

→ BHP Billiton Iron Ore



→ **LEVEL 2 FLORA & VEGETATION SURVEY**
LEVEL 1 FAUNA SURVEY

→ Shay Gap Aerodrome, Yarrie Area A, Yarrie Area B

→ November 2010



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1	D.Brearley M.O'Connell	J.Bull	20/11/10	D.Brearley	C.Higham B.Barnett	21/11/10
2	D.Brearley	J.Bull	30/11/10	D.Brearley	C.Higham B.Barnett	08/12/10



Onshore Environmental Consultants Pty Ltd
 ACN 095 837 120
 PO Box 227
 YALLINGUP WA 6282
 Telephone / Fax (08) 9756 6206
 E-mail: onshoreenv@westnet.com.au



Biologic Environmental Survey
 CAN 133 116 131
 24 Gregory Avenue
 Newman WA 6872
 Telephone / Fax (08) 9175 0580
 E-mail: morgan@biologicenv.com.au

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Executive Summary

In response to an invitation from BHP Billiton Iron Ore Pty Ltd (BHP Billiton), Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned to undertake a one-season Level 2 flora and vegetation survey and Level 1 fauna survey, at three relatively small survey areas at the Goldsworthy Mining Operations. The survey is to support a Native Vegetation Clearing Permit (NVCP) application to disturb areas required for expansion of the existing Shay Gap Aerodrome (referred to as the Shay Gap Aerodrome survey area), and two options for the development of a crushing area to replace the existing facility at Cattle Gorge (referred to as Yarrie Area A and Yarrie Area B survey areas). The Goldsworthy Mining Operations are located approximately 200 km east south-east of Port Hedland in the north-east Pilbara region of Western Australia.

A total number of 165 plant taxa (including varieties and subspecies) from 37 families and 93 genera were recorded from the three survey areas, with species representation greatest among the Fabaceae, Poaceae, Malvaceae and Amaranthaceae families. A breakdown of the three survey areas confirms that Yarrie Area A supported the highest species richness (28 families, 62 genera, 100 taxa), followed by Yarrie Area B (21 families, 51 genera, 73 taxa) and Shay Gap Aerodrome (23 families, 44 genera, 66 taxa).

There were no plant taxa gazetted as Declared Rare Flora (DRF) pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)*, and no plant taxa were listed under the *EPBC Act 1999*. In addition, there no Priority flora species recorded, as determined by the Department of Environment and Conservation (DEC). There were five introduced (weed) species recorded from the Yarrie Area A and Yarrie Area B survey areas; **Aerva javanica*, **Cenchrus ciliaris*, **Chloris virgata*, **Cucumis melo* subsp. *agrestis* and **Portulaca oleracea*. None of the weed taxa are listed as Declared Weeds under the *Agriculture and Related Resources Protection Act, 1976* (ARRP Act). No introduced flora was recorded from the Shay Gap Aerodrome survey area.

A total of eight vegetation associations and five broad floristic formations were described and mapped within the Shay Gap Aerodrome survey area:

1	Acacia Low Open Heath (regrowth)	Low Open Heath of <i>Acacia tumida</i> var. <i>pilbarensis</i> (regrowth), <i>Bonamia rosea</i> and <i>Senna notabilis</i> over Very Open Tussock Grassland of <i>Aristida holathera</i> and <i>Chrysopogon fallax</i>
2a	Acacia Low Scattered Shrubs	Low Scattered Shrubs of <i>Acacia bivenosa</i> over Open Hummock Grassland of <i>Triodia epactia</i>
2b	Acacia Low Scattered Shrubs	Low Scattered Shrubs of <i>Bonamia rosea</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> over Scattered Tussock Grasses of <i>Aristida holathera</i> , <i>Aristida inaequiglumis</i> and <i>Eriachne aristidea</i> over Scattered Hummock Grasses of <i>Triodia epactia</i>
3	Triodia Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia epactia</i> over Scattered Climbers of <i>Cassytha capillaris</i>
4a	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Shrubland of <i>Acacia hilliana</i> over Scattered Climbers of <i>Cassytha capillaris</i>

4b	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia ancistrocarpa</i> and <i>Bonamia rosea</i> with Low Open Woodland of <i>Corymbia zygomorpha</i> and <i>Erythrophleum chlorostachys</i>
4c	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia ancistrocarpa</i> and <i>Bonamia rosea</i> with Scattered Trees of <i>Corymbia zygomorpha</i>
5	Tracks	none

A total of twelve vegetation associations and nine broad floristic formations were described and mapped within the Yarrie Area A survey area:

1	<i>Eucalyptus</i> Woodland	Woodland of <i>Eucalyptus victrix</i> over High Open Shrubland of <i>Petalostylis labicheoides</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> over Low Shrubland of <i>Tephrosia rosea</i> var. <i>clementii</i> and <i>Corchorus</i> sp.
2	<i>Acacia</i> Open Scrub	Open Scrub of <i>Acacia colei</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Acacia elachantha</i> over Hummock Grassland of <i>Triodia epactia</i> with Low Open Woodland of <i>Corymbia flavescens</i> and <i>Corymbia hamersleyana</i>
3a	<i>Acacia</i> High Shrubland	High Shrubland of <i>Acacia colei</i> over Scattered Herbs of <i>Alternanthera nodiflora</i> and <i>Centipeda minima</i>
3b	<i>Acacia</i> High Shrubland	High Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia colei</i> and <i>Acacia pyrifolia</i> over Low Shrubland of <i>Tephrosia rosea</i> var. <i>clementii</i> , <i>Pluchea tetranthera</i> and <i>Melhantha oblongifolia</i> with Low Open Woodland of <i>Corymbia flavescens</i> and <i>Corymbia hamersleyana</i>
3c	<i>Acacia</i> High Shrubland	High Shrubland of <i>Acacia colei</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i> and <i>Grevillea pyramidalis</i> over Low Open Shrubland of <i>Pluchea tetranthera</i> over Hummock Grassland of <i>Triodia epactia</i>
4	<i>Acacia</i> Scattered Shrubs	Scattered Shrubs of <i>Acacia</i> spp. and <i>Grevillea</i> spp. over Low Scattered Shrubs of <i>Pluchea tetranthera</i> and Scattered Hummock Grassland of <i>Triodia epactia</i>
5	<i>Pluchea</i> Low Shrubland	Low Shrubland of <i>Pluchea tetranthera</i> over Open Hummock Grassland of <i>Triodia epactia</i> with an Open High Shrubland of <i>Acacia colei</i>
6	<i>Triodia</i> Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia epactia</i> with High Shrubland of <i>Acacia colei</i> , <i>Grevillea pyramidalis</i> and <i>Acacia elachantha</i> over Low Open Shrubland of <i>Pluchea tetranthera</i>
7a	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> with High Open Shrubland of <i>Grevillea pyramidalis</i> , <i>Acacia inaequilatera</i> and <i>Acacia colei</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i>
7b	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia epactia</i> with High Shrubland of <i>Grevillea wickhamii</i> subsp. <i>aprica</i>

8	Triodia Open Hummock Grassland	Open Hummock Grassland of <i>Triodia epactia</i> and <i>Triodia longiceps</i> with Low Open Shrubland of <i>Pluchea tetranthera</i> over Scattered Low Herbs of <i>Trianthema triquetra</i> and * <i>Portulaca oleracea</i>
9	Access Tracks, Haul Roads, Railway Lines and Mine Infrastructure	none

A total of eleven vegetation associations and nine broad floristic formations were described and mapped within the Yarrie Area B survey area:

1a	Acacia Open Scrub	Open Scrub of <i>Acacia tumida</i> , <i>Acacia colei</i> and <i>Acacia pyrifolia</i> over Open Hummock Grassland of <i>Triodia epactia</i> with Low Open Woodland of <i>Corymbia hamersleyana</i>
1b	Acacia Open Scrub	Open Scrub of <i>Acacia colei</i> , <i>Acacia tumida</i> and <i>Grevillea wickhamii</i> over Open Hummock Grassland of <i>Triodia epactia</i> with Low Open Shrubland of <i>Pluchea tetranthera</i>
2	Acacia Low Open Heath	Low Open Heath of <i>Acacia stellaticeps</i> over Hummock Grassland of <i>Triodia epactia</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i>
3	Low Scattered Shrubs	Scattered Shrubs over Scattered Hummock Grassland
4	Triodia Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia epactia</i> with High Shrubland of <i>Acacia tumida</i> , <i>Acacia colei</i> and <i>Acacia inaequilatera</i> over Low Open Shrubland of <i>Pluchea tetranthera</i>
5a	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> with High Open Shrubland of <i>Acacia inaequilatera</i> , <i>Grevillea pyramidalis</i> and <i>Grevillea wickhamii</i> with Scattered Shrubs of <i>Senna glutinosa</i> ssp. <i>glutinosa</i>
5b	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Shrubland of <i>Acacia ptychophylla</i> with Scattered High Shrubs of <i>Acacia colei</i> and <i>Acacia inaequilatera</i>
6	Triodia Open Hummock Grassland	Open Hummock Grassland of <i>Triodia epactia</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i> over Scattered High Shrubs of <i>Acacia tumida</i> , <i>Grevillea wickhamii</i> and <i>Acacia inaequilatera</i>
7	Marsilea Herbland	Herbland of <i>Marsilea hirsuta</i> with Scattered Sedges of <i>Cyperus vaginatus</i> with Scattered Hummock Grasses of <i>Triodia longiceps</i> and <i>Triodia epactia</i>
8	Cleared Tracks, Haul Roads and Mine Infrastructure	none
9	Waste Dumps	none

Field assessments confirmed that none of the vegetation associations described and mapped from the three survey areas was listed as a Threatened Ecological Community (TEC) or Priority Ecological Community (PEC).

The Level 1 fauna survey was completed between the same dates as the flora and vegetation survey (9th and 14th of September 2010) and recorded thirteen mammal species, 21 bird species and ten reptile species in four broad habitat types. Four fauna species of conservation significance recorded in the survey areas were:

- Northern Quoll (*Dasyurus hallucatus*);
- Western Pebble-mound Mouse (*Pseudomys chapmani*);
- Australian Bustard (*Ardeotis australis*); and
- Rainbow Bee-eater (*Merops ornatus*).

Old (no longer used) burrows that may belong to the *Crest-tailed Mulgara* (*Dasyercus cristicauda*) or *Brush-tailed Mulgara* (*Dasyercus blythi*) were also recorded.

Introduced fauna were recorded from tracks and scats and included Wild Dog (*Canis lupus*), Cat (*Felis catus*) Camel (*Camelus dromedaries*) and Cow (*Bos taurus*). The Introduced House Mouse (*Mus musculus*) would also occur in the area and is likely to be picked-up in a trapping regime.

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1.0 Introduction

1.1 Preamble

BHP Billiton Iron Ore Pty Ltd (BHPBIO) wishes to obtain Native Vegetation Clearing Permits (NVCP) for three separate areas at their Goldsworthy Mining Operations, located approximately 200 km east south-east of Port Hedland in the north-east Pilbara region of Western Australia (Figure 1).

In response to an invitation from BHPBIO, Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned to undertake a Level 2 flora and vegetation survey and Level 1 fauna survey¹ of the three survey areas required for expansion of the existing Shay Gap Aerodrome (referred to as the Shay Gap Aerodrome survey area), and two options for the development of a crushing area to replace the existing facility at Cattle Gorge (referred to as Yarrie Area A and Yarrie Area B survey areas).

1.2 Climate

The Yarrie and Shay Gap survey areas are situated in the north-east Pilbara region of Western Australia, which experiences an arid-tropical climate characterised by two distinct seasons. The majority of annual rainfall is received during the hot summer months from October to April. Summer and autumn rainfall is typically associated with cyclone activity and thunderstorms, with falls being of higher intensity and shorter duration contributing to an erratic annual range. Annual evaporation exceeds rainfall by as much as 2,500 mm per year. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses only flow briefly due to the short wet season. From May to September extensive cold fronts that develop off the south coast occasionally stray northwards into the Pilbara; these events are less frequent at Yarrie than in southern areas of the Pilbara. Rainfall associated with these fronts is relatively low.

Annual average rainfall for the Pilbara ranges from 180 mm to over 400 mm (Beard 1975), with the long-term average for Yarrie being 338 mm occurring over 35 rain days. Over 70% of total annual precipitation occurs between the four months from December to March. Diurnal maximum temperatures frequently exceed 40°C between December and March. The average maximum summer temperatures are typically in the range 35°C to 42°C, and winter maximum temperatures ranging between 22°C and 30°C.

Rainfall at Yarrie between January and October 2010 has been below average (218.8 mm for the ten months). Good summer rainfall occurred during the months of December 2009 (212.6 mm) and January 2010 (99.4 mm) with above average

¹ Biologic Environmental Survey was sub-contracted to complete the Level 1 fauna survey

winter rainfall received during the months of July 2010 (64.4 mm) and September 2010 (32.4 mm). However, the remaining seven months from February to October 2010 have experienced monthly rainfall totals below 11 mm (Figure 2).

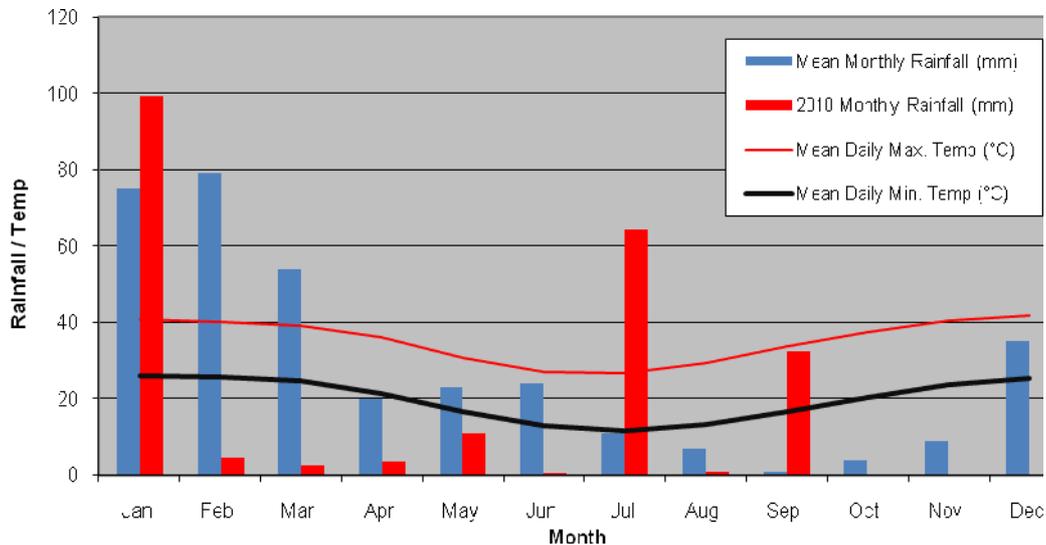


Figure 2 Climatic Data for Yarrie.

1.3 Biogeographic Regions

Thackway and Cresswell (1995) describe a system of 85 ‘biogeographic regions’ (bioregions) and 403 subregions covering the entire Australian continent. Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

The Pilbara biogeographic region includes four major components; Hamersley, Fortescue Plains, Chichester and Roebourne. The Shay Gap and Yarrie survey areas fall within the Roebourne sub-region which is described as:

- Quaternary alluvial plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia translucens* over *Triodia pungens*. Arid tropical with summer rain (Thackway and Cresswell 1995).

1.4 Existing Land Use

Land tenure in the Pilbara region consists of Aboriginal and leasehold reserves, national parks and reserves and crown land which fall under a range of pastoral and mining leases. The dominant landuses in the Pilbara are mining, pastoralism in the form of cattle grazing, conservation, unallocated crown land, crown reserves and urban areas (Kendrick 2001a).

The first mining exploration in the Pilbara commenced in the early 1800s and currently the Pilbara region provides the majority of WA’s petroleum, gas and iron

ore exports. Exploration and mining has occurred in the Yarrie area since the mid-1980's and continues in 2010.

The Yarrie Pastoral Station was established in the late 19th century and continues to graze cattle on native pastures in 2010. Pastoral leases in the Pilbara support cattle for domestic and export markets through the port at Port Hedland. In 2010 mining companies hold an increasing number of the pastoral leases in both region to ensure security of access to land adjacent to mines and infrastructure.

1.5 Landforms

For the Shay Gap Aerodrome survey area, two landforms were recorded:

- Drainage flats / zones; and
- Sandplains.

For the Yarrie Area A survey area, eight landforms were recorded:

- Major drainage lines;
- Minor drainage lines (three types);
- Drainage flats / zones;
- Sandy floodplains;
- Stony floodplains;
- Sandplains;
- Stony hill slopes; and
- Hill crests and slopes (dolerite).

For the Yarrie Area B survey area, six landforms were recorded:

- Medium drainage lines;
- Minor drainage lines;
- Waterhole and drainage zones;
- Stony plains;
- Stony sandplains; and
- Hill slopes and footslopes.

1.6 Geology

The Archaean geology of the Shay Gap and Yarrie survey areas comprises the exposed northern portions of the Muccan and Warrawagine batholiths, flanked by the supracrustal rocks belonging to the Warrawoona and Gorge Creek Groups (BHP 1995). The Yarrie mine site is located in an area that consists of Archaean banded iron formations (BIF) belonging to the Gorge Creek Group, with shallow iron enrichment in the crustal deposits. The stratigraphy of the Yarrie plateau is dominated by an elevated block of the Cleaverville Formation (BE) that has undergone several stages of deformation, overlying an intruded basement granitoid. Horizontally bedded Cretaceous sandstone and siltstone of the Callawa formation and a thin cover of Tertiary to Recent sediments occur sporadically throughout lowland areas. Dolerite dykes and sills are common but rarely have surface expression and are not extensive within the survey areas.

1.7 Land Systems

The Department of Agriculture has conducted an inventory and condition survey of the Pilbara (van Vreeswyk *et al.* 2004) using an integrated survey method involving the land system approach to rangeland description and evaluation. The primary objective of the survey was to provide comprehensive description and mapping of the biophysical resources of the region as well as an evaluation on the condition of soils and vegetation.

A total of 102 land systems were defined in the Pilbara at a scale of 1:250,000 (van Vreeswyk *et al.* 2004), with one land system overlapping the Shay Gap Aerodrome survey area (Nita Land System), two land systems represented across the Yarrie Area A survey area (Boolgeeda Land System and Talga Land System), and two land systems represented across the Yarrie Area B survey area (Boolgeeda Land System and Capricorn Land System, see Table 1 and Figure 3).

Table 1 Land Systems occurring within the Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B survey areas (descriptions from Van Vreeswyk *et al.* 2004).

Land system	Representation in the Pilbara	Description
Boolgeeda	7,748 km ² or 4.3%	Stony plains with hard spinifex grasslands or mulga shrublands. The geology is quarternary colluvium.
Capricorn	5,296 km ² or 2.9%	Hills and ridges of sandstone and dolemite supporting shrubby hard and soft Spinifex grasslands.
Nita	11,250 km ² or 6.2%	Sandplains supporting shrubby soft Spinifex grasslands with occasional trees.
Talga	2,124 km ² or 1.2%	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.

1.8 Flora and Vegetation

Historical systematic flora surveys in the Pilbara are limited to work completed by Burbidge (1959) and Beard (1975), and further refining of the original Beard mapping by Shepherd *et al.* (2002). Beard (1975) mapped vegetation of the Pilbara at a scale of 1:1,000,000. Vegetation within the Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B survey areas was mapped as two vegetation associations:

- *Eucalyptus leucophloia* (snappy gum) and *Triodia wiseana* (hard spinifex) tree steppe on the ranges (e₁₆Lr.t₃Hi); and
- *Acacia aneura* (mulga) low woodland continuous in the valleys (a₁Li).

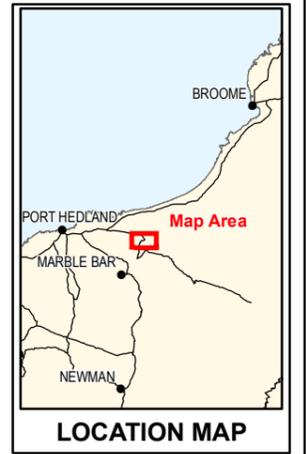
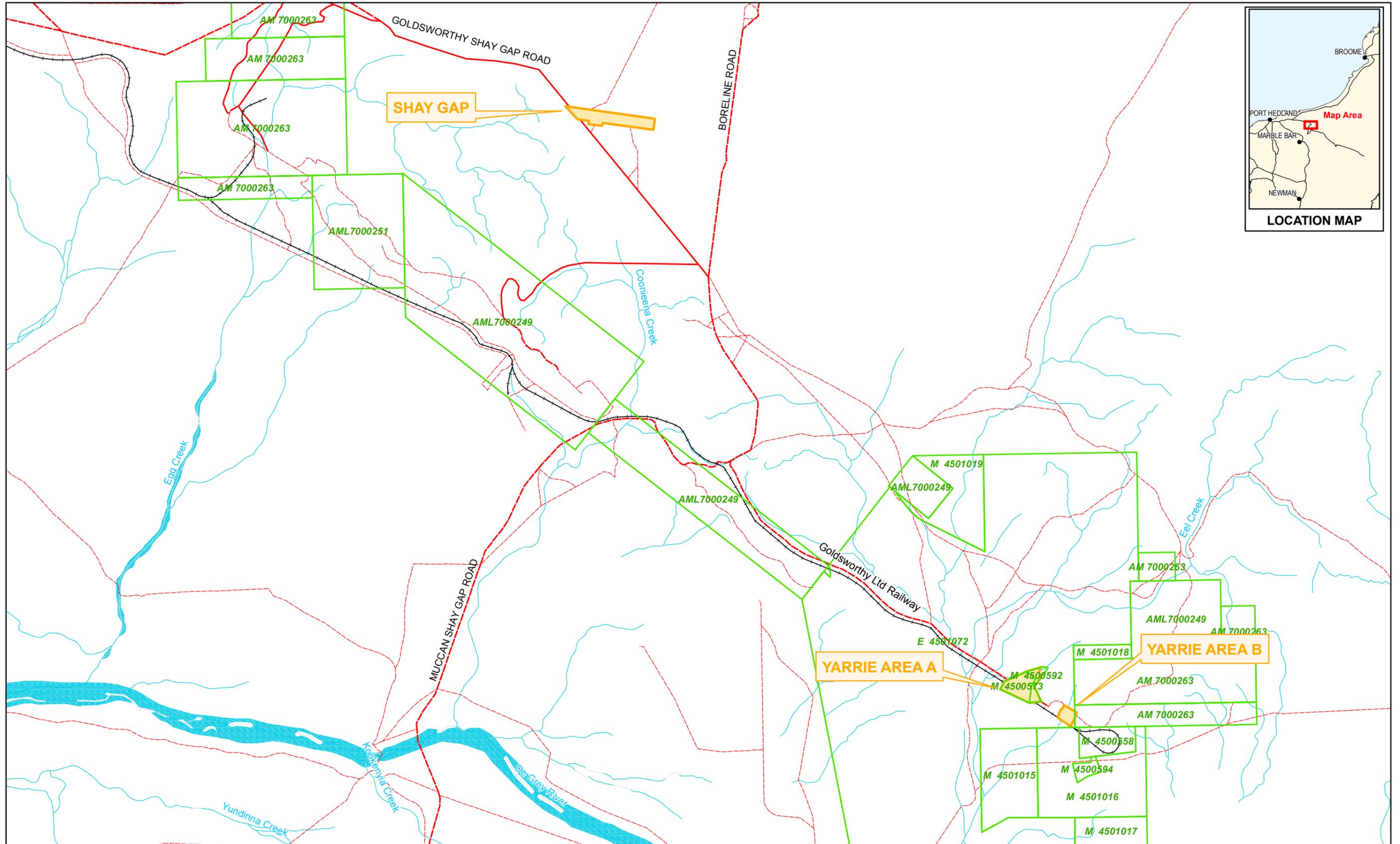
A comprehensive and systematic field review of the entire Pilbara's regional flora, fauna, aquatic life and ecosystems is currently in preparation by the Department of Environment and Conservation (DEC). The \$12.5 million biological survey has

included 800 study sites distributed across the entire Pilbara region between 2002 and 2007. The survey results have been published in parts between 2009 and 2010.

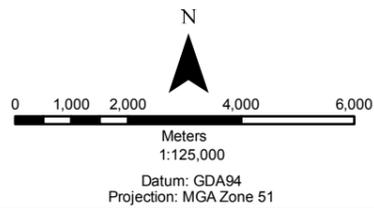
The resources boom in the Pilbara over the past decade has resulted in a significant number of site-specific biological surveys being completed as part of the formal environmental approvals process. These include:

- Callawa Biological Assessment (Ecologia 2005a);
- Cundaline Biological Assessment (Ecologia 2005b);
- Goldsworthy Extension Project Biological Assessment (Ecologia 2005c);
- Cundaline and Callawa Mining Operations Flora and Vegetation Assessment (ENV 2008);
- Yarrie Cattle Gorge Biological Survey (Ecologia 2004a);
- Nim B Extension Priority Flora Search (Ecologia 2004b);
- Yarrie Biological Survey (Ecologia 1999); and
- Yarrie Botanical Survey (Ecologia 1994)

These fine-scale surveys have contributed greatly to the identification of locally significant flora and fauna values.



ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	07/12/2010
Sheet Size:	A3	Status: Final
Drawn by GSM	Requested by DB	GSM Reference FIGURE 1



LOCATION MAP

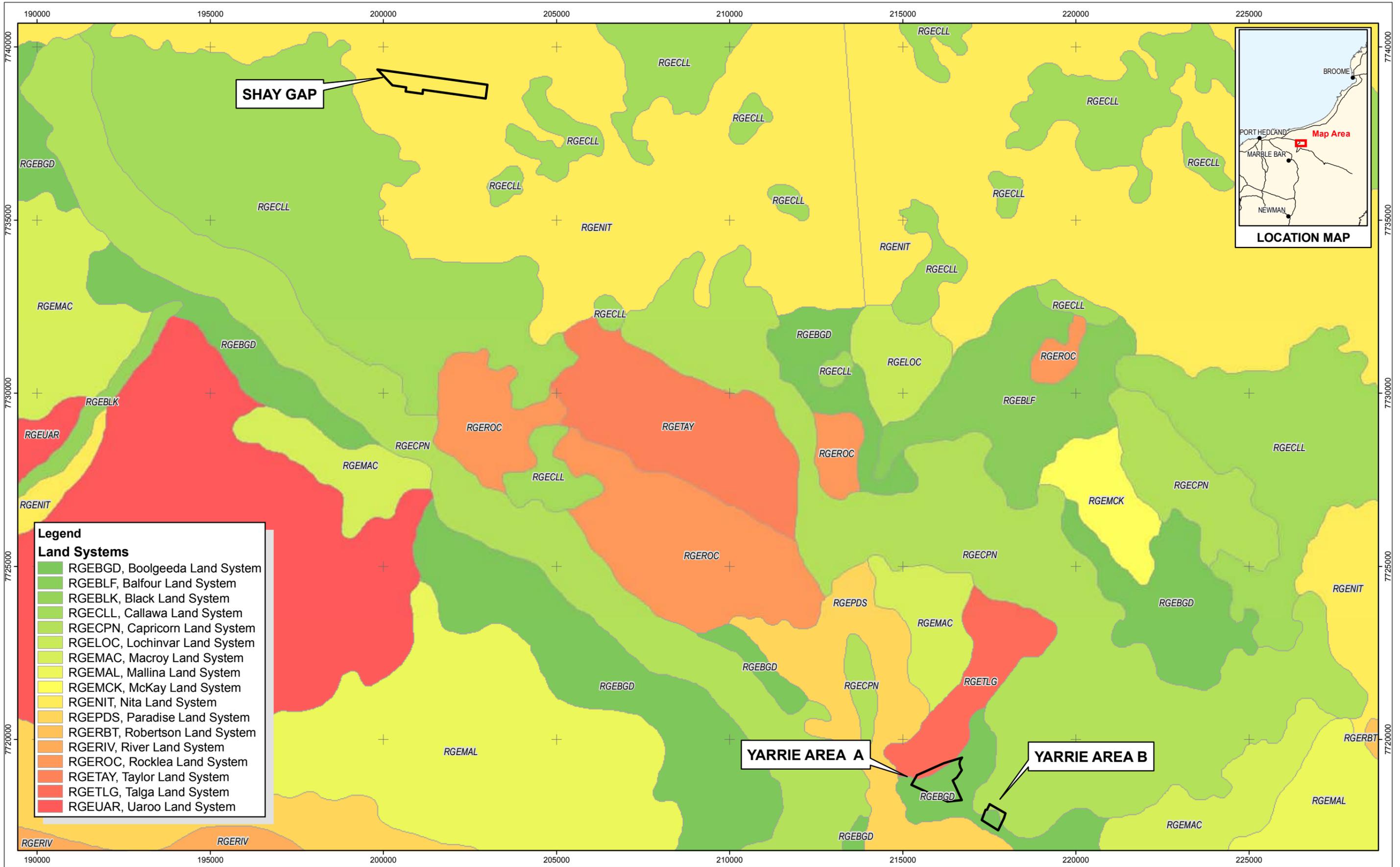
Shay Gap Aerodrome, Yarrie Area A & Yarrie Area B

Legend

- Survey Area
- Tenements - Live



2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213



- Legend**
- Land Systems**
- RGEBGD, Boolgeeda Land System
 - RGEBLF, Balfour Land System
 - RGEBLK, Black Land System
 - RGECLL, Callawa Land System
 - RGECPN, Capricorn Land System
 - RGELOC, Lochinvar Land System
 - RGEMAC, Macroy Land System
 - RGEMAL, Mallina Land System
 - RGEMCK, McKay Land System
 - RGENIT, Nita Land System
 - RGEPDS, Paradise Land System
 - RGERBT, Robertson Land System
 - RGERIV, River Land System
 - RGEROC, Rocklea Land System
 - RGETAY, Taylor Land System
 - RGETLG, Talga Land System
 - RGEUAR, Uaroo Land System

ON SHORE ENVIRONMENTAL CONSULTANTS

Date:	13/11/2010
Sheet Size:	A3
Status:	Final
Drawn by:	GSM
Requested by:	DB
GSM Reference:	FIGURE 3

N

0 500 1,000 2,000 3,000 4,000
Meters
1:100,000
Datum: GDA94
Projection: MGA Zone 51

LAND SYSTEMS

Shay Gap Aerodrome, Yarrie Area A & Yarrie Area B

Legend

□ Survey Area

Griffin Spatial & Mapping
2 Epacris Elbow Pelican Point
Bundary WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213

2.0 Objectives

2.1 Survey Tasks

The purpose of this report is to undertake a Level 2 flora and vegetation survey and Level 1 fauna survey of three survey areas in the Shay Gap / Yarrie area:

- Shay Gap Aerodrome survey area;
- Yarrie Area A survey area; and
- Yarrie Area B survey area.

