*, *Triodia irritans*, *Acacia merrallii*, *Olearia mullerii* and *Westringia rigida*. Dominant species from the vegetation assemblage according to Muir (1977) is shown in Table 17.

**Table 17: Vegetation assemblage Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii* (Muir, 1977)**

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	10-30%	<i>Eucalyptus horistes</i> <i>Eucalyptus oleosa</i>
Shrubs 1.5-2m	10-30%	<i>Melaleuca scalene</i> <i>Melaleuca zeteticorum</i>
Shrubs 0 – 0.5m	30-70% 10-30%	<i>Daviesia benthamii</i> <i>Triodia irritans</i>

No broad scale clearing has occurred for agricultural purposes in this vegetation community within the survey area. This vegetation community is best represented by the Mallee woodlands and shrublands vegetation community according to the ANRA, which covers 2% of the State of Western Australia (ANRA, 2012).





Plate 13: Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii*

### 5.12 Vegetation of Conservation Significance

None of the eleven vegetation communities have national environmental significance as defined by the *EPBC Act 1999* as they do not contain DRF or listed as a TEC. However the survey area does occur within the Priority 3 Ecological Community known as the *Parker Range vegetation complexes* which covers an area of 55,960ha. This PEC contains a variety of vegetation units as described by the DEC below (DEC, 2010);

“*Hakea pendens* Tall Shrubland is of particular significance. *Eucalyptus sheathiana* with *E. transcontinentalis* and/or *E. eremophila* woodland on sandy soils at the base of ridges and low rises; *E. longicornis* with *E. corrugata* and *E. salubris* or *E. myriadena* woodland on broad flats; *E. salmonophloia* and *E. salubris* woodland on broad flats; *Allocasuarina acutivalvis* and *A. corniculata* on deeper sandy soils of lateritic ridges; *E. capillosa* subsp. *polyclada* and/or *E. loxophleba* over *Hakea pendens* thicket on skeletal soils on ridges (laterites, breakaways and massive gossanous caps); and *Callitris glaucophylla* low open woodland on massive greenstone ridges.”

*Hakea pendens* (P2) was identified within the survey area however these were isolated plants rather than a *Hakea pendens* Tall Shrubland as described within the PEC. The Thicket of *Allocasuarina campestris/Allocasuarina helmsii* over heath of *Baeckea elderiana* and Low woodland of *Eucalyptus salubris* and *Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii* vegetation communities identified within the survey area appear to be similar to vegetation communities that characterise the Parker Range PEC described above.

Three of the vegetation communities identified within the survey area are considered to be of conservation significance as they contain one or more Priority Flora species. These include Thicket of *Allocasuarina campestris/ Allocasuarina helmsii* over heath of *Baeckea elderiana*, Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*, Low woodland of *Eucalyptus salubris/Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii*.

The survey area is not located within DEC managed land, however it is located approximately 2km west of the Jilbadji Nature Reserve, which is managed by the DEC as a Class C Nature Reserve for the conservation of flora and fauna and also listed on the RNE which do not have formal protection under the *EPBC Act 1999* (DSEWPaC, 2012). The Jilbadji Nature Reserve contains a high level of endemic and rare flora and fauna species and serves as an important refuge for many organisms with approximately 80% of the Wheatbelt cleared for agriculture (DSEWPaC, 2012). Activities taking place within the survey area are unlikely to have an impact on this nearby Conservation area.

The Jilbadji Nature Reserve is also listed by the DEC as an ESA (Appendix 2). The entire Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora/Melaleuca hamata/Melaleuca teuthidoides* vegetation community (2.5ha) located within the northern extremity of the proposed water pipeline occurs within a drainage line which is also listed as an ESA (Appendix 5). The entire survey area is located within a Schedule 1 Area, as described in Regulation 6 and Schedule 1, clause 4 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (Appendix 5).

### 5.13 Vegetation Condition

Based on Keighery's vegetation health rating scale (1994) eight of the eleven vegetation communities within the area surveyed were rated as being in 'very good' health; Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii*, Thicket of *Allocasuarina campestris/ Allocasuarina helmsii* over heath of *Baeckea elderiana*, Low woodland of *Eucalyptus salubris/Eucalyptus salmonophloia* over dwarf scrub of *Acacia merrallii* and Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over thicket of *Melaleuca pauperiflora* subsp. *pauperiflora*. A 'very good' health condition is defined as vegetation that has been altered due to obvious signs of disturbance, in this instance as a result of historic tracks, as well as current and historic drilling exploration.

Two vegetation communities, Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthioides* and Scrub of *Allocasuarina campestris* over *Hibbertia eatoniae*/*Calytrix tetragona*/*Verticordia eriocephala* were rated 'good'. A 'good' health condition is the structure affected by multiple disturbances; however it retains its basic structure and has the ability to regenerate. The one remaining vegetation community, Very open mallee of *Eucalyptus capillosa* subsp. *polyclada* over open dwarf scrub of *Grevillea paradoxa*/*Melaleuca cordata*/*Phebalium filifolium* within an historically cleared gravel pit was rated as a 'degraded' health condition, which is defined as a vegetation structure which is severely disturbed; it has the ability to regenerate to a good condition; however it will require intensive management.

#### 5.14 PATN Analysis on the Dulcie Project

This statistical analysis was used to determine the similarities or differences in species composition between and within delineated vegetation communities identified within the Level 2 flora and vegetation survey of the Dulcie project to produce a quantitative estimate of the relationship between the species composition of each quadrat. Figure 10 shows the dendrogram for all perennial species recorded. The quadrats are represented as Q1-Q15.

With a few exceptions allocations of quadrats to different vegetation communities using PATN analysis supported delineations of vegetation communities made in the field. The compositions of the upper storey species in the two vegetation communities containing *Eucalyptus* species were found to be similar. The species composition of the remaining vegetation communities differed from one another with the exception of two Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana* quadrats which shared more common species with the Thicket of *Acacia* sp. narrow phyllode over low heath of *Thryptomene kochii* quadrats. This intermixing of seemingly different communities (as determined in the field) suggests that there was a level of homogeneity between the *Eucalyptus* vegetation communities and between the *Acacia* and *Allocasuarina* vegetation communities within the survey area. Figure 8 provides a dendrogram resulting from the PATN analysis which shows the consolidation of vegetation communities.

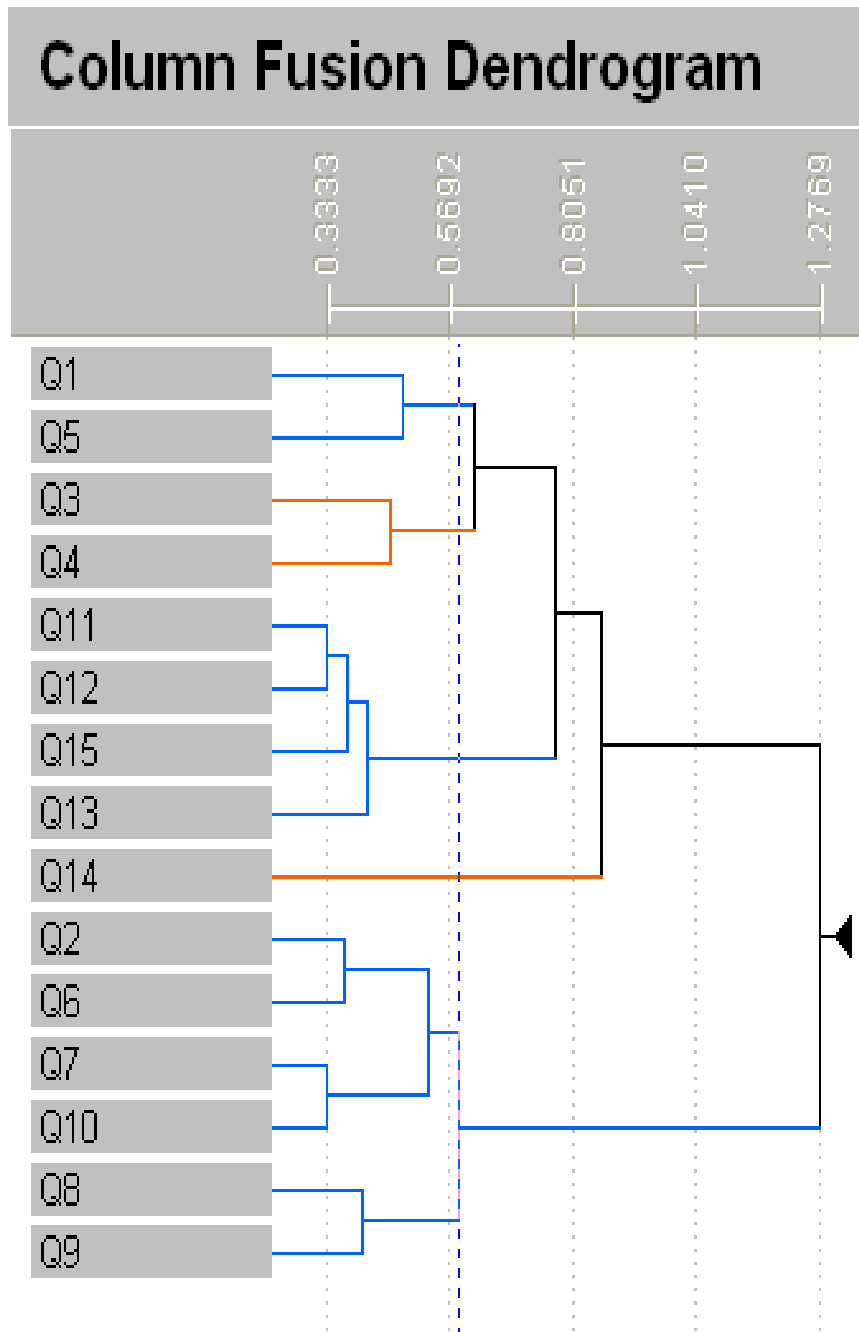


Figure 8: Dendrogram illustrating the groupings of Quadrats into communities based on similarities of perennial species recorded during the Level 2 Dulcie survey area (Beta value -0.1).

## 6 Introduced Species

Two introduced species *Centaurea melitensis* and *Dittrichia graveolens* were recorded within the survey area. According to the DAFWA database neither of these species are listed as a Declared Plant (DAFWA, 2011).

### 6.1 *Centaurea melitensis* (Maltese Cockspur)

This species is described as an erect annual or biennial herb that grows up to heights of 0.2 – 1m. It produces yellow flowers from September to December or from January to March. It prefers to grow along roadsides, cultivated areas or anywhere there has been disturbance (WAHERB, 2011). *Centaurea melitensis* was recorded within the Thicket of *Allocasuarina campestris*/*Allocasuarina helmsii* over heath of *Baeckea elderiana* vegetation community.



Plate 14 *Centaurea melitensis*

## 6.2 *Dittrichia graveolens* (Stinkwort)

This species is described as an erect, bushy, aromatic annual herb that can grow up to heights of 0.1 to 0.5m. It produces yellow/yellow-white coloured flowers from January to November and prefers to grow on waste grounds, along rivers and roadsides (WAHERB, 2012). This species was found in the Open mallee of *Eucalyptus horistes* and *Eucalyptus oleosa* over heath of *Daviesia benthamii* vegetation community.



Plate 15: Image of *Dittrichia graveolens* (Stinkwort) (WAHERB, 2012)

## 7 Conclusions

### 7.1 Conclusions

The entire Level 2 flora survey area (approximately 373 ha) and Level 1 flora survey area (20 hectares) recorded eleven vegetation communities; These communities were represented by a total of 27 Families, 51 Genera and 112 Species

No DRF/Threatened Flora pursuant to Subsection 2 of Section 23F of the *Wildlife Conservation Act (1950)*, *EPBC Act 1999* and listed by the DEC were identified within the survey area. Two Priority Flora species, *Grevillea lissopleura* (P1) and *Hakea pendens* (P2) were identified within the survey area.

None of the vegetation communities have National Environmental Significance as defined by the *EPBC Act 1999*. There were no TEC as defined by the *EPBC Act 1999* or listed by the DEC within the survey area (DEC, 2009, DSEWPaC, 2012). The survey area is however located within the buffer zone of a Priority 3 Ecological Community known as the *Parker Range vegetation complexes*. It is also located approximately 2km west of the Jilbadji Nature Reserve, which is managed by the DEC as a Class C Nature Reserve for the conservation of flora and fauna.

The Jilbadji Nature Reserve is listed on the RNE by the DSEWPaC. RNE do not have formal protection under the *EPBC Act 1999*. The Jilbadji Nature Reserve is also listed by the DEC as an ESA. The entire Scrub of *Melaleuca pauperiflora* subsp. *pauperiflora*/*Melaleuca hamata*/*Melaleuca teuthidoides* vegetation community (2.5ha) located within the northern extremity of the proposed water pipeline occurs within a drainage line which is also listed as an ESA (Appendix 5). The entire survey area is located within a Schedule 1 Area, as described in Regulation 6 and Schedule 1, clause 4 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (Appendix 5).

Based on Keighery's vegetation health rating scale (1994), eight of the eleven vegetation communities within the area surveyed by BC were classed as being in 'very good' health. Two vegetation communities was classed as "good" and one vegetation community was classed as having a "degraded" health condition. Two weed species, *Centaurea melitensis* and *Dittrichia graveolens*, were recorded in the survey area. Neither of these species are classified as Declared Plants, by DAFWA.

## 8 References

- ANRA, (2012), *Australian Natural Resources Atlas (ANRA)*, Australian Government  
<http://www.anra.gov.au/topics/vegetation/extent/wa/index.html>  
Accessed 13/01/2012
- Atkins, K., (2010), *Declared Rare and Priority Flora List for Western Australia*, Department of Environment and Conservation
- Armstrong, P., (2004). *Rare Flora search and Vegetation Survey at British Hill Mine*, Polaris Metals. Paul Armstrong and Associates.
- BC, (2007-2010). *Flora and Vegetation Survey, Parker Range Survey Area*, Cazaly Resources. Botanica Consulting.
- BC, (2011a). *Level 1 Flora and Vegetation survey, Battler Survey Area*, Southern Cross Goldfields. Botanica Consulting.
- BC, (2011a). *Level 2 Flora and Vegetation survey, British Hill Survey Area*, Southern Cross Goldfields. Botanica Consulting.
- Beard, J.S., (1990), *Plant Life of Western Australia*, Kangaroo Press Pty Ltd, NSW.
- Beecham, (2001), *A Biodiversity Audit of Western Australia's 53 Biogeographical Region in 2002-Avon Wheatbelt 1 subregion*, Department of Conservation and Land Management.
- Beeston, G., Hopkins, A. and Shepherd, D., (2002), *Land-Use and Vegetation in Western Australia-National Land and Water Resources Audit Report*, Resource Management Technical Report 250, Department of Agriculture
- Blackall, W.E. and Grieve, B.J. (1980), *How to know Western Australian Wildflowers Part IIIA*, University of Western Australia Press, Nedlands, WA
- Blackall, W.E. and Grieve, B.J. (1981), *How to know Western Australian Wildflowers Part IIIB*, University of Western Australia Press, Nedlands, WA
- Blackall, W.E. and Grieve, B.J. (1982), *How to know Western Australian Wildflowers Part IV*, University of Western Australia Press, Nedlands, WA
- Blackall, W.E. and Grieve, B.J. (1988), *How to know Western Australian Wildflowers Part I*, University of Western Australia Press, Nedlands, WA
- BOM, (2011), *Youanmi Valley (Station # 012201) rainfall data for 2008 and 2011*, Bureau of Meteorology,  
[http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p\\_nccObsCode=139&p\\_display\\_type=dataFile&p\\_startYear=&p\\_c=&p\\_stn\\_num=012298](http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=012298)
- Campbell, R., Billing, N., Northcote, K., Hubble, G., Isbell, R., Thompson, C., and Bettenay, E., (1975), *A description of Australian Soils*, Canberra: C.S.I.R.O. Division of Soils
- Chinnock, R.J., (2007), *Eremophila and allied Genera – A Monograph of the Myoporaceae*, Rosenberg Publishing Pty. Ltd. NSW
- Cousens, R.D., Dodd, J., Lloyd, S.G., Hussey, B.M.J., and Keighery, G.J. (1997), *Western Weeds – A guide to weeds of Western Australia*, The Plant Protection society of Western Australia, Victoria Park
- DAFWA, (2012), *Declared Plants Search*, Department of Agriculture and Food  
[http://agwdsrv02.agric.wa.gov.au/dps/version02/01\\_plantsearch.asp](http://agwdsrv02.agric.wa.gov.au/dps/version02/01_plantsearch.asp)



Accessed: 14/01/12

DAFWA, (2007), *Pre-European Vegetation - Western Australia* (NVIS Compliant Version GIS file), Department of Agriculture and Food Western Australia

DEC, (2007), *Banded Ironstone Formation Ranges of the Midwest and Goldfields: Interim Status Report- Biodiversity Values and Conservation Requirement*, Department of Environment and Conservation

DEC, (2009), *TEC/PEC database search results*, Department of Environment and Conservation  
Requested: June 2009

DEC, (2010a), *A biodiversity and cultural conservation strategy for the Great Western Woodlands*, Department of Environment and Conservation.

DEC, (2010b), *Priority Ecological Communities List for Western Australia*, Department of Environment and Conservation

DEC, (2011), *Threatened Flora Database search results*, Department of Environment and Conservation  
Requested: May 2011

DSEWPaC, (2012), *Protected Matters Search Tool, Environment Protection and Biodiversity Conservation Act 1999*, Department of the Environment, Sustainability, Water, Population and Communities

[http://www.environment.gov.au/cgi-bin/erin/ert/ert\\_dispatch.pl?loc\\_type=coordinate&search=Search&report=epbc](http://www.environment.gov.au/cgi-bin/erin/ert/ert_dispatch.pl?loc_type=coordinate&search=Search&report=epbc)

Accessed 20/01/12

EPA, (2004), *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986), Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, Environmental Protection Authority

Grieve, B.J., (1998), *How to know Western Australian Wildflowers – A key to the flora of the extratropical regions of Western Australia Part II*, University of Western Australia Press, Nedlands, WA.

Keighery, B. J., (1994), *Bushland Plant Survey: A guide to plant community survey for the community*. Wildflower Society of Western Australia (Inc.), Nedlands

Mitchell, A. & Wilcox, D. G. (1988), *Arid Shrubland Plants of Western Australia*, University of Western Australia Press, Nedlands, WA

Morgan, G, (2000), *A rapid assessment of the relative condition of Australia's bioregions and subregions*. Environment Australia, 2000

Muir, B. G., (1977), *Biological Survey of the Western Australian Wheatbelt. Pt 2. Vegetation and habitat of the Bendering Reserve*, *Rec. West. Aust. Mus. Suppl.* **3**.

WAHERB, (2011), *Florabase – Information on the Western Australian Flora*, Department of Environment and Conservation.

<http://florabase.dec.wa.gov.au>

Accessed 12/01/11

Watson, A., Judd, S., Watson J., Lam, A. and Mackenzie, D., (2008) *The Extraordinary Nature of The Great Western Woodlands*. The Wilderness Society of WA.

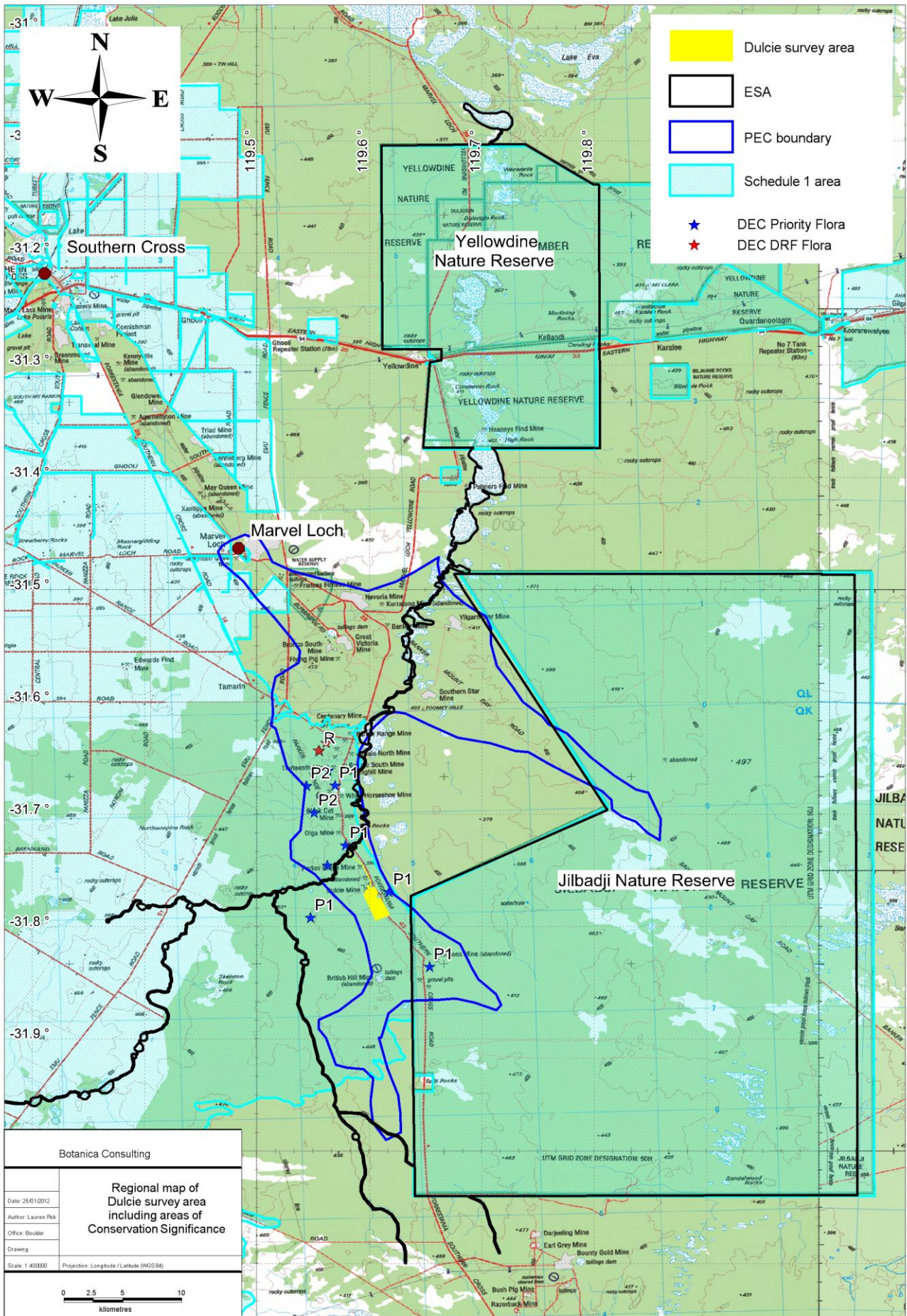
WWF, (2005), *Woodland Watch Conservation outcomes summary: 2000-2005*. World Wildlife Fund-Australia.

## 9 Appendices

Appendix 1: DEC Databases search results for Declared Rare and Priority species within a 20km radius of the survey area (DEC, 2011).

<b>Genus</b>	<b>Species</b>	<b>Conservation Code</b>
<i>Acacia</i>	<i>concolorans</i>	P2
<i>Euryomyrtus</i>	<i>ciliata</i>	P1
<i>Gnephosis</i>	<i>intonsa</i>	P1
<i>Grevillea</i>	<i>lissopleura</i>	P1
<i>Hakea</i>	<i>pendens</i>	P2
<i>Verticordia</i>	<i>multiflora</i> subsp. <i>solox</i>	P2
<i>Calandrinia</i>	<i>porifera</i>	P3
<i>Eremophila</i>	<i>caerulea</i> subsp. <i>merrallii</i>	P4
<i>Eutaxia</i>	<i>lasiocalyx</i>	P2
<i>Lasiopetalum</i>	<i>fitzgibbonii</i>	P3
<i>Pityrodia</i>	sp. Yilgarn (A.P. Brown 2679)	P3
<i>Prostanthera</i>	<i>nanophylla</i>	P3

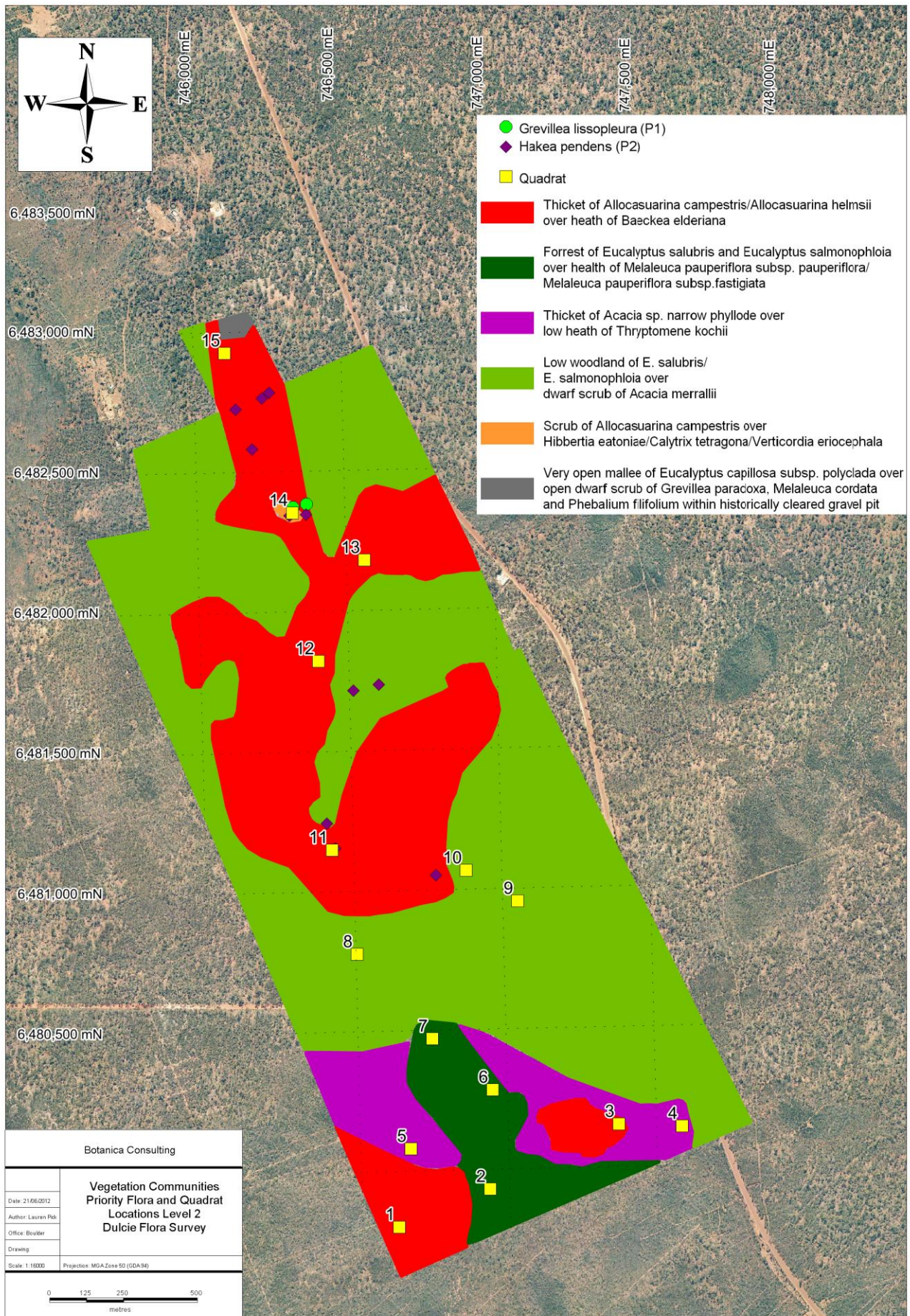
Appendix 2: Regional map of the Dulcie survey area including areas of conservation significance (survey area not to scale).



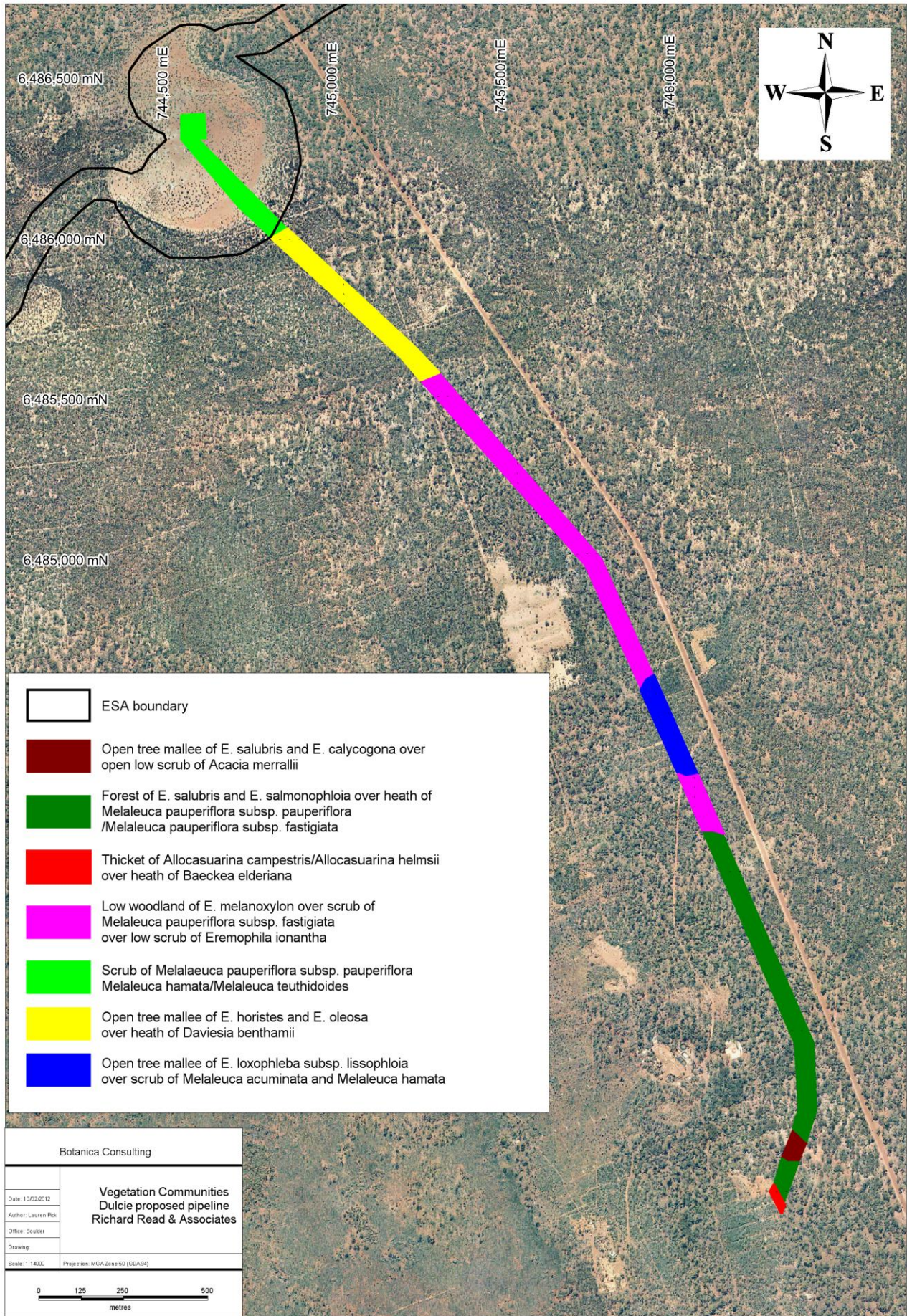
**Appendix 3: GPS locations of Priority Flora species recorded within the survey area**

<b>Species</b>	<b>GDA94 Zone</b>	<b>Easting</b>	<b>Northing</b>	<b>Numbers</b>
<i>Grevillea lissopleura</i> (P1)	50 J	746371	6482383	2
<i>Grevillea lissopleura</i> (P1)	50 J	746325	6482373	2
<i>Hakea pendens</i> (P2)	50 J	746139	6482725	2
<i>Hakea pendens</i> (P2)	50 J	746229	6482762	2
<i>Hakea pendens</i> (P2)	50 J	746253	6482782	2
<i>Hakea pendens</i> (P2)	50 J	746313	6482342	2
<i>Hakea pendens</i> (P2)	50 J	746776	6481052	Approx. 20 plants
<i>Hakea pendens</i> (P2)	50 J	746600	6481734	Approx. 15 plants
<i>Hakea pendens</i> (P2)	50 J	746513	6481715	
<i>Hakea pendens</i> (P2)	50 J	746439	6481154	2
<i>Hakea pendens</i> (P2)	50 J	746413	6481244	5
<i>Hakea pendens</i> (P2)	50 J	746368	6482345	1
<i>Hakea pendens</i> (P2)	50 J	746192	6482581	2

Appendix 4: Vegetation Map of the Level 2 Dulcie survey area (including Quadrat and Priority Flora locations)



Appendix 5 Vegetation map of the Level 1 Dulcie proposed pipeline survey area (including ESA boundary)



**Appendix 6: GPS coordinates of each quadrat (GDA94)**

<b>Sample Point</b>	<b>Zone</b>	<b>Easting</b>	<b>Northing</b>	<b>Sample Point</b>	<b>Zone</b>	<b>Easting</b>	<b>Northing</b>
Q1 corner	50 J	746609	6479799	Q9 corner	50 J	747066	6480942
Q1 corner	50 J	746622	6479818	Q9 corner	50 J	747043	6480941
Q1 corner	50 J	746641	6479801	Q9 corner	50 J	747034	6480965
Q1 corner	50 J	746630	6479781	Q9 corner	50 J	747053	6480968
Q2 corner	50 J	746926	6479940	Q10 corner	50 J	746872	6481053
Q2 corner	50 J	746943	6479946	Q10 corner	50 J	746893	6481064
Q2 corner	50 J	746945	6479926	Q10 corner	50 J	746886	6481079
Q2 corner	50 J	746922	6479910	Q10 corner	50 J	746861	6481073
Q3 corner	50 J	747368	6480136	Q11 corner	50 J	746448	6481133
Q3 corner	50 J	747362	6480157	Q11 corner	50 J	746440	6481169
Q3 corner	50 J	747380	6480163	Q11 corner	50 J	746408	6481154
Q3 corner	50 J	747388	6480145	Q11 corner	50 J	746421	6481133
Q4 corner	50 J	747583	6480126	Q12 corner	50 J	746407	6481813
Q4 corner	50 J	747601	6480132	Q12 corner	50 J	746405	6481834
Q4 corner	50 J	747594	6480152	Q12 corner	50 J	746385	6481836
Q4 corner	50 J	747571	6480144	Q12 corner	50 J	746387	6481810
Q5 corner	50 J	746656	6480075	Q13 corner	50 J	746570	6482189
Q5 corner	50 J	746675	6480065	Q13 corner	50 J	746547	6482184
Q5 corner	50 J	746685	6480079	Q13 corner	50 J	746555	6482167
Q5 corner	50 J	746666	6480092	Q13 corner	50 J	746578	6482174
Q6 corner	50 J	746940	6480275	Q14 corner	50 J	746321	6482371
Q6 corner	50 J	746963	6480275	Q14 corner	50 J	746298	6482365
Q6 corner	50 J	746959	6480295	Q14 corner	50 J	746318	6482336
Q6 corner	50 J	746939	6480292	Q14 corner	50 J	746341	6482345
Q7 corner	50 J	746744	6480455	Q15 corner	50 J	746114	6482947
Q7 corner	50 J	746737	6480476	Q15 corner	50 J	746087	6482935
Q7 corner	50 J	746758	6480481	Q15 corner	50 J	746093	6482911
Q7 corner	50 J	746762	6480461	Q15 corner	50 J	746127	6482913
Q8 corner	50 J	746500	6480760				
Q8 corner	50 J	746516	6480773				
Q8 corner	50 J	746506	6480790				
Q8 corner	50 J	746485	6480783				

**Appendix 7: Muir Life Form/Height Class (Muir, 1977)**

<b>LIFE FORM/HEIGHT CLASS</b>	<b>CANOPY COVER</b>			
	<b>DENSE 70% -100%</b>	<b>MID DENSE 30% -70%</b>	<b>SPARSE 10% -30%</b>	<b>VERY SPARSE 2% -10%</b>
Trees > 30m Trees 15 – 30m Trees 5 – 15m Trees < 5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B
Mallee Tree Form Mallee Shrub Form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
Shrubs > 2m Shrubs 1.5 – 2m Shrubs 1 – 1.5m Shrubs 0.5 – 1m Shrubs 0 – 0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D
Mat Plants Hummock Grass Bunch grass >0.5m Bunch grass < 0.5m Herbaceous spp.	Dense Mat Plants Dense Hummock Grass Dense Tall Grass Dense Low Grass Dense Herbs	Mat Plants Mid-dense Hummock Grass Tall Grass Low Gras Herbs	Open Mat Plants Hummock Grass Open Tall Grass Open Low Grass Open Herbs	Very Open Mat Plants Open Hummock Grass Very Open Tall Grass Very Open Low Grass Very Open Herbs
Sedges > 0.5m Sedges < 0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges
Ferns Mosses, liverworts	Dense ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses



### Appendix 8: Keighery (1994) Health Ratings

Health Rating	Health Description	Definition
6	Pristine	No obvious signs of disturbance
5	Excellent	Vegetation intact despite disturbance affect, weeds are non-aggressive individual species
4	Very Good	Vegetation altered due to obvious signs of disturbance
3	Good	Structure affected multiple disturbances. Retains basic structure, has ability to regenerate
2	Degraded	Structure severely disturbed. Can regeneration to good condition, but requires intensive management
1	Completely Degraded	Completely bare no native species

**Appendix 9: List of species identified within each vegetation community**

(A) Denotes annual species; (W) denotes introduced species (listed as alien on WAHERB, 2012); red text denotes Priority Flora species.