2.2 Area Observations & Inferences

Observations and inferences of the three survey areas and their sensitivities are addressed in relation to the ten Clearing Principles, as specified in Schedule 5 of the *Environmental Protection Act 1986*. These include:

- 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 a 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.
- G. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.
- 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.
- 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 the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

2.3 Survey Deliverables

Key deliverables from the survey were to:

1. Complete a flora, vegetation and fauna database review for the three survey areas, including:
 - Threatened Flora and Fauna listed under the Commonwealth *EPBC Act* (EPBC 1999);
 - Declared Rare and Threatened Flora and Fauna listed under the *WA Wildlife Conservation (Rare Flora) Notice* and *WA Wildlife Conservation (Rare Fauna) Notice*;
 - Priority Flora and Fauna recognised by the DEC - as per current listing;
 - Threatened Ecological Communities (TECs) listed under State and Federal legislation; and
 - Priority Ecological Communities (PECs) recognised by DEC.
2. Provide a summary of previous flora and fauna surveys in the region.
3. Conduct a targeted survey of the proposed exploration area for:
 - Threatened Flora and Fauna listed under the Commonwealth *EPBC Act* (EPBC 1999);
 - Declared Rare and Threatened Flora and Fauna listed under the *WA Wildlife Conservation (Rare Flora) Notice* and *WA Wildlife Conservation (Rare Fauna) Notice*;
 - Priority Flora and Fauna recognised by Department of Environment and Conservation (DEC);
 - Other conservation significant flora and fauna;
 - Threatened Ecological Communities listed under the Commonwealth EPBC (1999);
 - Threatened Ecological Communities endorsed by the WA Minister of the Environment;
 - Priority Ecological Communities recognised by DEC; and
 - Declared weeds listed under the *Agriculture and Related Resources Protection Act, 1976* and other environmental weed species.
4. Provide a description of main vegetation associations present in each of the three survey areas, based on Specht as modified by Aplin & Trudgen classification system;
5. Prepare a vegetation association map for the three survey areas;
6. Preparation of a fauna habitat map for the three survey areas;
7. Describe the condition of the main vegetation associations at each of the three survey areas; and
8. Describe the representation in a regional context of each vegetation association.

3.0 Methodology - Flora

3.1 Background

3.1.1 Legislation and Guidance Statements

The flora and vegetation survey was designed to meet the requirements of the following State and Commonwealth legislation, and carried out in a manner that was compliant with EPA requirements for the environmental surveying and reporting of flora and vegetation in Western Australia:

- *Environmental Protection Act 1986 (WA)* (“EP Act 1986”);
- *Wildlife Conservation Act 1950 (WA)*;
- *EPBC Act 1999 (Cth)* (“EPBC Act 1999”);
- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No. 2* (EPA 2000);
- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002); and
- *EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51* (EPA 2004a).

There are two formal levels of flora survey delineated by the EPA:

- *Level One*: A ‘desktop’ study to collate historical knowledge conducted in conjunction with a reconnaissance survey (site inspection); and
- *Level Two*: An intensive survey that incorporates a detailed and comprehensive survey to characterise the flora present, combined with a Level One survey.

Where the scale and nature of the proposed impact is moderate to high, a Level 2 survey will be required in most areas of the State, and is typically required for resource development projects. The expectations of the EPA are set out in *Guidance Statement No. 51* (EPA 2004), which details the extent, design and intensity of field surveys for environmental assessments in Western Australia.

The high level of disturbance to the flora proposed for the Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B survey areas requires that a Level 2 flora and vegetation survey is completed. On the request of BHP Billiton, a one-season Level 2 survey was undertaken.

3.2 Desktop Searches

As part of the field survey, three desktop searches were undertaken for information relating to rare flora, Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) previously collected or described within, or in close proximity to, the survey areas. The database search was extended beyond the immediate survey limits to place flora values into a local and regional context. The search co-ordinates given were 20° 08’ - 21° 02’ S and 119° 49’ - 120° 43’ E

(GDA94) - a 50 km radial search of the Yarrie mine site. The State database search investigated three DEC databases:

1. The DEC Threatened (Declared Rare) Flora Data-base;
2. The DEC Declared Rare and Priority Flora List - this list contains species that are declared rare (Conservation Codes R, X), poorly known (Conservation Codes 1, 2, 3), or require monitoring (Conservation Code 4); and
3. The Western Australian Herbarium Specimen Database for priority species opportunistically collected in the area of interest.

The Federal database search investigated the EPBC database, and a third search was undertaken using the International Union for Conservation of Nature (IUCN) database.

3.3 Survey Methodology

3.3.1 Field Assessment

Prior to the field survey a variety of topographic, vegetation, and land system maps were used to provide preliminary vegetation classification across the three survey areas. The survey comprised a six day effort by one qualified Senior Botanist, Dr Jerome Bull, to ground truth the three survey areas, record identifiable changes in vegetation composition and structure, collect voucher specimens, and assess vegetation classification. The field survey was undertaken from the 9th to 15th September 2010.

Vegetation type, life-form strata, percentage cover, surface soil type, litter cover and disturbance details were recorded intensively from a total of 48 sites. At each sampling site flora and vegetation occurring within 50 m x 50 m quadrats was assessed in detail. Description of vegetation structure follows the height, life form and density classes of Specht as modified by Aplin & Trudgen (see Appendix 1). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account. Vegetation condition for each of the 48 sampling sites was determined using a recognised rating scale (based on Keighery 1994, see Appendix 2).

At least one voucher specimen was taken for each species collected to verify identification. Specimen identifications were confirmed at the State Herbarium by Dr Jerome Bull. Use was made of the Western Australian State Herbarium for confirmation of species identification. Nomenclature follows Green (1985 & 1987), Paczkowska and Chapman (2000) and the Western Australian Herbarium.

3.3.2 Field Survey Constraints

The EPA Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004) list twelve potential constraints that field surveys may encounter. These constraints are addressed in Table 2.

Table 2 Relevance of constraints, as identified by EPA (2004), to the Yarrie flora and vegetation survey.

Constraint	Relevance
Scope	The scope was established by BHP Billiton and is in compliance with relevant EPA Guidance Statements.
Proportion of flora collected and identified	The single season survey of the three relatively small survey areas by Onshore Environmental in September 2010 recorded 165 plant taxa, which is in line with species richness levels recorded from larger historical survey areas - Yarrie Biological and Soil Survey (206 taxa), Cattle Gorge (126 taxa), Nimingarra (183 taxa), Sunrise Hill (201 taxa), Callawa (147 taxa) and Cundaline (193 taxa).
Sources of information	A number of historical flora and vegetation surveys have been completed at Yarrie and neighbouring localities in recent years (see Section 1.8). These survey records provide excellent background data for the site, and also provide a good regional context.
The proportion of the task achieved & further work which might be needed	The three survey areas were relatively small and were able to be extensively ground truthed, providing a high probability that all plant taxa present were recorded.
Timing / weather / season / cycle	A single-season survey was completed in September 2010. Rainfall at Yarrie between January and October 2010 was below average totaling 218.8 mm. Good summer rainfall occurred during the months of December 2009 (212.6 mm) and January 2010 (99.4 mm) with above average winter rainfall received during the months of July 2010 (64.4 mm) and September 2010 (32.4 mm).
Disturbances, e.g. fire, flood	Localised areas were impacted by wildfire but large proportions of all three survey areas remained long unburnt. The major disturbances encountered resulted from grazing by domestic stock, and edge effects along cleared access tracks and haul roads.
Intensity	The entire study area was ground truthed as part of targeted searches and vegetation mapping. A total of 48 study sites were established along with numerous releve plots to ensure appropriate sampling within vegetation associations described.
Completeness	Results are provided from a single season flora and vegetation survey. A second season survey would increase completeness of the survey. However, species richness was within the expected range when compared to previous surveys completed over larger areas.
Resources	Appropriate resources were applied to the survey, with a Senior Botanist spending six field days between the three small survey areas.
Access problems	The entire study area was able to be accessed on foot from established access tracks and roads.
Availability of contextural information	A number of flora and vegetation surveys have previously been completed at Yarrie and surrounding satellite ore bodies. This data provides an extensive local and regional datadase.
Experience levels	A Senior Botanist with over 10 years Pilbara experience completed the field assessments. He has completed numerous surveys at, and in close proximity to Yarrie and is very familiar with flora and vegetation of the Pilbara.

3.3.3 Assessment of Conservation Significance

The conservation significance of flora and ecological communities are classified on a Commonwealth, State and Local level on the basis of various Acts and Agreements (EPA *Guidance Statement No. 51*, EPA 2004).

Commonwealth Level:

- *EPBC Act 1999:* The Department of the Environment, Water, Heritage and the Arts (DEWHA) lists Threatened Flora and Ecological Communities, which are determined by the Threatened Species Scientific Committee according to criteria set out in the Act (DEWHA 2006). The Act lists flora that are considered to be of conservation significance under one of six categories (Appendix 3).

State Level:

- *Wildlife Conservation Act 1950:* At a State level, native flora species are protected under the *Wildlife Conservation Act 1950 - Wildlife Conservation (Rare Flora) Notice*. A number of plant species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations. Species of the highest conservation significance are gazetted Declared Rare Flora (DRF) under subsection 2 of section 23F of the *Wildlife Conservation Act 1950*. It is an offence to take or damage DRF without Ministerial approval. Section 23F of the *Wildlife Conservation Act (1950)* defines 'to take' as "to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means".
- *DEC Priority list:* DEC produces a list of Priority species and ecological communities (PEC's) that have not been assigned statutory protection under the *Wildlife Conservation Act 1950*. Priority Flora are under consideration for declaration as 'Rare Flora', classified as in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four, see Appendix 4). The list of Priority Ecological Communities identifies those that need further investigation before nomination for Threatened Ecological Community status.

Local Level:

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally protected by legislation, such species are acknowledged to be in decline as a result of threatening processes, primarily habitat loss through land clearing.

4.0 Methodology - Fauna

4.1 Background

4.1.1 Legislation and Guidance Statements

The level 1 fauna survey was designed to meet the requirements of the following State and Commonwealth legislation, and carried out in a manner that was compliant with EPA requirements for the environmental surveying and reporting in Western Australia:

- *Environmental Protection Act 1986 (WA)* (“EP Act 1986”);
- *Wildlife Conservation Act 1950 (WA)* (“WC Act 1950”);
- *EPBC Act 1999 (Cth)* (“EPBC Act 1999”);
- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No. 2* (EPA 2000);
- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002); and
- *EPA Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56* (EPA 2004).

The conservation significance of fauna is classified on a Commonwealth, State and Local level on the basis of various Acts and Agreements (*EPA Guidance Statement No. 56*, EPA 2004).

Commonwealth Level:

- *EPBC Act 1999*: DEWHA lists Threatened fauna, which are determined by the Threatened Species Scientific Committee according to criteria set out in the Act (DEWHA 2006). The Act lists fauna that are considered to be of conservation significance under one of six categories (Appendix 5).

State Level:

- *Wildlife Conservation Act 1950*: At a State level, native fauna species are protected under the *Wildlife Conservation Act 1950*. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.
- DEC Priority list: DEC produces a list of Priority species and ecological communities (PEC’s) that have not been assigned statutory protection under the *Wildlife Conservation Act 1950*. This system is a ranking from Priority 1 to Priority 4.

Local Level:

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally protected by legislation, such species are acknowledged to be in decline as a result of threatening processes, primarily habitat loss through land clearing.

4.2 Survey Methodology

4.2.1 Field Assessment

The field survey took place from the 9th to the 15th of September 2010 by an experienced zoologist. Opportunistic records of vertebrate species encountered during the vegetation and flora survey or while travelling around site were also documented. Habitat assessments were undertaken to determine the quality of available fauna habitat and the likelihood of habitat to support species of conservation significance. Where habitat existed for threatened species identified in the desktop review, targeted species transects were undertaken to determine their likely presence in the project area and the value of this habitat to support significant populations.

Habitat Assessment

Habitats in the survey areas were assessed using methodology and terminology adapted from the Australian Soil and Land Survey Field Handbook (CSIRO 2009) and modified to suit the survey requirements. The characteristics recorded during the habitat assessments were:

- Site information, photo and location;
- Landform: slope, relative inclination of slope, morphological type, landform type;
- Vegetation: disturbance, condition, leaf litter %, twig litter %, wood litter (per 2500m²), dead stags (per 2500m²), hollow bearing trees (per 2500m²), broad floristic formation, tree structure (tall, mid and low), shrub structure (tall, mid and low), grass structure (tall, mid and low), dominant trees, shrubs, grasses and herbs;
- Land surface: microrelief, sheet erosion, rill erosion, gully erosion, gully depth, abundance and size of coarse fragments, rock outcropping, waterbodies, comments on nests, burrows, roosts and diggings;
- Soil: texture, colour, water status, strength; and
- Substrate: substrate form, rock type, comments on geology.

Fauna habitats were assessed for their conservation significance and the likelihood that they support conservation significant fauna.

Targeted Species Transect

Targeted transects were undertaken to determine the presence of significant fauna in the survey areas. Transects were placed approximately 50 m apart to adequately to cover the area. All signs (scats, burrows) and individuals encountered while conducting transects were recorded.

Birds

Birds were recorded on a presence/absence basis and were targeted during early morning transects. Presence was determined by call identification, visual identification and/or tracks and traces. Binoculars and scopes were used to determine species and to investigate potential nesting sites on distant rock faces.

Bats

One anabat unit was used to record the ultrasonic calls of bat species. Three anabat nights were conducted during the survey and were analysed by Mr Bob Bullen.

Reptiles

Opportunistic reptile encounters were recorded during transects. Habitat encountered during targeted species transects that were likely to contain reptiles were searched. This included looking under bark, under rocks, in wood hollows and in rock cracks and overhangs. No habitat was disturbed.

Opportunistic Records

Records of all vertebrate fauna species were made throughout the survey area. Secondary evidence was also used to determine the presence of certain species, e.g. burrows and scats.

Nomenclature

The taxonomy and nomenclature used in this report follows that used by the WA Museum (WAM 2009), except for birds which follow the taxonomy reviewed by Christidis and Boles (2008) and adopted for use by Birds Australia.

4.2.2 Field Survey Constraints

The Level 1 fauna survey did not include pit or cage trapping, only opportunistic records of species encountered. The survey was undertaken by an experienced Zoologist that has previous experience with the significant species of the area. Many previous surveys have taken place in the general area providing supporting information to the current survey. The survey was completed in full and was not interrupted by any events.

4.2.3 Desktop Survey

A desktop review was undertaken of all available published and unpublished reports and databases relevant to the survey area. The following databases and reports were accessed to obtain potential species lists for the project area:

- Department of the Environment, Water, Heritage and the Arts (DEWHA) Protected Matters database (SPRAT, 2009) - to identify species listed under the *EPBC Act 1999* (EPBC Act) potentially occurring within the project area;
- WA Museum's and DEC's NatureMap - to identify species listed under the *Wildlife Conservation Act 1950*, or those species listed as Priority by the DEC, that have previously been recorded within or adjacent to the project area. This database draws upon the same data as the DEC's Threatened Fauna database.

Past reports that were reviewed for this survey include:

- Yarrie Biological & Soil Survey (Ecologia 1999);
- Goldsworthy Extension Project Biological Assessment Survey (Ecologia 2005);
- Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey (Ecologia 2005);
- Goldsworthy Iron Ore Mining Operations - Cundaline and Callawa Mining Operations; Targeted Fauna Assessment (Outback Ecology Services 2008).

5.0 Results - Flora & Vegetation

5.1 Desktop Review

5.1.1 Database Searches

A search for rare flora previously collected or identified from a 50 km radius surrounding the Yarrie mine site was undertaken utilising databases maintained by IUCN, EPBC and DEC (Table 3). There were no records identified from either of the three database searches.

The State DEC search identified thirteen Priority flora species (Table 3). There were no DRF identified from the database searches.

Table 3 Rare flora previously recorded from a 50 km search radius around the Shay Gap and Yarrie survey areas.

SCC - State Conservation Code (*Wildlife Conservation Act 1999*) and DEC (2008)
 FCC - Federal Conservation Code (*EPBC Act 99*)
 IUCN - 2008 Red List of Threatened Species

Species	SCC	FCC	IUCN
<i>Desmodium pullenii</i>	1		
<i>Eremophila maculata</i> subsp. <i>filifolia</i>	1		
<i>Euphorbia clementii</i>	2		
<i>Euryomyrtus patrickiae</i>	3		
<i>Fimbristylis</i> sp. Shay Gap (KR Newbey 10293)	1		
<i>Goodenia hartiana</i>	2		
<i>Heliotropium murinum</i>	3		
<i>Heliotropium parviantrum</i>	1		
<i>Indigofera ammobia</i>	3		
<i>Phyllanthus aridus</i>	3		
<i>Rostellularia adscendens</i> var. <i>latifolia</i>	3		
<i>Tephrosia bidwillii</i>	3		
<i>Vigna</i> sp. Central (M.E. Trudgen 1626)	2		

5.1.2 Previous Surveys in the Shay Gap / Yarrie Area

Yarrie Biological and Soil Survey (Ecologia 1999)

The Yarrie Biological and Soil Survey (Ecologia 1999) occurred over a 36 km² study area that included the Yarrie mine site, open-cut mine areas and associated infrastructure including waste dumps, haul roads, workshops and accommodation village.

The vegetation was classified into twelve vegetation associations:

1. Calcrete baseplains: Scattered *Corymbia hamersleyana* over sparse *Acacia inaequilatera* / *Grevillea pyramidalis* and sparse to moderately dense *Triodia wiseana*;
2. *Triodia wiseana* steppe;
3. Steep rocky slopes: Sparse emergents over open *Triodia pungens* / *T. wiseana*;

4. *Triodia pungens* dominated steppes;
5. Open density emergents over moderately dense *Triodia pungens*;
6. *Triodia basedowii* steppes;
7. Low rocky slopes: Sparse mixed shrubs over sparse *Triodia pungens*;
8. Gullies: Sparse *Eucalyptus leucophloia* and other Eucalypts over *Acacia tumida*, mixed soft grasses and *Triodia pungens*;
9. Minor drainage lines: Open to dense *Acacia tumida* over *Triodia pungens*;
10. Major drainage lines: *Eucalyptus camaldulensis* / *E. victrix* over sparse to moderately dense tall shrubs and mixed soft grasses and spinifex;
11. Minor spring: Dense *Sesbania formosa* over dense *Cyperus vaginatus*;
12. Sandplain: Sparse *Corymbia hamersleyana* / *Eucalyptus candida* ms over *Indigofera monophylla* and mixed shrubs and *Ipomoea muelleri*.

A total of 209 plant taxa were recorded from the Yarrie study area originating from 47 families and 105 genera, 67 of which were represented by a single taxon. The most frequently represented families were Poaceae (30 taxa), Papilionaceae (22 taxa), Mimosaceae (16 taxa), Malvaceae (12 taxa) and Myrtaceae (11 taxa). The total flora included four introduced taxa (2 % of all taxa collected) with the most widely distributed being **Cenchrus ciliaris*, which was common within Eel Creek and Chinaman's Creek. Three other species, **Vachellia farnesiana*, **Aerva javanica* and **Chloris gayana* were all localised in their distribution and present at low density. None of the weed species are gazetted within the current schedule published by the Agricultural Protection Board. No DRF were collected within the Yarri survey area. One Priority 2 species (*Euphorbia clementii*) and one Priority 3 species (*Euphorbia inappendiculata*) were collected. *Euphorbia clementii* and *Euphorbia inappendiculata* were observed from four and three locations respectively widely scattered on the spinifex steppes of the Yarrie plateau and northern and southern baseplains. Both species were present in both disturbed (either cleared or recently burnt) and undisturbed habitats.

Goldsworthy Extension Project -Biological Assessment Survey (Ecologia 2005c)

The Goldsworthy Extension Project examined the potential development of the Goldsworthy mine sites and associated infrastructure within the Pilbara, from Yarrie to Port Hedland. Specifically, the following sites were included in the investigation:

1. Yarrie
2. Cattle Gorge
3. Nimingarra
4. Sunrise Hill

Yarrie

The vegetation within the Yarrie survey area was classified into twelve vegetation associations:

1. Scattered *Corymbia hamersleyana* over sparse *Acacia inaequilatera* / *Grevillea pyramidalis* subsp. *pyramidalis* and sparse to moderately dense *Triodia wiseana* on calcrete baseplains;
2. *Triodia wiseana* steppes;
3. Sparse emergents over open *Triodia epactia*/*T. wiseana* on steep rocky slopes;
4. *Triodia epactia* dominated steppes;
5. Open density emergents over moderately dense *Triodia epactia*;
6. *Triodia basedowii* steppes;
7. Sparse mixed shrubs over sparse *Triodia epactia* on low rocky slopes;
8. Sparse *Eucalyptus leucophloia* and other *Eucalyptus* spp. over *Acacia tumida* var. *pilbarensis*, mixed soft grasses and *Triodia epactia* on gullies;
9. Open to dense *Acacia tumida* var. *pilbarensis* over *Triodia epactia* on major drainage lines;
10. *Eucalyptus camaldulensis*/*E. victrix* over sparse to moderately dense tall shrubs and mixed soft grasses and spinifex;
11. Dense *Sesbania formosa* over dense *Cyperus vaginatus* on minor spring;
12. Sparse *Corymbia hamersleyana*/*Eucalyptus candida* ms over *Indigofera monophylla* and mixed shrubs and *Ipomoea muelleri* on sandplains.

A total of 209 plant taxa from 47 families and 105 genera was recorded. The most frequently represented families were Poaceae (30 taxa), Papilionaceae (22 taxa), Mimosaceae (16 taxa), Malvaceae (12 taxa) and Myrtaceae (11 taxa). The genera represented by the greatest number of taxa were *Acacia* (16 taxa), *Eucalyptus*, *Ptilotus*, and *Eriachne* (all with six taxa) and *Triodia*, *Cyperus*, *Senna*, *Euphorbia*, *Solanum* and *Goodenia* (all with five taxa). The most widely distributed taxa within the sites were *Grevillea wickhamii* ssp. *aprica*, *Acacia ptychophylla*, *Acacia inaequilatera*, *Corymbia hamersleyana* and *Acacia tumida* var. *pilbarensis*. No species of Threatened Flora as listed in the *Environment Protection and Biodiversity Act 1999* (EPBC Act) or DRF as listed in the Department of Conservation and Land Management *Wildlife Conservation (Rare Flora) Schedule* were collected. One Priority 2 species, *Euphorbia clementii*, and one Priority 3 species *Euphorbia inappendiculata* were collected. Four introduced species were recorded from within the Yarrie survey area, of which **Cenchrus ciliaris* was the most widely distributed along Eel Creek and Chinaman's Creek. **Aerva javanica* was recorded at low densities within *Triodia wiseana* dominated base plains and the weedy native **Vachellia farnesiana* was also recorded at low densities within Eel Creek. **Chloris gayana* was recorded from a single location near the site office. None of these species are Gazetted Declared Weeds as listed by the Agriculture Protection Board.

Cattle Gorge

There were seven vegetation associations described and mapped from the Cattle Gorge survey area:

1. Open to scattered *Grevillea wickhamii* tall shrubland, over *Acacia tumida* var. *pilbarensis*/*Tephrosia spechtii* medium shrubs, over moderately dense *Triodia epactia* hummock steppe on hill crests and gentle slopes;
2. Moderately dense *Grevillea wickhamii* tall shrubland, over *Acacia tumida* var. *pilbarensis*, often with scattered *Corymbia hamersleyana* low trees, over moderately dense *Triodia epactia* hummock steppe along moderate to gentle gullies and hill slopes;
3. Scattered *Grevillea pyramidalis* subsp. *pyramidalis* / *Acacia pyrifolia* / *Senna glutinosa* subsp. *glutinosa* tall to medium shrubs, over sparse medium to low shrubs, over *Acacia ptychophylla* dwarf shrubs, over open to moderately dense *Triodia wiseana* hummock steppe on steep scarp slopes;
4. Moderately dense to dense *Acacia tumida* var. *pilbarensis* tall shrubland, over sparse to scattered medium / low shrubs, over soft grasses such as *Cymbopogon ambiguus*, over open to sparse *Triodia epactia* hummock grassland at rocky outcrops on steep upper scarp slopes;
5. Scattered *Eucalyptus leucophloia* with scattered *Corymbia hamersleyana* or *Grevillea wickhamii* subsp. *aprica*, over *Acacia spondylophylla* with open to moderately dense *Triodia epactia* / *Triodia wiseana* on moderately steep hill slopes;
6. Scattered *Acacia inaequilatera*/*Grevillea pyramidalis* low trees, sometimes with *Corymbia hamersleyana* low trees, over scattered *Grevillea wickhamii* ssp. *aprica* / *Acacia ptychophylla*, and other medium to low shrubs, over moderately dense *Triodia wiseana* / *Triodia wiseana* hummock steppe; and
7. Scattered *Acacia inaequilatera*, sometimes with *Corymbia hamersleyana* or *Corymbia flavescens* low trees, over scattered mixed *Acacia* species as medium to low shrubs, over moderately dense *Triodia wiseana* hummock steppe on gentle lower hill slopes.

The flora recorded included 126 plant taxa of which 23 families, 33 genera and 82 species were recorded for the Cattle Gorge area, and 24 families, 44 genera and 71 species were recorded for the proposed Rail Corridor. The most frequently represented families were Mimosaceae (17 taxa), Poaceae (15 taxa), Malvaceae (13 taxa), Tiliaceae (12 taxa) and Papilionaceae (11 taxa). No species of Threatened Flora as listed in the EPBC Act or DRF as listed in the DEC Rare Flora List were collected during the flora and vegetation survey of the Cattle Gorge area. In addition, there were no Priority flora species found during the survey of the Cattle Gorge area. The flora survey of Cattle Gorge showed no record of any weed species. However, along the Cattle Gorge Rail Corridor *Malvastrum americanum* was recorded as uncommon.

Nimingarra and Sunrise Hill

The vegetation types within the combined survey areas at Nimingarra and Sunrise Hill are categorised broadly as forest, woodland, and shrubland, and then further categorised into a number of sub-communities listed below:

A) Forest

- A1. *Melaleuca argentea* / *Eucalyptus victrix* dense to moderately dense tall to medium forest, over *Atalaya hemiglauca* / *Ficus brachypoda* / *Ficus opposita* var. *indecora* low trees, over *Typha domingensis* rushes, over *Cyperus vaginatus* sedgeland;
- A2. *Corymbia hamersleyana* and / or *Corymbia flavescens* and / or *Eucalyptus victrix* moderately dense to scattered medium forest to woodland, sometimes with *Melaleuca argentea*, over *Acacia tumida* var. *pilbarensis* / *Acacia colei* var. *colei* tall to low shrubland, often over *Bonamia pannosa*, *Trachymene oleracea*, *Waltheria indica* herbs, sometimes with *Cyperus* spp. Sedges; and
- A3. *Ficus virens* dense medium forest over *Ficus brachypoda* over *Atalaya hemiglauca* / *Corymbia flavescens* open low trees over *Ficus opposita* var. *indecora* / *Grevillea pyramidalis* subsp. *pyramidalis* over *Tinospora smilacina*.

B) Woodland

- B1. *Eucalyptus leucophloia* medium woodland over mixed shrubs such as *Senna glutinosa* subsp. *glutinosa* / *Acacia inaequilatera* / *Acacia adoxa* var. *adoxa* / *Indigofera monophylla* (small calyx form) over *Triodia epactia* hummock;
- B2. *Acacia ampliceps* / *Sesbania formosa* / *Corymbia hamersleyana* open medium trees over *Ficus opposita* var. *indecora* over *Typha domingensis* rushes over *Cyperus vaginatus* sedges;
- B3. *Corymbia hamersleyana* scattered low woodland over *Grevillea wickhamii* subsp. *aprica* medium shrubs over *Corchorus* aff. *parviflorus* (2) sparse low shrubs over *Acacia hilliana* dwarf shrubs over *Triodia epactia* open hummock grassland on cream / brown / pale yellow sandy clay with gravel on undulating plains.
- B4. *Corymbia hamersleyana* / *Corymbia flavescens* low trees over mixed *Acacia* spp. and other shrubs over *Acacia adoxa* var. *adoxa* / *Indigofera monophylla* (small calyx form) / *Bonamia rosea* / *Tephrosia* sp. Bungaroo Creek (M.E.Trudgen 11601) / *Bonamia linearis* / *Isotropis atropurpurea* over *Triodia epactia* hummock grassland on sand to clayey sand plain;
- B5. *Corymbia hamersleyana* scattered low trees, often found with *Eucalyptus odontocarpa* mallee over *Acacia tumida* var. *pilbarensis* open tall shrubland, over *Templetonia hookeri* over *Pterocaulon sphaeranthoides*, *Acacia adoxa* var. *adoxa* over *Triodia epactia* hummock grass on broad gullies and minor channels;
- B6. *Eucalyptus leucophloia* / *Grevillea pyramidalis* subsp. *pyramidalis* scattered low trees / medium shrubs over *Acacia colei* var. *colei* and *Solanum horridum* medium / low shrubs over *Triodia epactia* hummock grassland;
- B7. *Acacia inaequilatera* scattered low trees with or without *Corymbia hamersleyana* over *Grevillea* subsp. *aprica*, over *Acacia hilliana* / *Acacia adoxa* var. *adoxa* dwarf shrubs over *Triodia epactia* open to moderately dense hummock grassland;
- B8. *Acacia inaequilatera* low trees over *Grevillea wickhamii* subsp. *aprica* medium shrubs over *Acacia ptychophylla* over *Triodia epactia* hummock grassland on scarp plateaux;

- B9. *Acacia inaequilatera* scattered low trees, over *Acacia* sp. Ruddall River (B.R.Maslin 2046A) scattered medium shrubland over *Triodia epactia* moderately dense hummock grassland steppe with *Acacia pyrifolia* and *Eucalyptus leucophloia* on gentle slopes to gravel plains;
- B10. *Acacia inaequilatera* scattered low trees, over *Grevillea wickhamii* var. *aprica* / *Acacia tumida* var. *pilbarensis* / *Grevillea pyramidalis* subsp. *pyramidalis* / *Dodonaea coriacea* / *Ptilotus calostachyus*, over *Acacia hilliana* sparse dwarf shrubland, over *Bonamia media* var. *villosa* / *Goodenia stobbsiana* / *Fimbristylis simulans* over *Triodia epactia* moderately dense hummock grassland; and
- B11. *Ficus brachypoda* or *Ficus virens* low trees over *Atalaya hemiglauca* over *Jasminum didymum* over *Triumfetta maconochieana* over *Nicotiana benthamiana*, *Pterocaulon sphaeranthoides* herbs.