Family	Genus	Species	Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i> / <i>Calytrix tetragona</i> / <i>Verticordia eriocephala</i>	Very open mallee of <i>Eucalyptus capillosa</i> subsp. <i>polyciada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> / <i>Melaleuca cordata</i> / <i>Phebalium filifolium</i> within historically cleared gravel pit	Low woodland of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	Low woodland of <i>Eucalyptus melanoxylon</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i>	Open mallee of <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i>	Scrub of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca hamata</i> / <i>Melaleuca teuthidoides</i>	Open mallee of <i>Eucalyptus salubris</i> and <i>Eucalyptus calycogona</i> over open low scrub of <i>Acacia merrallii</i>	Open mallee of <i>Eucalyptus horistes</i> and <i>Eucalyptus oleosa</i> over heath of <i>Daviesia benthamii</i>
Amaranthaceae	<i>Ptilotus</i>	<i>holosericeus</i>										*	
Apocynaceae	<i>Alyxia</i>	<i>buxifolia</i>			*		*	*					
Asparagaceae	<i>Lomandra</i>	<i>effusa</i>											*
Asteraceae	<i>Olearia</i>	<i>muelleri</i>					*		*				*
Asteraceae	<i>Centaurea</i>	<i>melitensis</i> (W)		*									
Asteraceae	<i>Dittrichia</i>	<i>graveolens</i> (W)											*
Asteraceae	<i>Erymophyllum</i>	<i>ramosum</i>										*	
Asteraceae	<i>Olearia</i>	<i>dampieri</i> subsp. <i>eremicola</i>											*
Boraginaceae	<i>Halgania</i>	<i>andromedifolia</i>							*				*
Casuarinaceae	<i>Allocasuarina</i>	<i>campestris</i>		*	*					*			
Casuarinaceae	<i>Allocasuarina</i>	<i>corniculata</i>		*									
Casuarinaceae	<i>Allocasuarina</i>	<i>helmsii</i>	*	*									
Chenopodiaceae	<i>Maireana</i>	<i>georgei</i>					*						
Chenopodiaceae	<i>Sclerolaena</i>	<i>drummondii</i>						*					
Chenopodiaceae	<i>Sclerolaena</i>	<i>parviflora</i>						*				*	
Chenopodiaceae	<i>Tecticornia</i>	<i>lylei</i>									*		
Cupressaceae	<i>Callitris</i>	<i>preissii</i>	*	*									
Dilleniaceae	<i>Hibbertia</i>	<i>eatoniae</i>	*	*	*	*		*		*			
Dilleniaceae	<i>Hibbertia</i>	<i>rostellata</i>		*									
Droseraceae	<i>Drosera</i>	<i>andersoniana</i>		*	*	*							
Ericaceae	<i>Astroloma</i>	<i>serratifolium</i>		*	*								
Ericaceae	<i>Leucopogon</i>	sp. Wheatbelt (S. Murray 257)	*	*									

Family	Genus	Species	Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmisii</i> over heath of <i>Baeckea elderiana</i>	Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i> / <i>Calytrix tetragona</i> / <i>Verticordia eriocephala</i>	Very open mallee of <i>Eucalyptus capilliflora</i> subsp. <i>polyclada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> / <i>Melaleuca cordata</i> / <i>Phebalium filifolium</i> within historically cleared gravel pit	Low woodland of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	Low woodland of <i>Eucalyptus melanoxylon</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i>	Open mallee of <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i>	Scrub of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca hamata</i> / <i>Melaleuca teuthidoides</i>	Open mallee of <i>Eucalyptus salubris</i> and <i>Eucalyptus calycogona</i> over open low scrub of <i>Acacia merrallii</i>	Open mallee of <i>Eucalyptus horistes</i> and <i>Eucalyptus oleosa</i> over heath of <i>Daviesia benthamii</i>
Euphorbiaceae	<i>Beyeria</i>	<i>brevifolia</i>							*	*			*
Fabaceae	<i>Acacia</i>	<i>colletoides</i>		*			*	*	*				*
Fabaceae	<i>Acacia</i>	<i>merrallii</i>					*	*	*				*
Fabaceae	<i>Templetonia</i>	<i>sulcata</i>					*	*	*				*
Fabaceae	<i>Acacia</i>	<i>deficiens</i>					*	*					
Fabaceae	<i>Acacia</i>	<i>erinacea</i>					*	*					*
Fabaceae	<i>Acacia</i>	<i>hemiteles</i>	*			*				*			*
Fabaceae	<i>Acacia</i>	<i>ligulata</i>						*					
Fabaceae	<i>Acacia</i>	<i>neurophylla</i> subsp. <i>neurophylla</i>		*									
Fabaceae	<i>Acacia</i>	sp. narrow phyllode	*	*	*	*	*	*		*			
Fabaceae	<i>Acacia</i>	<i>steadmanii</i>		*	*								
Fabaceae	<i>Daviesia</i>	<i>argillacea</i>						*					*
Fabaceae	<i>Daviesia</i>	<i>benthamii</i>									*		*
Fabaceae	<i>Gastrolobium</i>	<i>parviflorum</i>		*									
Fabaceae	<i>Senna</i>	<i>artemisioides</i> subsp. <i>filifolia</i>					*	*					
Goodeniaceae	<i>Scaevola</i>	<i>bursariifolia</i>							*				
Goodeniaceae	<i>Scaevola</i>	<i>spinescens</i>		*			*		*				
Lamiaceae	<i>Prostanthera</i>	<i>grylloana</i>				*				*			
Lamiaceae	<i>Prostanthera</i>	<i>semiteres</i> subsp. <i>semiteres</i>		*									
Lamiaceae	<i>Westringia</i>	<i>cephalantha</i> var. <i>caterva</i>	*	*		*	*				*		*
Lamiaceae	<i>Westringia</i>	<i>rigida</i>								*			*
Lauraceae	<i>Cassytha</i>	<i>melantha</i>		*									
Myrtaceae	<i>Eucalyptus</i>	<i>melanoxylon</i>					*	*	*	*			
Myrtaceae	<i>Eucalyptus</i>	<i>oleosa</i>							*				*

Family	Genus	Species	Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i> / <i>Calytrix tetragona</i> / <i>Verticordia eriocephala</i>	Very open mallee of <i>Eucalyptus capillosa</i> subsp. <i>polyclada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> / <i>Melaleuca cordata</i> / <i>Phebalium filifolium</i> within historically cleared gravel pit	Low woodland of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>	Low woodland of <i>Eucalyptus melanoxylon</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i>	Open mallee of <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i>	Scrub of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca hamata</i> / <i>Melaleuca teuthioides</i>	Open mallee of <i>Eucalyptus salubris</i> and <i>Eucalyptus calycogona</i> over open low scrub of <i>Acacia merrallii</i>	Open mallee of <i>Eucalyptus horistes</i> and <i>Eucalyptus oleosa</i> over heath of <i>Daviesia benthamii</i>
Myrtaceae	<i>Eucalyptus</i>	<i>salubris</i>		*			*	*	*			*	*
Myrtaceae	<i>Eucalyptus</i>	<i>vittata</i>					*	*	*				
Myrtaceae	<i>Melaleuca</i>	<i>pauperiflora</i> subsp. <i>pauperiflora</i>					*	*	*		*		*
Myrtaceae	<i>Melaleuca</i>	<i>pauperiflora</i> subsp. <i>fastigiata</i>						*	*				*
Myrtaceae	<i>Baeckea</i>	<i>elderiana</i>		*									
Myrtaceae	<i>Calothamnus</i>	<i>gilesii</i>		*	*								
Myrtaceae	<i>Calytrix</i>	<i>tetragona</i>			*								
Myrtaceae	<i>Eucalyptus</i>	<i>calycogona</i>						*				*	
Myrtaceae	<i>Eucalyptus</i>	<i>capillosa</i> subsp. <i>polyclada</i>		*		*		*					
Myrtaceae	<i>Eucalyptus</i>	<i>flocktoniae</i>					*	*					
Myrtaceae	<i>Eucalyptus</i>	<i>horistes</i>											*
Myrtaceae	<i>Eucalyptus</i>	<i>leptophylla</i>		*									
Myrtaceae	<i>Eucalyptus</i>	<i>loxophleba</i> subsp. <i>lissophloia</i>	*	*			*			*			
Myrtaceae	<i>Eucalyptus</i>	<i>rigidula</i>					*						
Myrtaceae	<i>Eucalyptus</i>	<i>salmonophloia</i>					*	*					*
Myrtaceae	<i>Eucalyptus</i>	sp. sterile				*							
Myrtaceae	<i>Eucalyptus</i>	<i>urna</i>					*						
Myrtaceae	<i>Eucalyptus</i>	<i>yilgarnensis</i>					*						
Myrtaceae	<i>Euryomyrtus</i>	<i>maidenii</i>	*	*									
Myrtaceae	<i>Leptospermum</i>	<i>erubescens</i>	*	*									
Myrtaceae	<i>Melaleuca</i>	<i>acuminata</i>						*		*			
Myrtaceae	<i>Melaleuca</i>	<i>cordata</i>		*		*							
Myrtaceae	<i>Melaleuca</i>	<i>eleuterostachya</i>					*	*					
Myrtaceae	<i>Melaleuca</i>	<i>fulgens</i>		*	*								
Myrtaceae	<i>Melaleuca</i>	<i>hamata</i>					*			*	*		

Family	Genus	Species	Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i> / <i>Calytrix tetragona</i> / <i>Verticordia eriocephala</i>	Very open mallee of <i>Eucalyptus capillosa</i> subsp. <i>polyclada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> / <i>Melaleuca cordata</i> / <i>Phebalium filifolium</i> within historically cleared gravel pit	Low woodland of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	Low woodland of <i>Eucalyptus melanoxylon</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i>	Open mallee of <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i>	Scrub of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca hamata</i> / <i>Melaleuca teuthidoidea</i>	Open mallee of <i>Eucalyptus salubris</i> and <i>Eucalyptus calycogona</i> over open low scrub of <i>Acacia merrallii</i>	Open mallee of <i>Eucalyptus horistes</i> and <i>Eucalyptus oleosa</i> over heath of <i>Daviesia benthamii</i>
Myrtaceae	<i>Melaleuca</i>	<i>lateriflora</i>					*	*					
Myrtaceae	<i>Melaleuca</i>	<i>laxiflora</i>					*	*					
Myrtaceae	<i>Melaleuca</i>	<i>scalena</i>											*
Myrtaceae	<i>Melaleuca</i>	<i>teuthidoidea</i>									*		
Myrtaceae	<i>Melaleuca</i>	<i>zeteticorum</i>											*
Myrtaceae	<i>Thryptomene</i>	<i>kochii</i>	*	*			*						
Myrtaceae	<i>Verticordia</i>	<i>eriocephala</i>			*								
Myrtaceae	<i>Verticordia</i>	<i>plumosa</i> var. <i>incrassata</i>	*	*									
Poaceae	<i>Triodia</i>	<i>irritans</i>											*
Proteaceae	<i>Grevillea</i>	<i>acacioides</i>	*	*									
Proteaceae	<i>Grevillea</i>	<i>acuaria</i>					*	*					
Proteaceae	<i>Grevillea</i>	<i>didymobotrya</i> subsp. <i>didymobotrya</i>	*	*		*							
Proteaceae	<i>Grevillea</i>	<i>huegelii</i>											*
Proteaceae	<i>Grevillea</i>	<i>lissopleura</i> (P1)		*	*								
Proteaceae	<i>Grevillea</i>	<i>paradoxa</i>	*	*			*						
Proteaceae	<i>Hakea</i>	<i>francisiana</i>	*	*									
Proteaceae	<i>Hakea</i>	<i>kippistiana</i>									*		
Proteaceae	<i>Hakea</i>	<i>pendens</i> (P2)		*	*		*						
Proteaceae	<i>Hakea</i>	<i>scoparia</i>		*	*		*						
Proteaceae	<i>Persoonia</i>	<i>striata</i>		*									
Rhamnaceae	<i>Cryptandra</i>	<i>aridicola</i>		*									
Rhamnaceae	<i>Trymalium</i>	<i>myrtillus</i> subsp. <i>myrtillus</i>		*								*	
Rutaceae	<i>Microcybe</i>	<i>multiflora</i>						*		*			
Rutaceae	<i>Phebalium</i>	<i>filifolium</i>	*	*				*		*			*
Rutaceae	<i>Phebalium</i>	<i>megaphyllum</i>	*	*			*	*					

Family	Genus	Species	Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i> / <i>Calytrix tetragona</i> / <i>Verticordia eriocephala</i>	Very open mallee of <i>Eucalyptus capillosa</i> subsp. <i>polyclada</i> over open dwarf scrub of <i>Grevillea paradoxa</i> / <i>Melaleuca cordata</i> / <i>Phebalium filifolium</i> within historically cleared gravel pit	Low woodland of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over heath of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	Low woodland of <i>Eucalyptus melanoxylon</i> over scrub of <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> over low scrub of <i>Eremophila ionantha</i>	Open mallee of <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> over scrub of <i>Melaleuca acuminata</i> and <i>Melaleuca hamata</i>	Scrub of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca hamata</i> / <i>Melaleuca teuthioides</i>	Open mallee of <i>Eucalyptus salubris</i> and <i>Eucalyptus calycogona</i> over open low scrub of <i>Acacia merrallii</i>	Open mallee of <i>Eucalyptus horistes</i> and <i>Eucalyptus oleosa</i> over heath of <i>Daviesia benthamii</i>	
Rutaceae	<i>Phebalium</i>	<i>tuberculosum</i>	*	*										
Santalaceae	<i>Exocarpos</i>	<i>aphyllus</i>					*	*	*					*
Santalaceae	<i>Santalum</i>	<i>acuminatum</i>	*	*				*	*	*				
Sapindaceae	<i>Dodonaea</i>	<i>adenophora</i>		*	*									
Sapindaceae	<i>Dodonaea</i>	<i>stenozyga</i>					*	*						
Scrophulariaceae	<i>Eremophila</i>	<i>ionantha</i>					*	*	*					
Scrophulariaceae	<i>Eremophila</i>	<i>scoparia</i>					*	*	*				*	
Scrophulariaceae	<i>Eremophila</i>	<i>clarkei</i>		*		*								
Scrophulariaceae	<i>Eremophila</i>	<i>decipiens</i>											*	
Scrophulariaceae	<i>Eremophila</i>	<i>oldfieldii</i> subsp. <i>angustifolia</i>								*			*	
Scrophulariaceae	<i>Eremophila</i>	<i>oppositifolia</i> subsp. <i>angustifolia</i>			*		*							
Scrophulariaceae	<i>Eremophila</i>	<i>saligna</i>												
Solanaceae	<i>Solanum</i>	<i>hoplopetalum</i>						*	*					
Thymelaeaceae	<i>Pimelea</i>	<i>microcephala</i> subsp. <i>microcephala</i>					*							
Zygophyllaceae	<i>Zygophyllum</i>	<i>glaucum</i> (A)							*					
Zygophyllaceae	<i>Zygophyllum</i>	<i>eremaum</i> (A)					*							

Appendix 10: Photographic Monitoring Level 2 flora and vegetation survey spring 2011-Dulcie project



Quadrat 1



Quadrat 2



**Quadrat 3**



**Quadrat 4**





**Quadrat 5**



**Quadrat 6**



**Quadrat 7**



**Quadrat 8**



**Quadrat 9**



**Quadrat 10**



**Quadrat 11**



**Quadrat 12**



**Quadrat 13**



**Quadrat 14**



**Quadrat 15**

Appendix 11: Datasheets from the Quadrat Flora Survey Spring 2011.

Survey Name: Dulcie project		
Date: 23-11-2011	Botanist: Lauren Pick and Samantha Stapleton	
Location: Richard Read and Associates	Quadrat: Q1	
Quadrat size: 20x20		
WP: 095	Vegetation group: Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	
Photo number: 22-24		
Landform: Flat/plain		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0/-/-		
Rock outcrop (abundance/runoff): 0/1		
Soil (profile/field texture/soil surface): U/CL/L		
%Cover leaf litter: 60		
%Cover bare ground: 20		
Tallest stratum	Mid-stratum	Lower stratum
Growth form: Mallee Tree Form	Growth form: Shrub	Growth form: Shrub
Height: 6m	Height: 4m	Height: 3m
Crown cover %: 10-30	Crown cover %: 30-70	Crown cover %: 30-70
Dominant taxa:	Dominant taxa:	Dominant taxa:
<i>Eucalyptus capillosa</i> subsp. <i>polyclada</i>	<i>Acacia</i> sp. narrow phyllode <i>Allocasuarina corniculata</i>	<i>Hibbertia eatoniae</i> <i>Baeckea elderiana</i> <i>Euryomyrtus maidenii</i>
ALL SPECIES		
<i>Acacia</i> sp. narrow phyllode		
<i>Allocasuarina corniculata</i>		
<i>Baeckea elderiana</i>		
<i>Eucalyptus capillosa</i> subsp. <i>polyclada</i>		
<i>Euryomyrtus maidenii</i>		
<i>Grevillea acacioides</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Grevillea paradoxa</i>		
<i>Hibbertia eatoniae</i>		
<i>Phebalium filifolium</i>		
<i>Santalum acuminatum</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011		<b>Botanist:</b> Lauren Pick and Samantha Stapleton
<b>Location:</b> Richard Read and Associates		<b>Quadrat:</b> Q2
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 101		<b>Vegetation group:</b> Forrest of <i>Eucalyptus salubris</i> and <i>Eucalyptus salmonophloia</i> over health of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> / <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>
<b>Photo number:</b> 8-10		
<b>Landform:</b> Flat plain		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 5/1/R		
<b>Rock outcrop (abundance/runoff):</b> 0/1		
<b>Soil (profile/field texture/soil surface):</b> U/CL/S		
<b>%Cover leaf litter:</b> 70		
<b>%Cover bare ground:</b> 10		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Tree	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 6m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Eucalyptus salubris</i>	<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> <i>Melaleuca lateriflora</i> <i>Melaleuca eleuterostachya</i>	<i>Acacia merrallii</i>
<b>ALL SPECIES</b>		
<i>Acacia merrallii</i>		
<i>Eremophila scoparia</i>		
<i>Eucalyptus salubris</i>		
<i>Grevillea acuaria</i>		
<i>Melaleuca eleuterostachya</i>		
<i>Melaleuca lateriflora</i>		
<i>Melaleuca laxiflora</i>		
<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>		



Project Name: Dulcie project		
Date:23-11-2011	Botanist: Lauren Pick and Samantha Stapleton	
Location: Richard Read and Associates	Quadrat: Q3	
Quadrat size: 20x20		
WP: 105	Vegetation group: Thicket of <i>Allocasuarina campestris</i> / <i>Allocasuarina helmsii</i> over heath of <i>Baeckea elderiana</i>	
Photo number: 4-7		
Landform: Flat plain		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 5/2/R		
Rock outcrop (abundance/runoff): 0/1		
Soil (profile/field texture/soil surface): U/CLS/L		
%Cover leaf litter: 80		
%Cover bare ground: 30		
Tallest stratum	Mid-stratum	Lower stratum
Growth form: Mallee Tree Form	Growth form: Shrub	Growth form: Shrub
Height: 6m	Height: 4m	Height: 3m
Crown cover %: 10-30	Crown cover %: 30-70	Crown cover %: 30-70
Dominant taxa:	Dominant taxa:	Dominant taxa:
<i>Eucalyptus salubris</i> <i>Eucalyptus leptophylla</i>	<i>Hakea scoparia</i> <i>Santalum acuminatum</i> <i>Hakea francisiana</i> <i>Leptospermum erubescens</i> <i>Acacia acuminata</i> <i>Allocasuarina campestris</i>	<i>Trymalium myrtillus</i> subsp. <i>myrtillus</i> <i>Phebalium filifolium</i> <i>Euryomyrtus maidenii</i>
ALL SPECIES		
<i>Acacia</i> sp narrow phyllode		
<i>Allocasuarina campestris</i>		
<i>Astroloma serratifolia</i>		
<i>Cassytha melantha</i>		
<i>Eucalyptus leptophylla</i>		
<i>Eucalyptus salubris</i>		
<i>Euryomyrtus maidenii</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Hakea francisiana</i>		
<i>Hakea scoparia</i>		
<i>Hibbertia eatoniae</i>		
<i>Leptospermum erubescens</i>		
<i>Phebalium filifolium</i>		
<i>Phebalium megaphyllum</i>		
<i>Santalum acuminatum</i>		
<i>Trymalium myrtillus</i> subsp. <i>myrtillus</i>		
<i>Verticordia plumosa</i> subsp. <i>incrassata</i>		
<i>Westringia cephalantha</i> subsp. <i>caterva</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Read and Associates	<b>Quadrat:</b> Q4	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 109	<b>Vegetation group:</b> Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	
<b>Photo number:</b> 1-3		
<b>Landform:</b> Flat plain		
<b>Land surface/disturbance:</b> Road in middle		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 5/2/R		
<b>Rock outcrop (abundance/runoff):</b> 0/0		
<b>Soil (profile/field texture/soil surface):</b> U/CLS/L		
<b>%Cover leaf litter:</b> 80		
<b>%Cover bare ground:</b> 20		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Shrub Mallee Form	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 5m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 10-30	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>	<i>Acacia</i> sp narrow phyllode <i>Leptospermum erubescens</i> <i>Allocasuarina helmsii</i>	<i>Thryptomene kochii</i> <i>Westringia cephalantha</i> var. <i>caterva</i> <i>Phebalium tuberosum</i> <i>Trymalium myrtillus</i> subsp. <i>myrtillus</i> <i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i> <i>Phebalium filifolium</i>
<b>ALL SPECIES</b>		
<i>Acacia hemiteles</i>		
<i>Acacia</i> sp narrow phyllode		
<i>Allocasuarina helmsii</i>		
<i>Callitris preissii</i>		
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Hakea francisiana</i>		
<i>Leptospermum erubescens</i>		
<i>Phebalium filifolium</i>		
<i>Phebalium tuberosum</i>		
<i>Santalum acuminatum</i>		
<i>Trymalium myrtillus</i> subsp. <i>myrtillus</i>		
<i>Thryptomene kochii</i>		
<i>Verticordia plumosa</i> subsp. <i>incrassata</i>		
<i>Westringia cephalantha</i> var. <i>caterva</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Reed and Associates	<b>Quadrat:</b> Q5	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 114	<b>Vegetation group:</b> Thicket of <i>Acacia</i> sp. narrow phyllode over low heath of <i>Thryptomene kochii</i>	
<b>Photo number:</b> 22-24		
<b>Landform:</b> Flat plain		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 4/2/R		
<b>Rock outcrop (abundance/runoff):</b> 0/0		
<b>Soil (profile/field texture/soil surface):</b> U/CL/L		
<b>%Cover leaf litter:</b> 90		
<b>%Cover bare ground:</b> 10		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 4m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Acacia</i> sp. narrow phyllode <i>Allocasuarina helmsii</i>	<i>Leptospermum erubescens</i> <i>Phebalium megaphyllum</i>	<i>Thryptomene kochii</i> <i>Grevillea paradoxa</i> <i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i> <i>Hibbertia eatoniae</i>
<b>ALL SPECIES</b>		
<i>Acacia</i> sp. narrow phyllode		
<i>Allocasuarina helmsii</i>		
<i>Euryomyrtus maidenii</i>		
<i>Grevillea acacioides</i>		
<i>Grevillea paradoxa</i>		
<i>Hakea francisiana</i>		
<i>Hibbertia eatoniae</i>		
<i>Leptospermum erubescens</i>		
<i>Leucopogon</i> sp Wheatbelt		
<i>Phebalium megaphyllum</i>		
<i>Santalum acuminatum</i>		
<i>Thryptomene kochii</i>		