C) Shrublands

- C1. *Acacia tumida* var. *pilbarensis* scattered to sparse tall to low shrubland with or without *Corymbia hamersleyana* / *Grevillea wickhamii* subsp. *aprica* over *Acacia hilliana* / *Acacia adoxa* dwarf shrubs over *Triodia epactia* open to moderately dense hummock grassland;
- C2. *Acacia orthocarpa* sparse to scattered tall / medium shrubland with *Acacia inaequilatera* over sparse to scattered *Acacia adoxa* var. *adoxo* / *Acacia hilliana* dwarf shrubs over *Triodia epactia* open to moderately dense hummock grassland;
- C3. *Acacia tumida* var. *pilbarensis* / *Acacia colei* var. *colei* tall to low shrubland, over *Acacia inaequilatera* / *Acacia pyrifolia* over *Ptilotus calostachyus* often over *Salsola tragus* over *Aristida contorta*, *Aristida holathera* / *Cymbopogon ambiguus* grasses over *Ipomoea muelleri* / *Mukia maderaspatana* lianas over *Triodia epactia* / *Triodia lanigera* / *Triodia wiseana* hummock grass;
- C4. Mixed medium to tall shrubland including *Tephrosia spechtii* over *Acacia adoxa* var. *adoxo* / *Acacia hilliana* sparse to moderately dense dwarf shrubland over sparse to open *Triodia epactia* hummock grassland;
- C5. Mixed medium shrubs over *Acacia inaequilatera* low shrubs or *Acacia adoxa* var. *adoxo* dwarf shrubs over *Indigofera monophylla* (small calyx form) / *Corchorus* aff. *parviflorus* / *Bonamia media* var. *villosa* over *Triodia epactia* or *Triodia wiseana* hummock grassland;
- C6. *Grevillea wickhamii* subsp. *aprica* open to scattered medium - low shrubland usually with *Corymbia hamersleyana* low trees over *Acacia adoxa* var. *adoxo* dwarf shrubland over *Triodia epactia* open hummock grassland;
- C7. *Acacia inaequilatera* scattered medium shrubland over *Acacia stellaticeps* / *Acacia hilliana* / *Acacia adoxa* var. *adoxo*, *Acacia* sp. Ruddall River (B.R. Maslin) / *Acacia tumida* var. *pilbarensis* / *Ptilotus calostachyus* over *Triodia epactia* moderately dense hummock grassland;
- C8. *Acacia ptychophylla*, *Acacia ancistrocarpa*, *Acacia pyrifolia*, *Grevillea wickhamii* subsp. *aprica* scattered low shrubland over *Dodonaea coriacea*, *Acacia colei* var. *colei* dwarf shrubs over *Triumfetta maconochieana* over *Triodia wiseana* moderately dense hummock grassland;
- C9. *Melaleuca glomerata* sparse medium shrubland with *Ficus opposita* var. *indecora*, over *Typha domingensis* rushes over *Cyperus vaginatus* sedges over *Flaveria australasica* herbs; and

C10. Mixed shrubs including *Triumfetta* spp. over *Trachymene oleracea* over *Evolvulus alsinoides* var. *villosicalyx* over *Bulbostylis barbata* over *Triodia epactia* / *Triodia wiseana* hummock spinifex steppe.

A total of 183 distinct flora taxa, from 41 families and 149 genera were recorded from the Nimingarra survey area. The plant families that recorded the highest number of species were: Poaceae (23 taxa), Mimosaceae (19 taxa), Papilionaceae (19 taxa), Malvaceae (13 taxa) and Amaranthaceae (11 taxa). The genera with the most species recorded were *Acacia* (19 taxa), *Sida* and *Ptilotus* (eight taxa each), *Tephrosia* (eight taxa), and *Eriachne* and *Solanum* (five taxa each).

A total of 201 distinct flora taxa, from 45 families and 100 genera were recorded from the Sunrise Hill survey area. The plant families that recorded the highest number of species were Poaceae (31 taxa), Mimosaceae (25 taxa), Papilionaceae, Amaranthaceae, Asteraceae (11 taxa each), Myrtaceae (nine taxa) and Tiliaceae (nine taxa). The genera with the most recorded species were *Acacia* (24 taxa), *Ptilotus* and *Eriachne* (eight taxa each), *Triodia* / *Senna* / *Triumfetta* and *Sida* (five taxa each).

No species of Threatened Flora as listed in the EPBC Act or DRF as listed in the DEC Rare Flora List were collected during the flora and vegetation survey of the Nimingarra and Sunrise Hill survey areas.

The flora survey of the Nimingarra survey area failed to record any introduced (weeds) species. For the Sunrise Hill survey area three weed species were associated with disturbance resulting from road verges, waste rock dumps, rehabilitation areas, and cattle grazing on the lower slope areas; **Aerva javanica*, **Cenchrus ciliaris* and **Nerium oleander*.

Goldsworthy Extension Project - Cattle Gorge Haul Road Biological Assessment Survey (Ecologia 2005d)

The Goldsworthy Extension Project and development of ore bodies such as Cattle Gorge required a haul road to be established between Cattle Gorge and the Yarrie ore processing facility. A flora and vegetation assessment was completed along the proposed haul road corridor in December 2004 and January 2005 (Ecologia 2005d).

There were eight broad vegetation types identified and 102 flora taxa recorded along the proposed haul road. The vegetation was dominated by a variety of species, which often included sparse to scattered woodlands of *Corymbia hamersleyana*, *Corymbia flavescens*, *Eucalyptus camaldulensis* or *Eucalyptus victrix*. The most commonly recorded spinifex hummock grassland species was *Triodia epactia*, followed by *Triodia wiseana* and then *Triodia longiceps*. The shrub wattle species *Acacia colei* var. *colei* and *Acacia trachycarpa* were recorded quite frequently in the corridor area. The most well represented genera for the proposed haul road corridor were *Acacia*, *Cullen* and *Bonamia*. The landscape habitat types varied from undulating gravel plains and low slopes, to sand plains, creek beds and banks, and rocky spurs. There were three weed species recorded: Buffel Grass (**Cenchrus ciliaris*), Feathertop Rhodes Grass (**Chloris virgata*) and **Citrullus colocynthis* (wild melon). There were no flora species recorded of conservation significance that are listed as threatened or endangered on the

Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*. Also, there were no recorded species of DRF as listed under the *Western Australian Wildlife Conservation (Rare Flora) Notice of the Wildlife Conservation Act 1950*. There was however one Priority flora species recorded for the proposed Cattle Gorge Haul Road corridor area; *Acacia glaucocaesia* (P3). A large population was found growing on gravelly clay-loam floodplains just south of the Cattle Gorge ore body in an area heavily affected by disturbance from cattle grazing. *Acacia glaucocaesia* was found as the dominant species of an almost completely monospecific open tall shrubland, over mixed *Triodia longiceps* / *Triodia epactia* open hummock grassland.

Goldsworthy Iron Ore Mining Operations - Cundaline and Callawa Mining Operations Flora and Vegetation Assessment (ENV 2008)

Ecologia completed the original flora and survey work on the Callawa and Cundaline ridges in 2005, on behalf of the Goldsworthy Iron Ore Mining Operations (Ecologia 2005a, 2005b). ENV (2008) completed a supplementary flora survey in March 2008.

A total of 147 plant taxa were recorded in the Callawa survey area and 193 plant taxa were recorded from the Cundaline survey area. No Endangered or Vulnerable species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the Callawa and Cundaline study areas or are considered likely to occur. No Priority Flora species are likely to be significantly impacted by the planned Callawa and Cundaline mining operations. Two Priority Flora species recorded within the Cundaline study area are outside the planned disturbance areas, namely, *Euphorbia clementii* (Priority 2) and *Goodenia nuda* (Priority 3). One Priority Flora species has been previously recorded in the Callawa study area, *Euphorbia inappendiculata* (Priority 3). Six introduced species were recorded; **Cenchrus ciliaris*, **Echinochloa colona*, **Chloris virgata*, **Portulaca oleracea* and **Passiflora foetida* var. *hispida* occurred within the Callawa study area, and **Cenchrus ciliaris*, **Portulaca oleracea*, **Chloris virgata* and **Cucumis melo* subsp. *agrestis* were recorded within the Cundaline study area. A total of 14 vegetation associations were identified in the Callawa study area and 21 vegetation associations were recorded in the Cundaline study area. Both study areas comprised mainly woodlands and shrublands. No vegetation communities recorded are listed as Threatened Ecological Communities, Priority Ecological Communities or are considered to be of regional significance.

5.2 Flora Species

A total number of 165 plant taxa (including varieties and subspecies) from 37 families and 93 genera were recorded from the Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B survey areas between the 9th and 15th September 2010 (see Appendix 6). Species representation was greatest among the Fabaceae, Poaceae, Malvaceae and Amaranthaceae families, which is typical for the Pilbara Bioregion (Table 4).

A breakdown of the three survey areas shows that Yarrie Area A supported the highest species richness (28 families, 62 genera, 100 taxa), followed by Yarrie Area B (21 families, 51 genera, 73 taxa) and Shay Gap Aerodrome (23 families, 44 genera, 66 taxa).

Table 4 Statistics for total flora recorded from the Shay Gap Aerodrome (SG), Yarrie Area A (YA) and Yarrie Area B (YB) survey areas.

Parameter	SG	YA	YB
No. Families	23	28	21
No. Genera	44	62	51
No. Species (incl. subspecies and varieties)	66	100	73
No. Native Species (incl. subspecies and varieties)	66	97	69
Priority Flora	0	0	0
No. Introduced Species	0	3	4
Speciose Families			
FABACEAE	15	27	15
POACEAE	11	15	13
MALVACEAE	7	8	5
AMARANTHACEAE	4	3	7
Speciose Genera			
<i>Acacia</i> (Fabaceae)	9	12	6
<i>Goodenia</i> (Goodeniaceae)	3	2	3
<i>Ptilotus</i> (Amaranthaceae)	4	2	4
<i>Tephrosia</i> (Fabaceae)	1	6	1
<i>Eriachne</i> (Poaceae)	2	1	3
<i>Solanum</i> (Solanaceae)	1	3	4
<i>Senna</i> (Fabaceae)	1	3	2
Introduced Flora			
* <i>Aerva javanica</i> Kapok Bush (Amaranthaceae)			y
* <i>Cenchrus ciliaris</i> Buffel Grass (Poaceae)		y	y
* <i>Chloris virgata</i> Feathertop Rhodes Grass (Poaceae)			y
* <i>Cucumis melo</i> subsp. <i>agrestis</i> Ulcardo Melon (Cucurbitaceae)		y	
* <i>Portulaca oleracea</i> Purslane (Portulacaceae)		y	y

5.3 Conservation Significant Flora Species

Following intensive quadrat sampling and extensive ground truthing of the three survey areas by an experienced botanist, no plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)*, or listed under the *EPBC Act 1999* were recorded. In addition, there no Priority flora species (as defined by DEC) recorded.

5.4 Introduced Flora

There was three introduced (weed) flora recorded from the Yarrie Area A; **Cenchrus ciliaris* (Buffel Grass), **Cucumis melo* subsp. *agrestis* (Ulcardo Melon) and **Portulaca oleracea* (Purslane) (Figure 4), and four introduced (weed) flora recorded from the Yarrie Area B survey area; **Aerva javanica* (Kapok Bush), **Cenchrus ciliaris* (Buffel Grass), **Chloris virgata* (Feathertop Rhodes Grass) and **Portulaca oleracea* (Purslane) (Figure 5). None of these taxa are listed as Declared Weeds under the *Agriculture and Related Resources Protection Act, 1976* (ARRP Act). No introduced flora was recorded from the Shay Gap Aerodrome survey area.

**Aerva javanica* (Kapok Bush, see Plate 1) is a short-lived soft-wooded perennial or diffuse herb, up to 1.6 m high, originating from Northern Africa and south-west Asia. It is widespread across Australia, occurring in Northern Territory, South Australia, Queensland and Western Australia. Kapok Bush was recorded as a single plant from one location within the central eastern fringe of the Yarrie Area B survey area.

**Cenchrus ciliaris* (Buffel Grass, see Plate 2) is a tufted perennial grass introduced from the Middle East as a fodder species by pastoralists. It grows in dense tussocks up to 1 m tall and typically occurs in monospecific stands on loamy plains and creekline levee banks. It is an aggressive colonizing species that has become well established throughout the Pilbara, Gascoyne and Murchison regions and is continuing to spread in the south west (Hussey *et al.* 1997). **Cenchrus ciliaris* was recorded from two locations at each of Yarrie Area A and Yarrie Area B survey areas, occurring as clumps of between four and 25 plants on plains and in drainage depressions.

**Chloris virgata* (Feathertop Rhodes Grass) is an annual grass up to 1 m in height and flowering between April and September. It was recorded as one plant from a single location in the north-west corner of the Yarrie Area B survey area, associated with a drainage depression.

**Cucumis melo* subsp. *agrestis* (Ulcardo Melon) is a trailing annual herb or climber flowering between February to June and September to October. It was recorded from a single location on a plain in the middle of the Yarrie Area A survey area.

Portulaca oleracea (Purslane, see Plate 3) is a widespread succulent herb, distributed from the Kimberley to the south-west of Western Australia. It was recorded from one location at each of Yarrie Area A and Yarrie Area B survey areas, in both instances associated with drainage depressions.



Plate 1 *Aerva javanica*



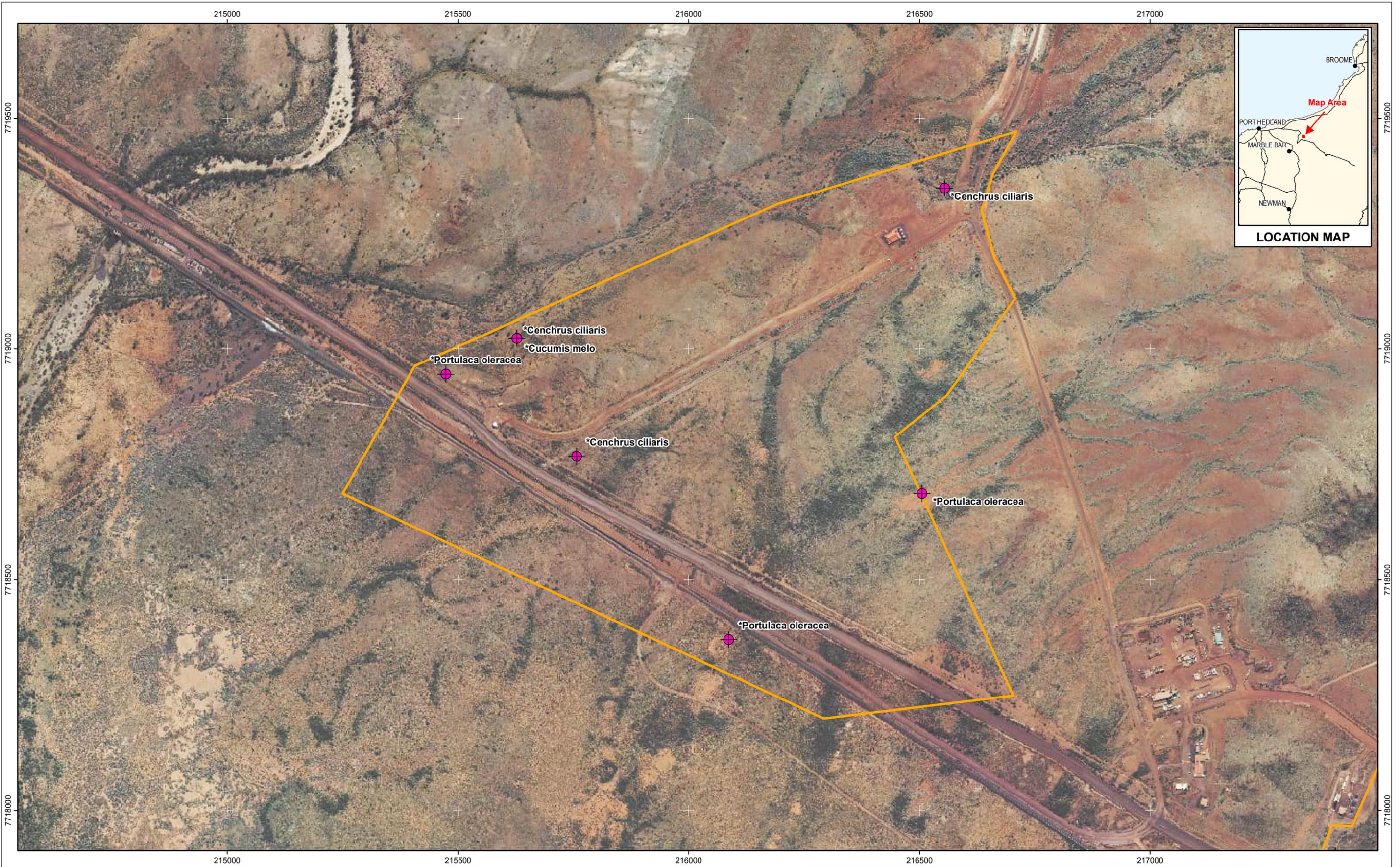
Plate 2 *Cenchrus ciliaris*



Portulaca oleracea

Photos: G. Byrne, C.P. Campbell & L. Fontanini

Plate 3 *Portulaca oleracea*



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Drawn by: GSM	Requested by: DB	Reference: FIGURE 4

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Meters

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Datum: GDA94
Projection: MGA Zone 51

YARRIE AREA A STUDY AREA

Location of Introduced Species

Legend

- Survey Area
- Introduced Species

Griffin Spatial & Mapping

2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213



*Cenchrus ciliaris
 *Chloris virgata
 *Portulaca oleracea

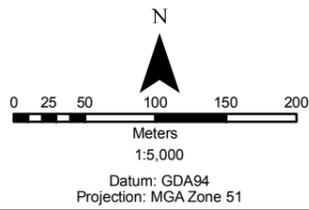
*Aerva javanica
 *Aerva javanica

*Cenchrus ciliaris

*Cenchrus ciliaris
 *Aerva javanica



ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	07/12/2010
Sheet Size:	A3	Status:	Final
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GSM	DB	FIGURE 5	



YARRIE AREA B STUDY AREA

Location of Introduced Species

Legend

- Survey Area
- Introduced Species
- Weed widespread - Aerva javanica



2 Epacris Elbow Pelican Point
 Bunbury WA 6230
 griffinspatial@bigpond.com
 +61 (0) 8 9725 3213

5.5 Threatened & Priority Ecological Communities

A vegetation association is considered a Threatened Ecological Community (TEC) if it is found to fit into one of the following categories:

- Presumed Totally Destroyed;
- Critically Endangered;
- Endangered; or
- Vulnerable.

Threatened species and ecological community conservation is coordinated by DEC's Nature Conservation Division, primarily through the Western Australian Threatened Species and Associations Unit (WATSCU). No State legislation deals specifically with TECs. However, TECs can be listed as nationally threatened and are protected under the EPBC Act (1999).

A search of the EPBC database confirmed there were no TEC's previously recorded within or adjacent to, the Shay Gap and Yarrie survey areas. A search of the State database by DEC again confirmed there were no previous TEC records for a 50 km radius surrounding the survey areas.

In addition to TEC's, DEC has generated a list of Priority Ecological Communities (PEC's) occurring in the Pilbara. The list identifies communities that require further investigation prior to nomination for TEC status. Field assessment confirmed that none of the PEC's listed for the Pilbara region occurred within the Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B survey areas.

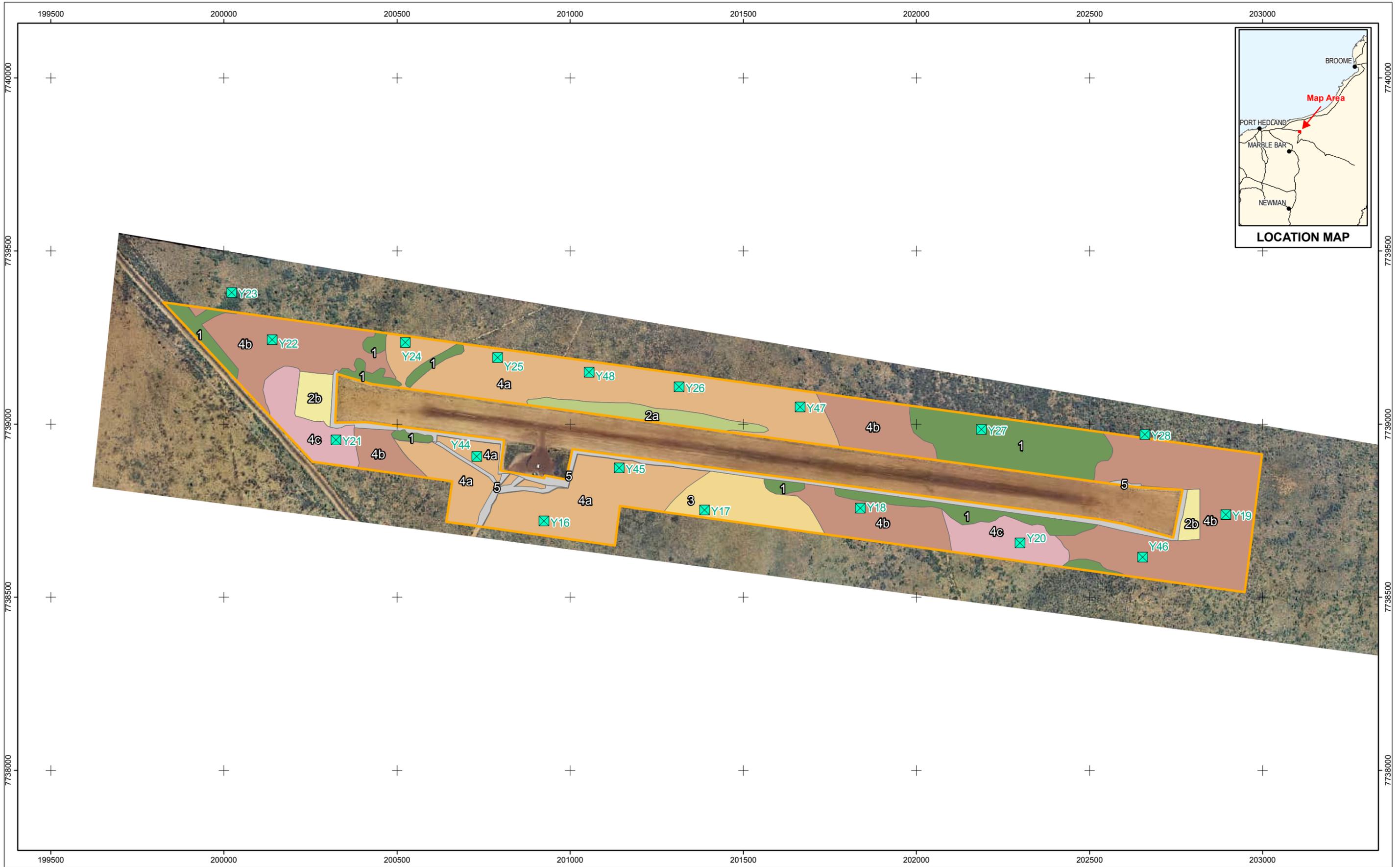
5.6 Vegetation

5.6.1 Shay Gap Aerodrome

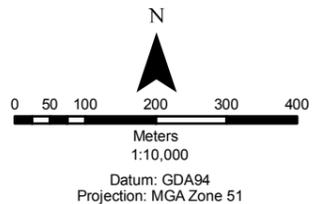
A total of eight vegetation associations were described and mapped (Figure 6) within the Shay Gap Aerodrome survey area (Table 5). The vegetation associations were classified into five Broad Floristic Formations on the basis of canopy structure (Table 5).

Table 5 Vegetation descriptions (and associated landform and vegetation condition) for eight vegetation associations mapped within the Shay Gap Aerodrome survey area by Onshore Environmental, September 2010. *Area (ha) represented within the survey area and % of total survey area.

Vegetation Association Code	Broad Floristic Formation	Vegetation Association Description	*Area (ha)	Landform	Vegetation Condition
1	Acacia Low Open Heath (regrowth)	Low Open Heath of <i>Acacia tumida</i> var. <i>pilbarensis</i> (regrowth), <i>Bonamia rosea</i> and <i>Senna notabilis</i> over Very Open Tussock Grassland of <i>Aristida holathera</i> and <i>Chrysopogon fallax</i>	13.48	Drainage depressions	Excellent
2a	Acacia Low Scattered Shrubs	Low Scattered Shrubs of <i>Acacia bivenosa</i> over Open Hummock Grassland of <i>Triodia epactia</i>	2.44	Drainage depressions	Degraded
2b	Acacia Low Scattered Shrubs	Low Scattered Shrubs of <i>Bonamia rosea</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> over Scattered Tussock Grasses of <i>Aristida holathera</i> , <i>Aristida inaequiglumis</i> and <i>Eriachne aristidea</i> over Scattered Hummock Grasses of <i>Triodia epactia</i>	2.11	Sandplain	Good
3	Triodia Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia epactia</i> over Scattered Climbers of <i>Cassytha capillaris</i>	4.60	Sandplain	Excellent
4a	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Shrubland of <i>Acacia hilliana</i> over Scattered Climbers of <i>Cassytha capillaris</i>	29.24	Sandplain	Excellent
4b	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia ancistrocarpa</i> and <i>Bonamia rosea</i> with Low Open Woodland of <i>Corymbia zygophylla</i> and <i>Erythrophleum chlorostachys</i>	32.01	Sandplain	Excellent
4c	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Open Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia ancistrocarpa</i> and <i>Bonamia rosea</i> with Scattered Trees of <i>Corymbia zygophylla</i>	6.95	Sandplain	Excellent
5	Tracks	none	4.66		Completely Degraded



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Drawn by GSM	Requested by DB	GSM Reference FIGURE 6	



SHAY GAP STUDY AREA Vegetation Map

- Legend**
- Onshore Environmental Studies Sites
 - Survey Area

Griffin Spatial & Mapping
 2 Epacris Elbow Pelican Point
 Bunbury WA 6230
 griffinspatial@bigpond.com
 +61 (0) 8 9725 5213

Legend

Shay Gap Aerodrome Study Area

Acacia Low Open Heath (regrowth)

 1 *Low Open Heath of Acacia tumida var. pilbarensis (regrowth), Bonamia rosea and Senna notabilis over Very Open Tussock Grassland of Aristida holathera and Chrysopogon fallax*

Acacia Low Scattered Shrubs

 2a *Low Scattered Shrubs of Acacia bivenosa over Open Hummock Grassland of Triodia epactia*

 2b *Low Scattered Shrubs of Bonamia rosea and Acacia tumida var. pilbarensis over Scattered Tussock Grasses of Aristida holathera, Aristida inaequiglumis and Eriachne aristidea over Scattered Hummock Grasses over Triodia epactia*

Triodia Closed Hummock Grassland

 3 *Closed Hummock Grassland of Triodia epactia over Scattered Climbers of Cassytha*

Triodia Hummock Grassland

 4a *Hummock Grassland of Triodia epactia with Low Shrubland of Acacia hilliana over Scattered Climbers of Cassytha*

 4b *Hummock Grassland of Triodia epactia with Low Shrubland of Acacia tumida var. pilbarensis, Acacia ancistrocarpa and Bonamia rosea with Low Open Woodland of Corymbia zygophylla and Gyrostemon americanus*

 4c *Hummock Grassland of Triodia epactia with Low Open Shrubland of Acacia tumida var. pilbarensis, Acacia ancistrocarpa and Bonamia rosea with Scattered Trees of Corymbia zygophylla*