Project Name: Dulcie project		
Date: 23-11-2011	Botanist: Lauren Pick and Samantha Stapleton	
Location: Richard Reed and Associates	Quadrat: Q6	
Quadrat size: 20x20		
WP: 118	Vegetation group: Low woodland of <i>Eucalyptus salmonophloia</i> / <i>Eucalyptus salubris</i> over thicket of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>	
Photo number: 19-21		
Landform: Flat plain		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 4/2/R		
Rock outcrop (abundance/runoff): 0/0		
Soil (profile/field texture/soil surface): U/CL/L		
%Cover leaf litter: 95		
%Cover bare ground: 15		
Tallest stratum	Mid-stratum	Lower stratum
Growth form: Tree	Growth form: Shrub	Growth form: Shrub
Height: 5m	Height: 4m	Height: 3m
Crown cover %: 30-70	Crown cover %: 30-70	Crown cover %: 30-70
Dominant taxa:	Dominant taxa:	Dominant taxa:
<i>Eucalyptus salubris</i> <i>Eucalyptus salmonophloia</i>	<i>Santalum acuminatum</i> <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>	<i>Acacia merrallii</i> <i>Dodonaea stenozyga</i> <i>Grevillea acuaria</i> <i>Melaleuca eleuterostachya</i>
ALL SPECIES		
<i>Acacia merrallii</i>		
<i>Dodonaea stenozyga</i>		
<i>Eucalyptus salmonophloia</i>		
<i>Eucalyptus salubris</i>		
<i>Grevillea acuaria</i>		
<i>Melaleuca eleuterostachya</i>		
<i>Melaleuca lateriflora</i>		
<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>		
<i>Santalum acuminatum</i>		
<i>Templetonia sulcata</i>		

Project Name: Dulcie project		
Date: 23-11-2011	Botanist: Lauren Pick and Samantha Stapleton	
Location: Richard Reed and Associates	Quadrat: Q7	
Quadrat size: 20x20		
WP: 15-17	Vegetation group: Low woodland of <i>Eucalyptus salmonophloia</i> / <i>Eucalyptus salubris</i> over thicket of <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>	
Photo number: 38		
Landform: Flat plain		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 5/2/R		
Rock outcrop (abundance/runoff): 1/0		
Soil (profile/field texture/soil surface): U/CL/L		
%Cover leaf litter: 95		
%Cover bare ground: 20		
Tallest stratum	Mid-stratum	Lower stratum
Growth form: Tree	Growth form: Shrub	Growth form: Shrub
Height: 6m	Height: 4m	Height: 0.5-1m
Crown cover %: 30-70	Crown cover %: 30-70	Crown cover %: 30-70
Dominant taxa:	Dominant taxa:	Dominant taxa:
<i>Eucalyptus salmonophloia</i> <i>Eucalyptus salubris</i> <i>Eucalyptus capillosa</i> subsp. <i>polyclada</i>	<i>Melaleuca eleuterostachya</i> <i>Santalum acuminatum</i> <i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>	<i>Phebalium megaphyllum</i> <i>Dodonaea stenozyga</i> <i>Grevillea acuaria</i>
ALL SPECIES		
<i>Acacia</i> sp. narrow phyllode		
<i>Acacia colletioides</i>		
<i>Acacia erinacea</i>		
<i>Acacia ligulata</i>		
<i>Acacia merrallii</i>		
<i>Alyxia buxifolia</i>		
<i>Dodonaea stenozyga</i>		
<i>Eremophila ionantha</i>		
<i>Eucalyptus capillosa</i> subsp. <i>polyclada</i>		
<i>Eucalyptus salmonophloia</i>		
<i>Eucalyptus salubris</i>		
<i>Exocarpos aphyllus</i>		
<i>Grevillea acuaria</i>		
<i>Hibbertia eatoniae</i>		
<i>Melaleuca eleuterostachya</i>		
<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>		
<i>Phebalium filifolium</i>		
<i>Phebalium megaphyllum</i>		
<i>Santalum acuminatum</i>		
<i>Templetonia sulcata</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Reed and Associates	<b>Quadrat:</b> Q8	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 129	<b>Vegetation group:</b> Low woodland of <i>Eucalyptus salubris</i> / <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	
<b>Photo number:</b> 28-33		
<b>Landform:</b> Flat plain		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 2/1/R		
<b>Rock outcrop (abundance/runoff):</b> 0/0		
<b>Soil (profile/field texture/soil surface):</b> U/CL/L		
<b>%Cover leaf litter:</b> 90		
<b>%Cover bare ground:</b> 40		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Tree	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 6m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> <10
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Eucalyptus salubris</i> <i>Eucalyptus urna</i>	<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>	<i>Acacia merrallii</i>
<b>ALL SPECIES</b>		
<i>Acacia merrallii</i>		
<i>Eucalyptus salubris</i>		
<i>Eucalyptus urna</i>		
<i>Maireana georgei</i>		
<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>		
<i>Templetonia sulcata</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Reed and Associates	<b>Quadrat:</b> Q9	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 133	<b>Vegetation group:</b> Low woodland of <i>Eucalyptus salubris</i> / <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	
<b>Photo number:</b> 25-27		
<b>Landform:</b> Flat plain		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 4/2/R		
<b>Rock outcrop (abundance/runoff):</b> 0/0		
<b>Soil (profile/field texture/soil surface):</b> U/CL/L		
<b>%Cover leaf litter:</b> 85		
<b>%Cover bare ground:</b> 50		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Tree	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 6m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 10-30	<b>Crown cover %:</b> 10-30	<b>Crown cover %:</b> 10-30
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Eucalyptus salmonophloia</i> <i>Eucalyptus salubris</i> <i>Eucalyptus urna</i>	<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> <i>Melaleuca eleuterostachya</i>	<i>Acacia merrallii</i> <i>Acacia deficiens</i> <i>Templetonia sulcata</i>
<b>ALL SPECIES</b>		
<i>Acacia deficiens</i>		
<i>Acacia erinacea</i>		
<i>Acacia merrallii</i>		
<i>Eremophila ionantha</i>		
<i>Eucalyptus salmonophloia</i>		
<i>Eucalyptus salubris</i>		
<i>Eucalyptus urna</i>		
<i>Grevillea acuaria</i>		
<i>Maireana georgei</i>		
<i>Melaleuca eleuterostachya</i>		
<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>		
<i>Olearia muelleri</i>		
<i>Phebalium megaphyllum</i>		
<i>Templetonia sulcata</i>		

Project Name: Dulcie project		
Date: 23-11-2011	Botanist: Lauren Pick and Samantha Stapleton	
Location: Richard Reed and Associates	Quadrat: Q10	
Quadrat size: 20x20		
WP: 137	Vegetation group: Low woodland of <i>Eucalyptus salubris</i> / <i>Eucalyptus salmonophloia</i> over dwarf scrub of <i>Acacia merrallii</i>	
Photo number: 34-36		
Landform: Flat plain		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 2/3/S		
Rock outcrop (abundance/runoff): 1/0		
Soil (profile/field texture/soil surface): U/CL/L		
%Cover leaf litter: 80		
%Cover bare ground: 50		
Tallest stratum	Mid-stratum	Lower stratum
Growth form: Tree	Growth form: Shrub	Growth form: Shrub
Height: 6m	Height: 4m	Height: 3m
Crown cover %: 10-30	Crown cover %: 10-30	Crown cover %: 10-30
Dominant taxa:	Dominant taxa:	Dominant taxa:
<i>Eucalyptus salmonophloia</i> <i>Eucalyptus salubris</i>	<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i> <i>Exocarpos aphyllus</i>	<i>Dodonaea stenozyga</i> <i>Acacia erinacea</i> <i>Acacia merrallii</i>
ALL SPECIES		
<i>Acacia</i> sp. narrow phyllode		
<i>Acacia colletioides</i>		
<i>Acacia erinacea</i>		
<i>Acacia merrallii</i>		
<i>Dodonaea stenozyga</i>		
<i>Eremophila ionantha</i>		
<i>Eremophila scoparia</i>		
<i>Eucalyptus salmonophloia</i>		
<i>Eucalyptus salubris</i>		
<i>Exocarpos aphyllus</i>		
<i>Grevillea acuaria</i>		
<i>Melaleuca pauperiflora</i> subsp. <i>pauperiflora</i>		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>		
<i>Zygophyllum ermaeum</i>		



<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Reed and Associates	<b>Quadrat:</b> Q11	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 143	<b>Vegetation group:</b> Thicket of <i>Allocasuarina</i> over heath of <i>Baeckea elderiana</i>	
<b>Photo number:</b> 37-39		
<b>Landform:</b> C/T/HCR		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 4/3/U		
<b>Rock outcrop (abundance/runoff):</b> 0/1		
<b>Soil (profile/field texture/soil surface):</b> U/CL/L		
<b>%Cover leaf litter:</b> 80		
<b>%Cover bare ground:</b> 30		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Shrub Mallee Form	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 6m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 10-30	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>	<i>Allocasuarina helmsii</i> <i>Grevillea paradoxa</i> <i>Phebalium filifolium</i> <i>Acacia</i> sp. narrow phyllode	<i>Hibbertia eatoniae</i> <i>Phebalium megaphyllum</i>
<b>ALL SPECIES</b>		
<i>Acacia</i> sp. narrow phyllode		
<i>Acacia neurophylla</i> subsp. <i>neurophylla</i>		
<i>Allocasuarina helmsii</i>		
<i>Calothamnus gilesii</i>		
<i>Cassytha melantha</i>		
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Grevillea paradoxa</i>		
<i>Hakea pendens</i> (P2)		
<i>Hibbertia eatoniae</i>		
<i>Melaleuca cordata</i>		
<i>Persoonia striata</i>		
<i>Phebalium filifolium</i>		
<i>Phebalium megaphyllum</i>		

Project Name: Dulcie project		
Date:23-11-2011	Botanist: Lauren Pick and Samantha Stapleton	
Location: Richard Reed and Associates	Quadrat: 12	
Quadrat size: 20x20		
WP: 151	Vegetation group: Thicket of <i>Allocasuarina</i> over heath of <i>Baeckea elderiana</i>	
Photo number: 40-42		
Landform: C/T/HCR		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 4/3/U		
Rock outcrop (abundance/runoff): 0/2		
Soil (profile/field texture/soil surface): U/CL/L		
%Cover leaf litter: 100		
%Cover bare ground: <5		
Tallest stratum	Mid-stratum	Lower stratum
Growth form: Shrub	Growth form: Shrub	Growth form: Shrub
Height: 4m	Height: 4m	Height: 2m
Crown cover %: >70	Crown cover %: 30-70	Crown cover %: 30-70
Dominant taxa:	Dominant taxa:	Dominant taxa:
<i>Allocasuarina helmsii</i> <i>Acacia neurophylla</i> subsp. <i>neurophylla</i>	<i>Baeckea elderiana</i> <i>Grevillea paradoxa</i> <i>Melaleuca cordata</i> <i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>	<i>Drosera andersoniana</i> <i>Hibbertia eatoniae</i>
ALL SPECIES		
<i>Acacia neurophylla</i> subsp. <i>neurophylla</i>		
<i>Allocasuarina helmsii</i>		
<i>Baeckea elderiana</i>		
<i>Calothamnus gilesii</i>		
<i>Drosera andersoniana</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Grevillea paradoxa</i>		
<i>Hibbertia eatoniae</i>		
<i>Melaleuca cordata</i>		
<i>Phebalium filifolium</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Reed and Associates	<b>Quadrat:</b> Q13	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 155	<b>Vegetation group:</b> Thicket of <i>Allocasuarina</i> over heath of <i>Baeckea elderiana</i>	
<b>Photo number:</b> 43-45		
<b>Landform:</b> Flat plain		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 2/3/U		
<b>Rock outcrop (abundance/runoff):</b> 0/1		
<b>Soil (profile/field texture/soil surface):</b> U/CL/L		
<b>%Cover leaf litter:</b> 95		
<b>%Cover bare ground:</b> <5		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 5m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> <10
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Allocasuarina campestris</i> <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>	<i>Baeckea elderiana</i> <i>Grevillea paradoxa</i> <i>Hakea scoparia</i> <i>Melaleuca cordata</i> <i>Calothamnus gilesii</i>	<i>Melaleuca cordata</i> <i>Baeckea elderiana</i>
<b>ALL SPECIES</b>		
<i>Acacia neurophylla</i> subsp. <i>neurophylla</i>		
<i>Allocasuarina campestris</i>		
<i>Allocasuarina helmsii</i>		
<i>Baeckea elderiana</i>		
<i>Calothamnus gilesii</i>		
<i>Cassutha melantha</i>		
<i>Drosera andersoniana</i>		
<i>Eucalyptus loxophleba</i> ssp. <i>lissophloia</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Grevillea paradoxa</i>		
<i>Hakea francisiana</i>		
<i>Hakea scoparia</i>		
<i>Leptospermum erubescens</i>		
<i>Melaleuca cordata</i>		
<i>Persoonia striata</i>		
<i>Santalum acuminatum</i>		
<i>Thryptomene kochii</i>		

Project Name: Dulcie project		
Date: 23-11-2011		Botanist: Lauren Pick and Samantha Stapleton
Location: Richard Reed and Associates		Quadrat: Q14
Quadrat size: 20x20		
WP: 165		Vegetation group: Scrub of <i>Allocasuarina campestris</i> over <i>Hibbertia eatoniae</i>
Photo number: 46-48		
Landform: C/T/HCR		
Land surface/disturbance: 2		
Coarse fragments on the surface (abundance/size/shape): 5/3/S		
Rock outcrop (abundance/runoff): 2/1		
Soil (profile/field texture/soil surface): D/CL/L		
%Cover leaf litter: 5		
%Cover bare ground: 80		
Tallest stratum	Mid-stratum	Lower stratum
<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 4m	<b>Height:</b> 3m	<b>Height:</b> 2m
<b>Crown cover %:</b> <1	<b>Crown cover %:</b> <1	<b>Crown cover %:</b> 10-30
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Allocasuarina campestris</i>	<i>Calothamnus gilesii</i> <i>Acacia</i> sp. narrow phyllode	<i>Calytrix tetragona</i> <i>Hibbertia eatoniae</i> <i>Verticordia eriocephala</i>
ALL SPECIES		
<i>Acacia</i> sp. narrow phyllode		
<i>Allocasuarina campestris</i>		
<i>Astroloma serratifolia</i>		
<i>Calothamnus gilesii</i>		
<i>Calytrix tetragona</i>		
<i>Drosera andersoniana</i>		
<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>		
<i>Grevillea lissopleura</i>		
<i>Hibbertia eatoniae</i>		
<i>Melaleuca fulgens</i>		
<i>Verticordia eriocephala</i>		

<b>Project Name: Dulcie project</b>		
<b>Date:</b> 23-11-2011	<b>Botanist:</b> Lauren Pick and Samantha Stapleton	
<b>Location:</b> Richard Reed and Associates	<b>Quadrat:</b> Q15	
<b>Quadrat size:</b> 20x20		
<b>WP:</b> 170	<b>Vegetation group:</b> Thicket of <i>Allocasuarina</i> over heath of <i>Baeckea elderiana</i>	
<b>Photo number:</b> 49-51		
<b>Landform:</b> C/T/HCR		
<b>Land surface/disturbance:</b> 0		
<b>Coarse fragments on the surface (abundance/size/shape):</b> 5/3/U		
<b>Rock outcrop (abundance/runoff):</b> 0/2		
<b>Soil (profile/field texture/soil surface):</b> U/CL/L		
<b>%Cover leaf litter:</b> 100		
<b>%Cover bare ground:</b> 5		
<b>Tallest stratum</b>	<b>Mid-stratum</b>	<b>Lower stratum</b>
<b>Growth form:</b> Shrub Mallee Form	<b>Growth form:</b> Shrub	<b>Growth form:</b> Shrub
<b>Height:</b> 5m	<b>Height:</b> 4m	<b>Height:</b> 3m
<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70	<b>Crown cover %:</b> 30-70
<b>Dominant taxa:</b>	<b>Dominant taxa:</b>	<b>Dominant taxa:</b>
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> <i>Allocasuarina campestris</i>	<i>Calothamnus gilesii</i> <i>Baeckea elderiana</i> <i>Melaleuca cordata</i> <i>Allocasuarina helmsii</i> <i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>	<i>Hibbertia eatoniae</i> <i>Prostanthera semiteres</i> subsp. <i>semiteres</i>
<b>ALL SPECIES</b>		
<i>Acacia neurophylla</i> subsp. <i>neurophylla</i>		
<i>Allocasuarina campestris</i>		
<i>Allocasuarina helmsii</i>		
<i>Baeckea elderiana</i>		
<i>Calothamnus gilesii</i>		
<i>Cassutha melantha</i>		
<i>Drosera andersoniana</i>		
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>		
<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>		
<i>Hibbertia eatoniae</i>		
<i>Leucopogon</i> sp. Wheatbelt		
<i>Melaleuca cordata</i>		
<i>Phebalium megaphyllum</i>		
<i>Prostanthera semiteres</i> subsp. <i>semiteres</i>		
<i>Westringia cephalantha</i>		

## **APPENDIX 3: NATUREMAP SEARCH RESULTS NOVEMBER 2023**

## Nature Map Interim Data Search Service Result 17 November 2023 Dulcie

This is a NatureMap interim data search service result. Please see attached the Copyright, Conditions and Disclaimers for the NatureMap data used to create these results.

Please note that the species list/s provided should be treated as an indicative list of species that have been observed to occur in the area of interest, and should be treated as a desktop search only. On ground surveys should be undertaken when required.

Please find attached the species list/s results from the Species and Communities Interim NatureMap search service.

The search criteria used were:

Search Reference Number: 39-1123NM

Conservation listed species included: Yes

Non-listed species included: Yes

Search Area Method: Point buffer

Search Area Value: Coordinates provided

Buffer: 20km

**\*Note Buffer minimum is 10km around a single point or a minimum polygon area of 300km<sup>2</sup>.**

**The search area is within the potential range of the arid bronze azure butterflies host ant and the medium priority survey area for night parrots. Refer to the Guideline for the survey of arid bronze azure butterfly (ABAB) in Western Australia (and additional information in the zipped folder) and the Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia for more information.**

Given the huge variation in data accuracy, comprehensiveness, and maintenance schedules, NatureMap cannot and does not take responsibility for the data therein. We aim to ensure that information from sources databases is transmitted without alteration. Any errors are therefore the responsibility of the contributing custodian. Please note that many of the data sources NatureMap extracts its data from are static and therefore there may be discrepancies between current and non-current species name.

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The Biodiversity Information Office (BIO) is planned to establish the new data repository platform for Western Australian biodiversity information and will be able to provide the functionality that was previously available through NatureMap. Data curation and improvements are still taking place, so please continue sending NatureMap requests to the Species and Communities team until further notice. For queries regarding the new platform (Dandjoo), please email [bio@dbca.wa.gov.au](mailto:bio@dbca.wa.gov.au).

Kind regards,

Yasmyn Skinner

Species and Communities Program | Biodiversity and Conservation Science

Department of Biodiversity, Conservation and Attractions

E: [flora.data@dbca.wa.gov.au](mailto:flora.data@dbca.wa.gov.au) | W: <http://www.dbca.wa.gov.au>

For information on Threatened Species and Communities visit: <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities>

For information on Threatened Flora Authorisations visit: <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants/200-authorisation-to-take-threatened-plants>



Department of Biodiversity,  
Conservation and Attractions



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## Conservation Species Results

Taxon	Common Name	Class	WA Conservation Status	EPBC status	Change Since 2012	Number of Records
<i>Aganippe castellum</i>	tree-stem trapdoor spider	BIRD	P4	Migratory	Yes	1
<i>Dasyurus geoffroi</i>	chuditch, western quoll	BIRD	VU	Migratory	No	1
<i>Leipoa ocellata</i>	malleefowl	BIRD	VU	Migratory	No	1
<i>Notamacropus irma</i>	western brush wallaby	BIRD	P4	Vulnerable	No	18
<i>Paroplocephalus atriceps</i>	Lake Cronin snake	MAMMAL	P3	Vulnerable	No	1
<i>Acacia asepala</i>	No data	PLANT	P2	No data	Yes	1
<i>Acacia concolorans</i>	No data	PLANT	P2	No data	No	13
<i>Balaustion grandibracteatum subsp. grandibracteatum</i>	No data	PLANT	P3	No data	Yes	7
<i>Balaustion grandibracteatum subsp. junctura</i>	No data	PLANT	P2	No data	Yes	2
<i>Banksia shanklandiorum</i>	No data	PLANT	P4	No data	No	2
<i>Boronia ternata var. promiscua</i>	No data	PLANT	P3	No data	Yes	1
<i>Chamelaucium sp. Parker Range (B.H. Smith 1255)</i>	No data	PLANT	P1	No data	Yes	7
<i>Drummondita wilsonii</i>	No data	PLANT	P1	No data	No	10
<i>Eremophila caerulea subsp. merrallii</i>	No data	PLANT	P4	No data	Yes	2
<i>Eucalyptus calycogona subsp. miraculum</i>	No data	PLANT	P1	No data	Yes	1
<i>Eucalyptus polita</i>	No data	PLANT	P3	No data	Yes	4
<i>Eucalyptus sp. Dunbar Road (D. Nicolle &amp; M. French DN 5466)</i>	No data	PLANT	P1	No data	Yes	2
<i>Eutaxia lasiocalyx</i>	No data	PLANT	P2	No data	Yes	2
<i>Grevillea lissopleura</i>	No data	PLANT	P1	No data	No	4
<i>Grevillea neodissecta</i>	No data	PLANT	P4	No data	Yes	1
<i>Hakea pendens</i>	No data	PLANT	P3	No data	Cons Status	32
<i>Isopogon robustus</i>	No data	PLANT	Threatened	No data	Cons Status	17
<i>Lepidosperma sp. Mt Caudan (N. Gibson &amp; M. Lyons 2081)</i>	No data	PLANT	P1	No data	Yes	5
<i>Lepidosperma sp. Parker Range (N. Gibson &amp; M. Lyons 2094)</i>	No data	PLANT	P1	No data	Yes	1
<i>Leucopogon sp. Yellowdine (M. Hislop &amp; F. Hort MH 3194)</i>	No data	PLANT	P2	No data	Yes	1
<i>Leucopogon validus</i>	No data	PLANT	P1	No data	No	8
<i>Melaleuca grieviana</i>	No data	PLANT	P1	No data	Yes	2
<i>Melaleuca ochroma</i>	No data	PLANT	P3	No data	Yes	1
<i>Myriophyllum petraeum</i>	No data	PLANT	P4	No data	Yes	8
<i>Notisia intonsa</i>	No data	PLANT	P3	No data	Cons Status	1
<i>Rinzia medifila</i>	No data	PLANT	P1	No data	Name	5
<i>Rinzia torquata</i>	No data	PLANT	P3	No data	Yes	1
<i>Verticordia mitodes</i>	No data	PLANT	P3	No data	Yes	1
<i>Verticordia multiflora subsp. solox</i>	No data	PLANT	P2	No data	No	6
<i>Verticordia pulchella</i>	No data	PLANT	P2	No data	Yes	3
<i>Verticordia stenopetala</i>	No data	PLANT	P3	No data	Yes	3

**APPENDIX 4: LEVEL 1 FAUNA RISK ASSESSMENT FOR  
SOUTHERN CROSS GOLDFIELDS DULCIE PROJECT AREA  
(TERRESTRIAL ECOSYSTEMS, 2009)**

# **Level 1 Fauna Risk Assessment for Southern Cross Goldfields Dulcie Project Area**



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November 2009

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Front Cover: Tawny Frogmouth (*Podargus strigoides*)

## Executive Summary

Southern Cross Goldfields Ltd is seeking to develop a gold deposit at its Dulcie project area which is approximately 37km south of Marvel Loch in Western Australia (WA). The project area is approximately 370ha and is contained in the Avon Wheatbelt (AW1 – Ancient Drainage) IBRA subregion, but is near to the Coolgardie (COO2 – Southern Cross) IBRA subregion.

This fauna risk assessment was supported by searches of the EPBC Act online database, the Department of Environment and Conservation's threatened and priority species database as shown in NatureMap and Terrestrial Ecosystems' fauna survey database. A site visit was undertaken to assess the condition of the fauna habitat and to search for active Malleefowl mounds and other evidence of conservation significant species.

Areas that have been previously mined were rated as highly degraded fauna habitat, areas that contained exploration tracks, mostly in the Allocasuarina shrubland were rated as degraded fauna habitat and the western and southern sections of the project area that was either Eucalypt woodland or Acacia shrubland was rated as good fauna habitat and of moderate to high ecological value.

The project area currently does not provide any important ecological linkage or fauna movement corridor. An effective rehabilitation program of disturbed areas, once they are no longer required, is likely to provide similar habitat to that which currently exists in the long term.

Clearing native vegetation is likely to result in the loss of small vertebrate fauna on site that are unable to move away during the clearing process. Larger animals such as kangaroos and most of the birds will move into adjacent areas once clearing commences. Shifting animals into adjacent areas will increase the pressure on resources in those areas and it is likely that there will be some disruption to these assemblages for a period of time until a balance is restored. Little can be done to address this impact other than to minimise the area of vegetation that is cleared. Impacts associated with clearing vegetation in the project area in a landscape or bioregional context on the vertebrate fauna are likely to be low.

It is unlikely the project area contains Malleefowl (*Leipoa ocellata*) and there is a low possibility that Chuditch (*Dasyurus geoffroii*) and Carpet Pythons (*Morelia spilota imbricata*) are in the general area. However, clearing of native vegetation in the project area is unlikely to have a significant impact on these conservation significant fauna. There is a possibility that the area contains Shy Heathwrens (*Hylacola cauta whitlocki*), Crested Bellbirds (*Oreoica gutturalis gutturalis*), Western Rosellas (*Platycercus icterotis xanthogenys*) and the White-browed Babbler (*Pomatostomus superciliosus ashbyi*). It is more probable that the Rainbow Bee-eater (*Merops ornatus*) will be seen in the area during summer. These birds will move to adjacent areas once vegetation clearing commences. This might result in a period of instability in these ecosystems until new territories are resolved for the sedentary species.

Terrestrial Ecosystems' assessment is that clearing of native vegetation within the project area to accommodate the proposed mine's operations will have a low impact on the native fauna when viewed in a bioregional context. To minimise this impact the following recommendations are made:

- the area to be cleared should be minimised and planned such that it does not result in the creation of isolated remnants of native vegetation that have no ecological corridors to allow fauna movement to adjacent areas;
- a rehabilitation plan is prepared for existing and proposed disturbance areas and is progressively implemented when the land is no longer required for mining operations; and
- a fauna management plan is prepared for the entire site before mining operations commence.

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## 1.0 Introduction

### 1.1 Background

Southern Cross Goldfields Ltd is seeking to develop a gold deposit at its Dulcie project area which is approximately 37km south of Marvel Loch in WA. Terrestrial Ecosystems was commissioned by Southern Cross Goldfields Ltd to undertake a Level 1 Fauna Risk Assessment to support mining and clearing native vegetation applications.

### 1.2 Survey Area

The project area is approximately 370ha and is shown in Figure 1. Southern Cross Goldfields Limited proposed mine site is located in the Avon Wheatbelt (AW1 – Ancient Drainage) IBRA subregion, but is near to the Coolgardie (COO2 – Southern Cross) IBRA subregion. A site inspection indicated that the fauna habitat is similar to that found in the western section of the Coolgardie (COO2 – Southern Cross) IBRA subregion, therefore biogeographic data for this subregion are applicable to this fauna risk assessment.

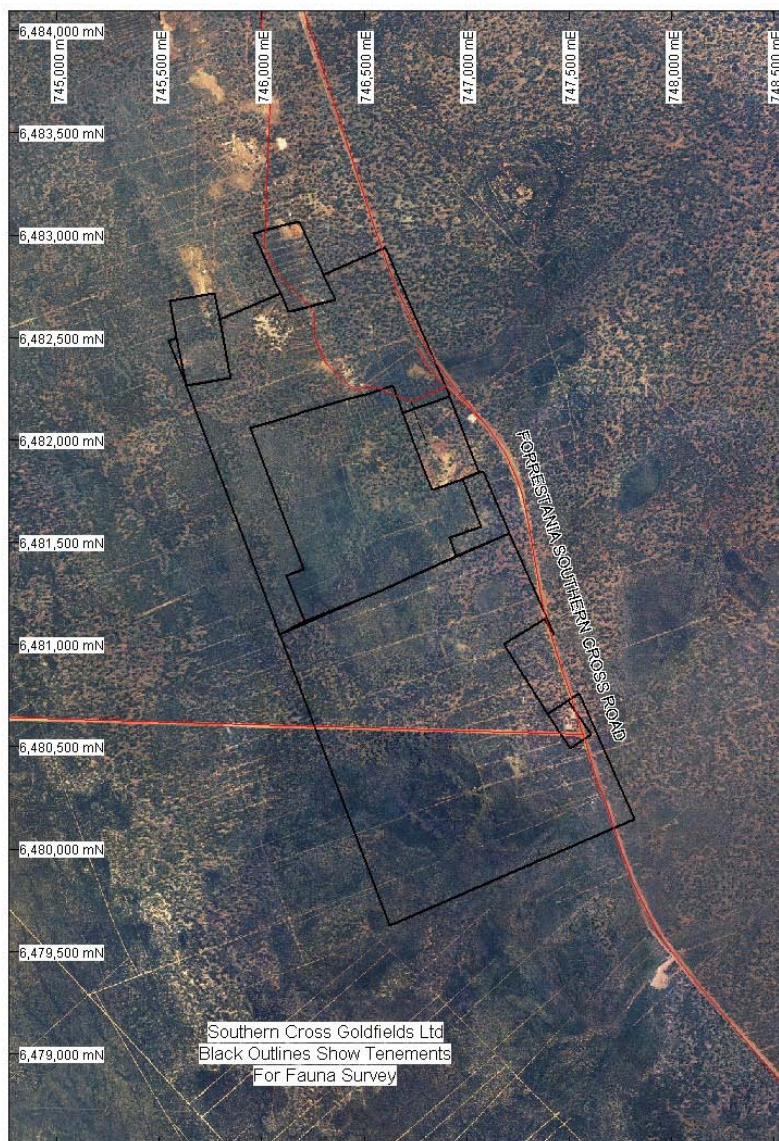


FIGURE 1  
SOUTHERN CROSS GOLDFIELDS PROJECT AREA OUTLINED IN BLACK

### 1.3 Scope of Works

Terrestrial Ecosystems undertook a fauna risk assessment of the project area (Figure 1). This assessment included:

- a review of fauna species of national environmental significance that are protected under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* that potentially occur within the vicinity of the project area;
- a review of the Terrestrial Ecosystems' on-line database to identify vertebrate fauna and fauna assemblages that occur within the vicinity of the project area;
- a description of the fieldwork methodology and results;
- a site investigation, including a search of suitable habitat for active Malleefowl mounds and foot prints;
- an assessment of the potential risks to the fauna associated with clearing additional areas of native vegetation;
- a discussion of the likelihood of *EPBC Act 1999* and *Wildlife Conservation Act 1950* listed species being present in the project area; and
- management recommendations to minimise potential impacts on the fauna in the project area.

This fauna assessment was undertaken in accordance with the Environmental Protection Authority (EPA) *Terrestrial Biological Surveys as an Element of Biodiversity Protection Position Statement No. 3* (Environmental Protection Authority 2002).

### 1.4 Previous Biological Surveys in the Region

The frogs, reptiles, mammals and birds in the vicinity of the Southern Cross Goldfields proposed mine site have been previously surveyed. The following survey reports have been reviewed as part of this assessment:

- Bell, D. T., Bell, R. C. and Loneragan, W. A. (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. *Journal of the Royal Society of Western Australia* 90, 219-227.
- Biota Environmental Sciences (2006a) *Forrestania Fauna. Survey Fauna and Faunal Assemblages Report*. Unpublished report for Western Areas, Perth.
- Biota Environmental Sciences (2006b) *Forrestania Water Disposal Pipeline Fauna Survey*. Unpublished report for Western Areas, Perth.
- Biota Environmental Sciences (2007a) *Diggers South Fauna Survey – Phase 1*. Unpublished report for Western Areas, Perth.
- Biota Environmental Sciences (2007b) *Forrestania Fauna Monitoring Survey- Flying Fox Phases III and IV*. Unpublished report for Western Areas, Perth.
- Biota Environmental Sciences (2008) *Forrestania Targeted Malleefowl Survey*. Unpublished report for Western Areas NL, Perth.
- Burbidge AH, Rolfe, JK, McKenzie NL and Roberts, JD (2004) Biogeographic patterns in small ground-dwelling vertebrates of the Western Australian wheatbelt. *Records of the Western Australian Museum*, Supplement No 67, 109-127. Data from this survey.
- McKenzie, N.L and Rolfe, J.K. Vertebrate fauna (1995) *Records of the Western Australian Museum*, Supplement No 49, 31-65.

The Wheatbelt data (Burbidge et al. 2004) are for sites to the west of the Dulcie project area, the McKenzie and Rolfe (1995) survey data, which are for sites to the east and north-east of Dulcie project area and come from a biological survey of the Boorabbin – Southern Cross Study area that was undertaken as part of the biological survey of the eastern goldfields. Biota's (2006a, 2006b, 2007b, 2007a) data are for a series of survey sites around the Spotted Quoll and Diggers South mine sites, which is to the south of the Dulcie project area. The Bell *et al.* (2007) survey data are for birds around the Yellowdine townsite.

The location of the survey sites used in this analysis is shown in Figure 2. There were many other survey sites within both the Avon Wheatbelt (AW1 – Ancient Drainage) IBRA subregion and the Coolgardie (COO3 – Eastern Goldfields) IBRA subregion, but those selected best represent the fauna likely to be found in the Dulcie project area.



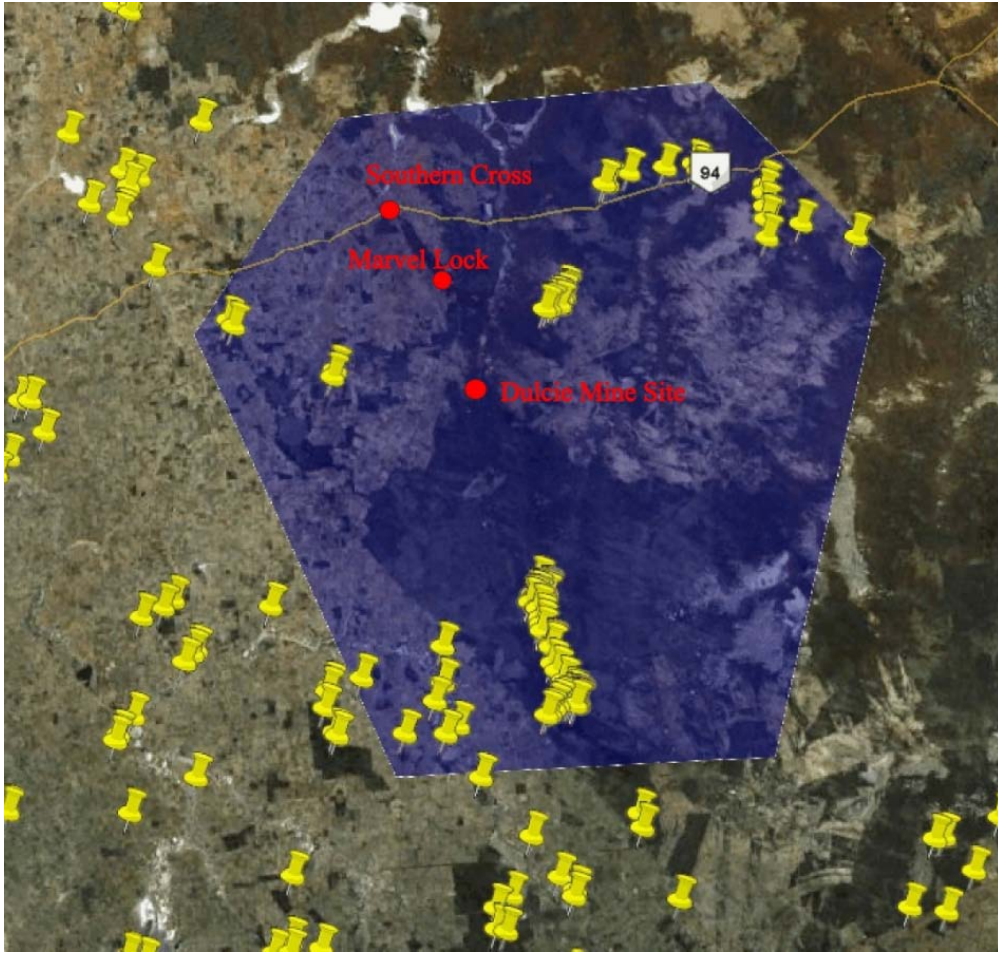


FIGURE 2  
TERRESTRIAL ECOSYSTEMS' FAUNA SURVEY DATABASE SEARCH AREA (IN BLUE) WITH THE  
PROJECT AREA SHOWN AS THE MOST SOUTHERN RED DOT

## 2 Existing Environment

### 2.0 Climate

The average mean monthly maximum and minimum temperatures and rainfall for Southern Cross, which is the closest weather station, are shown in Figure 3. Temperatures are highest between December – February. Most rain falls in winter as a result of low pressure cells that move in an easterly direction from the south-west of the state.

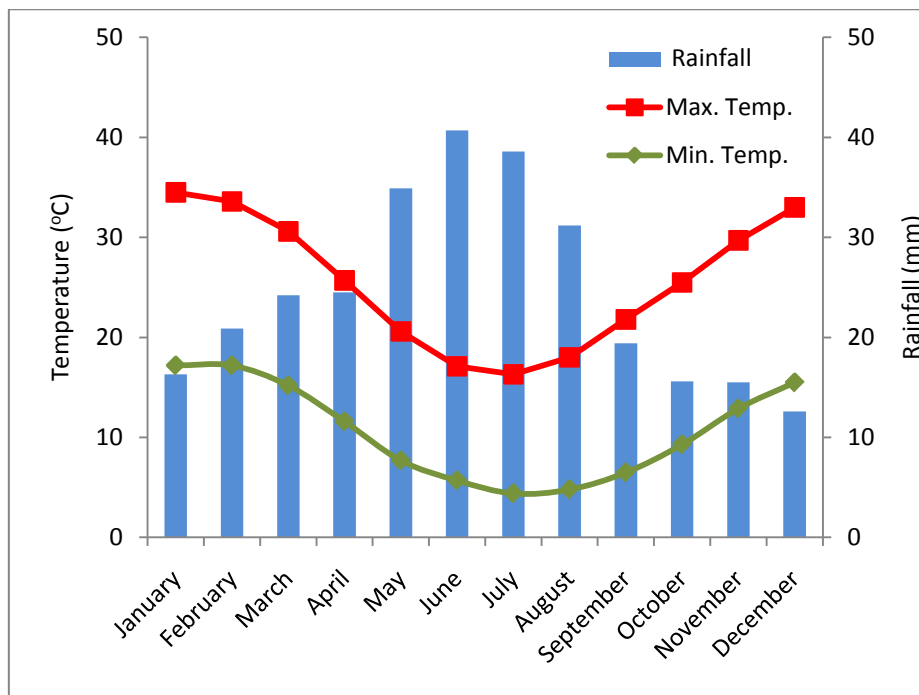


FIGURE 3  
MEAN MONTHLY MAXIMUM AND MINIMUM TEMPERATURES AND RAINFALL FOR SOUTHERN CROSS

### 2.1 Landforms and Vegetation

The Avon Wheatbelt 1 IBRA subregion consists of gently undulating plain of low relief that is drained to the west (Beecham 2001). The Coolgardie 2 IBRA subregion consists of undulating uplands with broad valleys between low greenstone hills (Cowan 2002).