Tracks

 5



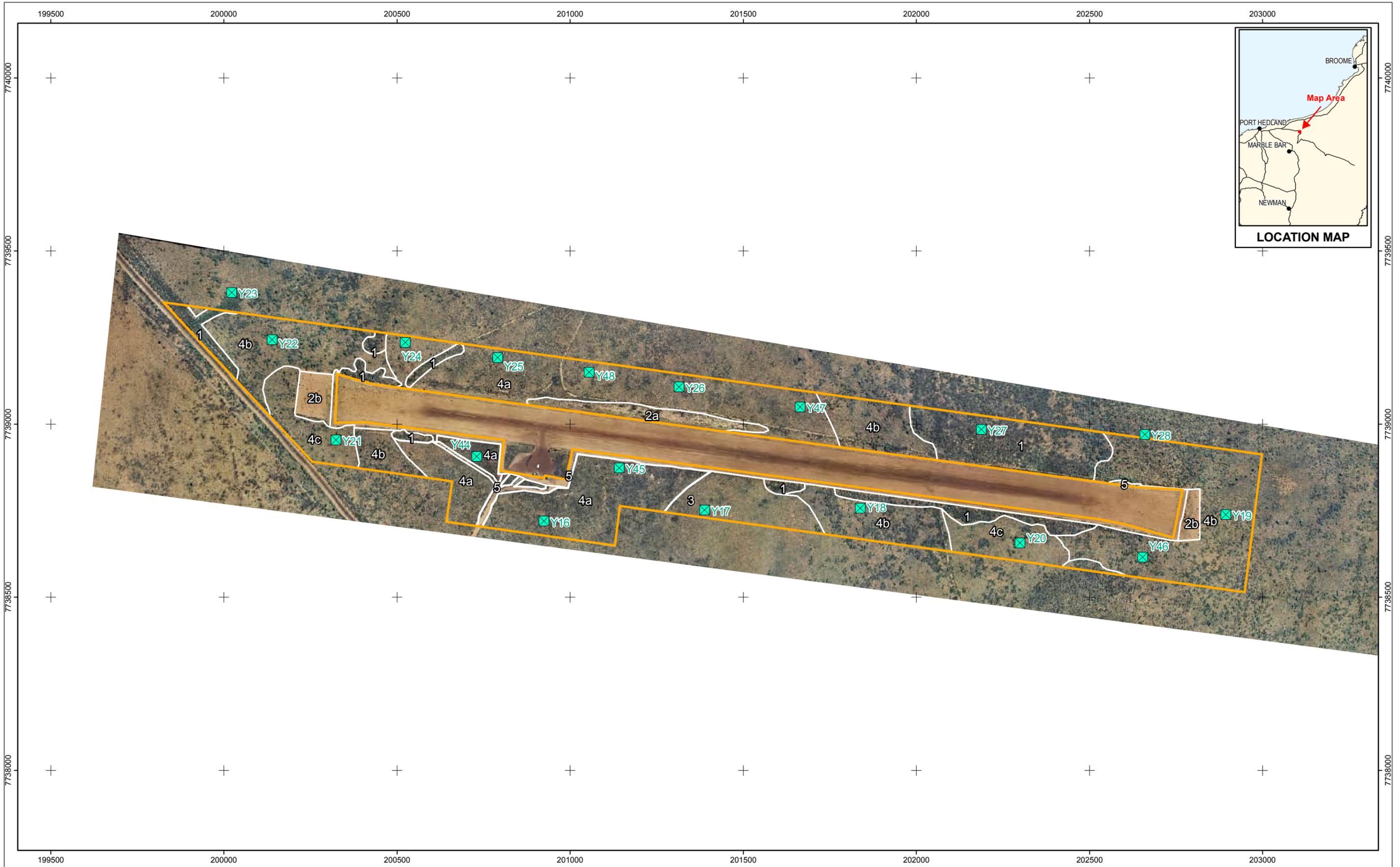
ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	7/12/2010
Sheet Size:	A3	Status:	Final
Drawn by GSM	Requested by DB	Reference	FIGURE 6

SHAY GAP AERODROME STUDY AREA

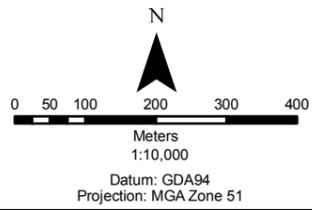
Vegetation Map Legend



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Drawn by GSM	Requested by DB	GSM Reference FIGURE 6a	



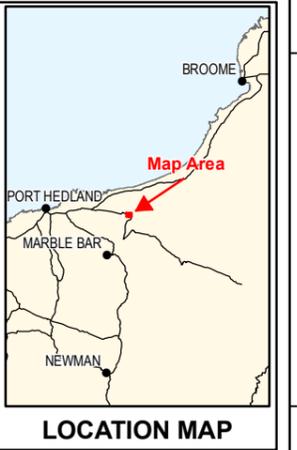
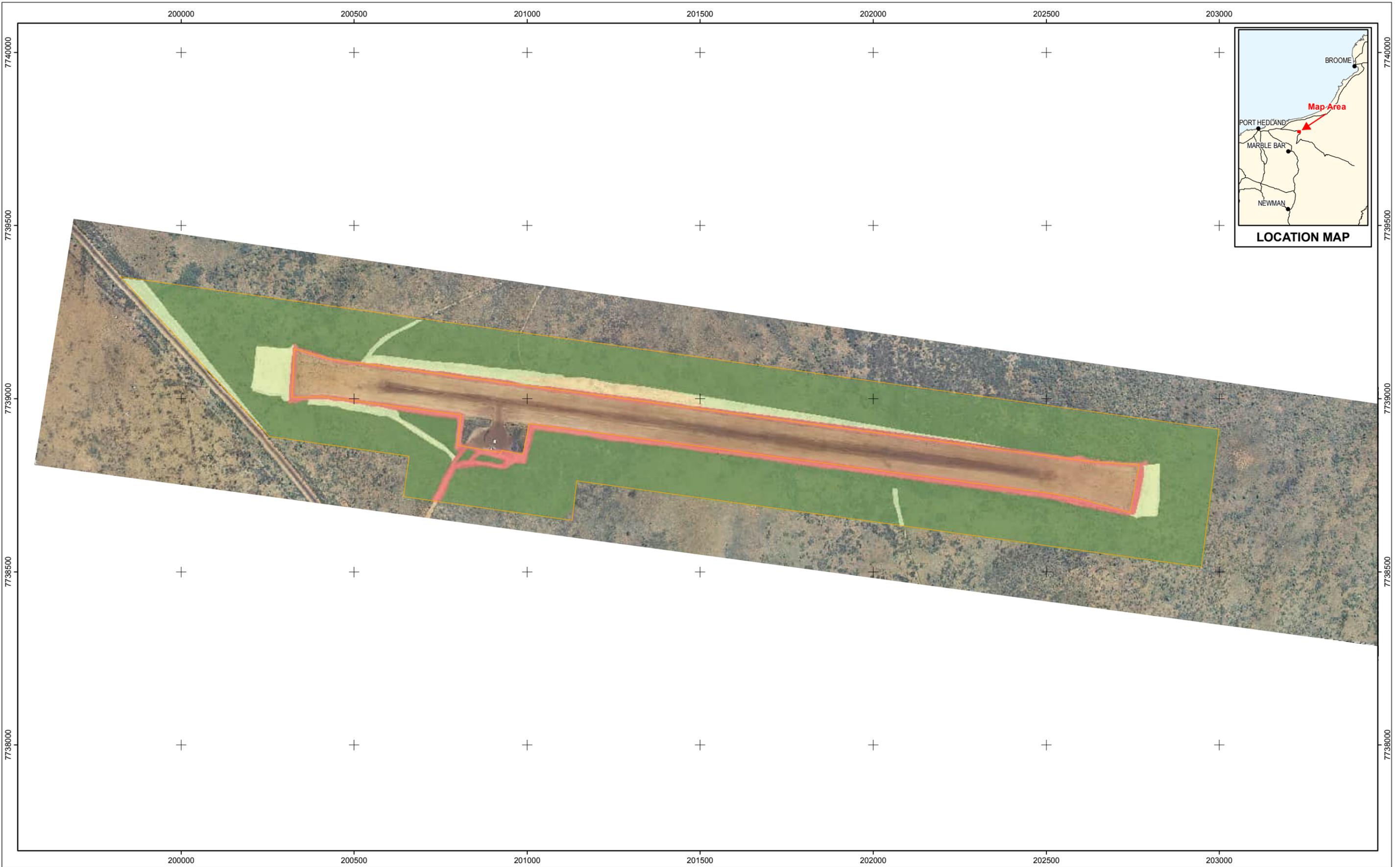
SHAY GAP STUDY AREA Vegetation Map

Legend

- ✕ Onshore Environmental Studies Sites
- Survey Area



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ONSHORE ENVIRONMENTAL

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0 50 100 200 300 400 500
Meters
1:10,000

Datum: GDA94
Projection: MGA Zone 51

SHAY GAP AERODOME STUDY AREA Vegetation Condition Map

Legend

Survey Area	Vegetation Condition
	Excellent
	Very Good
	Good
	Degraded
	Completely Degraded

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1 *Acacia* Low Open Heath

Low Open Heath of *Acacia tumida* var. *pilbarensis* (regrowth), *Bonamia rosea* and *Senna notabilis* over Very Open Tussock Grassland of *Aristida holathera* and *Chrysopogon fallax*

Area Mapped: 13.48 ha

Quadrats Sampled: 23, 27

Location and Landform

Vegetation Association 1 occurred in drainage lines and run-on zones present across the survey area, with the largest block occurring at the eastern end of the existing airstrip. Smaller areas were represented alongside tracks in response to pooling of surface run-off water. Soil was a red brown sandy loam with the parent rock being ironstone. Vegetation condition was rated as 'excellent' with disturbance restricted to minor grazing of native vegetation by cattle, occasional access tracks, and fire.

Vegetation was characterised by a low open heath stratum dominated by *Acacia tumida* var. *pilbarensis*. In the unburnt state this vegetation layer would be taller, forming open to closed scrub. A very open ground cover was formed by the tussock grasses *Aristida holathera* and *Chrysopogon fallax*, with *Triodia epactia* reduced to scattered hummocks. Other understorey species present included *Bonamia rosea*, *Senna notabilis*, *Rulingia loxophylla* and *Halgania solanacea* var. *solanacea*, with scattered trees of *Corymbia zygophylla*.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia zygophylla*

Tallest shrub layer: *Acacia tumida* var. *pilbarensis*, *Bonamia rosea*, *Senna notabilis*, *Rulingia loxophylla*, *Halgania solanacea* var. *solanacea*, *Grevillea wickhamii* subsp. *aprica*

Tallest ground species: *Aristida holathera*, *Chrysopogon fallax*, *Triodia epactia*



2 *Acacia* Low Scattered Shrubs

2a Low Scattered Shrubs of *Acacia bivenosa* over Open Hummock Grassland of *Triodia epactia*

Area Mapped: 2.44 ha

Quadrats Sampled: R37

Location and Landform

Vegetation Association 2a was restricted to a linear borrow pit running along the central northern fringe of the existing airstrip, and likely excavated during construction of the landing ground. Prior to disturbance the unit would have supported Vegetation Association 1. Vegetation condition was rated as 'degraded' with low scattered shrubs of *Acacia bivenosa* and open hummock grassland of *Triodia epactia* being post-disturbance regrowth.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia bivenosa*

Tallest ground species: *Triodia epactia*



2 *Acacia* Low Scattered Shrubs

2b Low Scattered Shrubs of *Bonamia rosea* and *Acacia tumida* var. *pilbarensis* over Scattered Tussock Grasses of *Aristida holathera*, *Aristida inaequiglumis* and *Eriachne aristidea* over Scattered Hummock Grasses of *Triodia epactia*

Area Mapped: 2.11 ha

Quadrats Sampled: R34, R35

Location and Landform

Vegetation Association 2b was restricted to well defined areas of recent clearing (less than one year ago) present at both ends of the existing airstrip. Soil was a red sand with the larger landform described as a sandplain. Vegetation was characterised by a very open cover of regenerating low shrubs including *Bonamia rosea* and *Acacia tumida* var. *pilbarensis*, scattered tussock grasses of *Aristida holathera*, *Aristida inaequiglumis* and *Eriachne aristidea* and scattered hummock grasses of *Triodia epactia*. Vegetation condition was rated as 'good' in response to the recent clearing disturbance.

Vegetation Structure and Floristics

Tallest shrub layer: *Bonamia rosea*, *Acacia tumida* var. *pilbarensis*

Tallest ground species: *Aristida holathera*, *Aristida inaequiglumis*,
Eriachne aristidea, *Triodia epactia*



3 *Triodia* Closed Hummock Grassland

Closed Hummock Grassland of *Triodia epactia* over Scattered Climbers of *Cassytha capillaris*

Area Mapped: 4.60 ha

Quadrats Sampled: 17

Location and Landform

Vegetation Association 3 was restricted to a sandplain present in the central southern sector of the survey area. Soil was red orange sand. Vegetation was characterised by a dense ground cover of *Triodia epactia* forming closed hummock grassland. The shrub stratum was largely absent, at best represented by scattered individuals. Vegetation condition was rated as 'excellent' and vegetation was long unburnt.

Vegetation Structure and Floristics

Climbers: *Cassytha capillaris*

Tallest shrub layer: *Grevillea wickhamii* subsp. *aprica*, *Acacia ancistrocarpa*, *Hakea chordophylla*

Lower shrub layer: *Dodonaea coriacea*

Tallest ground species: *Triodia epactia*



4 *Triodia* Hummock Grassland

4a Hummock Grassland of *Triodia epactia* with Low Shrubland of *Acacia hilliana* over Scattered Climbers of *Cassytha capillaris*

Area Mapped: 29.24 ha

Quadrats Sampled: 16, 24, 25, 26, 44, 45, 47, 48

Location and Landform

Vegetation Association 4a occurred extensively on sandplain present in the western half of the survey area. Soil was red / orange sand over loamy sand at depth. Vegetation was characterised by *Acacia hilliana* forming low shrubland or in some instances low heath. *Triodia epactia* occurred as hummock grassland, with ground cover influenced by the burn mosaic. Vegetation condition was rated as 'excellent', with only minor disturbances evident.

Vegetation Structure and Floristics

Tallest tree sub-stratum: *Corymbia hamersleyana*

Climbers: *Cassytha capillaris*

Tallest shrub layer: *Acacia ancistrocarpa*, *Acacia bivenosa*

Lower shrub layer: *Acacia hilliana*, *Acacia adoxa* var. *adoxo*, *Bonamia rosea*

Tallest ground species: *Triodia epactia*



4 *Triodia* Hummock Grassland

4b Hummock Grassland of *Triodia epactia* with Low Shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia ancistrocarpa* and *Bonamia rosea* with Low Open Woodland of *Corymbia zygophylla* and *Erythrophleum chlorostachys*

Area Mapped: 32.01 ha

Quadrats Sampled: 18, 19, 22, 28, 46

Location and Landform

Vegetation Association 4b occurred extensively on sandplain present over the eastern half and western fringe of the survey area. Soil was red orange sand over loamy sand at depth. Vegetation was characterised by a low shrubland of *Acacia tumida* var. *pilbarensis* and *Acacia ancistrocarpa* (likely forming high shrubland when mature) over hummock grassland of *Triodia epactia*. Tree cover provided by *Corymbia zygophylla* and *Erythrophleum chlorostachys* was sparse, not exceeding 5%, and *Eriachne lanata* was a frequent scattered low grass. *Senna notabilis* and *Rulingia loxophylla* were other common low shrubs. Vegetation condition was rated as 'excellent', with only minor disturbances evident.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia zygophylla*, *Erythrophleum chlorostachys*

Tallest shrub layer: *Acacia tumida* var. *pilbarensis*, *Acacia ancistrocarpa*, *Bonamia rosea*, *Senna notabilis*, *Rulingia loxophylla*

Tallest ground species: *Triodia epactia*, *Eriachne lanata*



4 *Triodia* Hummock Grassland

4c Hummock Grassland of *Triodia epactia* with Low Open Shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia ancistrocarpa* and *Bonamia rosea* with Scattered Trees of *Corymbia zygomorpha*

Area Mapped: 6.95 ha

Quadrats Sampled: 20, 21

Location and Landform

Vegetation Association 4c showed a similar species composition to Vegetation Association 4b but differed through the openness of tree (scattered trees) and shrub (low open shrubland) strata. Vegetation Association 4c occurred on sandplain at the western end of the existing airstrip and south-east sector of the survey area. Soil was red / orange sand over loamy sand at depth. Vegetation condition was rated as 'excellent', with minor disturbances including access tracks, fire scars and grazing by cattle.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia zygomorpha*

Tallest shrub layer: *Acacia tumida* var. *pilbarensis*, *Acacia ancistrocarpa*, *Bonamia rosea*, *Halgania solanacea* var. *solanacea*, *Corchorus elachocarpus*

Tallest ground species: *Triodia epactia*



5 *Triodia* Hummock Grassland

Vegetation Totally Cleared

Area Mapped: 4.66 ha

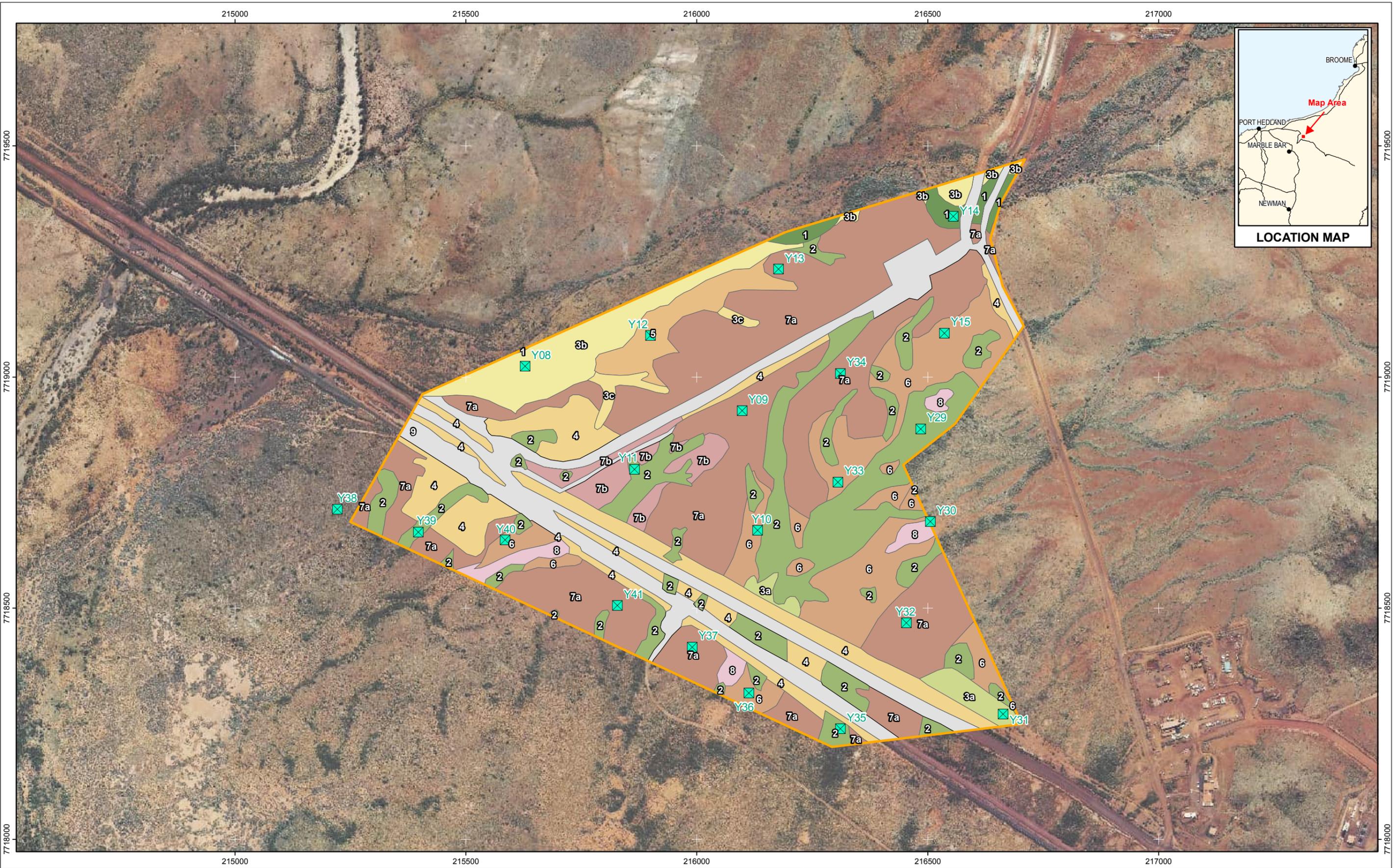
Quadrats Sampled: NA

Location and Landform

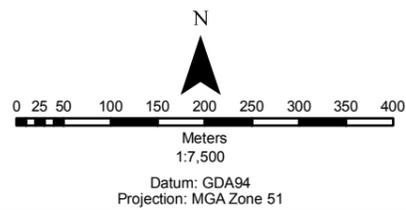
Vegetation Association 5 included access tracks and roads where native vegetation had been totally cleared, and no regeneration was evident. Vegetation condition was rated as 'completely degraded'. These areas were associated with accessing and servicing the existing airstrip.

5.6.2 Yarrie Area A

A total of twelve vegetation associations were described and mapped (Figure 8) within the Yarrie Area A survey area (Table 6). The vegetation associations were classified into nine Broad Floristic Formations on the basis of canopy structure (Table 6).



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GSM	DB	FIGURE 8	



YARRIE A STUDY AREA Vegetation Map

Legend

- Onshore Environmental Studies Sites
- Survey Area



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Legend

Yarrie Area A Study Area Vegetation

Eucalyptus Woodland

 1 Woodland of *Eucalyptus victrix* over High Open Shrubland of *Petalostylis labicheoides* and *Acacia tumida* var. *pilbarensis* over Low Shrubland of *Tephrosia rosea* var. *clementii* and *Corchorus* sp.

Acacia Open Scrub

 2 Open Scrub of *Acacia coleii*, *Acacia tumida* var. *pilbarensis* and *Acacia elachantha* over Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana*

Acacia High Shrubland

 3a High Shrubland of *Acacia coleii* over Scattered Herbs of *Alternanthera nodiflora* and *Centipeda minima*

 3b High Shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia coleii* and *Acacia pyrifolia* over Low Shrubland of *Tephrosia rosea* var. *clementii*, *Pluchea tetranthera* and *Melhania oblongifolia* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana*

 3c High Shrubland of *Acacia coleii*, *Grevillea wickhamii* and *Grevillea pyramidalis* over Low Open Shrubland of *Pluchea tetranthera* over Hummock Grassland of *Triodia epactia*

Various species

 4 Scattered Shrubs of *Acacia* spp. and *Grevillea* spp. over Low Scattered Shrubs of *Pluchea tetranthera* and Scattered Hummock Grassland of *Triodia epactia*

Pluchea Low Shrubland

 5 Low Shrubland of *Pluchea tetranthera* over Open Hummock Grassland of *Triodia epactia* with an Open High Shrubland of *Acacia coleii*

Triodia Closed Hummock Grassland

 6 Closed Hummock Grassland of *Triodia epactia* with High Shrubland of *Acacia coleii*, *Grevillea pyramidalis* and *Acacia elachantha* over Low Open Shrubland of *Pluchea tetranthera*

Triodia Hummock Grassland

 7a Hummock Grassland of *Triodia wiseana* with High Open Shrublands of *Grevillea pyramidalis*, *Acacia inaequilatera* and *Acacia coleii* with Scattered Low Trees of *Corymbia hamersleyana*

 7b Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with High Shrublands of *Grevillea wickhamii*

Triodia Open Hummock Grassland

 8 Open Hummock Grassland of *Triodia epactia* and *Triodia longiceps* with Low Open Shrubland of *Pluchea tetranthera* over Scattered Low Herbs of *Trianthema triquetra* and *Portulaca oleracea*

Access Tracks, Haul Roads, Railway Lines and Mine Infrastructure

 9



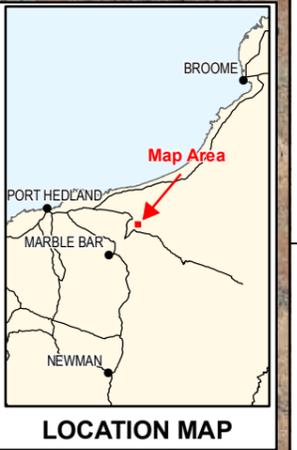
ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	14/11/2010
Sheet Size:	A3	Status:	FINAL
Drawn by GSM	Requested by DB	Reference	FIGURE 7

YARRIE AREA A STUDY AREA

Vegetation Map Legend



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Datum: GDA94
Projection: MGA Zone 51

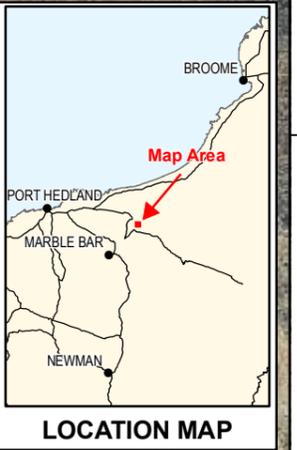
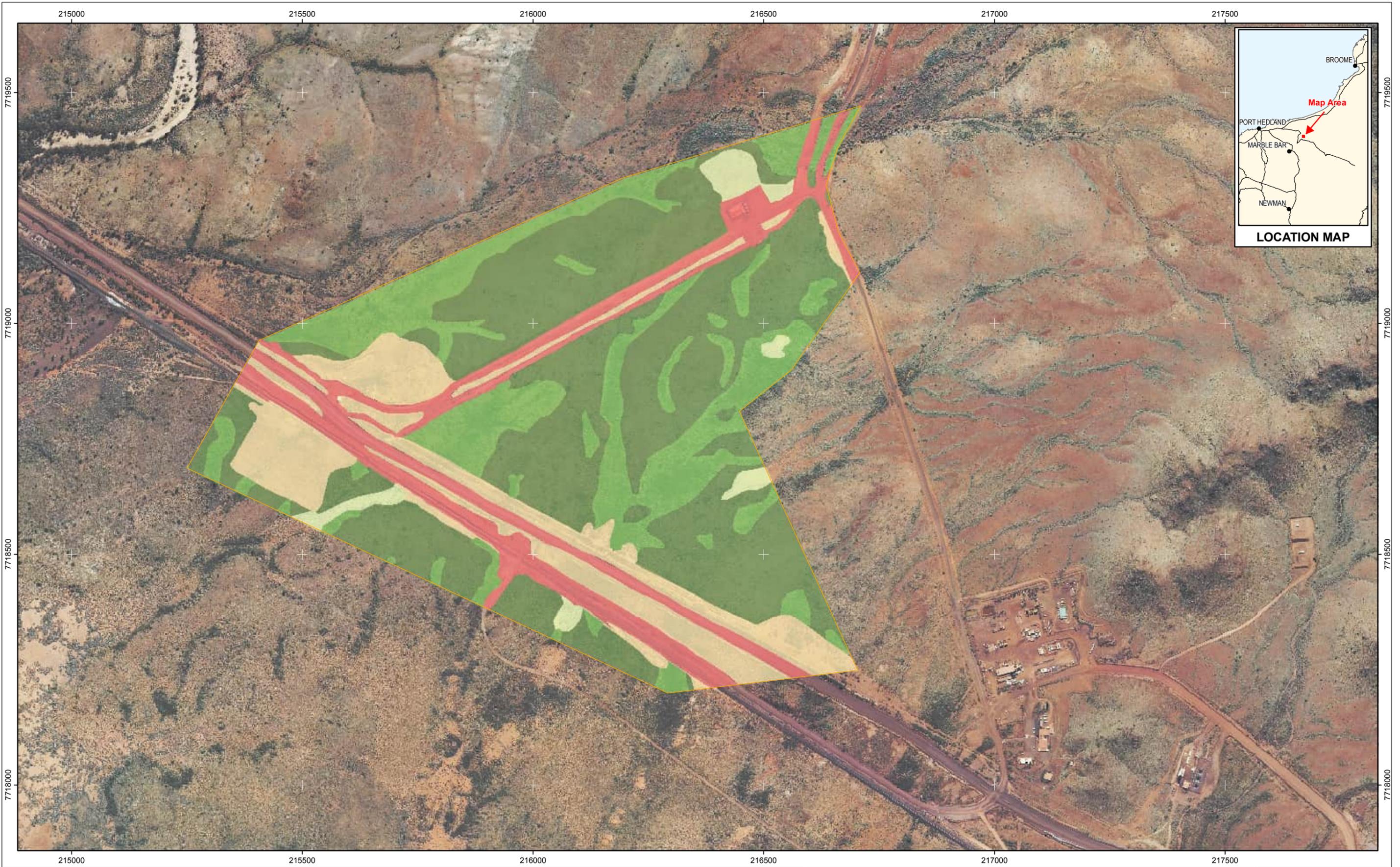
YARRIE A STUDY AREA Vegetation Map

Legend

- ✕ Onshore Environmental Studies Sites
- Survey Area

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Drawn by: GSM	Requested by: DB	Reference: FIGURE 9

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Meters
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Datum: GDA94
Projection: MGA Zone 51

YARRIE AREA A STUDY AREA

Vegetation Condition Map

Legend

Survey Area	Vegetation Condition
	Excellent
	Very good
	Good
	Degraded
	Completely Degraded

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& Mapping

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Table 6 Vegetation descriptions (and associated landform and vegetation condition) for twelve vegetation associations mapped within the Yarrie Area A survey area by Onshore Environmental, September 2010. *Area (ha) represented within the survey area and % of total survey area.

Vegetation Association Code	Broad Floristic Formation	Vegetation Association Description	*Area (ha)	Landform	Vegetation Condition
1	<i>Eucalyptus</i> Woodland	Woodland of <i>Eucalyptus victrix</i> over High Open Shrubland of <i>Petalostylis labicheoides</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> over Low Shrubland of <i>Tephrosia rosea</i> var. <i>clementii</i> and <i>Corchorus</i> sp.	1.25	Major Drainage Line	Very Good
2	<i>Acacia</i> Open Scrub	Open Scrub of <i>Acacia colei</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> and <i>Acacia elachantha</i> over Hummock Grassland of <i>Triodia epactia</i> with Low Open Woodland of <i>Corymbia flavescens</i> and <i>Corymbia hamersleyana</i>	16.72	Minor Drainage Line/ Zone	Very Good
3a	<i>Acacia</i> High Shrubland	High Shrubland of <i>Acacia colei</i> over Scattered Herbs of <i>Alternanthera nodiflora</i> and <i>Centipeda minima</i>	1.47	Drainage Flats/ Zone	Degraded
3b	<i>Acacia</i> High Shrubland	High Shrubland of <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia colei</i> and <i>Acacia pyrifolia</i> over Low Shrubland of <i>Tephrosia rosea</i> var. <i>clementii</i> , <i>Pluchea tetranthera</i> and <i>Melhania oblongifolia</i> with Low Open Woodland of <i>Corymbia flavescens</i> and <i>Corymbia hamersleyana</i>	5.81	Sandy Floodplain (associated with Major Drainage Line)	Very Good
3c	<i>Acacia</i> High Shrubland	High Shrubland of <i>Acacia colei</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i> and <i>Grevillea pyramidalis</i> over Low Open Shrubland of <i>Pluchea tetranthera</i> over Hummock Grassland of <i>Triodia epactia</i>	0.77	Minor drainage lines (dolerite)	Very Good
4	<i>Acacia</i> Scattered Shrubs	Scattered Shrubs of <i>Acacia</i> spp. and <i>Grevillea</i> spp. over Low Scattered Shrubs of <i>Pluchea tetranthera</i> and Scattered Hummock Grassland of <i>Triodia epactia</i>	11.67	Borrow pits, Road Verges	Degraded
5	<i>Pluchea</i> Low Shrubland	Low Shrubland of <i>Pluchea tetranthera</i> over Open Hummock Grassland of <i>Triodia epactia</i> with an Open High Shrubland of <i>Acacia colei</i>	2.80	Stony Floodplain	Excellent

Vegetation Association Code	Broad Floristic Formation	Vegetation Association Description	*Area (ha)	Landform	Vegetation Condition
6	<i>Triodia</i> Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia epactia</i> with High Shrubland of <i>Acacia coleii</i> , <i>Grevillea pyramidalis</i> and <i>Acacia elachantha</i> over Low Open Shrubland of <i>Pluchea tetranthera</i>	12.42	Sandplain	Excellent
7a	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> with High Open Shrubland of <i>Grevillea pyramidalis</i> , <i>Acacia inaequilatera</i> and <i>Acacia coleii</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i>	36.04	Hill crests and slopes (dolerite)	Excellent
7b	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia epactia</i> with High Shrubland of <i>Grevillea wickhamii subsp. aprica</i>	2.61	Stony hill slopes	Very Good
8	<i>Triodia</i> Open Hummock Grassland	Open Hummock Grassland of <i>Triodia epactia</i> and <i>Triodia longiceps</i> with Low Open Shrubland of <i>Pluchea tetranthera</i> over Scattered Low Herbs of <i>Trianthema triquetra</i> and * <i>Portulaca oleracea</i>	1.57	Minor Drainage Line with Scalds	Good
9	Access Tracks, Haul Roads, Railway Lines and Mine Infrastructure	none	13.21	Access tracks, roads, railway lines and infrastructure	Completely Degraded

1 *Eucalyptus* Woodland

Woodland of *Eucalyptus victrix* over High Open Shrubland of *Petalostylis labicheoides* and *Acacia tumida* var. *pilbarensis* over Low Shrubland of *Tephrosia rosea* var. *clementii* and *Corchorus* sp.