The Avon Wheatbelt 1 subregion supports Proteaceous scrub-heath that is rich in endemics and mixed Eucalypt woodlands. Similarly, the Coolgardie 2 subregion supports a diverse Eucalypt woodland and scrub-heath.

### 2.2 Land Use

The dominant land uses for the Coolgardie subregion are grazing, crown reserves and mining. In contrast, the dominant land uses in the Avon Wheatbelt subregion are cultivated dry land farming and grazing on improved pastures. The Wheatbelt contains a small number of remnant plots mostly set aside as nature reserves. There are also a number of nature reserves to the east and the north-east of the project area.

Mining around Southern Cross has a history of over 100 years with many of the tenements being mined, abandoned and remined as the technology developed and the price of gold increased.

## **3 Survey Methodology**

### **3.0 Database Searches**

A review of the Commonwealth *EPBC Act 1999* list of protected species was undertaken to identify species of conservation interest to the Commonwealth Government. This search centred on the project area and used a 100km buffer. In addition, a desktop search of the Terrestrial Ecosystems' fauna survey database was used to develop an appreciation of the vertebrate fauna assemblages in the vicinity of the project area. The Terrestrial Ecosystems' fauna survey database search area is shown in Figure 2. The DEC threatened and priority species database was searched via the records in NatureMap.

Other more general texts were also used to provide supplementary information on vertebrates in the bioregion, including Tyler *et al.* (2000) for frogs; Storr *et al.* (1983, 1990, 1999, 2002) and Thompson and Thompson (2006) for reptiles; Johnstone and Storr (1998, 2004) for birds; and Van Dyck and Strahan (2008) for mammals.

### **3.1 Site Assessment**

A field assessment was conducted on 1-2 November 2009. As survey data for the bioregion indicated that Malleefowl had been recorded in the general area, suitable habitat on the Dulcie project area was searched for active Malleefowl mounds and footprints during this assessment. All sections of the project area were visited during the site visit.

Conditions were suitable for the field assessment as the weather was fine and sunny.

### **3.2 Survey and Reporting staff**

The field assessment was undertaken by Dr Graham Thompson and Mr Dene Edmunds and the report was prepared by Dr Graham Thompson of Terrestrial Ecosystems. Dr Thompson is familiar with the fauna of the Goldfields and the fauna habitats that were assessed.

### **3.3 Limitations**

This terrestrial fauna assessment of the survey area is based on a site visit, information contained in the Commonwealth Government database and other published and unpublished fauna survey data for the bioregion. It is acknowledged that multiple surveys conducted in different seasons, repeated over several years are necessary to fully appreciate the fauna assemblage in the project area; however, in this circumstance it is Terrestrial Ecosystems' opinion that adequate data were available to assess the potential impact of the proposed development on the terrestrial vertebrate fauna.

The EPA *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56* (2004) suggested that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 1.

**TABLE 1**  
**FAUNA SURVEY LIMITATIONS AND CONSTRAINTS**

<b>Possible limitations</b>	<b>Constraint (yes/no); significant, moderate or negligible</b>	<b>Comment</b>
Competency and experience of the consultant carrying out the survey	No	The consultants who undertook this assessment are familiar with terrestrial fauna in the region and terrestrial fauna risk assessments.
Scope	No	All aspects of the scope of works have been addressed.
Proportion of fauna identified, recorded and/or collected	No	Not applicable.
Accuracy of previous survey work	Yes, negligible	Terrestrial Ecosystems has reported fauna survey data recorded by the various authors, but is not in a position to vouch for the accuracy of this information. It is acknowledged that the taxonomy of Western Australian vertebrates is continually being revised and the nomenclature of some of the species listed in the appendices may have changed since publication by the authors.
Sources of information	Yes, negligible	Vertebrate fauna information was available from an on-line database and unpublished and published reports of surveys conducted in the bioregion in a variety of habitat types. Many of these surveys employed a low level of trapping effort which significantly impacts on the capacity of these data to represent the fauna assemblages in the areas surveyed.
Proportion of the task achieved	No	All tasks completed.
Timing/weather/season/ cycle	Yes, negligible	Surveys undertaken by consultants and researchers have not always been undertaken in the optimal season; therefore the data reported for these surveys can be incomplete.
Disturbances which affected results of the survey	Yes, negligible	Sections of the project area have been mined and disturbed over many years. Exploration grid lines were evident in much of the project area. This disturbance has been factored into the assessment.
Intensity of survey effort	No	The intensity of the on-ground assessment was proportional to the potential scale of impact in a degraded area and knowledge of fauna and fauna assemblages in the area.
Completeness	No	All areas were adequately investigated.
Resources	No	Adequate resources were available.
Remoteness and/or access problems	No	Access was not a problem.
Availability of contextual information on the region	No	Terrestrial Ecosystems' fauna survey database, <i>EPBC Act 1999</i> database and other surveys in the broader region were available.

## **4 Results**

### **4.0 Fauna Habitats**

Sections of the Dulcie project area have been mined over many years. There were abandoned small shallow mining shafts, waste dumps and exploration lines in the project area. The remains of accommodation used by earlier miners are evident in some sections of the project area. Recently cleared exploration tracks that run almost east-west across much of the eastern section of the project area are approximately 50m apart.

The project area has a central rise in the northern section that runs almost parallel to the long axis of the project area. There are five broad fauna habitat types:

- a) Allocasuarina shrub land that is often quite dense to about 2.5 m.
- b) Open Eucalypt woodland with little understorey
- c) Eucalypt woodland over Melaleuca that can be quite dense, but with little vegetation at ground level.
- d) Acacia shrubland to about 2.5m
- e) Disturbed areas that have been previously mined or subject to exploration activity.

Plate 1 provides a visual indication of the varying fauna habitat types found in the project area.

### **4.1 Fauna Habitat Quality**

Using the Fauna Habitat Quality descriptors provided in Appendix 1, the project area contains three ratings. Areas that have been previously mined were rated as Highly Degraded Fauna Habitat, areas that had been extensively explored and contained exploration tracks, mostly in the Allocasuarina shrub land were rated as Degraded Fauna Habitat and the western and southern section of the project area that were either Eucalypt woodland or Acacia shrubland were rated as Good Fauna Habitat.

### **4.2 Fauna Habitat Value**

The original fauna habitat on this site is abundant in this bioregion and in areas adjacent to the project area. The Eucalypt woodlands have moderate to high ecological value and the disturbed areas have low ecological value.

### **4.3 Bioregional Vertebrate Fauna**

Appendix 2 provides a summary of the fauna survey data that are available in the vicinity of the project area and in the Avon Wheatbelt and the Coolgardie IBRA subregions. Although the reptile, mammal and avian assemblages are different at each survey site, overall there is a high level of similarity when the data are aggregated. The fauna assemblage on the Dulcie project area is not unique and is abundant in adjacent areas.

Species that have been caught or observed in fauna surveys in adjacent areas that are of conservation significance include the Shy Heathwrens, Crested Bellbirds, Western Rosellas and the White-browed Babbler, all of which are discussed below.



Disturbed area



Historical mining activity



Dense Allocasuarina scrubland



Allocasuarina shrubland



Open Eucalypt woodland



Open Eucalypt woodland



Dense Acacia shrub land



Dense Acacia shrub land

PLATE 1  
FAUNA HABITAT TYPES PRESENT IN THE PROJECT AREA

## 4.4 Significant Fauna Species Recorded or Predicted to Occur in the Project Area

Species listed under the *EPBC Act 1999* or the *Wildlife Conservation Act 1950* as being threatened or of conservation significance or are on the DEC Priority and Threatened Species list are shown in Table 2.

TABLE 2  
SPECIES THAT ARE POTENTIALLY FOUND IN THE VICINITY OF THE PROJECT AREA AND THAT ARE LISTED AS BEING OF CONSERVATION SIGNIFICANCE UNDER STATE OR COMMONWEALTH GOVERNMENT LEGISLATION OR WITH DEC.

Species	Status under the Wildlife Conservation Act / DEC	Status under the EPBC Act	Potential to be found in the area
<i>Leipoa ocellata</i> Malleefowl	Schedule 1	Vulnerable	Unlikely in the project area.
<i>Dasyurus geoffroii</i> Chuditch	Schedule 1	Vulnerable	Possibly in the general area.
<i>Calyptrorhynchus latirostris</i> Carnaby's Black-Cockatoo	Schedule 1	Endangered	Infrequently in the general area.
<i>Phascogale calura</i> Red-tailed Phascogale	Schedule 1	Endangered	Unlikely in the project area.
<i>Platycercus icterotis xanthogenys</i> (Mallee) Western Rosella	Schedule 1		Potentially in the general area.
<i>Acanthiza iredalei iredalei</i> Slender-billed Thornbill (western)		Vulnerable	Unlikely in the general area.
<i>Merops ornatus</i> Rainbow Bee-eater		Migratory	Likely to be in the general area.
<i>Apus pacificus</i> Fork-tailed Swift		Migratory	May infrequently be seen in the general area.
<i>Egernia stokesii badia</i> Western Spiny-tailed Skink	Schedule 1		Unlikely to be in the general area.
<i>Falco peregrinus</i> Peregrine Falcon	Schedule 4		Likely to be in the general area.
<i>Cacatua leadbeateri</i> Major Mitchell' Cockatoo	Schedule 4		Unlikely to be in the general area.
<i>Morelia spilota imbricata</i> Carpet Python	Schedule 4		Highly unlikely in the project area.
<i>Aspidites ramsayi</i> Woma (southwestern)	Schedule 4		Highly unlikely in the project area.
<i>Paroplocephalus atriceps</i> Lake Cronin Snake	Priority 3		Unlikely in the general area.
<i>Macropus irma</i> Western Brush Wallaby	Priority 4		Unlikely in the general area.
<i>Hylacola cauta whilocki</i> Shy Heathwren	Priority 4		Potentially in the general area.
<i>Oreoica gutturalis gutturalis</i> Crested Bellbird	Priority 4		Potentially in the general area.
<i>Nyctophilus(timoriensis)</i> sp. 1 Greater Long-eared Bat	Priority 4		Potentially in the general area.
<i>Charadrius rubricollis rubricollis</i> Hooded Plover (western subspecies)	Priority 4		Unlikely to be seen in the project area.
<i>Falcunculus frontatus leucogaster</i> Crested Shrike-tit (south-western subspecies)	Priority 4		Unlikely to be in the general area.
<i>Burhinus grallarius</i> Bush Stone-Curlew	Priority 4		Unlikely to be in the general area.
<i>Calamanthus campestris montanellus</i> Rufous Fieldwren	Priority 4		Likely to be in the general area.
<i>Pomatostomus superciliosus ashbyi</i> White-browed Babbler	Priority 4		Likely to be in the general area.

#### 4.4.1 Potential impact on species of conservation significance

**Malleefowl** (*Leipoa ocellata*) - Schedule 1 under the *Wildlife Conservation Act 1950* and Vulnerable under the *EPBC Act 1999*.

Malleefowl are large, ground-dwelling birds that rarely fly unless alarmed or are perching for the night. Historically, Malleefowl have been found in mallee regions of southern Australia from approximately the 26<sup>th</sup> parallel of latitude southwards. Recently their range has contracted due to fox predation and land clearance. Their abundance in the eastern Goldfields is low and they are sparsely distributed, favouring those areas that are more densely vegetated. Malleefowl build distinctive nests that comprise a large mound of soil/rock covering a central core of leaf litter. These nest mounds range in diameter but can span more than five metres and may be over one metre high. Malleefowl are generally monogamous and, once breeding commences, they pair for life. The presence of active nest mounds provides an indication of the presence of Malleefowl in the area.

There is evidence of the presence of Malleefowl in the vicinity of the Dulcie project in reports by McKenzie and Rolfe (1995) and Biota (2006b, Biota Environmental Sciences 2007a, Biota Environmental Sciences 2008). Terrestrial Ecosystems' search of the project area located three inactive Malleefowl mounds that had not been used for some time and no tracks were found in the area. Images of the three mounds are shown in Plate 2.

Terrestrial Ecosystems' assessment is that it is unlikely that there are Malleefowl or active Malleefowl mounds within the project area.



Malleefowl mound 1



Malleefowl mound 2



Malleefowl mound 3

#### PLATE 2 OLD MALLEEFOWL MOUNDS IN THE PROJECT AREA

**Chuditch** (*Dasyurus geoffroii*) – Schedule 1 under the *Wildlife Conservation Act 1950* and Vulnerable under the *EPBC Act 1999*.

The Chuditch is the largest carnivorous marsupial in Western Australia (WA). It is usually active from dusk to dawn. Formally known from over 70% of Australia, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west WA and other isolated areas. Chuditch are solitary animals for most of their life and den in hollow logs, burrows, culverts, etc and have also been recorded in tree hollows and rock cavities. Chuditch are opportunistic feeders, and forage primarily on the ground at night. Their diet can include other mammals,



birds, lizards, bird and reptile eggs but the majority is a mixture of large invertebrates (e.g. spiders, scorpions and crickets).

Chuditch have been found to the south of the project area around the Spotted Quoll mine in Eucalypt woodland (Biota Environmental Sciences 2006a, 2007b). Subsequent research by a UWA student, Kelly Rayner, indicated that the population density of Chuditch at Forrestania was less than half that observed at Jarrah forest and the home range size of radio-tracked animals was about eight times larger than the average for Jarrah forest Chuditch.

Terrestrial Ecosystems' assessment is that it is possible that Chuditch are in the vicinity of the project area, but their population density is likely to be low. Given that the exploration grid lines have already been cleared in the area and that the proposed vegetation clearing is likely to result in individuals moving to adjacent habitat, any impact on Chuditch is likely to be low and not significant, unless they are killed or injured during the clearing process.

**Carnaby's Black-Cockatoo** (*Calyptorhynchus latirostris*) – Schedule 1 under the *Wildlife Conservation Act 1950* and Endangered under the *EPBC Act 1999*.

Carnaby's Cockatoo is found in the south-west of Australia from Kalbarri through to Ravensthorpe. It has a preference for feeding on the seeds of *Banksia*, *Dryandra*, *Hakea*, *Eucalyptus*, *Grevillea*, *Pinus* and *Allocasuarina* spp.. It is nomadic often moving toward the coast after breeding. It breeds in tree hollows that are 2.5 – 12m above the ground and has an entrance of 23-30cm with a depth of 1-2.5m. Nesting mostly occurs in smooth-barked trees (e.g. Salmon Gum, Wandoo, Red Morrell). Loss of habitat, in particular, feeding areas near breeding sites is considered to be a major threat to this species.

The Dulcie project area is on the eastern fringe of their normal geographic distribution (Johnstone & Storr 1998), but Davies (1966) reported Carnaby's Cockatoo as far east as Norseman, but this was a rare occurrence and given the recently reported reduction in the population, they are unlikely to be seen this far east again.

No evidence was found in the project area of the characteristic chewed nuts or flowers which would indicate Carnaby's Black-Cockatoo have foraged in the area. Terrestrial Ecosystems' assessment is that they are probably infrequent visitors to the area, and clearing of the vegetation in the project area is unlikely to significantly impact on this species.

**Red-Tailed Phascogale** (*Phascogale calura*) – Schedule 1 under the *Wildlife Conservation Act 1950* and Vulnerable under the *EPBC Act 1999*.

This small nocturnal, arboreal marsupial lives mostly in unburnt eucalypt woodlands such as wandoo in areas that receive 350 - 600mm of rain per year. It is an opportunistic predator, preying on insects, spiders, small birds and small mammals. It constructs a small nest either in a tree fork or tree hollow of leaves and twigs. It is currently found in remnant bushland in the WA wheatbelt between Brookton and the Fitzgerald River National Park. It is threatened by habitat loss and fragmentation associated with clearing for agriculture, and possibly by predation by foxes and cats. Altered fire regimes resulting in a loss of old, long-unburnt vegetation is also considered a primary reason for the contraction in its geographic distribution.

Terrestrial Ecosystems' fauna survey database indicates that there are no records for this species within the vicinity of the Dulcie project area. Most records are to the south and the south-west. Therefore, it is Terrestrial Ecosystems' assessment that it would be unlikely this species would be found in the project area or impacted by vegetation clearing.

**Western Rosella** (*Platycercus icterotis xanthogenys*) – Schedule 1 under the *Wildlife Conservation Act 1950* and Vulnerable under the *EPBC Act 1999*.

The mallee form of the Western Rosella is found mostly in eucalypt and casuarina woodland and shrublands, especially Wandoo, Flooded Gums and Salmon Gums. This species was sighted by McKenzie and Rolfe (1995) in the Boorabbin – Southern Cross biological survey and by Biota (2007a, 2006a, 2006b, 2007b) at Diggers South mine and around the Forrestania mine site. If this species was seen in the project area, it is mostly likely to be in the treed area.

Given that the proposed clearing represents a very small fraction of similar habitat in the area, it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have any significant impact on this species.

**Western Spiny-tailed Skink** (*Egernia stokesii badia*) – Schedule 1 under the *Wildlife Conservation Act 1950* and Vulnerable under the *EPBC Act 1999*.

*Egernia stokesii badia* is a large skink that grows to about 28cm, is covered with short dorsal spines and has a short tail (StorrSmith & Johnstone 1999, HowDell & Robinson 2003). This subspecies is known from a number of disjunction populations in the wheatbelt and the mid-west of WA (HowDell & Robinson 2003). In South Australia, *E. s. badia* live in small social groups on rocky outcrops (Gardner *et al.* 2001) and we have seen similar social groups in the mid-west. Of particular interest is its behaviour of depositing faecal pellets in a pile in close proximity to their refuge, which provides an opportunity to identify the species presence in an area.

A search of Terrestrial Ecosystems' fauna survey database indicated that none had been caught in the vicinity of the project area. Therefore, it is highly unlikely that they will be present and impacted on by the proposed vegetation clearing.

**Slender-billed Thornbill** (*Acanthiza iredalei iredalei*) – Vulnerable species under the *EPBC Act 1999*.

The Slender-billed Thornbill has a preference for chenopod shrubland in close association with samphire flats. Johnstone and Storr's (2004) distribution maps for this species indicate that it is unlikely to occur in this area. The preferred habitat for this species is very different to that found in the project area. It is therefore Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have any significant impact on this species.

**Rainbow Bee-eater** (*Merops ornatus*) - Migratory under the *EPBC Act 1999*.

The Rainbow Bee-eater is widespread during late spring and summer in the southern section of WA, particularly in sandy areas that have access to water. This species was recorded in the area during spring and summer in other surveys undertaken in the bioregion (Appendix 2).

Given that the proposed land clearing represents a very small fraction of similar habitat in the general area, it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have any significant impact on this species. This species will readily move to other areas if it is disturbed.

**Fork-tailed Swift** (*Apus pacificus*) - Migratory under the *EPBC Act 1999*.

The Fork-tailed Swift breeds in north-east and mid-east Asia and winters in Australia and New Guinea. It arrives in the Kimberley in late September and in central and southern WA in November and leaves in late April. The Fork-tailed Swift may be an infrequent visitor to the area although it has not been recorded in previous surveys.

Given that the proposed land clearing represents a very small fraction of similar habitat in the general area, it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have any significant impact on this species.

**Lake Cronin Snake** (*Paroplocephalus atriceps*) – Priority 3 with DEC

Storr *et al.* (2002) reported the Lake Cronin Snake had been found around Lake Cronin, Peak Eleanora and Maggie Hayes Hills. Terrestrial Ecosystems' fauna database includes nine records for this snake. All are to the south or the south-east of the Dulcie project area. As none have been caught in the vicinity of the project area, it is Terrestrial Ecosystems' assessment that they are unlikely to be impacted on by any vegetation clearing in the project area.

**Peregrine Falcon** (*Falco peregrinus*) – Schedule 4 *Wildlife Conservation Act 1950*.

The Peregrine Falcon is uncommon, although widespread throughout much of Australia excluding the extremely dry areas and has a wide and patchy distribution. It favours hilly or mountainous country and open woodlands and may be an occasional visitor to the project area. Nesting sites include ledges along cliffs, granite outcrops and quarries, hollow trees near wetlands and old nests of other large bird species. There is no evidence to suggest any change in status in the last 50 years.

It is Terrestrial Ecosystems' assessment that the proposed land clearing in the project area is unlikely to have a significant impact on this species as there is plenty of similar habitat in adjacent areas.

**Western Brush Wallaby** (*Macropus irma*) - - Priority 4 with DEC.

The Western Brush Wallaby is generally only found in the south-west corner of WA. It normally has a preference for open forest or woodland, with low grasses and scrubby thickets. There are no records of the Western Brush Wallaby being found in the vicinity of the Dulcie project area in the Terrestrial Ecosystems' fauna survey database. They have, however, been recorded further to the south and the west.

It is Terrestrial Ecosystems' assessment that the Western Brush Wallaby is unlikely to be seen in the project area, and therefore impacted by any vegetation clearing.

**Major Mitchell's Cockatoo** (*Cacatua leadbeateri*) - Schedule 4 under the *Wildlife Conservation Act 1950*.

The geographic distribution of Major Mitchell's Cockatoo includes some of the semi-arid and arid zones of Australia. It has a disjunct geographic distribution in WA with a population in the semi-arid area east of Geraldton to include Lake Moore and Lake Barlee and another in the southern Great Victoria Desert (Johnstone and Storr 1998) but is not known in the vicinity of the project area. Major Mitchell's Cockatoo are most often seen high up in the branches of Salmon Gums (*Eucalyptus salmonophloia*) and other large eucalypts, in heavily timbered creek-lines or roadside verges, and in parts of the WA wheatbelt. Major Mitchell's Cockatoo breeds in the hollows of large eucalypts. It is scarce throughout most of WA and the primary cause for its decline is land clearing for agriculture and subsequent fragmentation of remaining habitat.

The project area is not within its known geographical distribution; therefore, it is Terrestrial Ecosystems' assessment that the proposed land clearing is unlikely to have any significant impact on this species.

**Carpet Python** (*Morelia spilota imbricata*) - Schedule 4 under the *Wildlife Conservation Act 1950*.

The Carpet Python is a large snake found across the south-west of WA, north to Geraldton and Yalgoo, and east to Kalgoorlie, Fraser Range and Eyre. It inhabits forest, heath or wetland areas and shelters in hollow logs or in branches of large trees. It feeds on a variety of vertebrates including small mammals and reptiles. Carpet Python assemblages are generally found in low numbers and are dispersed across a relatively large area; except during the breeding season when aggregations have been recorded. The very open and disturbed habitat in the project area is generally not suitable for Carpet Pythons.

Terrestrial Ecosystems' fauna survey database contains records of the Carpet Python being caught east of Southern Cross and near the Dulcie project area. It has also been seen/caught in open woodland areas in the Goldfields and around the Maggie Hays mine. Based on these records it is Terrestrial Ecosystems' assessment that Carpet Pythons may be in the general area but would be in very low abundance, therefore, the proposed vegetation clearing in the project area is unlikely to have any significant impact on this species, particularly as the proposed land clearing represents a very small fraction of similar habitat in the general area.

**Woma** (southern form: *Aspidites ramsayi*) - Schedule 4 under the *Wildlife Conservation Act 1950*.

This python was once common in a crescent shaped distribution from Shark Bay through the wheatbelt to Kitchener. It is now only found in one small population in the wheatbelt, around Shark Bay and east of Kalgoorlie. It is mostly found in sand plain habitat which is not present in the project area.

Terrestrial Ecosystems' assessment is that the Woma is highly unlikely to be found in the project area.

**Shy Heathwren** (*Hylacola cauta whitlocki*) - Priority 4 with DEC.

The Shy Heathwren is a small ground species that is found in the semi-arid interior of WA, including much of the southern wheatbelt. Its habitat includes shrubland in the understorey of eucalypt woodland, often on sandy soils. Johnstone and Storr (2004) recorded it as locally moderately common or common, but generally scarce or uncommon and patchily distributed. It was reported in other surveys conducted around the project area (Appendix 2).

Given that the proposed land clearing represents a very small fraction of similar habitat in the area, it is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in the project area is unlikely to have any significant impact on this species. If it is in the area then it will move once clearing commences.

**Australian Bustard** (*Ardeotis australis*) – Priority 4 with DEC.

Australian Bustards are tall birds that live in wooded grasslands (including spinifex), chenopod flats, low heathland and farmed areas and are widely distributed across WA. Terrestrial Ecosystems' has infrequently seen this species north of Southern Cross, so it may infrequently be seen in the general area.

Given that the proposed land clearing represents a very small fraction of similar habitat in the general area, it is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in the project area is unlikely to have any significant impact on this species.

**Crested Bellbird** (*Oreoica gutturalis gutturalis*) – Priority 4 with DEC.

Johnstone and Storr (2004) reported the geographic distribution for the Crested Bellbird to include the greater part of WA. Its preferred habitat is scrub and thickets (but not near edges). In the south-west of WA it is found mostly in wooded areas, including open Banksia scrub and heathland. It was seen during the biological survey of the Boorabbin – Southern Cross project area (McKenzie & Rolfe 1995) and by Biota (2006a, 2006b, 2007b) around the Forrestania mine site. It is therefore in the general area.

It is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in the project area is unlikely to have any significant impact on this species because, if it is in the area, it will move to adjacent areas where there are many hectares of similar habitat once vegetation clearing commences.

**Central Long-eared Bat** (*Nyctophilus timorensis* sp.) – Priority 4 with DEC.

The Central Long-eared Bat is probably the species referred to by Churchill (2008) as the Central Long-eared Bat (*Nyctophilus* sp. 1.). This species is distributed across the southern and central wheatbelt, Great Victoria Desert and the Nullarbor coast. It roosts in tree cavities, foliage and under loose bark.

Given that the proposed land clearing represents a very small fraction of similar habitat in the general area, it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have any significant impact on this species.

**Hooded Plover** (*Charadrius rubricollis*) – Priority 4 species with DEC.

This species frequents the margins and shallows of salt lakes, and is also seen along coastal beaches, where it forages for invertebrates. It is found along the southern coast and salt lakes north to Port Gregory, Three Springs, Mt Gibson, Lake Brown, Lake Barlee, Lake Cowan and Eyre. It is an uncommon to common resident on the southern sea beaches from Cape Naturaliste east to Eyre. It probably breeds in the samphire habitat along the boundary of some of the salt lakes in the bioregion.

The proposed clearing is not in habitat frequented by this species. It is Terrestrial Ecosystems' assessment that the proposed vegetation clearing in the project area is unlikely to have any significant impact on this species.

**Crested Shrike-tit** (south-western subspecies: *Falcunculus frontatus leucogaster*) – Priority 4 with DEC.

The Crested Shrike-tit is found in the semi-arid interior of WA from Moora south-east to Hyden and east of Norseman and south almost to the coast. It has a preference for woodlands, shrublands and open eucalypt forests. Johnstone and Storr (2004) indicated that it was generally scarce or rare in the south-west of WA. It was not seen in any of the fauna surveys in the bioregion. It was not recorded in the other surveys in the vicinity of the project area.

It is Terrestrial Ecosystems' assessment that it is unlikely to be seen in the project area, and if it was, then it would quickly move to adjacent areas. The clearing of vegetation in the project area is therefore unlikely to significantly impact on this species.

**Bush Stone-Curlew** (*Burhinus grallarius*) – Priority 4 with DEC.

The Bush Stone-curlew is nocturnal, inhabits open woodlands and lives in small groups. The tendency for this species is to freeze when in danger making it vulnerable to feral predators. The Bush Stone-Curlew is becoming rare in the southern sections of its range, a possible result of habitat loss or feral predation.

Johnstone and Storr (1998) recorded Southern Cross as the most easterly part of its geographical distribution in the southern part of WA. It was not recorded in any of the fauna surveys in the vicinity of the Dulcie project area, so based on the available information, Terrestrial Ecosystems' assessment is that it is unlikely to be in the proposed Dulcie project area.

**Rufous Fieldwren** (*Calamanthus campestris montananellus*) – Priority 4 with DEC.

The Rufous Fieldwren geographic distribution extends from Exmouth south to Dongara along the coast and then in the eastern part of the wheatbelt and along the southern coast to Eyre (Johnstone & Storr 2004). Its known geographical distribution includes the Dulcie project area. It has a preference for heaths and other low shrubland on sandplains and lateritic ridges, shrub steppes (*Maireana*, *Atriplex* and *Halosarcia* samphires) on limestone plains and around salt lakes (Johnstone & Storr 2004), none of which are present in the project area.

It was recorded by Biota (2007b) in the Forrestania mine project area, so it is possible that they are in the general area. However, as they are likely to move once vegetation clearing commences, the impact of mine development on this species is unlikely to be significant.

**White-browed Babbler** (*Pomatostomus superciliosus ashbyi*) - Priority 4 with DEC.

Johnstone and Storr (2004) reported the geographic distribution to include most of WA south of the Tropic of Capricorn. It prefers arid and semi-arid areas, on the edges of thickets and scrub, including Mulga, Wattle and Acacia. It was seen during the biological survey of the Boorabbin – Southern Cross project area (McKenzie & Rolfe 1995) and by Biota (2007a) at Diggers South mine and again by Biota (2006a) at Forrestania. It is therefore in the general area.

It is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in the project area is unlikely to have any significant impact on this species because, if it is in the project area, it will move to adjacent areas once vegetation clearing commences.

## 4.5 Risk Assessment

Fauna surveys to support ecological impact assessments (EciAs) are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on the biodiversity of a particular area and region. Potential impacts to fauna from the proposed development are identified and briefly described above. Tables 3-5 provide a summary of the risk assessment associated with clearing additional vegetation in this project area.

Results from this assessment indicate that the risks of significantly impacting on native fauna, fauna assemblages and fauna habitat are low when placed in a regional context and, if the recommended management strategies are implemented, then the risks will be further reduced.

TABLE 3  
FAUNA IMPACT RISK ASSESSMENT DESCRIPTORS

Any risk assessment is a product of the likelihood of an *event* or *impact* occurring and the consequences of that *event* or *impact*. Likelihood and consequences are categorised and described below. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the events or impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 5.

<b>Likelihood</b>		
Level	Description	Criteria
A	Rare	The environmental event may rarely occur.
B	Unlikely	The environmental event is unlikely to occur.
C	Moderate	The environmental event could occur.
D	Likely	The environmental event should occur.
E	Almost certain	The environmental event will occur.
<b>Consequences</b>		
Level	Description	Criteria
1	Insignificant	No loss of conservation significant fauna or regional biodiversity and an insignificant impact on non-conservation significant fauna.
2	Minor	No loss of conservation significant fauna or the localised loss of individuals and species in a regional context.
3	Moderate	Loss of an individual from a conservation significant species or a moderate loss of non-conservation significant fauna in a regional context.
4	Major	Significant loss of conservation significant fauna as defined in the DEH (2006) publication or a loss of a significant number of non-conservation significant fauna at landscape scale.
5	Catastrophic	Loss of a population of conservation significant at a local scale or loss of a significant number of non-conservation significant fauna at regional scale.
<b>Acceptability of Risk</b>		
Level of risk	Management Action Required	
Acceptable	No action required.	
Moderate	Avoid if possible, routine management with internal audit and review of monitoring results annually.	
High	Externally approved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually. Will require a referral to the Commonwealth under the <i>EPBC Act 1999</i> .	
Extreme,	Unacceptable, project should be redesigned or not proceed.	

TABLE 4  
LEVELS OF ACCEPTABLE RISK

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequences	Insignificant (1)	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
	Minor (2)	Acceptable	Acceptable	Acceptable	Moderate	Moderate
	Moderate (3)	Acceptable	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

TABLE 5.  
A RISK ASSESSMENT OF THE IMPACT OF GROUND DISTURBANCE ACTIVITY ON FAUNA

		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Management	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Inadequate fauna survey data.	Unknown loss of fauna, fauna of conservation significance, fauna assemblage(s) in the project area.	B	2	Acceptable				
Inadequate knowledge of potential impacts.	Unknown or poorly assessed impact(s) on the fauna assemblage and conservation significant species.	B	2	Acceptable				
Inadequate bioregional data for contextual purposes.	Incomplete analysis of data and appreciation of impacts on biodiversity values in a regional context.	B	2	Acceptable				
Removal of habitat – site scale.	Almost complete loss of terrestrial fauna in habitats that are cleared, severe impact on local fauna assemblage.	E	2	Moderate	Minimise the extent of clearing and avoid leaving isolated remnants.	E	1	Acceptable
Significant reduction of habitats – local scale.	Loss of fauna and fauna habitat and impacts on the local fauna assemblage (excluding conservation significant species).	B	2	Acceptable				
Significant reduction of habitats – landscape scale.	Loss of fauna and fauna habitat and impacts on fauna in a landscape context (excluding conservation significant species).	B	1	Acceptable				
Significant reduction of habitats – regional scale.	Loss of fauna and fauna habitat and impacts on fauna in a bioregional context (excluding conservation significant species).	B	1	Acceptable				
Impact on resident conservation significant terrestrial species.	Death of a Chuditch.	B	2	Acceptable				
	Death of a Red-tailed Phascogale.	A	3	Acceptable				
	Death of a Lake Cronin Snake.	B	1	Acceptable				



		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Management	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Resident avian species.	Death of a Malleefowl.	B	2	Acceptable				
	Death of a Western Rosella.	B	1	Acceptable				
Migratory avian species.	Loss of conservation significant species.	B	1	Acceptable				
Habitat fragmentation.	Isolation of fauna assemblages.	C	2	Acceptable	Avoid leaving isolated remnants of vegetation that have no movement corridors to adjacent areas.			

## **5 Discussion**

### **5.0 Adequacy of available vertebrate fauna data**

No fauna trapping surveys have been undertaken for the Southern Cross Goldfields project area. However, there are survey data from the Boorabbin – Southern Cross study undertaken by the Biological Survey Committee for areas to the east and north-east and by Biota (2006a, 2006b, 2007b, 2007a) around the Forrestania and Diggers South mines to the south and by the Department of Environment and Conservation (formerly CALM) to the west during its wheatbelt surveys. It is unlikely that the project area contains a vertebrate fauna assemblage that is significantly different to those areas.

There was the potential for the project area to contain active Malleefowl mounds and to be a foraging area for Malleefowl. However, an extensive search of the area found no active Malleefowl mounds or Malleefowl tracks, but Terrestrial Ecosystems did find three inactive mounds. These data suggest that Malleefowl occupied this area in the past but are no longer present.

These survey data and the extensive search of the area are adequate to make an informed assessment of the potential impacts on the fauna assemblage in the project area.

### **5.1 Biodiversity values of the site**

#### **5.1.1 Condition of fauna habitat and extent of habitat degradation**

As a consequence of many decades of mining, some sections of the project area highly degraded. There appears to have been little effort to rehabilitate previously disturbed areas. More recently, parallel exploration tracks that have been cleared across much of the project area will have disturbed the fauna and may have caused some species to move into adjacent areas. The open Eucalypt woodland on the western side, and the Eucalypt woodland over Melaleuca and the Acacia shrub land in the southern section of the project area are the best available fauna habitat.

#### **5.1.2 Ecological linkages**

The project area currently does not provide any important ecological linkage or fauna movement corridor. There are multiple exploration tracks that dissect the project area but most of these are relatively narrow and are unlikely to provide a barrier that would inhibit the movement of fauna within the general area. The southern section of the project area is bisected by Dunbar Road that runs east-west but this is infrequently used and is unlikely to act as barrier to most fauna movements.

#### **5.1.3 Size and scale of the proposed disturbance and potential impacts**

The project area is about 370ha but Southern Cross Goldfields is not intending to clear the whole area. A separate report outlines those areas that the company would like to clear of native vegetation. Given the extent of existing disturbance and the abundance of similar fauna habitat in adjacent areas, additional vegetation clearing within the project area is unlikely to significantly impact on the fauna in a landscape or bioregional context. An effective rehabilitation program of disturbed areas, once they are no longer required, is likely to provide similar habitat in the long term.

#### **5.1.4 Abundance and distribution of similar habitat in the adjacent areas and the bioregion**

To the east of the project area there is a large nature reserve (Jilbadji Nature Reserve) that incorporates a similar vegetation community to that in the project area. It is therefore likely that the fauna assemblage in the project area is similar to that in this large nature reserve. There are other nature reserves to the north-east, including Condarnin Rock Nature Reserve, as well as the Boorabbin National Park.

The project area represents a small fraction of similar habitat in the bioregion and in adjacent areas. There is an abundance of similar fauna habitat surrounding the project area, including nature reserves.

### **5.1.5 Ecological functional value of the site**

The project area has some disturbed areas, other sections are in good condition and are likely to support a near natural fauna assemblage. The ecological functional value for the undisturbed sections of the project area is assessed as high and the already disturbed areas as low. As this fauna habitat is abundant in adjacent areas, clearing habitat in sections of the project area is unlikely to significantly impact on the vertebrate fauna when considered in a bioregional context.

### **5.1.6 Potential impacts on ecosystem function**

Clearing native vegetation is likely to result in the loss of small vertebrate fauna on site that are unable to move away during the clearing process. Larger animals such as kangaroos and most of the birds will move into adjacent areas once clearing commences. Shifting animals into adjacent areas will increase the pressure on resources in those areas and it is likely that there will be some disruption to these assemblages for a period of time until a balance is restored. Little can be done to address this impact other than to minimise the area of vegetation that is cleared.

### **5.1.7 Potential impacts on conservation significant species and ecosystems**

Clearing of native vegetation in the project area is unlikely to have a significant impact on conservation significant fauna. There is a possibility that the area contains Shy Heathwrens (*Hylacola cauta whitlocki*), Crested Bellbirds (*Oreoica gutturalis gutturalis*), Western Rosellas (*Platycercus icterotis xanthogenys*) and the White-browed Babbler (*Pomatostomus superciliosus ashbyi*). It is more probable that the Rainbow Bee-eater (*Merops ornatus*) will be seen in the area during summer. These birds will move to adjacent areas once vegetation clearing commences. This might result in a period of instability in these ecosystems until new territories are resolved for the sedentary species. It is unlikely the project area supports Malleefowl, as no active Malleefowl mounds or tracks were found during the search of the site. It is possible that the general area contains a low density of Chuditch and Carpet Pythons. Chuditch are likely to move to adjacent areas when vegetation clearing commences, as long as they are not hurt during the process. Any Carpet Pythons in the area would most likely be killed during the clearing process as they are slow to move. The loss of a few individuals of either of these species would not be considered as significant.

## **5.2 A summary of the fauna risk assessment**

Clearing of vegetation in the project area is likely to have a low ecological impact on the fauna in the bioregion but will result in the loss of individuals that remain on site once clearing commences. It is unlikely that any threatened fauna will be significantly impacted by the proposed vegetation clearing.

## 6 Recommendations

Terrestrial Ecosystems' assessment is that clearing of native vegetation within the project area to accommodate the proposed mine's operations will have a low impact on the native fauna when viewed in a bioregional context. To minimise this impact the following recommendations are made:

- the area to be cleared should be minimised and planned such that it does not result in the creation of isolated remnants of native vegetation that have no ecological corridors to allow fauna movement to adjacent areas;
- a rehabilitation plan is prepared for existing and proposed disturbance areas and is progressively implemented when the land is no longer required for mining operations; and
- a fauna management plan is prepared for the entire site before mining operations commence.