Area Mapped: 1.25 ha

Quadrats Sampled: 14

Location and Landform

Vegetation Association 1 occurred along the northern extremities of the survey area associated with the levee banks and incised drainage channel of a major drainage line. The soil was described as brown loamy sand mixed with washed cobbles and pebbles. Vegetation condition was rated as 'very good' with disturbance including grazing of native vegetation by cattle, occasional access tracks, alteration to natural drainage flows and weeds. Vegetation was characterised by the coolabah tree *Eucalyptus victrix* forming woodland over a high open shrubland of *Petalostylis labicheoides* and *Acacia tumida* var. *pilbarensis*. The ground cover supported the low shrubs *Tephrosia rosea* var. *clementii* and *Corchorus* sp., with a very open hummock grassland of *Triodia epactia* and very open tussock grassland of *Eriachne tenuiculmis*.

Vegetation Structure and Floristics

Tallest tree stratum:	<i>Eucalyptus victrix</i>
Tallest shrub layer:	<i>Petalostylis labicheoides</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia coleii</i> , <i>Acacia pyrifolia</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i>
Lower shrub layer:	<i>Tephrosia rosea</i> var. <i>clementii</i> , <i>Corchorus</i> sp., <i>Cleome viscosa</i> , <i>Stemodia grossa</i>
Tallest ground species:	<i>Triodia epactia</i> , <i>Eriachne tenuiculmis</i>



2 *Acacia* Open Scrub

Open Scrub of *Acacia colei*, *Acacia tumida* var. *pilbarensis* and *Acacia elachantha* over Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana*

Area Mapped: 16.72 ha

Quadrats Sampled: 11, 29, 35, 39

Location and Landform

Vegetation Association 2 occurs along minor drainage lines and in drainage depressions broadly aligned north-east to south-west and extending throughout the entire survey area. Vegetation is long unburnt and characterised by a dense stand of *Acacia* species between 2 m and 4 m in height; *Acacia colei*, *Acacia tumida* var. *pilbarensis* and *Acacia elachantha*. There is typically a well established layer of leaf litter at ground level providing between 40 - 60% cover. The trees *Corymbia flavescens* and *Corymbia hamersleyana* form low open woodland over a hummock grassland of *Triodia epactia*, with a low open shrubland of *Pluchea tetranthera* providing a fourth stratum in the vegetation. Vegetation condition was rated as 'very good' impacts from grazing by cattle the most common disturbance.

Vegetation Structure and Floristics

Tallest tree stratum:	<i>Corymbia flavescens</i> , <i>Corymbia hamersleyana</i>
Tallest shrub layer:	<i>Acacia colei</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia elachantha</i> , <i>Acacia ancistrocarpa</i> , <i>Acacia inaequilatera</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i> , <i>Acacia trachycarpa</i> , <i>Grevillea refracta</i>
Lower shrub layer:	<i>Pluchea tetranthera</i>
Tallest ground species:	<i>Triodia epactia</i> , <i>Triodia wiseana</i> , <i>Chrysopogon fallax</i>



3 *Acacia* High Shrubland

3a High Shrubland of *Acacia colei* over Scattered Herbs of *Alternanthera nodiflora* and *Centipeda minima*

Area Mapped: 1.47 ha

Quadrats Sampled: 31

Location and Landform

Vegetation Association 3a is located in the south-east corner of the survey area where artificial pooling of surface water occurs on the upslope of windrows established during clearing of access tracks. Vegetation is long unburnt and characterised by a high shrubland dominated by *Acacia colei* over scattered herbs. Vegetation condition was rated as 'degraded' in response to disturbance associated with clearing for access tracks, siltation in areas of pooling water, and grazing impacts from cattle.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia colei*, *Acacia elachantha*

Herb layer: *Alternanthera nodiflora*, *Centipeda minima*



3 *Acacia* High Shrubland

3b High Shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia colei* and *Acacia pyrifolia* over Low Shrubland of *Tephrosia rosea* var. *clementii*, *Pluchea tetranthera* and *Melhania oblongifolia* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana*

Area Mapped: 5.81 ha

Quadrats Sampled: 8

Location and Landform

Vegetation Association 3b occurs on sandy floodplains adjacent to the major drainage line (Vegetation Association 1) located along the northern fringe of the survey area. Vegetation supports open woodland of *Corymbia flavescens* and *Corymbia hamersleyana* over high shrubland of *Acacia* species, with low shrubland of *Tephrosia rosea* var. *clementii*, *Pluchea tetranthera* and *Melhania oblongifolia* and open hummock grassland of *Triodia epactia*. The introduced fodder species **Cenchrus ciliaris* (Buffel Grass) occurs as scattered plants. Vegetation condition was rated as 'very good' with disturbances related to cattle and weeds.

Vegetation Structure and Floristics

Tallest tree stratum:	<i>Corymbia flavescens</i> , <i>Corymbia hamersleyana</i>
Tallest shrub layer:	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia colei</i> , <i>Acacia pyrifolia</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i>
Lower shrub layer:	<i>Tephrosia rosea</i> var. <i>clementii</i> , <i>Pluchea tetranthera</i> , <i>Melhania oblongifolia</i> , <i>Tephrosia spechtii</i> , <i>Mollugo molluginis</i>
Tallest ground species:	<i>Triodia epactia</i> , * <i>Cenchrus ciliaris</i>



3 *Acacia* High Shrubland

3c High Shrubland of *Acacia colei*, *Grevillea wickhamii* subsp. *hispidulus* and *Grevillea pyramidalis* over Low Open Shrubland of *Pluchea tetranthera* over Hummock Grassland of *Triodia epactia*

Area Mapped: 0.77 ha

Quadrats Sampled: R28

Location and Landform

Vegetation Association 3c occurs along minor drainage lines (dolerite) restricted to the northern sector of the survey area. Vegetation shows a high degree of similarity to neighbouring Vegetation Association 7a (dolerite hill crests and slopes), differing in respect to the denser shrublands and dominance of *Triodia epactia* (as opposed to *Triodia wiseana* on hill slopes). Soil was red brown sand. Vegetation condition was rated as 'very good'.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia colei*, *Grevillea wickhamii* subsp. *hispidulus*,
Grevillea pyramidalis

Lower shrub layer: *Pluchea tetranthera*, *Tephrosia rosea* var. *clementii*,
Hibiscus sturtii var. *campylochlamys*

Tallest ground species: *Triodia epactia*



4 *Acacia* Scattered Shrubs

Scattered Shrubs of *Acacia* spp. and *Grevillea* spp. over Low Scattered Shrubs of *Pluchea tetranthera* and Scattered Hummock Grassland of *Triodia epactia*

Area Mapped: 11.67 ha

Quadrats Sampled: R47

Location and Landform

Vegetation Association 4 was associated with borrow pits and road verges occurring predominantly in the southern sector of the survey area. Vegetation condition was rated as 'degraded', with vegetation characterised by isolated individual shrubs of *Acacia tumida* var. *pilbarensis*, *Acacia colei*, *Acacia pyrifolia*, *Grevillea wickhamii* subsp. *hispidulus* and *Grevillea pyramidalis* over a variable cover of *Triodia epactia*.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia tumida* var. *pilbarensis*, *Acacia colei*, *Acacia pyrifolia*, *Grevillea wickhamii* subsp. *hispidulus*, *Grevillea pyramidalis*

Lower shrub layer: *Pluchea tetranthera*

Tallest ground species: *Triodia epactia*



5 *Pluchea* Low Shrubland

Low Shrubland of *Pluchea tetranthera* over Open Hummock Grassland of *Triodia epactia* with an Open High Shrubland of *Acacia colei*

Area Mapped: 2.80 ha

Quadrats Sampled: 12

Location and Landform

Vegetation Association 5 occurred in red brown sandy loam soils on stony floodplains in the central northern sector of the survey area. The unit was closely associated with the major drainage line (Vegetation Association 1) and adjacent sandy floodplains (Vegetation Association 3a). Vegetation was characterised by the dominance of *Pluchea tetranthera* in the low shrub stratum. Less prominent strata were the open hummock grassland (*Triodia epactia*), open high shrubland (*Acacia colei*), and scattered low trees (*Corymbia hamersleyana*). Vegetation condition was rated as 'excellent'.

Vegetation Structure and Floristics

Tallest tree stratum:	<i>Corymbia hamersleyana</i>
Tallest shrub layer:	<i>Acacia colei</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidulus</i> , <i>Grevillea pyramidalis</i>
Lower shrub layer:	<i>Pluchea tetranthera</i> , <i>Acacia stellaticeps</i> , <i>Tephrosia clementii</i> , <i>Mollugo molluginis</i>
Tallest ground species:	<i>Triodia epactia</i> , <i>Triodia wiseana</i>



6 *Triodia* Closed Hummock Grassland

Closed Hummock Grassland of *Triodia epactia* with High Shrubland of *Acacia colei*, *Grevillea pyramidalis* and *Acacia elachantha* over Low Open Shrubland of *Pluchea tetranthera*

Area Mapped: 12.42 ha

Quadrats Sampled: 9, 10, 15, 33, 36, 40

Location and Landform

Vegetation Association 6 occurred in red brown loamy sands on sandplains (sometimes stony) aligned north-east south-west through the middle of the survey area. Vegetation was characterised by the dense (closed) hummock grassland of *Triodia epactia*. A high shrubland stratum supported *Acacia colei*, *Grevillea pyramidalis* and *Acacia elachantha* above the cosmopolitan low shrub *Pluchea tetranthera*. Vegetation condition was rated as 'excellent'.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia colei*, *Grevillea pyramidalis*, *Acacia elachantha*, *Grevillea wickhamii* subsp. *hispidula*, *Acacia inaequilatera*, *Acacia pyrifolia*

Lower shrub layer: *Pluchea tetranthera*, *Tephrosia spechtii*

Tallest ground species: *Triodia epactia*, *Triodia wiseana*



7 *Triodia* Hummock Grassland

7a Hummock Grassland of *Triodia wiseana* with High Open Shrubland of *Grevillea pyramidalis*, *Acacia inaequilatera* and *Acacia colei* with Scattered Low Trees of *Corymbia hamersleyana*

Area Mapped: 36.04 ha

Quadrats Sampled: 13, 32, 34, 37, 38, 41

Location and Landform

Vegetation Association 7a occurred in red brown loamy sands on dolerite low hill crests and slopes distributed across the entire survey area. Vegetation was characterised by the presence of *Triodia wiseana* forming hummock grassland (with *Triodia epactia* in places), and *Acacia inaequilatera* forming high open shrubland with *Grevillea pyramidalis* and *Acacia colei*. Vegetation condition was rated as 'excellent'.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia hamersleyana*

Tallest shrub layer: *Grevillea pyramidalis*, *Acacia inaequilatera*, *Acacia colei*, *Acacia elachantha*, *Grevillea wickhamii* subsp. *aprica*

Lower shrub layer: *Pluchea tetranthera*, *Sida cardiophylla*

Tallest ground species: *Triodia wiseana*, *Triodia epactia*



7 *Triodia* Hummock Grassland

7b Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with High Shrublands of *Grevillea wickhamii* subsp. *aprica*

Area Mapped: 2.61 ha

Quadrats Sampled: R25, R26

Location and Landform

Vegetation Association 7b is restricted to one location in the western sector of the survey area, occurring on stony low hill slopes. Vegetation is similar to that represented on neighbouring low hills in Vegetation Association 7b, with the major differences being the denser cover provided by the high shrubland stratum, and dominance of *Grevillea wickhamii* subsp. *aprica* within this layer, and co-dominance of *Triodia wiseana* and *Triodia epactia* in the ground cover. The vegetation condition for Vegetation Association 7b was rated as 'very good', with grazing impacts by cattle evident along with edge effects from the adjacent road.

Vegetation Structure and Floristics

Tallest shrub layer: *Grevillea wickhamii* subsp. *aprica*, *Grevillea pyramidalis*

Tallest ground species: *Triodia wiseana*, *Triodia epactia*



8 *Triodia* Open Hummock Grassland

Open Hummock Grassland of *Triodia epactia* and *Triodia longiceps* with Low Open Shrubland of *Pluchea tetranthera* over Scattered Low Herbs of *Trianthema triquetra* and **Portulaca oleracea*

Area Mapped: 1.57 ha

Quadrats Sampled: 30, R40, R46, R48

Location and Landform

Vegetation Association 8 occurred as localised occurrences throughout the survey area, associated with unincised drainage lines supporting open vegetation structure owing to the presence of surface scalds. Vegetation was characterised by presence of *Triodia longiceps*, which formed open hummock grassland with *Triodia epactia*, and scattered herbs at ground level. *Pluchea tetranthera* formed low open shrubland and there were scattered clumps of the tall shrub *Acacia coleii* also evident. Vegetation condition was rated as 'good', with major disturbance related to grazing by cattle.

Vegetation Structure and Floristics

Tallest shrub layer: *Grevillea wickhamii* subsp. *aprica*, *Grevillea pyramidalis*

Lower shrub layer: *Pluchea tetranthera*

Tallest ground species: *Triodia epactia*, *Triodia longiceps*, *Trianthema triquetra*, **Portulaca oleracea*



9 Totally Cleared Vegetation

Bare

Area Mapped: 13.21 ha

Quadrats Sampled: NR

Location and Landform

Vegetation Association 9 was mapped along the cleared alignment of access tracks, haul roads, railway lines and mine infrastructure, which was most evident along the southern and eastern fringes of the survey area. Vegetation condition was rated as 'completely degraded'.

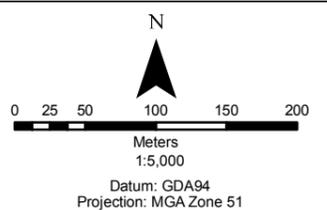
5.6.3 Yarrie Area B

A total of eleven vegetation associations were described and mapped (Figure 10) within the Yarrie Area B survey area (Table 7). The vegetation associations were classified into nine Broad Floristic Formations on the basis of canopy structure (Table 7).



ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	07/12/2010
Sheet Size:	A3	Status: Final
Drawn by: GSM	Requested by: DB	GSM Reference: FIGURE 10



YARRIE AREA B STUDY AREA Vegetation Map

- Legend**
- ✕ Onshore Environmental Studies Sites
 - Survey Area

Griffin Spatial & Mapping

2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 5213

Legend

Yarrie Area B Study Area

Acacia Open Scrub

 1a *Open Scrub of Acacia tumida, Acacia colei and Acacia pyrifolia over Open Hummock Grassland of Triodia epactia with Low Open Woodland of Corymbia hamersleyana*

 1b *Open Scrub of Acacia colei, Acacia tumida and Grevillea wickhamii over Open Hummock Grassland of Triodia epactia with Low Open Shrubland of Pluchea tetranthera*

Acacia Low Open Heath

 2 *Low Open Heath of Acacia stellaticeps over Hummock Grassland of Triodia epactia with Scattered Low Trees of Corymbia hamersleyana*

Low Scattered Shrubs

 3 *Scattered Shrubs over Scattered Hummock Grassland*

Triodia Closed Hummock Grassland

 4 *Closed Hummock Grassland of Triodia epactia with High Shrubland of Acacia tumida, Acacia colei and Acacia inaequilatera over Low Open Shrubland of Pluchea tetranthera*

Triodia Hummock Grassland

 5a *Hummock Grassland of Triodia wiseana with High Open Shrublands of Acacia inaequilatera, Grevillea pyramidalis and Grevillea wickhamii with Scattered Shrubs of Senna glutinosa ssp. glutinosa*

 5b *Hummock Grassland of Triodia epactia with Low Shrubland of Acacia ptychophylla with Scattered High Shrubs of Acacia colei and Acacia inaequilatera*

Triodia Open Hummock Grassland

 6 *Open Hummock Grassland of Triodia epactia with Scattered Low Trees of Corymbia hamersleyana over Scattered High Shrubs of Acacia tumida, Grevillea wickhamii and Acacia inaequilatera*

Marsilea Herbland

 7 *Herbland of Marsilea hirsuta with Scattered Sedges of Cyperus vaginatus with Scattered Hummock Grasses of Triodia longiceps and Triodia epactia*

Cleared Tracks, Haul Roads and Mine Infrastructure

 8

Waste Dumps

 9



ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	14/11/2010
Sheet Size:	A3	Status:	Final
Drawn by GSM	Requested by DB	Reference	FIGURE 10

YARRIE AREA B STUDY AREA

Vegetation Map Legend

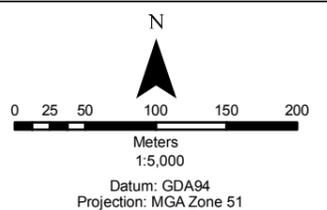


2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213



ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	07/12/2010
Sheet Size:	A3	Status: Final
Drawn by: GSM	Requested by: DB	GSM Reference: FIGURE 10a



YARRIE AREA B STUDY AREA Vegetation Map

- Legend**
- X Onshore Environmental Studies Sites
 - Survey Area

Griffin Spatial
& Mapping

2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 5213

217000

217500

218000

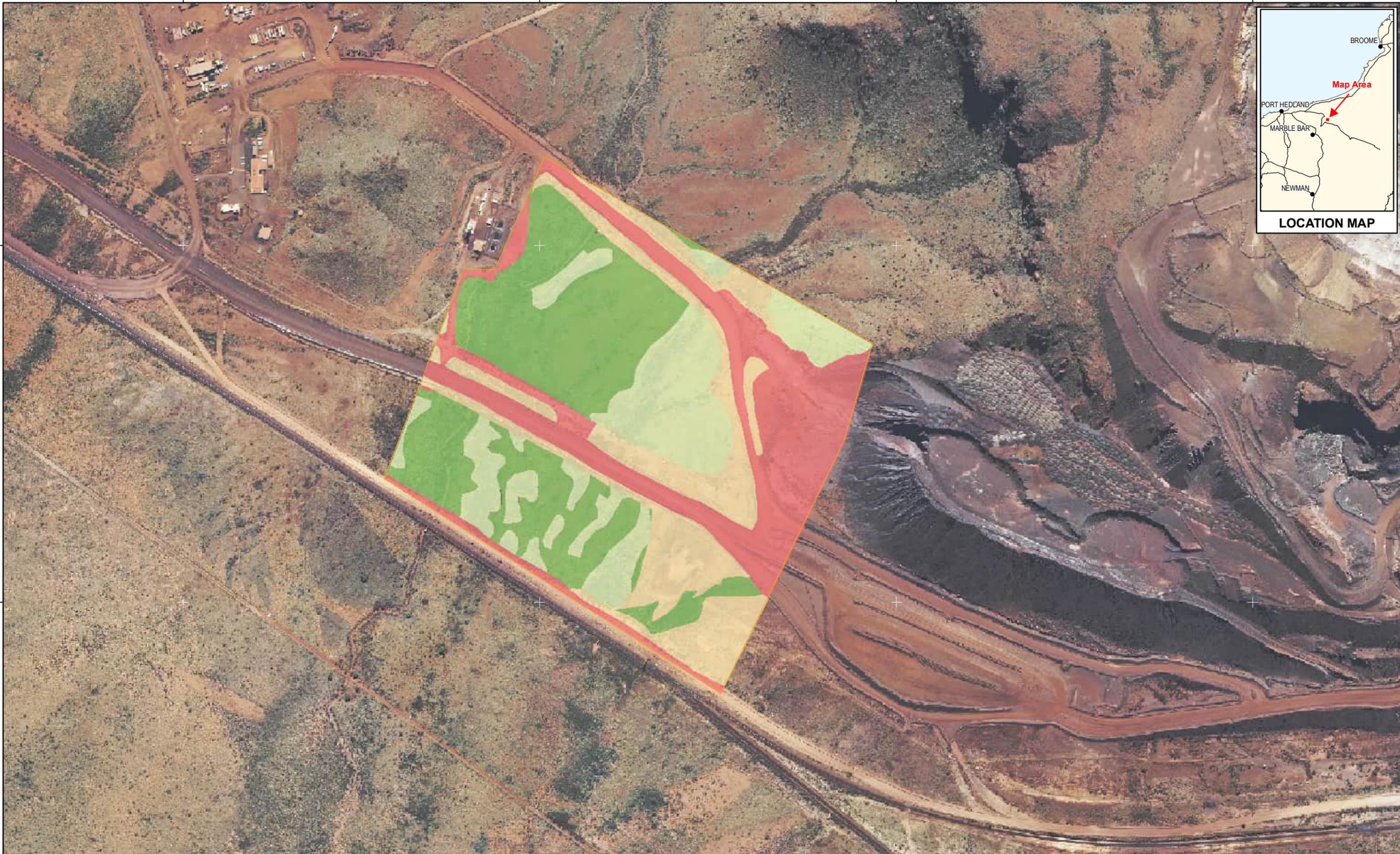
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LOCATION MAP

217000

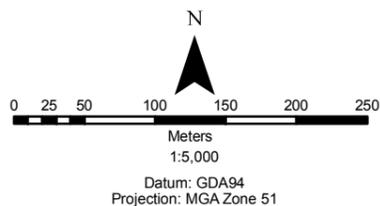
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ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	7/12/2010
Sheet Size:	A3	Status:	Final
Drawn by	Requested by	Reference	
GSM	DB	FIGURE 11	



YARRIE AREA B STUDY AREA

Vegetation Condition Map

Legend

- Survey Area
- Vegetation Condition**
- Excellent
- Very good
- Good
- Degraded
- Completely Degraded



2 Epacris Elbow Pelican Point
 Bunbury WA 6230
 griffinspatial@bigpond.com
 +61 (0) 8 9725 3213

Table 7 Vegetation descriptions (and associated landform and vegetation condition) for eleven vegetation associations mapped within the Yarrie Area B survey area by Onshore Environmental, September 2010. *Area (ha) represented within the survey area and % of total survey area.

Vegetation Association Code	Broad Floristic Formation	Vegetation Association Description	*Area (ha)	Landform	Vegetation Condition
1a	Acacia Open Scrub	Open Scrub of <i>Acacia tumida</i> , <i>Acacia colei</i> and <i>Acacia pyrifolia</i> over Open Hummock Grassland of <i>Triodia epactia</i> with Low Open Woodland of <i>Corymbia hamersleyana</i>	1.77	Medium Drainage Line	Very Good
1b	Acacia Open Scrub	Open Scrub of <i>Acacia colei</i> , <i>Acacia tumida</i> and <i>Grevillea wickhamii</i> over Open Hummock Grassland of <i>Triodia epactia</i> with Low Open Shrubland of <i>Pluchea tetranthera</i>	4.85	Minor drainage lines/zones	Good
2	Acacia Low Open Heath	Low Open Heath of <i>Acacia stellaticeps</i> over Hummock Grassland of <i>Triodia epactia</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i>	1.53	Stony plain	Very Good
3	Low Scattered Shrubs	Scattered Shrubs over Scattered Hummock Grassland	3.66	Tailings areas, borrow pits, old soil dumps, road verges	Degraded
4	Triodia Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia epactia</i> with High Shrubland of <i>Acacia tumida</i> , <i>Acacia colei</i> and <i>Acacia inaequilatera</i> over Low Open Shrubland of <i>Pluchea tetranthera</i>	2.44	Stony sandplains	Very Good
5a	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> with High Open Shrubland of <i>Acacia inaequilatera</i> , <i>Grevillea pyramidalis</i> and <i>Grevillea wickhamii</i> with Scattered Shrubs of <i>Senna glutinosa</i> ssp. <i>glutinosa</i>	3.36	Hill slopes and footslopes	Good
5b	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia epactia</i> with Low Shrubland of <i>Acacia ptychophylla</i> with Scattered High Shrubs of <i>Acacia colei</i> and <i>Acacia inaequilatera</i>	2.94	Stony plain	Very Good

Vegetation Association Code	Broad Floristic Formation	Vegetation Association Description	*Area (ha)	Landform	Vegetation Condition
6	Triodia Open Hummock Grassland	Open Hummock Grassland of <i>Triodia epactia</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i> over Scattered High Shrubs of <i>Acacia tumida</i> , <i>Grevillea wickhamii</i> and <i>Acacia inaequilatera</i>	3.20	Stony plain	Very Good
7	Marsilea Herbland	Herbland of <i>Marsilea hirsuta</i> with Scattered Sedges of <i>Cyperus vaginatus</i> with Scattered Hummock Grasses of <i>Triodia longiceps</i> and <i>Triodia epactia</i>	0.52	Waterhole and drainage zone	Degraded
8	Cleared Tracks, Haul Roads and Mine Infrastructure	none	3.53		Completely Degraded
9	Waste Dumps	none	1.80		Completely Degraded

1 *Acacia* Open Scrub

1a Open Scrub of *Acacia tumida*, *Acacia colei* and *Acacia pyrifolia* over Open Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia hamersleyana*

Area Mapped: 1.77 ha

Quadrats Sampled: 6

Location and Landform

Vegetation Association 1a was linked to a medium drainage line present along the western fringe of the survey area, and aligned roughly north-south. Soil was brown orange loamy sand in the incised drainage channel changing to brown loam on the banks. Vegetation was long unburnt and characterised by low open woodland of *Corymbia hamersleyana* above an open scrub stratum of *Acacia* species, with open hummock grassland of *Triodia epactia*. Tussock grasses and herbs were common in the drainage channel including *Eriachne tenuiculmis*, **Cenchrus ciliaris*, *Ipomoea muelleri* and *Cleome viscosa*. Vegetation condition was rated as 'very good' with disturbances related to grazing by cattle, occasional access tracks, and presence of introduced (weed) species.

Vegetation Structure and Floristics

Tallest tree stratum:	<i>Corymbia hamersleyana</i>
Tallest shrub layer:	<i>Acacia tumida</i> , <i>Acacia colei</i> , <i>Acacia pyrifolia</i> , <i>Melaleuca glomerata</i>
Lower shrub layer:	<i>Ipomoea muelleri</i> , <i>Cleome viscosa</i> , <i>Dysphania</i> <i>rhadinostachya</i> subsp. <i>rhadinostachya</i> , <i>Euphorbia</i> <i>schultzii</i> , <i>Salsola tragus</i>
Tallest ground species:	<i>Triodia epactia</i> , <i>Eriachne tenuiculmis</i> , * <i>Cenchrus</i> <i>ciliaris</i>



1 *Acacia* Open Scrub

1b Open Scrub of *Acacia colei*, *Acacia tumida* and *Grevillea wickhamii* subsp. *aprica* over Open Hummock Grassland of *Triodia epactia* with Low Open Shrubland of *Pluchea tetranthera*

Area Mapped: 4.85 ha

Quadrats Sampled: 1

Location and Landform

Vegetation Association 1b occurred along small (minor) drainage lines and drainage zones aligned roughly north-east south-west throughout the entire survey area.

Soil was brown silty sandy loam with surface pebbly scree. Vegetation was long unburnt and characterised by a dense stand of *Acacia* species between 1-3 m in height, forming open scrub. There were scattered low trees of *Corymbia hamersleyana* and open hummock grassland of *Triodia epactia*. There was a distinctive thick cover of leaf litter. Vegetation condition was rated as 'good' with disturbances related to grazing by cattle, edge effects from adjacent roads and tracks and scattered weeds.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia hamersleyana*

Tallest shrub layer: *Acacia colei*, *Acacia tumida*, *Grevillea wickhamii* subsp. *aprica*, *Acacia inaequilatera*, *Hakea lorea* subsp. *lorea*, *Grevillea pyramidalis*

Lower shrub layer: *Pluchea tetranthera*, *Melhania oblongifolia*

Tallest ground species: *Triodia epactia*, **Cenchrus ciliaris*



2 *Acacia* Low Open Heath

Low Open Heath of *Acacia stellaticeps* over Hummock Grassland of *Triodia epactia* with Scattered Low Trees of *Corymbia hamersleyana*

Area Mapped: 1.53 ha

Quadrats Sampled: 5, R4, R5, R12

Location and Landform

Vegetation Association 2 occurred on stony plains occurring adjacent to the medium drainage line (Vegetation Association 1a) present along the western fringe of the survey area. Soil was orange brown loam or sandy loam (compacted) with ironstone and siliceous chert cobbles on the surface. Vegetation was long unburnt and characterised by a low open heath (or sometimes low shrubland) of *Acacia stellaticeps*. Other strata included scattered low trees of *Corymbia hamersleyana*, scattered high shrubland of *Acacia tumida*, and hummock grassland of *Triodia epactia*. Vegetation condition was rated as 'very good' with the major disturbance being sitation of *in situ* soils originating from surface run-off.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia hamersleyana*

Tallest shrub layer: *Acacia tumida*, *Grevillea wickhamii* subsp. *aprica*,
Grevillea pyramidalis, *Acacia colei*, *Acacia*
inaequilatera, *Hakea lorea* subsp. *lorea*

Lower shrub layer: *Acacia stellaticeps*

Tallest ground species: *Triodia epactia*



3 Low Scattered Shrubs

Scattered Shrubs over Scattered Hummock Grassland

Area Mapped: 3.66 ha
Quadrats Sampled: R9

Location and Landform

Vegetation Association 3 occurred as narrow linear features distributed throughout the survey area, and typically occurring adjacent to areas of cleared vegetation; they included tailings deposition areas, borrow pits, historical soil dumps, road verges. Vegetation condition was rated as 'degraded' with vegetation structure reduced to scattered shrubs over scattered hummock grassland.