## 7 References

- Beecham, B., (2001) Avon Wheatbelt 1 (AW1 - Ancient Drainage subregion). In: *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*: 7. J. E. May & N. L. McKenzie (Eds.). Department of Conservation and Land Management, Perth.
- Bell, D. T., R. C. Bell & W. A. Loneragan (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. *Journal of the Royal Society of Western Australia*, 90, 219.
- Biota Environmental Sciences, (2006a) Forrestania Fauna. Survey Fauna and Faunal Assemblages Report. Perth.
- Biota Environmental Sciences, (2006b) Forrestania Water Disposal Pipeline Fauna Survey. Perth.
- Biota Environmental Sciences, (2007a) Diggers South Fauna Survey - Phase I. Perth.
- Biota Environmental Sciences, (2007b) Forrestania Fauna Monitoring Survey- Flying Fox Phases III and IV. Perth.
- Biota Environmental Sciences, (2008) Forrestania Targeted Malleefowl Survey. Perth.
- Burbidge, A. H., J. K. Rolfe, N. L. McKenzie & J. D. Roberts (2004) Biogeographic patterns in small ground-dwelling vertebrates of the Western Australian wheatbelt. *Records of the Western Australian Museum*, Supplement No 67, 109.
- Churchill, S. (2008) *Australian Bats*. Crows Nest, NSW: Jacana Books.
- Cowan, M., Graham, G, McKenzie, N., (2002) Coolgardie 2 (COO2 - Southern Cross subregion). In: *A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002*: 143. Department of Conservation and Land Management, Perth.
- Davies, S. J. J. F. (1966) The movements of the White-tailed Black Cockatoo (*Calyptorhynchus baudini*) in south-western Australia. *Western Australian Naturalist*, 10, 33.
- Department of the Environment and Heritage, (2006) EPBC Act Policy Statement 1.1, Significant Impact Guidelines. Department of the Environment and Heritage, Canberra.
- Environmental Protection Authority, (2002) Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3. i. Environment Protection Authority, Perth.
- Environmental Protection Authority, (2004) Guidance for the Assessment of Environmental Factors. Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56. 40. Perth.
- Gardner, M. G., C. M. Bull, S. J. B. Cooper & G. A. Duffield (2001) Genetic evidence for a family structure in stable social aggregations of the Australian lizard *Egernia stokesii*. *Molecular Ecology*, 10, 175.
- How, R. A., J. Dell & D. J. Robinson (2003) The Western Spiny-Tailed Skink, *Egernia stokesii badia*: Declining distribution in a habitat specialist. *The Western Australian Naturalist*, 24, 138.
- Johnstone, R. E. & G. M. Storr (1998) *Handbook of Western Australian Birds. Volume 1 - Non-Passerines (Emu to Dollarbird)*. Perth: Western Australian Museum.
- Johnstone, R. E. & G. M. Storr (2004) *Handbook of Western Australian Birds, Volume II Passerines (Blue-winged Pitta to Goldfinch)*. Perth: Western Australian Museum.
- McKenzie, N. L. & J. K. Rolfe (1995) Vertebrate fauna. *Records of the Western Australian Museum*, Supplement No 49, 31.
- Storr, G., L. Smith & R. Johnstone (1983) *Lizards of Western Australia. II: Dragons and Monitors*. Perth, Western Australia: Western Australian Museum.
- Storr, G., L. Smith & R. Johnstone (1990) *Lizards of Western Australia. III: Geckos and Pygopods*. Perth: Western Australian Museum.
- Storr, G., L. Smith & R. Johnstone (1999) *Lizards of Western Australia. I: Skinks*. Perth: Western Australian Museum.
- Storr, G., L. Smith & R. Johnstone (2002) *Snakes of Western Australia*. Perth: Western Australian Museum.
- Thompson, S. A. & G. G. Thompson (2006) *Reptiles of the Western Australian Goldfields*. Kalgoorlie, WA: Goldfields Environmental Management Group.
- Tyler, M. J., L. A. Smith & R. E. Johnstone (2000) *Frogs of Western Australia*. Perth: Western Australian Museum.
- Van Dyck, S. & R. Strahan (2008) *The Mammals of Australia*. Sydney: Reed New Holland

## APPENDIX 1. HABITAT CONDITION DESCRIPTORS

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Habitat condition label	Condition description
High quality fauna habitat:	These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.
Very good fauna habitat:	These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and retain almost all of the characteristics of the habitat had it not been disturbed. The habitat has connectivity with other habitats, and fauna assemblages in these areas are likely to be minimally effected by disturbance.
Good fauna habitat:	These areas show signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat had it not been disturbed. The habitat has connectivity with other habitats but fauna assemblages in these areas are likely to be affected by disturbance. Fauna assemblages in these areas are likely to be similar to what might be expected in the area.
Disturbed fauna habitat:	These areas show signs of significant disturbance. Many of the trees, shrubs and undergrowth have died or have been cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain weeds or have been damaged by vehicles or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.
Highly degraded fauna habitat:	These areas often have a significant loss of vegetation, and / or abundance of weeds, and / or a large number of vehicle tracks or have been completely cleared. There is limited or no fauna habitat connectivity. Fauna assemblages in these areas are likely to differ significantly to what existed prior to the disturbance, and are often depleted compared to what existed prior to the disturbance.

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APPENDIX 2A. SUMMARY OF FAUNA SURVEY DATA IN THE VICINITY OF THE PROJECT AREA

Family	Species	Common Name	A																																						
			Koorarawayee	Pools on granite	Site 7E	Site 7E01A	Site 7E02	Site 7E03	Site 7E03A	Site 7E04	Site 7E05	Site 7E06	Site 7E06A	Site 7W	Site 7W01	Site 7W02	Site 7W03	Site 7W04	Site 7W05	Site 7W06	Site BN	Site BN1	Site BN2	Site BN4	Site BN6	South 6.5km 7E	West 1.9km 7W03	West 1.9km 7W04	West 1.9km 7W05	West 2.9km 7W03	West 2.9km 7W04	West 2.9km 7W05	West 2.9km 7W06	West 2.9km 7W07	West 4.0km 7W03	West 4.0km 7W04	West 4.0km 7W05				
<b>Birds</b>																																									
Casuariidae	<i>Dromaius novaehollandiae</i>	Emu					2									1																									
Megapodiidae	<i>Leipoa ocellata</i>	Malleefowl											X	X		X																									
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck																			X																				
Anatidae	<i>Anas gracilis</i>	Grey Teal																			X																				
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe																			X																				
	<i>Polioccephalus poliocephalus</i>	Hoary-headed Grebe																			X																				
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing					2				3															2															
	<i>Ocyphaps lophotes</i>	Crested Pigeon																			X																				
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth						1													X																				
Caprimulgidae	<i>Eurostopodus argus</i>	Spotted Nightjar					1									2																									
Aegothelidae	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar									1							4		X																					
	<i>Lophoictinia isura</i>	Square-tailed Kite											X																												
	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard											X																												
	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk							1	1																															
	<i>Aquila audax</i>	Wedge-tailed Eagle																				X																			
	<i>Hieraaetus morphnoides</i>	Little Eagle								1				1																											
Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel			X																	X																			
	<i>Falco berigora</i>	Brown Falcon			X																	X																			
	<i>Falco hypoleucos</i>	Grey Falcon													X																										
	<i>Falco peregrinus</i>	Peregrine Falcon											X																												
Rallidae	<i>Fulica atra</i>	Eurasian Coot																				X																			
Charadriidae	<i>Vanellus tricolor</i>	Banded Lapwing																				X																			
Turnicidae	<i>Turnix varius</i>	Painted Button-quail																									1														
Cacatuidae	<i>Nymphicus hollandicus</i>	Cockatiel			X																	X																			
Psittacidae	<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet					1	8	6					25			12		X																						
	<i>Polytelis anthopeplus</i>	Regent Parrot						1	14							3									2																
	<i>Platycercus icterotis zanthogenys</i>										1					1	1																								
	<i>Barnardius zonarius</i>	Australian Ringneck					6	14	5	1				3	3		5								1	1															
	<i>Psephotus varius</i>	Mulga Parrot																																							
Cuculidae	<i>Chalcites basalus</i>	Horsfield's Bronze-Cuckoo			X										1						X																				
	<i>Chalcites osculans</i>	Black-eared Cuckoo														2																									
	<i>Cacomantis pallidus</i>	Pallid Cuckoo					2							1								X																			
Strigidae	<i>Ninox novaeseelandiae</i>	Southern Boobook			X								X									X																			
Alcedinidae	<i>Todiramphus pyrrophygius</i>	Red-backed Kingfisher					1	2						1												4															





Family	Species	Common Name	A																																																			
			Koorarawallee	Pools on granite	Site 7E	Site 7E01A	Site 7E02	Site 7E03	Site 7E03A	Site 7E04	Site 7E05	Site 7E06	Site 7E06A	Site 7W	Site 7W01	Site 7W02	Site 7W03	Site 7W04	Site 7W05	Site 7W06	Site BN	Site BN1	Site BN2	Site BN4	Site BN6	South 6.5km 7E	West 1.9km 7W03	West 1.9km 7W04	West 1.9km 7W05	West 2.9km 7W03	West 2.9km 7W04	West 2.9km 7W05	West 2.9km 7W06	West 2.9km 7W07	West 4.0km 7W03	West 4.0km 7W04	West 4.0km 7W05																	
	<i>Oreoica gutturalis</i>	Crested Bellbird				4	1	7	3					3	3	2	2						3	1																														
Artamidae	<i>Artamus personatus</i>	Masked Woodswallow		X												52	5																																					
	<i>Artamus cinereus</i>	Black-faced Woodswallow							1					4					X																																			
	<i>Artamus cyanopterus</i>	Dusky Woodswallow				3			2	1	3			13									3	5																														
	<i>Cracticus torquatus</i>	Grey Butcherbird			1													4		1		1																																
	<i>Cracticus nigrogularis</i>	Pied Butcherbird				1	6	1						1				2	X																																			
	<i>Cracticus tibicen</i>	Australian Magpie		X																X																																		
	<i>Strepera versicolor</i>	Grey Currawong				1									2		3	X																																				
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail															1																																					
	<i>Rhipidura leucophrys</i>	Willie Wagtail				2	12	8					9	1								2																																
Corvidae	<i>Corvus coronoides</i>	Australian Raven																				2																																
	<i>Corvus bennetti</i>	Little Crow																		X																																		
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-Lark																		X																																		
Petroicidae	<i>Microeca leucophaea</i>	Jacky Winter				2	1		7				1	10								3	1																															
	<i>Petroica multicolor</i>	Pacific Robin																																																				
	<i>Petroica goodenovii</i>	Red-capped Robin				7	7	1					9	21	3	6			4			1																																
	<i>Melanodryas cucullata</i>	Hooded Robin				4													X																																			
	<i>Eopsaltria griseogularis</i>	Western Yellow Robin														6																																						
	<i>Drymodes brunneopygia</i>	Southern Scrub-robin				2								1	4	6																																						
Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin				7							7									4	8																															
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird													1							1																																
Motacilidae	<i>Anthus novaeseelandiae</i>	Australasian Pipit			7	1							X								3																																	
<b>Mammals</b>																																																						
Canidae	<i>Canis lupus familiaris</i>	Dog					X																																															
Felidae	<i>Felis catus</i>	House Cat			X	X																																																
Molossidae	<i>Austronomus australis</i>	White-striped Freetail Bat	X	X	7			1					2	1	2	6	1	3			1					X	X			X																								
	<i>Mormopterus planiceps</i>	Southern Freetail-bat						1	2							5																																						
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	X		13			1	3						4	10	1	5									X				X																							
	<i>Chalinolobus morio</i>	Chocolate Wattled Bat			3			1	3																	X																												
	<i>Nyctophilus geoffroyi</i>	Lesser Longeared Bat			1										1	1																																						
	<i>Nyctophilus major</i>	Western Longeared Bat		X	X								X																																									
	<i>Scotorepens balstoni</i>	Inland Broadnosed Bat						1																																														
	<i>Vespadelus regulus</i>	Southern Forest Bat	X	X	11				5					1	1	5		3								X		X																										
Dasyuridae	<i>Antechinomys laniger</i>	Kultarr													2																																							
	<i>Ningauai yvonneae</i>	Mallee Ningauai				1	3	1	1												2		2																															
	<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart				8																																																
	<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart				1		2	1	4	1			2	1	1	2	3	2				1																															









Family	Species	Common Name	A												B																			
			HY02	Y09	KN13	LK08	LK10	K11	LK12	MN01	N02	03	MN04	MN05	MN06	O02	Y09	DR01	DR02	DR03	DR04	DR05	DR06	DR07	DR08	DR09	DR10	DR11	DR12	DRbat	DRopp			
Muridae	<i>Mus musculus</i>	House Mouse	4		2				19	2		3		2	3	7	2													1				
	<i>Notomys mitchelli</i>	Mitchell's Hopping Mouse					1						1		1																			
	<i>Pseudomys albocinereus</i>	Ash-grey Mouse																												1				
<b>Amphibians</b>																																		
Limnodynastidae	<i>Heleioporus albopunctatus</i>	Western Spotted Frog					1	2		1							1														3			
	<i>Heleioporus eyrei</i>	Moaning Frog							1								9																	
	<i>Limnodynastes dorsalis</i>	Western Banjo Frog					2	53								1																		
	<i>Neobatrachus albipes</i>	White-footed Trilling Frog					1	4	3	1																								
	<i>Neobatrachus kunapalari</i>	Kunapalari Frog		1	2		6						3																					
	<i>Neobatrachus pelobatoides</i>	Humming Frog		1	2					2		1			1		3																	
	<i>Neobatrachus sutor</i>	Shoemaker Frog								5																								
Myobatrachidae	<i>Crinia glauerti</i>	Clicking Frog														1																		
	<i>Crinia pseudinsignifera</i>	Bleating Froglet													20	295																		
	<i>Myobatrachus gouldii</i>	Turtle Frog													1																			
	<i>Pseudophryne guentheri</i>	Crawling Toadlet						2		1						1																		
<b>Reptiles</b>																																		
Agamidae	<i>Ctenophorus adelaidensis</i>						1																											
	<i>Ctenophorus cristatus</i>																3			1														
	<i>Ctenophorus maculatus</i>						3	3					3									2				2		1						
	<i>Ctenophorus ornatus</i>														4																			
	<i>Ctenophorus salinarum</i>		2																															
	<i>Ctenophorus scutulatus</i>											2																						
	<i>Moloch horridus</i>											4	7																					
	<i>Pogona minor</i>						2	5							1																			
Carphodactylidae	<i>Nephrurus milii</i>																																	
Diplodactylidae	<i>Crenadactylus ocellatus</i>												1		1	1	2																	
	<i>Crenadactylus ocellatus</i>																	1		14	3	2		1	4	1								
	<i>Diplodactylus granariensis</i>						2	1		2	1	4		6	1			1	1	1	1	1												
	<i>Diplodactylus pulcher</i>			4									1	2			1															1		
	<i>Lucasium maini</i>			1			1					4	2	7	1			2					2											
	<i>Oedura reticulata</i>									6	7		6											1										
Elapidae	<i>Echiopsis curta</i>																							1										
	<i>Paroplocephalus atriceps</i>																																	1

Family	Species	Common Name	A														B											
			HY02	Y09	KN13	LK08	LK10	K11	LK12	MN01	N02	03	MN04	MN05	MN06	O02	YO09	DR01	DR02	DR03	DR04	DR05	DR06	DR07	DR08	DR09	DR10	DR11
	<i>Pseudonaja affinis affinis</i>																									1	1	1
	<i>Simoselaps bertholdi</i>								1		1					1												
Gekkonidae	<i>Christinus marmoratus</i>				2										1													
	<i>Gehyra variegata</i>			2				8	1		11		6															
Pygopodidae	<i>Aprasia repens</i>				4	2																						
	<i>Delma australis</i>												1				1								1			
	<i>Delma fraseri</i>															2						1						
Scincidae	<i>Acritoscincus trilineatum</i>														2													
	<i>Cryptoblepharus buchananii</i>			1	1			2	1				1	2	3	1			1		5							
	<i>Ctenotus impar</i>				2	1														1		1				2		
	<i>Ctenotus schomburgkii</i>		2		2	10		1			1	2								1	2	1	1	3	1	2		
	<i>Egernia richardi</i>															1												
	<i>Hemiergis initialis</i>				2											1												
	<i>Hemiergis peronii</i>		2		1																							
	<i>Lerista distinguenda</i>		4		6	3	2	3				2	1		2	1		1	1	2		1						
	<i>Lerista dorsalis</i>						1																					
	<i>Lerista macropisthopus</i>										3																	
	<i>Lerista sp.</i>							1	17	1																		
	<i>Menetia greyii</i>		1	1					2	4	1		19					1										
	<i>Morethia butleri</i>							1	4																			
	<i>Morethia obscura</i>				8	1	3				2	1						3		1				1				
	<i>Tiliqua occipitalis</i>																							1				
	<i>Tiliqua rugosa</i>						1	2			1	1									1					1		
Typhlopidae	<i>Ramphotyphlops australis</i>													2				2		2	1	1						
	<i>Ramphotyphlops waitii</i>										1	1																
Varanidae	<i>Varanus gouldii</i>																											2
	<i>Varanus rosenbergi</i>																											1
Cheluidae	<i>Chelodina oblonga</i>														1													

A Data from Burbidge AH, Rolfe, JK, McKenzie NL and Roberts, JD (2004) Biogeographic patterns in small ground-dwelling vertebrates of the Western Australian wheatbelt. *Records of the Western Australian Museum*, Supplement No 67, 109-127.

B Biota Environmental Sciences (2007a) Diggers South Fauna Survey, Unpublished report for Western Areas, Perth.









Family	Species	Common Name	A												B										C	D											E												
			ER03	ER04	ER05	ER06	ER07	ER08	ER09	ER10	ER11	ER12	ER13	ER14	ERC	EROmn	ER03	ER04	ER05	ER06	ER07	ER08	ER09	ER10	ER11	ER12	ER13	ERC	EROmn	ERbat	Unknown	Dic1	Dic2	Dic3	Dic4	DieMinc	FR11	FR20	FR21	FR21E	FR22	FR24	FR25	FR26	EROmn	ERhard	Yellowdine		
	<i>Pogona minor</i>							1	1	1		1				1					1				1													3	2	2									
Carphodactylidae	<i>Nephrurus milii</i>															2	1	3				4				1																			1				
Diplodactylidae	<i>Crenadactylus ocellatus</i>		6	7	2	1	1									2	1	3																									2	1					
	<i>Diplodactylus granariensis</i>		1		3	6	1									1	1			1	1																					2							
	<i>Diplodactylus pulcher</i>									2																																							
	<i>Lucasium maini</i>			9	15			1	3	5						1		1				2																						1	2				
	<i>Oedura reticulata</i>			2		1																																											
	<i>Strophurus strophurus</i>																					2																											
Elapidae	<i>Parasuta gouldii</i>		1	2	2													1				1																						1					
	<i>Parasuta nigriceps</i>					1																																											
	<i>Pseudonaja affinis</i>												2	1											1																								
	<i>Simoselaps bertholdi</i>					2																																											
Gekkonidae	<i>Gehyra variegata</i>																1														2																		
Pygopodidae	<i>Delma australis</i>								1																																						1		
	<i>Delma fraseri</i>		1								1																																						
	<i>Lialis burtonis</i>		1						1																																					1			
	<i>Pygopus lepidopus</i>													1																																			
Scincidae	<i>Cryptoblepharus buchananii</i>			1	1		1						1			4	2		1							4	2																						
	<i>Ctenotus impar</i>					1					3																																						
	<i>Ctenotus schomburgkii</i>		1				3	1			1					3			4	2																													
	<i>Egernia multiscutata</i>																						1																					1					
	<i>Egernia richardi</i>			1	1								2																																				
	<i>Hemiergus initialis</i>			5					1	1																					2																		
	<i>Lerista dorsalis</i>																										1																						
	<i>Lerista picturata</i>					1																																					1						
	<i>Morethia obscura</i>			1	6	1			1			1				2	2									1															1								
	<i>Tiliqua occipitalis</i>																1																																
	<i>Tiliqua rugosa</i>					2																																											
Typhlopidae	<i>Ramphotyphlops australis</i>					1										1							1																										
Varanidae	<i>Varanus gouldii</i>																																																

- A Biota Environmental Sciences (2006a) Forresteria Fauna, Survey Fauna and Faunal Assemblages, Unpublished report for Western Areas, Perth.
- B Biota Environmental Sciences (2007b) Forresteria Fauna Monitoring Survey – Flying Fox Phases III and IV, Western Areas, Perth.
- C Biota Environmental Sciences (2008) Forresteria Targeted Malleefowl Survey, Unpublished report for Western Areas, Perth.
- D Biota Environmental Sciences (2006b) Forresteria Water Disposal Pipeline Survey, Unpublished report for Western Areas, Perth.
- E Bell DT, Bell RC and Loneragan (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. *Journal of the Royal Society of Western Australia* 90, 219-227