Vegetation Structure and Floristics

Tallest shrub layer: *Grevillea wickhamii* subsp. *aprica*, *Acacia coleii*
Lower shrub layer: **Aerva javanica*
Tallest ground species: *Triodia epactia*



4 *Triodia* Closed Hummock Grassland

Closed Hummock Grassland of *Triodia epactia* with High Shrubland of *Acacia tumida*, *Acacia coleii* and *Acacia inaequilatera* over Low Open Shrubland of *Pluchea tetranthera*

Area Mapped: 2.44 ha

Quadrats Sampled: 2, 42

Location and Landform

Vegetation Association 4 occurred on stony plains present in the south-west corner of the survey area. Soil was light brown sandy loam (compacted) with scattered pebbles on the surface. Vegetation was long unburnt and characterised by the dense (closed) hummock grassland of *Triodia epactia* and high shrubland dominated by *Acacia* species. Vegetation condition was rated as 'very good' with the major disturbances related to grazing by cattle and access tracks.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia tumida*, *Acacia coleii*, *Acacia inaequilatera*,
Acacia pyrifolia, *Grevillea wickhamii* subsp. *aprica*,
Grevillea pyramidalis

Lower shrub layer: *Pluchea tetranthera*

Tallest ground species: *Triodia epactia*



5 *Triodia* Hummock Grassland

5a Hummock Grassland of *Triodia wiseana* with High Open Shrubland of *Acacia inaequilatera*, *Grevillea pyramidalis* and *Grevillea wickhamii* subsp. *aprica* with Scattered Shrubs of *Senna glutinosa* subsp. *glutinosa*

Area Mapped: 3.36 ha

Quadrats Sampled: 3, 7

Location and Landform

Vegetation Association 5a occurred on hill slopes and foot slopes located predominantly in the north-east corner of the survey area, but with a small representation along the western fringe. Soil was red brown loam with surface scree of ironstone pebbles and cobbles. Vegetation was long unburnt and characterised by the presence of *Triodia wiseana* (forming hummock grassland). The two other vegetation strata present were high open shrubland of *Acacia inaequilatera*, *Grevillea pyramidalis* and *Grevillea wickhamii* subsp. *aprica* above scattered shrubs of *Senna glutinosa* subsp. *glutinosa*. Vegetation condition was rated as 'good' with the major disturbances related to proximity of existing mining operations; waste dumps, haul road, dust.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia hamersleyana*

Tallest shrub layer: *Acacia inaequilatera*, *Grevillea pyramidalis*, *Grevillea wickhamii* subsp. *aprica*, *Grevillea pyramidalis*, *Acacia colei*

Lower shrub layer: *Senna glutinosa* subsp. *glutinosa*, *Pluchea tetranthera*

Tallest ground species: *Triodia wiseana*, *Triodia epactia*



5 *Triodia* Hummock Grassland

5b Hummock Grassland of *Triodia epactia* with Low Shrubland of *Acacia ptychophylla* with Scattered High Shrubs of *Acacia colei* and *Acacia inaequilatera*

Area Mapped: 2.94 ha

Quadrats Sampled: 4, 43

Location and Landform

Vegetation Association 5b occurs as 'fingers' of vegetation on stony plains as well as along subtle drainage depressions, below footslopes in the central and south-eastern sectors of the survey area. Soil was red brown loam with ironstone pebbles and cobbles evident at the surface. Vegetation was long unburnt and characterised by low shrubland (to low open heath) of *Acacia ptychophylla* over *Triodia epactia* hummock grassland. There were scattered high shrubs of *Acacia colei* and *Acacia inaequilatera* and scattered low shrubs of *Pluchea tetranthera*. Vegetation condition ranged from 'excellent' to 'degraded' within this unit, and was rated as 'good' overall. The major disturbances recorded were grazing impacts from cattle and altered drainage along access tracks and powerline corridors.

Vegetation Structure and Floristics

Tallest shrub layer: *Acacia colei*, *Acacia inaequilatera*

Lower shrub layer: *Acacia ptychophylla*, *Pluchea tetranthera*

Tallest ground species: *Triodia epactia*



6 *Triodia* Open Hummock Grassland

Open Hummock Grassland of *Triodia epactia* with Scattered Low Trees of *Corymbia hamersleyana* over Scattered High Shrubs of *Acacia tumida*, *Grevillea wickhamii* subsp. *aprica* and *Acacia inaequilatera*

Area Mapped: 3.20 ha

Quadrats Sampled: R11, R14, R18, R51

Location and Landform

Vegetation Association 6 occurs between the 'fingers' of Vegetation Association 5b on stony plains located in the central sector of the survey area. Soil was red brown loam with a cover of ironstone pebbles and cobbles. A large proportion of this unit is bare stony areas. Vegetation was long unburnt and characterised by a very open vegetation structure comprising open hummock grassland of *Triodia epactia*, scattered low trees of *Corymbia hamersleyana*, and scattered high shrubs of *Acacia tumida*, *Grevillea wickhamii* subsp. *aprica* and *Acacia inaequilatera*. Vegetation condition was rated as 'very good' with disturbances related to grazing impacts from cattle.

Vegetation Structure and Floristics

Tallest tree stratum: *Corymbia hamersleyana*

Tallest shrub layer: *Acacia tumida*, *Grevillea wickhamii* subsp. *aprica*,
Acacia inaequilatera

Tallest ground species: *Triodia epactia*



7 *Marsilea* Herbland

Herbland of *Marsilea hirsuta* with Scattered Sedges of *Cyperus vaginatus* with Scattered Hummock Grasses of *Triodia longiceps* and *Triodia epactia*

Area Mapped: 0.52 ha
Quadrats Sampled: R3

Location and Landform

Vegetation Association 7 occurs in the south-east corner of the survey area associated with ephemeral man-made water holes and drainages. Soil was brown clay. Vegetation was characterised by a dense mat of *Marsilea hirsuta* ferns and other herb species including *Alternanthera nodiflora* and *Dysphania rhadinostachya* ssp. *rhadinostachya*. There were scattered sedges of *Cyperus vaginatus* and scattered hummock grasses of *Triodia longiceps* and *Triodia epactia*. Vegetation condition was rated as 'degraded' owing to the large amount of physical disturbance in the area.

Vegetation Structure and Floristics

Herb layer: *Marsilea hirsuta*, *Alternanthera nodiflora*, *Dysphania rhadinostachya* subsp. *rhadinostachya*
Sedge layer: *Cyperus vaginatus*
Tallest ground species: *Triodia longiceps*, *Triodia epactia*



8 Totally Cleared Vegetation - Tracks, Haul Roads and Mine Infrastructure

Bare

Area Mapped: 3.53 ha
Quadrats Sampled: NR

Location and Landform

Vegetation Association 8 was mapped along the cleared alignment of access tracks, haul roads and other mine infrastructure, which dissected the entire survey area. Vegetation condition was rated as 'completely degraded'.

9 Totally Cleared Vegetation - Waste Dumps

Bare

Area Mapped: 1.80 ha
Quadrats Sampled: NR

Location and Landform

Vegetation Association 9 occurred as bare stockpile areas generally located alongside the cleared alignment of access tracks and haul roads, and distributed across the entire survey area. Vegetation condition was rated as 'completely degraded'.

6.0 Results - Fauna

6.1 Desktop Review

6.1.1 Database Searches

Twenty nine species of significance have been previously recorded or may potentially occur in or near the survey areas according to the EPBC Act SPRAT database, DEC's NatureMap and previous surveys in the area (see Table 8). NatureMap yielded 81 vertebrate records for species recorded within 10 km of Shay Gap Aerodrome survey area and 99 vertebrate records for species recorded within 10 km of the two survey areas near the mine site (Yarrie Area A and Yarrie Area B).

6.1.2 Previous Surveys in the Area

A number of previous fauna surveys have taken place in the general area and include:

- Yarrie Biological & Soil Survey (Ecologia 1999);
- Goldsworthy Extension Project Biological Assessment Survey (Ecologia 2005);
- Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey (Ecologia 2005); and
- Goldsworthy Iron Ore Mining Operations - Cundaline and Callawa Mining Operations Targeted Fauna Assessment (Outback Ecology Services 2008).

For a comparison of species list see Appendix 7.

Yarrie Biological & Soil Survey (Ecologia 1999);

Five main habitats were recognized in the three survey areas. These were:

- Riverine;
- Gorge;
- Shrubland;
- Scree Slope; and
- Hilltop.

A total of eighty seven fauna species, comprised of 16 mammals (three of which were introduced), 43 birds, 24 reptiles, three amphibians and a single fish were recorded during the survey (ecologia, 1999). The only conservation significant species was the Western Pebble-mound Mouse (*Pseudomys chapmani*, Priority 4).

Goldsworthy Extension Project Biological Assessment Survey (Ecologia 2005)

Fauna sampling sites were located at Yarrie, Nimingarra, Sunrise Hill and Cattle Gorge in habitats consisting of:

- Gorge;
- Shrubland;
- Scree Slope;
- Plateau / Hilltop;
- Minor Drainage/Minor Gorge;
- Minor Drainage;
- Spinifex steppe;

- Major Drainage/Riverine; and
- Alluvial Plain.

The survey recorded 193 distinct taxa including numerous conservation significant species including:

- Australian Bustard (*Ardeotis australis*), Priority 4, Near Threatened;
- Bush Stone-curlew (*Burhinus grallarius*), Priority 4, Near Threatened;
- Common Sandpiper (*Actitis hypoleucos*), Migratory;
- Fork-tailed Swift (*Apus pacificus*), Migratory;
- Great Egret (*Ardea alba*), Migratory;
- Greenshank (*Tringa nebularia*) Migratory;
- Marsh Sandpiper (*Tringa stagnatilis*), Migratory;
- Snipe (*Gallinago* sp.) Migratory;
- Star Finch (*Neochmia ruficauda subclarescens*), Priority 4;
- Wood Sandpiper (*Tringa glareola*), Migratory;
- Lakeland Downs Mouse (*Leggadina lakedownensis*), Priority 4;
- Mulgara (*Dasyercus cristicauda*), Vulnerable and Schedule 1;
- Northern Quoll (*Dasyurus hallucatus*), Endangered and Schedule 1;
- Pilbara Leaf-nosed Bat (*Rhinonictus aurantius*), Vulnerable and Schedule 1;
- Western Pebble-mound Mouse (*Pseudomys chapmani*), Priority 4; and
- Pilbara Olive Python (*Liasis olivaceus barroni*), Vulnerable and Schedule 1.

Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey (Ecologia 2005)

Habitat of the area consisted predominantly of alluvial plain containing mixed *Acacia* spp. over *Triodia* hummock grassland. Eleven mammal species (including bats); 68 bird species; 27 reptile species; two amphibian species and one fish species were recorded during the survey. Significant species recorded include:

- Australian Bustard (*Ardeotis australis*), Priority 4.
- Common Sandpiper (*Actitis hypoleucos*), Migratory;
- Great Egret (*Ardea alba*), Migratory;
- Greenshank (*Tringa nebularia*) Migratory;
- Marsh Sandpiper (*Tringa stagnatilis*), Migratory;
- Wood Sandpiper (*Tringa glareola*), Migratory;
- Star Finch (*Neochmia ruficauda subclarescens*), Priority 4;
- Mulgara (*Dasyercus cristicauda*), Vulnerable and Schedule 1;
- Pilbara Leaf-nosed Bat (*Rhinonictus aurantius*), Vulnerable and Schedule 1; and
- Pilbara Olive Python (*Liasis olivaceus barroni*), Vulnerable and Schedule 1.

Goldsworthy Iron Ore Mining Operations - Cundaline and Callawa Mining Operations Targeted Fauna Assessment (Outback Ecology Services 2008)

This desktop and reconnaissance survey was undertaken to summarise the previous surveys at Callawa and Cundaline and describe the habitats at both locations. Trapping surveys undertaken by Ecologia in 2005 yielded 11 mammal species (10

native), 41 birds, 18 reptiles and one amphibian at Cundaline and 12 mammal species (11 native), 43 birds, 19 reptiles and one amphibian at Callawa.

Conservation significant species recorded during the survey include:

- Australian Bustard (*Ardeotis australis*), Priority 4;
- Peregrine Falcon (*Falco peregrinus*), Schedule 3;
- Rainbow Bee-eater (*Merops ornatus*), Migratory and
- Ghost Bat (*Macroderma gigas*), Priority 4;
- Northern Quoll (*Dasyurus hallucatus*), Endangered and Schedule 1;
- Pilbara Leaf-nosed Bat (*Rhinoicteris aurantius*), Vulnerable and Schedule 1;
- Western Pebble-mound Mouse (*Pseudomys chapmani*), Priority 4;
- Pilbara Olive Python (*Liasis olivaceus barroni*), Vulnerable and Schedule 1.

Table 8 Significant species recorded in or around the survey areas from the EPBC databases, NatureMap database, literature and Biologic’s local knowledge.

Group	Species	Common Name	IUCN	EPBC	State	DEC	Recorded this survey	Likelihood of occurrence in survey areas
Aves	<i>Apus pacificus</i>	Fork-tailed Swift		M			No	Medium :may fly over.
Aves	<i>Adrea alba</i>	Great Egret		M			No	Low : no suitable habitat.
Aves	<i>Ardea ibis</i>	Cattle Egret		M			No	Low : no suitable habitat.
Aves	<i>Ardeotis australis</i>	Australian Bustard	NT			P4	Yes	Recorded.
Aves	<i>Actitis hypoleucos</i>	Common Sandpiper		M				Low : no suitable habitat.
Aves	<i>Burhinus grallarius</i>	Bush Stone-curlew	NT			P4	No	High : Suitable habitat exists and species recorded near survey areas.
Aves	<i>Charadrius veredus</i>	Oriental Plover, Oriental Dotterel		M			No	Medium : Highly nomadic, may occur occasionally.
Aves	<i>Glareola maldivarum</i>	Oriental Pratincole		M			No	Medium : Highly nomadic, may occur occasionally.
Aves	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle		M			No	Low : no suitable habitat.
Aves	<i>Hirundo rustica</i>	Barn Swallow		M			No	Medium : habitat exists in the survey area.
Aves	<i>Merops ornatus</i>	Rainbow Bee-eater		M			Yes	Recorded.
Aves	<i>Neochmia ruficauda subclaescens</i>	Star Finch				P4		Low : no suitable habitat.
Aves	<i>Rostratula benghalensis s. lat.</i>	Australian Painted Snipe		M			No	Low : no suitable habitat.
Aves	<i>Snipe</i>	Gallinago sp.					No	Low : no suitable habitat.
Aves	<i>Tringa nebularia</i>	Greenshank		M			No	Low : no suitable habitat.
Aves	<i>Tringa stagnatilis</i>	Marsh Sandpiper		M			No	Low : no suitable habitat.
Aves	<i>Tringa glareola</i>	Wood Sandpiper		M			No	Low : no suitable habitat.
Mammalia	<i>Dasyercus blythi</i>	Brush-tailed Mulgara, Ampurta				P4	No. Possible old	High at Shay Gap Aerodrome - records exist around the airstrip from a survey in 1990s. Old burrows located during this survey may belong to

Group	Species	Common Name	IUCN	EPBC	State	DEC	Recorded this survey	Likelihood of occurrence in survey areas
							burrows recorded.	<p>this species. Species is not currently in the Survey areas but may move into the survey area in the future.</p> <p>Medium chance of occurrence at the survey areas (Yarrie Area A and B) in the east near the minesite: Very old burrows located during this survey may belong to this species. This area is highly disturbed with main mine roads in the area. No roadkills have been recorded. Record exists adjacent to the Cattle Gorge impact area (Ecologia, 2005).</p>
Mammalia	<i>Dasyercus cristicauda</i>	Crest-tailed Mulgara		V	S1		No. Possible old burrows recorded.	<p>High at Shay Gap Aerodrome - records exist around the airstrip from a survey in 1990s. Old burrows located during this survey may belong to this species. Species is not currently in the Survey areas but may move into the survey area in the future.</p> <p>Medium chance of occurrence at the Survey areas (Yarrie Area A and B) in the east near the minesite: Very old burrows located during this survey may belong to this species. This area is highly disturbed with main mine roads in the area. No roadkills have been recorded. Record exists adjacent to the Cattle Gorge impact area (Ecologia, 2005).</p>
Mammalia	<i>Dasyurus hallucatus</i>	Northern Quoll	E	E	S1		Yes	<p>Recorded in artificial habitat (portable infrastructure). No natural habitat for this species occurs in the survey areas apart from a small section of Major Drainage line.</p>

Group	Species	Common Name	IUCN	EPBC	State	DEC	Recorded this survey	Likelihood of occurrence in survey areas
Mammalia	<i>Lagorchestes conspicillatus subsp. leichardti</i>	Spectacled Hare-wallaby				P3	No	Low - Areas around the mine may be too disturbed. Medium - The Shay Gap Aerodrome is less disturbed. Species is not currently in the survey area but may move into the survey area in the future.
M	<i>Leggadina lakedownensis</i>	Short-tailed Mouse				P4	No	Low - no suitable habitat.
Mammalia	<i>Macroderma gigas</i>	Ghost Bat	V			P4	No	Medium - may forage in the area. No roosting habitat in survey area
Mammalia	<i>Macrotis lagotis</i>	Bilby, Dalgyte	V	V	S1		No	Low : no conspicuous burrow systems recorded. May utilise the areas for foraging.
Mammalia	<i>Notoryctes caurinus</i>	Northern Marsupial Mole	DD	E	S1		No	Low - no suitable habitat.
Mammalia	<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse				P4	Yes	Recorded
Mammalia	<i>Rhinonicteris aurantius</i>	Orange Leafnosed-bat		V	S1		No	Low - No roosting habitat. May forage in the area.
Reptilia	<i>Liopholis kintorei</i>	Great Desert Skink	V	V			No	Medium - Habitat exists in the survey areas. No evidence recorded during survey.
Reptilia	<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	V	V	S1		No	Low - no suitable habitat. Individuals may move through the area.

DD - Data deficient, V - Vulnerable, E - Endangered, S1 - Schedule 1, M - Migratory, P1 - Priority 1, P4 Priority 4, P4 - Priority 4, NT - Near Threatened, M - Migratory.

6.2 Vertebrate Fauna Species

During the survey 44 vertebrate species were recorded, the majority of which were avian taxa (see Tables 9-11). Thirteen mammal species, 21 bird species and 10 reptile species were recorded during the survey. Four hundred and eighty seven individual vertebrate records were made, of which over half were avian records.

Mammals

Thirteen mammal species were recorded during the survey (Table 9 details the mammals recorded). Two species of significance were recorded, Northern Quoll and Western Pebble-Mound Mouse. Possible burrows of Crest-tailed Mulgara or Brush-tailed Mulgara were recorded during the survey but have not been included in the species list as the identification of the burrows has been inconclusive. Four introduced species were recorded including Feral Cat (*Felis catus*).

Table 9 Recorded mammal species at Yarrie survey areas. A=Yarrie Area A, B=Yarrie Area B, SG=Shay Gap Aerodrome

Family	Scientific Name	Common Name	Areas
BOVIDAE	<i>Bos taurus</i>	Cow*	A, B, SG
CAMELIDAE	<i>Camelus dromedarius</i>	Camel*	SG
CANIDAE	<i>Canis lupus</i>	Wild Dog*	A, B, SG
DASYURIDAE	<i>Dasyurus hallucatus</i>	Northern Quoll	A
EMBALLONURIDAE	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tailed Bat	A, B
EMBALLONURIDAE	<i>Taphozous georgianus</i>	Common Sheath-tailed Bat	A, B
FELIDAE	<i>Felis catus</i>	Cat*	A, B, SG
MACROPODIDAE	<i>Macropus robustus</i>	Euro, Biggada	B
MACROPODIDAE	<i>Macropus rufus</i>	Red Kangaroo	A, B, SG
MURIDAE	<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	A
VESPERTILIONIDAE	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	A, B
VESPERTILIONIDAE	<i>Scotorepens greyii</i>	Little Broad-nosed Bat	A, B
VESPERTILIONIDAE	<i>Vespadelus finlaysoni</i>	Inland Cave Bat	A, B

*Denotes introduced species, **Bold** denotes species of significance

Birds

Twenty one bird species were recorded within the survey area (Table 10 details the birds recorded). Two species of significance were recorded, Australian Bustard (*Ardeotis australis*) and Rainbow Bee-eater (*Merops ornatus*).

Table 10 Recorded bird species at Yarrie survey areas. A=Yarrie Area A, B=Yarrie Area B, SG=Shay Gap Aerodrome

Family	Scientific Name	Common Name	Areas
ACCIPITRIDAE	<i>Aquila audax</i>	Wedge-tailed Eagle	A, B
ACCIPITRIDAE	<i>Haliastur sphenurus</i>	Whistling Kite	A, B
ACCIPITRIDAE	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	A, B
CACATUIDAE	<i>Eolophus roseicapillus</i>	Galah	A, B
CAMPEPHAGIDAE	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	A, B, SG
COLUMBIDAE	<i>Geopelia cuneata</i>	Diamond Dove	A, B
COLUMBIDAE	<i>Geophaps plumifera</i>	Spinifex Pigeon	A, B, SG
COLUMBIDAE	<i>Ocyphaps lophotes</i>	Crested Pigeon	A, B, SG
CORVIDAE	<i>Corvus orru</i>	Torresian Crow	A, B, SG

Family	Scientific Name	Common Name	Areas
DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	A, B, SG
ESTRILDIDAE	<i>Emblema pictum</i>	Painted Finch	A, B
ESTRILDIDAE	<i>Taeniopygia guttata</i>	Zebra Finch	A, B
FALCONIDAE	<i>Falco cenchroides</i>	Australian Kestrel	A, B
MALURIDAE	<i>Malurus lamberti</i>	Variegated Fairy-wren	A, B
MALURIDAE	<i>Malurus leucopterus</i>	White-winged Fairy-wren	A, B, SG
MELIPHAGIDAE	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	A, B
MELIPHAGIDAE	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	A, B
MELIPHAGIDAE	<i>Manorina flavigula</i>	Yellow-throated Miner	A, B
MEROPIIDAE	<i>Merops ornatus</i>	Rainbow Bee-eater	B
OTIDIDAE	<i>Ardeotis australis</i>	Australian Bustard	A
TURNICIDAE	<i>Turnix velox</i>	Little Button-quail	A, B

Bold denotes species of significance

Reptiles

10 reptile species were recorded from within the survey areas (Table 11 details the reptiles recorded). No significant reptile species were recorded.

Table 11 Recorded reptile species at Yarrie survey areas. A=Yarrie Area A, B=Yarrie Area B, SG=Shay Gap Aerodrome

Family	Scientific Name	Common Name	Areas
AGAMIDAE	<i>Amphibolurus longirostris</i>	Long-nosed Dragon	A, B
AGAMIDAE	<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon	A, B, SG
AGAMIDAE	<i>Ctenophorus isolepis</i>	Military Dragon	A, B, SG
AGAMIDAE	<i>Ctenophorus nuchalis</i>	Central Netted Dragon	A, B, SG
AGAMIDAE	<i>Pogona minor</i>	Bearded Dragon	A, B
GEKKONIDAE	<i>Gehyra punctata</i>	Spotted Dtella	A, B
SCINCIDAE	<i>Egernia depressa</i>	Spiny-tailed Skink	A, B
SCINCIDAE	<i>Morethia ruficauda</i>	Fire-tailed Skink	A
VARANIDAE	<i>Varanus eremius</i>		SG
VARANIDAE	<i>Varanus giganteus</i>	Perentie	A

Amphibian

No species of Amphibian were recorded.

6.3 Conservation Significant Fauna Species

Four species of conservation significance was recorded during the survey. Possible burrows of *Dasyercus* sp. were recorded but were considered old, and the decayed state did not allow for positive identification (see Figures 12-14 for locations of significant species).

Northern Quoll (*Dasyurus hallucatus*)

This species is considered Endangered under the EPBC Act and listed as Schedule 1 under the Wildlife Conservation Act 1950 (see Appendix 5 for conservation codes). Northern Quoll populations occur in six geographical centres, following an estimated 75% reduction the species range in the 20th Century: Drummond Range, central Queensland; the wet tropics of Northern Queensland; northern Cape York Peninsula; northern and western Top End, Northern Territory; north Kimberley and Pilbara, Western Australia (Braithwaite and Griffiths 1994).

Recent upgrading and interest in the conservation status of this species is due, in part, to the negative impact of Cane Toads (*Bufo marinus*) in more easterly parts of the Quoll's range, where local populations have become extinct within a year of Cane Toad arrival (Oakwood 2008). Studies suggest that the Cane Toad will colonise much of the remainder of the Northern Quoll's natural mainland range over the next 10 - 20 years (Sutherst et al.1995). Other threats include inappropriate fire regimes and predation.

Scats of this species were recorded from under the Mining Academy Buildings (GDA94 51K 216462, 7719249). It is likely that this species is living under the buildings and taking advantage of resources created by human activity e.g. water. No natural habitat occurs in the survey areas apart from a small area of Major Drainage Line habitat.

Western Pebble-mound Mouse (*Pseudomys chapmani*)

Western Pebble-mound Mice are listed as Priority 4 by the DEC, due to a significant decline in their range from the Gascoyne and Murchison (van Dyck and Strahan, 2008). Preferred habitat includes the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (van Dyck and Strahan, 2008). Three pebble mounds belonging to this species were recorded during the survey (see Table 12 for locations).

Table 12 Locations of *Pseudomys chapmani* mounds (51K, GDA94).

Species	Easting	Northing
<i>Pseudomys chapmani</i>	216404	7719287
<i>Pseudomys chapmani</i>	215763	7718508
<i>Pseudomys chapmani</i>	215699	7718571

Crest-tailed Mulgara (*Dasyercus cristicauda*) and Brush-tailed Mulgara (*Dasyercus blythi*)

Both species have been recorded in the area according to Naturemap, and a previous record exists at the Airstrip made during a previous survey in the 1990s. A more recent record was made adjacent to the Cattle Gorge impact area (Ecologia, 2005).

Potential burrows of Mulgara were recorded at five locations in all survey areas (see Appendix 8 for locations). These burrows were considerably old and decayed therefore the burrows have been deemed as potentially belonging to one of the *Dasyercus* species. The survey areas and adjacent good quality habitat were searched for active burrows and no records were made.

Australian Bustard (*Ardeotis australis*) - Priority 4

The Australian Bustard is one of the largest flighted birds in the world. It is found through most of Australia but is more common inland and north. Preferred habitat is grasslands, low shrublands and lightly timbered woodlands (Schodde, 1976). This species is listed as Priority 4 which is applied to taxa that are considered to have been adequately surveyed for and sufficient information is known to ascertain that they are not currently threatened but could become so if present circumstances change.

A feather belonging to this species was recorded near to the Haul Road into Yarrie (GDA94 51K 215940, 7718617).

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as Migratory under the EPBC Act and under Schedule 3 of the Wildlife Conservation Act. This species occurs year-around in the tropics of northern Australia, with a southward migration, to both south-eastern and south-western Australia, in early spring. Southern birds return north in autumn (Johnstone and Storr 1998). It has a wide range and occurs in the better watered parts of Western Australia, between the Kimberley and south-west of WA, preferring lightly wooded, preferably sandy country near water (Johnstone and Storr, 1998). It nests in burrows dug usually at a slight angle in flat ground, gently elevated slopes, sandy banks or cuttings, and often at the margins of roads or tracks.

This species was observed in the survey areas where it is likely to be utilising water from the mine site (GDA94 51K 217712 7717829).

6.4 Introduced Fauna

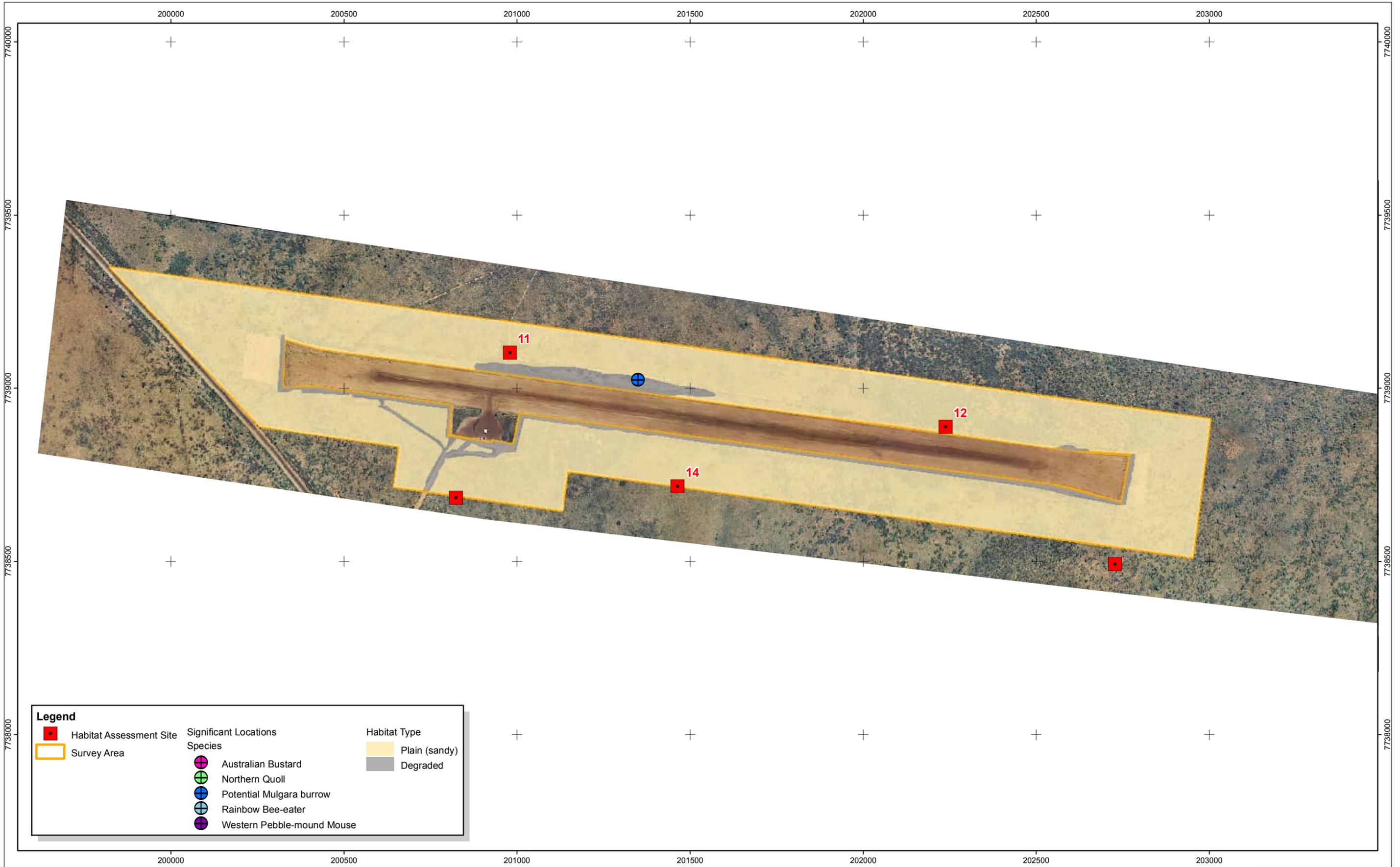
Tracks and scats of Wild Dog (*Canis lupus*), Cat (*Felis catus*) Camel (*Camelus dromedaries*) and Cow (*Bos taurus*) were recorded in the survey areas. Introduced House Mouse (*Mus musculus*) is likely to occur in the area and would be picked-up in a trapping regime.

6.5 Fauna Habitat

Four broad habitat types (see Figures 12-14 for the Habitat Maps) were identified in the survey areas and consisted of:

- Major Drainage Line;
- Slopes with Rocky outcrops;
- Plains, comprised of sandy and stoney plains, dissected by the occasional minor drainage line; and
- A single artificial waterbody.

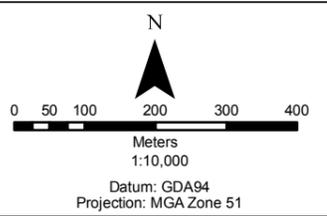
A description of each habitat type, its ecological characteristics and value for threatened fauna is provided in Table 13, and the details recorded during the habitat assessments is given in Appendix 10. The habitat assessments were analysed to determine the key characteristics that differentiated each habitat from the others (Table 13). The quality of the habitats in the survey areas is fairly degraded due to nearby mining operations and frequent fire regimes.



Legend

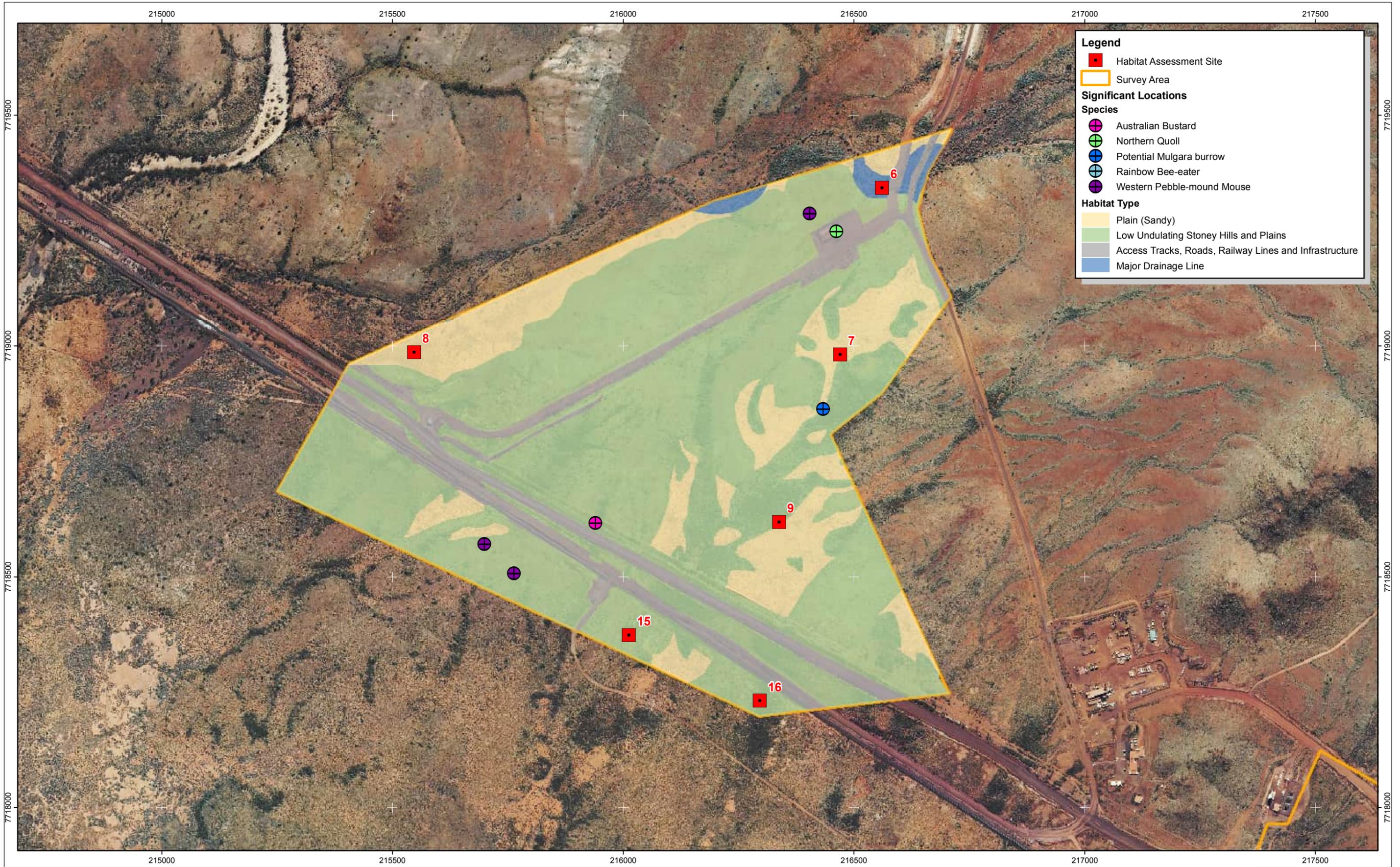
	Habitat Assessment Site	Significant Locations Species		Plain (sandy)	
	Survey Area		Australian Bustard		Degraded
			Northern Quoll		
			Potential Mulgara burrow		
			Rainbow Bee-eater		
			Western Pebble-mound Mouse		

ON SHORE ENVIRONMENTAL CONSULTANTS	Date: 7/12/2010
Sheet Size: A3	Status: Final
Drawn by: GSM	Requested by: DB
GSM Reference: FIGURE 12	

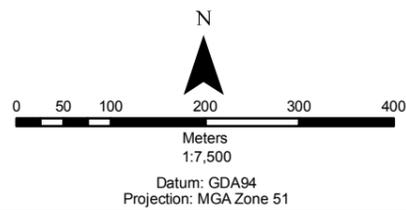


**SHAY GAP STUDY AREA
Fauna Habitat
& Significant Locations**

2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213



ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	07/12/2010
Sheet Size:	A3	Status: Final
Drawn by GSM	Requested by DB	GSM Reference FIGURE 13



YARRIE AREA A STUDY AREA

Fauna Habitat & Significant Locations



2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213

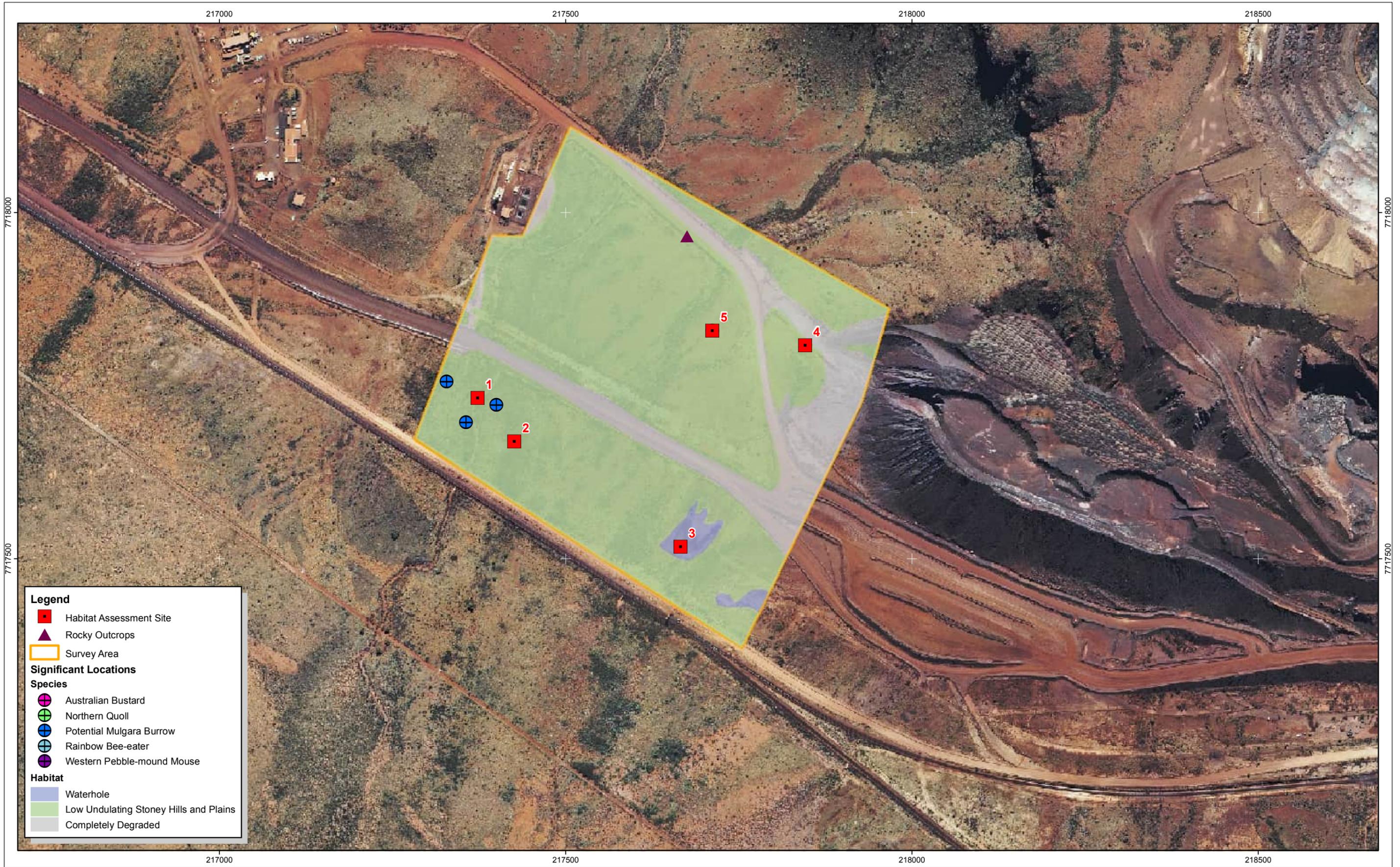


Table 13 Habitat types, their characteristics and their ability to support significant species.

Broad Fauna Habitat Type	Characteristics	Value for significant species	Overall Value	Photo
<p>Major Drainage Line: <i>Eucalyptus</i> woodland located in the corner of the middle survey area.</p>	<ul style="list-style-type: none"> • Large trees; • hollow bearing trees (2 per 2500m²); • Seasonal pools; • Many stags (15 per 2500m²); • Good ground cover (3% leaf litter, 5% twig litter); • Fallen logs (3 per 2500m²) and debris; and • Shady and cool. 	<p>Pilbara Olive Python:</p> <ul style="list-style-type: none"> • Habitat suitable for hunting; and • Habitat suitable for dispersal during wet periods. <p>Pilbara Leaf-nosed Bat:</p> <ul style="list-style-type: none"> • This species is known to hunt insects over waterbodies and dense stands of vegetation. <p>Northern Quoll:</p> <ul style="list-style-type: none"> • Habitat suitable for den sites (hollows) and hunting. <p>Bush Stone-curlew</p> <ul style="list-style-type: none"> • Habitat suitable for nesting and foraging. <p>Migratory species</p> <ul style="list-style-type: none"> • Habitat suitable to support migratory listed species especially after rain. Rainbow Bee-eater is likely to hunt insects in this habitat. <p>General Use:</p> <ul style="list-style-type: none"> • Tree hollows would be important for many hollow nesting bird species including the rarely recorded Barn Owl. The large trees would also provide potential nesting sites for birds of prey. Habitat probably important for providing cool areas to aid local reptiles in thermoregulation. 	<p>High</p>	

Broad Fauna Habitat Type	Characteristics	Value for significant species	Overall Value	Photo
<p>Spinifex slopes with rocky outcrops: Scattered <i>Eucalyptus</i> sp. over scattered medium shrubs, over <i>Triodia</i> hummock grassland. Recorded in one location.</p>	<ul style="list-style-type: none"> • Hummock grassland; • Low leaf litter (1%); • Low twig litter (1%); • Occasional tree hollows; • Small pebbles and cobbles; and • Crevices and cracks 	<p>Western Pebble Mound Mouse:</p> <ul style="list-style-type: none"> • Provides pebbles for mound construction; • Hummock grass provides protection; and foraging areas. 	<p>Low</p>	

Broad Fauna Habitat Type	Characteristics	Value for significant species	Overall Value	Photo
<p>Plain: Sandy plain with occasional stoney areas. The majority of the survey area consists of this habitat type.</p> <p>Habitat is dissected by occasional minor drainage line and covered with occasional patches of shrubland.</p>	<ul style="list-style-type: none"> • Hummock grassland; • Low leaf litter (0 - 5%); • Twig litter (0 - 5%); • Burnt in places; • Pebbles, cobbles and stones present in some locations. 	<p>Mulgara species</p> <ul style="list-style-type: none"> • Habitat suitable for the construction of burrow systems; and • Habitat suitable for hunting and foraging. <p>Bilby</p> <ul style="list-style-type: none"> • Habitat suitable for the construction of burrow systems; and • Habitat suitable for hunting and foraging. <p>Australian Bustard</p> <ul style="list-style-type: none"> • Habitat suitable for nesting; and • Habitat suitable for hunting and foraging. <p>Bush Stone-curlew</p> <ul style="list-style-type: none"> • Habitat suitable for hunting and foraging. <p>Oriental Plover</p> <ul style="list-style-type: none"> • Habitat suitable for hunting and foraging. <p>Great Desert Skink</p> <ul style="list-style-type: none"> • Habitat suitable for the construction of burrows. 	<p>High</p>	

Broad Fauna Habitat Type	Characteristics	Value for significant species	Overall Value	Photo
Artificial Waterbody	<ul style="list-style-type: none"> Body of water 60m x 60m 	<p>Significant Species</p> <ul style="list-style-type: none"> May provide water for significant species. <p>Migratory species</p> <ul style="list-style-type: none"> May support migratory listed species especially after rain. Rainbow Bee-eater is likely to benefit from this habitat. 	Low	

7.0 Native Vegetation Clearing Permit

7.1 Consideration for the Ten Clearing Principles

Sensitivities of the Shay Gap and Yarrie survey areas in respect to application for a Native Vegetation Clearing Permit can be addressed in relation to the ten Clearing Principles (Table 14), as specified in Schedule 5 of the *Environmental Protection Act 1986*.

Table 14 Considerations at the Shay Gap Aerodrome, Yarrie Area A, and Yarrie Area B survey areas with respect to the Native Vegetation Clearing Permit.

Principle*	Criterion	Assessment	Outcome
<i>a) Native vegetation should not be cleared if it comprises a high level of biological diversity.</i>	<i>a1) Native vegetation should not be cleared if it is representative of an area of outstanding biodiversity in the Bioregion.</i>	The vegetation within the survey areas is not representative of an area of outstanding biodiversity. Species richness for the Shay Gap and Yarrie survey areas is representative of the Pilbara bioregion.	Not at variance with the clearing principles
	<i>a2) Native vegetation should not be cleared if it has higher diversity of indigenous aquatic or terrestrial plant or fauna species than native vegetation of that ecological association in good or better condition in the Bioregion.</i>	The native vegetation within the survey areas is not considered to contain vegetation in good or better condition than similar vegetation within the vicinity of the survey areas.	Not at variance with the clearing principles
	<i>a3) Native vegetation should not be cleared if it has higher diversity of indigenous aquatic or terrestrial plant or fauna species than the remaining vegetation of that ecological association in the local area.</i>	Native vegetation in the survey areas is not considered to contain a higher diversity of indigenous aquatic or terrestrial plant or fauna species than the remaining vegetation of that ecological association in the local area	Not at variance with the clearing principles

Principle*	Criterion	Assessment	Outcome
	<p><i>a4) Native vegetation should not be cleared if it has higher ecosystem diversity than other native vegetation of that local area.</i></p>	<p>Native vegetation within the survey areas is not considered to have higher ecosystem diversity than other native vegetation of that local area.</p>	<p>Not at variance with the clearing principles</p>
	<p><i>a5) Native vegetation should not be cleared if it has higher genetic diversity than the remaining native vegetation of that ecological association.</i></p>	<p>The native vegetation is not considered to have a higher genetic diversity than the remaining native vegetation of that ecological association.</p>	<p>Not at variance with the clearing principles</p>
<p><i>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.</i></p>	<p><i>b1) Native vegetation should not be cleared if it is or is likely to be habitat for fauna that is declared Specially Protected under the Wildlife Conservation Act.</i></p>	<p>The Northern Quoll was recorded in the survey areas by secondary evidence. This record was made underneath portable accommodation. The only natural habitat that exists in the survey areas is a small area of Major Drainage Line habitat.</p> <p>Crest-tailed Mulgara may occur in the Survey areas, as old burrows that could not be ruled out as belonging to this species were recorded at five locations. Habitat for this species is extensive outside of the Survey areas.</p> <p>Characteristic and obvious Bilby burrow systems were not recorded during the survey despite ample transect searching. Habitat for this species exists in the Survey areas however habitat is extensive outside of the Survey areas.</p> <p>Great Desert Skink habitat exists in the Survey areas but no records of its characteristic burrow system were made despite ample transect searching</p>	<p>Unlikely to be at variance with the clearing principles as habitat does not appear to be necessary for the maintenance of a significant species.</p>

Principle*	Criterion	Assessment	Outcome
	<p><i>b2) Native vegetation should not be cleared if it is or is likely to be habitat for Priority Listed Fauna.</i></p>	<p>Habitat for the Australian Bustard (recorded) and Bush Stone-curlew was recorded in the Survey areas. Due to their nomadic nature, if disturbed both of these species have ability to move into ample adjacent habitat.</p> <p>Brush-tailed Mulgara may occur in the Survey areas as old burrows that could not be ruled out as belonging to this species were recorded at five locations. Habitat for this species is extensive outside of the Survey areas.</p> <p>Habitat for Spectacled Hare-wallaby exists in the Survey areas. This species was not recorded during the survey. Ample habitat for this species was recorded outside of the Survey areas.</p> <p>No Ghost Bat roosts occur in the Survey areas. This species may forage in the Survey areas but also likely to forage in surrounding suitable habitat and does not rely on the habitat in the Survey areas.</p> <p>Western Pebble-mound Mouse occurs in the Survey areas and are numerous on the ridges surrounding the Survey areas.</p>	<p>Unlikely to be at variance with clearing principles as ample habitat for priority species exists in the surrounding area. Most priority species can move to new areas when disturbed. Numerous records for most of these priority species exist in the surrounding area.</p>
	<p><i>b3) Native vegetation should not be cleared if it is or is likely to be habitat for fauna that is otherwise significant.</i></p>	<p>No otherwise significant fauna was recorded during the survey.</p>	<p>Considered unlikely to be at variance with the clearing principles</p>
	<p><i>b4) Native vegetation should not be cleared if it provides significant habitat for fauna species in the local area.</i></p>	<p>No otherwise significant fauna was recorded during the survey.</p>	<p>Considered unlikely to be at variance with the clearing principles</p>

Principle*	Criterion	Assessment	Outcome
	<i>b5) Native vegetation should not be cleared if it maintains ecological functions and processes that protect significant habitat for fauna</i>	Native vegetation in the area does not maintain ecological functions and processes that protect significant habitat for fauna.	Considered unlikely to be at variance with the clearing principles
	<i>b6) Native vegetation should not be cleared if it forms, or is part of, an ecological linkage that is necessary for the maintenance of fauna.</i>	Vegetation in the project area is not part of an ecological linkage.	Not at variance with the clearing principles
	<i>b7) Native vegetation should not be cleared if it provides significant habitat for fauna associations (assemblages) and metapopulations.</i>	Native vegetation in the project area does not provide significant habitat for fauna communities or metapopulations.	Not at variance with the clearing principles
<i>c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.</i>	<i>c1) Native vegetation should not be cleared if it is necessary for the continued in situ existence of populations of Declared Rare Flora under the Wildlife Conservation Act 1950.</i>	No DRF was recorded from the survey areas.	Not at variance with the clearing principles
	<i>c2) Native vegetation should not be cleared if it is necessary for the continued in situ existence of other significant flora.</i>	No significant flora species were recorded in the survey areas.	Not at variance with the clearing principles
	<i>c3) Native vegetation should not be cleared if it is necessary for the continued in situ existence of significant habitat for priority flora species published by the Department of Environment and Conservation.</i>	No Priority flora species were recorded in the survey areas.	Not at variance with the clearing principles
<i>d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance</i>	<i>d1) Native vegetation should not be cleared if threatened ecological associations listed under the Commonwealth EPBC Act 1999 are present.</i>	No EPBC Act TECs will be impacted by the proposed works.	Not at variance with the clearing principles

Principle*	Criterion	Assessment	Outcome
<i>of a threatened community.</i>	<i>d2) Native vegetation should not be cleared if it is necessary for the maintenance of Threatened Ecological Communities listed under the Commonwealth EPBC Act 1999.</i>	No EPBC Act TECs will be impacted by the proposed works.	Not at variance with the clearing principles
	<i>d3) Native vegetation should not be cleared if other significant ecological communities are present.</i>	No other significant ecological communities will be cleared by the proposed works.	Not at variance with the clearing principles
	<i>d4) Native vegetation should not be cleared if it is necessary for the maintenance of other significant ecological communities.</i>	No DEC listed TECs or associated native vegetation will be impacted by the proposed works.	Not at variance with the clearing principles
	<i>d5) Native vegetation should not be cleared if it is necessary for the continued in situ existence of significant examples of priority threatened ecological communities published by the Department of Environment and Conservation.</i>	No PECs are known from within the vicinity of the survey areas.	Not at variance with the clearing principles
<i>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.</i>	<i>e1) Native vegetation should not be cleared if the remaining native vegetation represents less than 30%, or the clearing would reduce the representation of remaining native vegetation to less than 30% in the Bioregion (or subregion where applicable).</i>	Clearing native vegetation within the survey areas will not significantly reduce the known extent from pre-European extents.	Not at variance with the clearing principles
	<i>e2) Native vegetation should not be cleared if an ecological community represents less than 30% of its original extent or clearing would reduce the representation of any ecological community to less than 30% of its original extent in the Bioregion (or subregion where applicable).</i>	Clearing Native vegetation within the survey areas will not significantly reduce the known extent from pre-European extents.	Not at variance with the clearing principles

Principle*	Criterion	Assessment	Outcome
	<i>e3) Native vegetation should not be cleared if clearing would reduce an community to less than 1% of the Bioregion (or subregion where applicable)</i>	Clearing Native vegetation within the survey areas will not significantly reduce the known extent from pre-European extents.	Not at variance with the clearing principles
	<i>e4) Native vegetation should not be cleared if the remaining native vegetation represents less than 30% or the clearing would reduce the representation of remaining native vegetation to less than 30% in the Local Area.</i>	Clearing Native vegetation within the survey areas will not significantly reduce the known extent from pre-European extents.	Not at variance with the clearing principles
	<i>e5) Native vegetation should not be cleared if an ecological community represents less than 30% of its original extent or clearing reduce the representation of any ecological community to less than 30% of its original extent in the Local Area.</i>	Clearing Native vegetation within the survey areas will not significantly reduce the known extent from pre-European extents.	Not at variance with the clearing principles
	<i>e6) Native vegetation should not be cleared if clearing would reduce any ecological community to less than 1% of the Local Area.</i>	Clearing Native vegetation within the survey areas will not significantly reduce the known extent from pre-European extents.	Not at variance with the clearing principles
<i>f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.</i>	<i>f1) Native vegetation should not be cleared if it is growing in a watercourse or wetland that has been identified as having significant environmental values.</i>	Native vegetation associations within the survey areas growing in ephemeral watercourses do not have significant environmental values.	Not at variance with the clearing principles
	<i>f2) Native vegetation should not be cleared if it provides a buffer area for watercourses and wetlands identified in criteria (f1) and (f2).</i>	There are no vegetation associations within the survey areas that provide a set-back (buffer) to watercourses or wetlands.	Not at variance with the clearing principles

Principle*	Criterion	Assessment	Outcome
	<i>f3) Native vegetation should not be cleared if water tables are likely to change and adversely affect ecological communities that are wetland or groundwater dependent.</i>	Due to the scale of clearing for the specific projects it is not considered likely to adversely alter water tables, and as such will not impact on any ecological communities that are wetland or groundwater dependent.	Not at variance with the clearing principles
	<i>f4) Native vegetation should not be cleared if it is growing in other watercourses or wetlands.</i>	There are no natural wetlands within the survey areas. There may be minor disturbance to ephemeral drainage lines present in the survey areas. However, the overall impact on associated vegetation types will be negligible.	Not at variance with the clearing principles
<i>g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.</i>	<i>g1) Native vegetation should not be cleared if wind or water erosion of soil is likely to be increased (on or off site).</i>	Short-term soil erosion may be associated with clearing. Soil erosion can be mitigated by use of appropriate water management and rehabilitation regimes.	Not at variance with the clearing principles
	<i>g2) Native vegetation on land with soils with high or low pH should not be cleared.</i>	The survey areas are not considered to contain soils at risk of having Acid Sulphate Soils present. No vegetation on soils with significantly low (or high) pH will be impacted by the proposed works.	Not at variance with the clearing principles
	<i>g3) Native vegetation should not be cleared if water logging is likely to be increased (on or off site).</i>	It not expected that waterlogging would be increased by the clearing of native vegetation within the survey areas.	Not at variance with the clearing principles
	<i>g4) Native vegetation should not be cleared if land salinisation is likely to be increased (on or off site).</i>	Soil salinity is not considered to be increased in the survey areas (on or off site) by the clearing of native vegetation.	Not at variance with the clearing principles

Principle*	Criterion	Assessment	Outcome
<i>h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values</i>	<i>h1) Native vegetation should not be cleared if it contributes significantly to the environmental values of a conservation area.</i>	There are no conservation areas within the vicinity of the survey areas.	Not at variance with the clearing principles
	<i>h2) Native vegetation should not be cleared if that vegetation provides a buffer to a conservation area.</i>	There are no conservation areas within the vicinity of the survey areas.	Not at variance with the clearing principles
	<i>h3) Native vegetation should not be cleared if the land contributes to an ecological linkage to a conservation area.</i>	There are no conservation areas within the vicinity of the survey areas.	Not at variance with the clearing principles
	<i>h4) Native vegetation should not be cleared if it provides habitats not well represented on conservation land.</i>	There are no habitats within the survey areas that are not well represented on conservation land.	Not at variance with the clearing principles
<i>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.</i>	<i>i1) Native vegetation should not be cleared if clearing the vegetation will reduce the quality of surface or underground water in proclaimed, gazetted or declared areas or catchments.</i>	The clearing of native vegetation is not considered likely to alter the quality of surface or ground waters within the survey areas due to the small size of the areas and lack of waterbodies in the vicinity.	Not at variance with the clearing principles
	<i>i2) Native vegetation should not be cleared if sedimentation, erosion, turbidity or eutrophication of water bodies on or off site is likely to be caused or increased.</i>	Localised erosion will not impact any waterbodies as none are present within the survey areas.	Not at variance with the clearing principles
	<i>i3) Native vegetation should not be cleared if water tables are likely to change significantly altering salinity or pH.</i>	The clearing of native vegetation is not considered likely to alter the quality of surface or ground waters within the survey areas.	Not at variance with the clearing principles

Principle*	Criterion	Assessment	Outcome
	<i>i4) Native vegetation should not be cleared if the clearing is likely to alter the water regimes of groundwater dependent ecosystems (GDEs) on or off site, causing degradation to the biological associations associated with these systems.</i>	The clearing of native vegetation is not considered likely to alter the regimes of surface or groundwater dependent vegetation within the survey areas.	Not at variance with the clearing principles
<i>j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.</i>	<i>j1) Native vegetation should not be cleared if it is likely to lead to an incremental increase in peak flood height.</i>	The clearing of native vegetation is not considered likely to cause any alteration to flood duration or flood height.	Not at variance with the clearing principles
	<i>j2) Native vegetation should not be cleared if it is likely to lead to an incremental increase in duration of flood peak.</i>	The clearing of native vegetation is not considered likely to cause any impact on local or regional flooding.	Not at variance with the clearing principles

8.0 Study Team

The Level 2 flora and vegetation survey and Level 1 fauna survey of the Shay Gap and Yarrie survey areas was planned, co-ordinated and executed by the following personnel:

Level 2 Flora & Vegetation Survey
Onshore Environmental Consultants P/L
ABN 41 095 837 120
PO Box 227
YALLINGUP WA 6282
pf 08 9756 6206 m0427 339 842
Email onshoreenv@westnet.com.au

Level 1 Fauna Survey
Biologic Environmental Survey P/L
ABN 18 077 458 834
24 Gregory Ave
Newman 6872
Pf 08 9175 0580 m0433 542 309
morgan@biologicenv.com.au

Project Staff

Dr Darren Brearley	PhD	Project Manager
Dr Jerome Bull	PhD	Senior Botanist
Mr Morgan O'Connell	BSc	Senior Biologist
Mr Thomas Rasmussen		Biologist

Licences

The field survey was conducted under the authorisation of the following licences issued by the Department of Environment & Conservation:

- Jerome Bull, Onshore Environmental Consultants 'Licence to take flora for scientific & other prescribed purposes' Licence No. SL007739
- Morgan O'Connell, Biologic Environmental 'Licence to take flora for scientific & other prescribed purposes' Licence No. SL008411
- Regulation 17 licence SF006985

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APPENDIX 1 Vegetation Classifications for the Pilbara based on Specht (1970), as modified by Aplin (1979) and Trudgen (2009).

Height Class	Canopy Cover				
	100 - 70%	70 - 30%	30 - 10%	10 - 2%	< 2%
Trees > 30 m	High Closed Forest	High Open Forest	High Woodland	High Open Woodland	Scattered Tall Trees
Trees 10-30 m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees < 10 m	Low Closed Woodland	Low Open Forest	Low Woodland	Low Open Woodland	Scattered Low Trees
Mallee	Closed Mallee	Mallee	Open Mallee	Very Open Mallee	Scattered Mallees
Shrubs > 2 m	Closed Scrub	Open Scrub	High Shrubland	High Open Shrubland	Scattered Tall Shrubs
Shrubs 1-2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland	Scattered Shrubs
Shrubs < 1 m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Low Scattered Shrubs
Hummock	Closed Hummock	Hummock	Open Hummock	Very Open Hummock	Scattered Hummock
Grass	Grassland	Grassland	Grassland	Grassland	Grass
Tussock	Closed Tussock	Tussock	Open Tussock	Very Open Tussock	Scattered Tussock
Grass	Grassland	Grassland	Grassland	Grassland	Grass
Bunch Grass	Closed Bunch Grassland	Bunch Grassland	Open Bunch	Very Open Bunch	Scattered Bunch
Sedges	Closed Sedges	Sedges	Open Sedges	Very Open Sedges	Scattered Sedges
Herbs	Closed Herbs	Herbs	Open Herbs	Very Open Herbs	Scattered Herbs

Source: S. Van Leeuwen (DEC)

APPENDIX 2 Vegetation condition scale (as developed by Keighery 1994).

CONDITION	SCALE	DESCRIPTION
Pristine	1	Pristine or nearly so, no obvious signs of disturbance.
Excellent	2	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	3	Vegetation structure altered; obvious signs of disturbance.
Good	4	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
Degraded	5	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching Very Good condition without intensive management.
Completely Degraded	6	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

APPENDIX 3 Conservation categories for flora described under the EPBC Act.

CATEGORY	DESCRIPTION
Extinct	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	A species is categorised as extinct in the wild if it is only known to survive in cultivations, in captivity, or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild and in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

APPENDIX 4 Conservation Codes for Western Australian Flora (see Atkins 2006).

R: Declared Rare Flora - Extant Taxa

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.

1: Priority One - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farm land, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further survey.

2: Priority Two - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further survey.

3: Priority Three - Poorly Known Taxa

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further survey.

4: Priority Four - Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

APPENDIX 5 Department of Environment and Conservation, Western Australian Wildlife Conservation Act and Environment and Protection and Biodiversity Conservation Act Categories of Conservation.

Categories used in the assessment of conservation status. IUCN categories (based on review by Mace and Stuart 1994) as used for the Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act 1950.

Category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not Threatened.

Schedules used in the WA Wildlife Conservation Act 1950.

Category	Definition
Schedule 1.	Rare and Likely to become Extinct.
Schedule 2	Extinct.
Schedule 3	Migratory species listed under international treaties.
Schedule 4	Other Specially Protected Fauna.

WA Department of Environment and Conservation Priority species (species not listed under the Conservation Act, but for which there is some concern).

Category	Definition
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

APPENDIX 6 Total flora recorded from the Shay Gap Aerodrome (SG), Yarrie Area A (YA) and Yarrie Area B (YB) survey areas by Onshore Environmental Consultants, 9th to 15th September 2010.

FAMILY	SPECIES	SG	YA	YB
AIZOACEAE	<i>Trianthema pilosa</i>	*		
	<i>Trianthema triquetra</i>		*	*
AMARANTHACEAE	* <i>Aerva javanica</i>			*
	<i>Alternanthera nodiflora</i>		*	
	<i>Amaranthus undulatus</i>			*
	<i>Gomphrena cunninghamii</i>			*
	<i>Ptilotus axillaris</i>	*	*	*
	<i>Ptilotus calostachyus</i>	*	*	
	<i>Ptilotus clementii</i>			*
	<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>			*
	<i>Ptilotus fusiformis</i>	*		*
	<i>Ptilotus polystachyus</i>	*		
ASTERACEAE	<i>Centipeda minima</i> subsp. <i>macrocephala</i>		*	*
	<i>Pluchea ferdinandi-muelleri</i>		*	*
	<i>Pluchea tetranthera</i>		*	*
	<i>Pterocaulon sphaeranthoides</i>		*	*
	<i>Pterocaulon</i> sp.			*
	<i>Streptoglossa decurrens</i>		*	
BORAGINACEAE	<i>Halgania solanacea</i> var. <i>solanacea</i>	*		
	<i>Heliotropium chrysocarpum</i>		*	
BRASSICACEAE	<i>Lepidium pholidogynum</i>			*
CARYOPHYLLACEAE	<i>Polycarpaea involucrata</i>		*	
CHENOPODIACEAE	<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>		*	*
	<i>Salsola tragus</i>			*
	<i>Sclerolaena costata</i>		*	
	<i>Sclerolaena</i> sp.		*	
CLEOMACEAE	<i>Cleome viscosa</i>		*	*
CONVOLVULACEAE	<i>Bonamia linearis</i>		*	
	<i>Bonamia media</i> var. <i>villosa</i>	*	*	
	<i>Bonamia rosea</i>	*		
	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	*		

FAMILY	SPECIES	SG	YA	YB
	<i>Ipomoea muelleri</i>	*	*	*
	<i>Ipomoea polymorpha</i>		*	
	<i>Polymeria ambigua</i>		*	
CUCURBITACEAE	<i>Cucumis maderaspatanus</i>	*	*	*
	* <i>Cucumis melo</i> subsp. <i>agrestis</i>		*	
CYPERACEAE	<i>Bulbostylis barbata</i>	*		
ELATINACEAE	<i>Bergia perennis</i>		*	
EUPHORBIACEAE	<i>Euphorbia australis</i>		*	
	<i>Euphorbia coghlanii</i>	*	*	*
	<i>Euphorbia schultzii</i>		*	*
FABACEAE	<i>Acacia adoxa</i> var. <i>adoxo</i>	*		
	<i>Acacia ancistrocarpa</i>	*	*	
	<i>Acacia bivenosa</i>	*		
	<i>Acacia colei</i> var. <i>colei</i>	*	*	*
	<i>Acacia elachantha</i>		*	
	<i>Acacia hilliana</i>	*		
	<i>Acacia inaequilatera</i>	*	*	*
	<i>Acacia monticola</i>	*		
	<i>Acacia orthocarpa</i>		*	
	<i>Acacia ptychophylla</i>		*	*
	<i>Acacia pyrifolia</i>		*	*
	<i>Acacia sericophylla</i>	*		
	<i>Acacia</i> sp.		*	
	<i>Acacia stellaticeps</i>		*	*
	<i>Acacia stellaticeps</i> x <i>ancistrocarpa</i> hybrid		*	
	<i>Acacia trachycarpa</i>		*	
	<i>Acacia tumida</i> var. <i>pilbarensis</i>	*	*	*
	<i>Crotalaria medicaginea</i> var. <i>neglecta</i>			*
	<i>Crotalaria ramosissima</i>		*	
	<i>Cullen leucanthum</i>		*	*
	<i>Cullen</i> sp.			*
	<i>Cullen stipulaceum</i>		*	
	<i>Erythrophleum chlorostachys</i>	*		
	<i>Indigofera monophylla</i>		*	*
	<i>Jacksonia aculeata</i>	*		
	<i>Leptosema anomalum</i>	*		
	<i>Mirbelia viminalis</i>	*		
	<i>Petalostylis labicheoides</i>		*	
	<i>Rhynchosia minima</i>		*	*

FAMILY	SPECIES	SG	YA	YB
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>		*	
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>			*
	<i>Senna glutinosa</i> subsp. <i>luerssenii</i>		*	
	<i>Senna notabilis</i>	*	*	*
	<i>Templetonia hookeri</i>			*
	<i>Tephrosia</i> aff. <i>supina</i>		*	
	<i>Tephrosia clementii</i>		*	
	<i>Tephrosia rosea</i> var. <i>clementii</i>		*	
	<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)	*	*	
	<i>Tephrosia spechtii</i>		*	*
	<i>Tephrosia supina</i>		*	
GOODENIACEAE	<i>Dampiera candidans</i>	*		*
	<i>Goodenia azurea</i>	*		
	<i>Goodenia forrestii</i>		*	
	<i>Goodenia microptera</i>	*	*	*
	<i>Goodenia muelleriana</i>			*
	<i>Goodenia stobbsiana</i>			*
	<i>Goodenia triodiophila</i>	*		
GYROSTEMONACEAE	<i>Codonocarpus cotinifolius</i>		*	
LAMIACEAE	<i>Clerodendrum tomentosum</i> var. <i>lanceolatum</i>	*		
LAURACEAE	<i>Cassytha capillaris</i>	*		
LORANTHACEAE	<i>Amyema</i> sp.	*		
MALVACEAE	<i>Abutilon hannii</i>		*	
	<i>Corchorus elachocarpus</i>	*		
	<i>Corchorus sidoides</i> subsp. <i>vermicularis</i>		*	
	<i>Corchorus</i> sp.		*	*
	<i>Hibiscus leptocladus</i>	*		
	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>			*
	<i>Keraudrenia nephrosperma</i>	*		
	<i>Melhania oblongifolia</i>		*	*
	<i>Rulingia loxophylla</i>	*		
	<i>Sida arenicola</i>	*		
	<i>Sida cardiophylla</i>		*	
	<i>Sida clementii</i>	*		
	<i>Sida</i> sp. Pilbara (A.A. Mitchell PRP 1543)		*	*
	<i>Triumfetta chaetocarpa</i>	*		*
	<i>Triumfetta clementii</i>		*	

FAMILY	SPECIES	SG	YA	YB
	<i>Waltheria indica</i>		*	
MARSILEACEAE	<i>Marsilea hirsuta</i>		*	*
MENISPERMACEAE	<i>Tinospora smilacina</i>	*		
MOLLUGINACEAE	<i>Mollugo molluginea</i>	*	*	
MORACEAE	<i>Ficus aculeata</i>		*	
MYRTACEAE	<i>Corymbia flavescens</i>	*	*	
	<i>Corymbia hamersleyana</i>	*	*	*
	<i>Corymbia zygomphylla</i>	*		
	<i>Eucalyptus victrix</i>		*	
	<i>Melaleuca glomerata</i>			*
NYCTAGINACEAE	<i>Boerhavia gardneri</i>		*	*
OLEACEAE	<i>Jasminum didymum subsp. lineare</i>	*		
PHYLLANTHACEAE	<i>Flueggea virosa ssp. melanthoides</i>		*	
PLANTAGINACEAE	<i>Stemodia grossa</i>		*	*
POACEAE	* <i>Cenchrus ciliaris</i>		*	*
	* <i>Chloris virgata</i>			*
	<i>Amphipogon sericeus</i>	*		
	<i>Aristida holathera var. holathera</i>	*	*	
	<i>Aristida inaequiglumis</i>	*		
	<i>Chloris pumilio</i>			*
	<i>Chrysopogon fallax</i>	*	*	
	<i>Cymbopogon ambiguus</i>		*	*
	<i>Cymbopogon obtectus</i>	*		
	<i>Dactyloctenium radulans</i>		*	*
	<i>Digitaria brownii</i>	*		
	<i>Enneapogon caerulescens</i>		*	
	<i>Eragrostis dielsii</i>		*	
	<i>Eragrostis eriopoda</i>		*	
	<i>Eriachne aristidea</i>	*		
	<i>Eriachne lanata</i>	*		
	<i>Eriachne mucronata</i>			*
	<i>Eriachne obtusa</i>	*		*
	<i>Eriachne tenuiculmis</i>		*	*
	<i>Eulalia aurea</i>	*		*

FAMILY	SPECIES	SG	YA	YB
	<i>Paraneurachne muelleri</i>		*	*
	<i>Paspalidium rarum</i>	*		
	<i>Perotis rara</i>		*	
	<i>Sporobolus australasicus</i>		*	*
	<i>Triodia epactia</i>	*	*	*
	<i>Triodia longiceps</i>		*	
	<i>Triodia wiseana</i>		*	*
PORTULACACEAE	<i>Calandrinia eremaea</i>			*
	* <i>Portulaca oleracea</i>		*	*
PROTEACEAE	<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>		*	*
	<i>Grevillea refracta</i> ssp. <i>refracta</i>	*	*	
	<i>Grevillea wickhamii</i> subsp. <i>aprica</i>	*	*	*
	<i>Hakea chordophylla</i>	*	*	
	<i>Hakea lorea</i> subsp. <i>lorea</i>			*
	<i>Hakea macrocarpa</i>	*		
RUBIACEAE	<i>Dentella</i> sp.			*
SAPINDACEAE	<i>Atalaya hemiglauca</i>		*	
	<i>Dodonaea coriacea</i>		*	
SOLANACEAE	<i>Solanum dioicum</i>	*	*	*
	<i>Solanum diversifolium</i>		*	
	<i>Solanum lasiophyllum</i>			*
	<i>Solanum phlomoides</i>		*	*
	<i>Solanum</i> sp.			*
VIOLACEAE	<i>Hybanthus aurantiacus</i>	*	*	
ZYGOPHYLLACEAE	<i>Tribulus macrocarpus</i>		*	

APPENDIX 7 Species recorded during database searches, this survey and surrounding surveys. A=Yarrie Area A survey area, B=Yarrie Area B survey area, SG=Shay Gap Aerodrome survey area.

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
Amphibians									
<i>Cyclorana maini</i>	Sheep Frog				x			x	
<i>Limnodynastes spenceri</i>	Spencer's Frog								x
<i>Litoria rubella</i>	Little Red Tree Frog				x			x	
<i>Uperoleia glandulosa</i>								x	x
Birds									
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater				x		A, B		
<i>Accipiter fasciatus</i>	Brown Goshawk				x			x	x
<i>Actitis hypoleucos</i>	Common Sandpiper							x	x
<i>Adrea alba</i>	Great Egret	M				x			
<i>Aegotheles cristatus</i>	Owlet Nightjar							x	
<i>Amytornis striatus</i>	Striated Grasswren				x			x	
<i>Anas gracilis</i>	Grey Teal				x			x	x
<i>Anas superciliosa</i>	Pacific Black Duck				x			x	x
<i>Anhinga novaehollandiae</i>	Australasian Darter				x				
<i>Anthus australis</i>	Australian Pipit				x			x	x
<i>Apus pacificus</i>	Fork-tailed Swift	M			x	x			
<i>Aquila audax</i>	Wedge-tailed Eagle				x		A, B	x	
<i>Ardea alba</i>	Great Egret							x	x
<i>Ardea ibis</i>	Cattle Egret	M				x			
<i>Ardea modesta</i>	Eastern Great Egret				x				
<i>Ardea pacifica</i>	White-necked Heron				x			x	
<i>Ardea pacifica</i>	White-necked Heron								x

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Ardeotis australis</i>	Australian Bustard			P4	x		A	x	x
<i>Artamus cinereus</i>	Black-faced Woodswallow				x			x	
<i>Artamus cinereus</i>	Black-faced Woodswallow								x
<i>Artamus minor</i>	Little Woodswallow				x			x	
<i>Artamus minor</i>	Little Woodswallow								x
<i>Aythya australis</i>	Hardhead				x			x	x
<i>Barnardius zonarius</i>	Australian Ringneck				x			x	
<i>Burhinus grallarius</i>	Bush Stone-curlew			P4	x			x	
<i>Cacatua roseicapilla</i>	Galah							x	
<i>Cacatua sanguinea</i>	Little Corella				x			x	
<i>Cacatua sanguinea</i>	Little Corella								x
<i>Cacomantis pallidus</i>	Pallid Cuckoo				x				
<i>Centropus phasianinus</i>	Pheasant Coucal							x	x
<i>Certhionyx variegatus</i>	Pied Honeyeater				x				
<i>Chalcites basalis</i>	Horsfield's Bronze-cuckoo				x				x
<i>Charadrius ruficapillus</i>	Red-capped Plover							x	
<i>Charadrius veredus</i>	Oriental Plover, Oriental Dotterel	M				x			
<i>Chlamydera guttata</i>	Western Bowerbird							x	x
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo							x	
<i>Cincloramphus cruralis</i>	Brown Songlark				x			x	
<i>Cincloramphus mathewsi</i>	Rufous Songlark				x			x	x
<i>Circus approximans</i>	Swamp Harrier				x				
<i>Circus assimilis</i>	Spotted Harrier				x			x	x
<i>Climacteris melanura</i>	Black-tailed Treecreeper				x				

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				x			x	
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				x		A, B, SG	x	x
<i>Corvus orru</i>	Torresian Crow				x		A, B, SG	x	x
<i>Corvus sp.</i>	Crow species				x				
<i>Coturnix ypsilophora</i>	Brown Quail				x			x	x
<i>Cracticus nigrogularis</i>	Pied Butcherbird				x			x	x
<i>Cracticus tibicen</i>	Australian Magpie				x				
<i>Cracticus torquatus</i>	Grey Butcherbird				x				
<i>Dacelo leachii</i>	Blue-winged Kookaburra							x	x
<i>Dicaeum hirundinaceum</i>	Mistletoe Bird							x	
<i>Egretta novaehollandiae</i>	White-faced Heron				x			x	
<i>Egretta novaehollandiae</i>	White-faced Heron								x
<i>Elanus axillaris</i>	Black-shouldered Kite				x			x	
<i>Euseyonis melanops</i>	Black-fronted Dotterel				x			x	x
<i>Emblema pictum</i>	Painted Finch				x		A, B	x	x
<i>Eolophus roseicapillus</i>	Galah				x		A, B		x
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork							x	x
<i>Eremiornis carteri</i>	Spinifexbird							x	x
<i>Eremiornis carteri</i>	Spinifex-bird				x				
<i>Erythrogonys cinctus</i>	Red-kneed Dotterel							x	x
<i>Eurostopodus argus</i>	Spotted Nightjar				x			x	x
<i>Falco berigora</i>	Brown Falcon				x			x	x
<i>Falco cenchroides</i>	Australian Kestrel				x		A, B	x	x
<i>Falco longipennis</i>	Australian Hobby				x			x	x
<i>Fulica atra</i>	Eurasian Coot				x				

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Gallinago megala</i>	Swinhoe's Snipe/ Snipe sp.				x			x	x
<i>Gallinago stenura</i>	Pin-tailed Snipe / Snipe sp.				x				
<i>Gallirallus philippensis</i>	Buff-banded Rail							x	
<i>Geopelia cuneata</i>	Diamond Dove				x		A, B	x	x
<i>Geopelia placida</i>	Peaceful Dove				x			x	x
<i>Geophaps plumifera</i>	Spinifex Pigeon				x		A, B, SG	x	x
<i>Gerygone fusca</i>	Western Gerygone				x				
<i>Glareola maldivarum</i>	Oriental Pratincole	M				x			
<i>Grallina cyanoleuca</i>	Magpie Lark				x		A, B, SG	x	x
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	M				x			
<i>Haliastur sphenurus</i>	Whistling Kite				x		A, B	x	x
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard						A, B		
<i>Heteromunia pectoralis</i>	Pictorella Mannikin							x	x
<i>Hieraaetus morphnoides</i>	Little Eagle				x			x	x
<i>Hirundo ariel</i>	Fairy Martin							x	
<i>Hirundo nigricans</i>	Tree Martin							x	
<i>Hirundo rustica</i>	Barn Swallow	M				x			
<i>Lalage sueurii</i>	White-winged Triller				x			x	x
<i>Lichenostomus keartlandi</i>	Grey-headed Honeyeater				x			x	x
<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater							x	
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater				x		A, B	x	x
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater							x	
<i>Lichenostomus virescens</i>	Singing Honeyeater				x			x	x
<i>Lichmera indistincta</i>	Brown Honeyeater				x			x	x
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck				x				

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Malurus lamberti</i>	Variiegated Fairy-wren				x		A, B	x	x
<i>Malurus leucopterus</i>	White-winged Fairy-wren						A, B, SG	x	
<i>Manorina flavigula</i>	Yellow-throated Miner				x		A, B	x	x
<i>Melithreptus gularis</i>	Black-chinned Honeyeater							x	x
<i>Melopsittacus undulatus</i>	Budgerigar				x				
<i>Merops ornatus</i>	Rainbow Bee-eater	M			x	x	B	x	x
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant				x				
<i>Mirafra javanica</i>	Singing Bushlark							x	x
<i>Neochmia ruficauda</i>	Star Finch							x	x
<i>Ninox novaeseelandiae</i>	Southern Boobook				x			x	x
<i>Nycticorax caledonicus</i>	Rufous Night Heron				x				
<i>Ocyphaps lophotes</i>	Crested Pigeon				x		A, B, SG	x	x
<i>Oreoica gutturalis</i>	Crested Bellbird				x				
<i>Pachycephala rufiventris</i>	Rufous Whistler				x				
<i>Pachycephala rufiventris</i>	Rufous Whistler							x	
<i>Pandion haliaetus</i>	Osprey							x	x
<i>Pardalotus rubricatus</i>	Red-browed Pardalote				x			x	x
<i>Pardalotus striatus</i>	Striated Pardalote							x	
<i>Pelecanus conspicillatus</i>	Australian Pelican				x			x	x
<i>Petrochelidon ariel</i>	Fairy Martin				x				x
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant							x	x
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant				x			x	
<i>Phaps chalcoptera</i>	Common Bronzewing							x	
<i>Platalea flavipes</i>	Yellow-billed Spoonbill							x	
<i>Platalea regia</i>	Royal Spoonbill							x	x

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Plegadis falcinellus</i>	Glossy Ibis							x	x
<i>Podargus strigoides</i>	Tawny Frogmouth				x				
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				x			x	x
<i>Porzana fluminea</i>	Spotted Crake							x	
<i>Ptilonorhynchus guttatus</i>	Spotted Bowerbird				x				
<i>Rhipidura leucophrys</i>	Willie Wagtail				x			x	
<i>Rostratula australis</i>	Australian Painted Snipe	M				x			
<i>Rostratula benghalensis s. lat.</i>	Painted Snipe	M				x			
<i>Sugomel niger</i>	Black Honeyeater				x				
<i>Taeniopygia guttata</i>	Zebra Finch				x		A, B	x	x
<i>Threskiornis spinicollis</i>	Straw-necked Ibis				x			x	
<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher				x			x	x
<i>Todiramphus sanctus</i>	Sacred Kingfisher				x			x	x
<i>Tringa glareola</i>	Wood Sandpiper							x	x
<i>Tringa nebularia</i>	Common Greenshank							x	x
<i>Tringa stagnatilis</i>	Marsh Sandpiper							x	x
<i>Turnix velox</i>	Little Button-quail				x		A, B	x	
Mammals									
<i>Bos Taurus*</i>	Cow						A, B, SG	x	
<i>Felis catus*</i>	Cat						A, B, SG	x	
<i>Camelus dromedarius</i>	Camel						Airstrip		
<i>Canis lupus</i>	Dog						A, B, SG		
<i>Canis lupus dingo</i>								x	
<i>Chaerophon jobensis</i>	Northern Freetail Bat							x	x
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat						A, B	x	x

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Dasyercus blythi</i>	Brush-tailed Mulgara, Ampurta			P4	x		possible		
<i>Dasyercus cristicauda</i>	Mulgara	V	S1			x		x	
<i>Dasykaluta rosamondae</i>								x	
<i>Dasyurus hallucatus</i>	Northern Quoll	E	S1			x	A	x	
<i>Lagorchestes conspicillatus subsp. leichardti</i>	Spectacled Hare-wallaby			P3	x				
<i>Leggadina lakedownensis</i>	Short-tailed Mouse				x			x	
<i>Macroderma gigas</i>	Ghost Bat			P4	x				
<i>Macropus robustus subsp. erubescens</i>	Euro, Biggada				x		B	x	x
<i>Macropus rufus</i>	Red Kangaroo						A, B, SG	x	x
<i>Macrotis lagotis</i>	Bilby, Dalgyte	V	S1		x	x			
<i>Mus musculus*</i>	House mouse							x	x
<i>Ningauai timealeyi</i>	Pilbara Ningauai				x			x	
<i>Notoryctes caurinus</i>	Karkarratul, Northern Marsupial Mole	E	S1			x			
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat							x	x
<i>Petrogale rothschildi</i>								x	
<i>Planigale sp.</i>								x	
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4	x		A	x	
<i>Pseudomys delicatulus</i>	Delicate Mouse				x			x	
<i>Pseudomys desertor</i>	Desert Mouse				x			x	x
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse							x	x
<i>Rhinonictes aurantius</i>	Orange Leafnosed-bat	V	S1		x	x		x	
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tailed Bat						A, B	x	

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Scotorepens greyii</i>	Little Broad-nosed Bat						A, B	x	x
<i>Sminthopsis macroura</i>								x	
<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart				x			x	
<i>Tachyglossus aculeatus</i>								x	
<i>Taphozous georgianus</i>	Common Sheath-tailed Bat						A, B	x	x
<i>Taphozous hilli</i>								x	
<i>Vespadelus baverstocki</i>								x	
<i>Vespadelus finlaysoni</i>	Inland Cave Bat						A, B	x	x
<i>Zyzomys argurus</i>	Common Rock-rat				x			x	
Reptiles									
<i>Acanthophs pyrrhus</i>	Desert Death Adder							x	x
<i>Amphibolurus longirostris</i>							A, B		
<i>Antaresia perthensis</i>	Pygmy Python				x			x	x
<i>Antaresia stimsoni</i>	Stimson's Python							x	x
<i>Brachyuropsis approximans</i>								x	
<i>Carlia munda</i>					x			x	x
<i>Carlia triacantha</i>								x	
<i>Chelodina steindachneri</i>								x	
<i>Crenadactylus ocellatus subsp. horni</i>					x			x	
<i>Cryptoblepharus plagiocephalus</i>								x	
<i>Ctenophorus caudicinctus subsp. caudicinctus</i>					x		A, B, SG	x	x
<i>Ctenophorus isolepis subsp. isolepis</i>	Central Military Dragon				x		A, B, SG	x	x
<i>Ctenophorus nuchalis</i>	Central Netted Dragon				x		A, B, SG	x	x

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Ctenotus hanloni</i>					x				
<i>Ctenotus helenae</i>								x	
<i>Ctenotus pantherinus subsp. ocellifer</i>					x			x	
<i>Ctenotus piankai</i>					x			x	x
<i>Ctenotus quattuordecimlineatus</i>					x				
<i>Ctenotus rubicundus</i>								x	
<i>Ctenotus saxatilis</i>	Rock Ctenotus				x				x
<i>Ctenotus saxatilis</i>								x	
<i>Ctenotus schomburgkii</i>					x				
<i>Cyclodomorphus melanops subsp. melanops</i>					x			x	
<i>Delma elegans</i>								x	
<i>Delma haroldi</i>					x				
<i>Delma nasuta</i>					x				
<i>Delma pax (desert pax)</i>								x	
<i>Delma tincta</i>					x			x	x
<i>Demansia psammophis</i>								x	
<i>Demansia rufescens</i>								x	
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko				x			x	x
<i>Diplodactylus savagei</i>								x	
<i>Diplodactylus stenodactylus</i>	Sand-plain Gecko							x	x
<i>Diplodactylus wombeyi</i>								x	x
<i>Diporiphora winneckeii</i>	Blue-lined Dragon				x			x	
<i>Egernia depressa</i>	Pygmy Spiny-tailed Skink				x		A, B	x	
<i>Egernia striata</i>	Night Skink				x				

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer				x				
<i>Eremiascincus sp.</i>								x	
<i>Furina ornata</i>	Moon Snake				x			x	
<i>Gehyra ?punctata</i>								x	
<i>Gehyra punctata</i>					x		A, B	x	
<i>Gehyra purparescens</i>					x			x	
<i>Gehyra variegata</i>	Variegated Dtella				x			x	x
<i>Heteronotia binoei</i>	Bynoe's Gecko							x	x
<i>Heteronotia spelea</i>	Desert Cave Gecko				x			x	
<i>Lerista bipes</i>					x			x	x
<i>Lerista jacksoni</i>					x				
<i>Lerista muelleri</i>								x	x
<i>Lerista vermicularis</i>								x	
<i>Lialis burtonis</i>								x	
<i>Liasis olivaceous barroni</i>								x	
<i>Limnodynastes spenceri</i>								x	
<i>Liopholis kintorei</i>	Great Desert Skink	V				x			
<i>Lophognathus longirostris</i>	Long-nosed Water Dragon							x	x
<i>Lucasium wombeyi</i>					x				
<i>Menetia greyii</i>								x	
<i>Morethia ruficauda subsp. exquisita</i>					x		A	x	x
<i>Nephrurus levis</i>	Smooth Knob-tailed Gecko								x
<i>Nephrurus levis pilbarensis</i>								x	
<i>Notoscincus ornatus subsp. ornatus</i>					x				

Species	Common Name	EPBC Listed	WC Act	DEC	Naturemap	Sprat	Biologic 2010	Ecologia 2005a	Ecologia 2005b
<i>Oedura marmorata</i>	Marbled Velvet Gecko				x				
<i>Pogona minor mitchelli</i>	Dwarf Bearded Dragon				x		A, B	x	x
<i>Pseudechis australis</i>	Mulga Snake							x	x
<i>Pseudonaja modesta</i>								x	
<i>Pseudonaja nuchalis</i>	Gwardar (orange morph)							x	x
<i>Ramphotyphlops ammodytes</i>					x				
<i>Ramphotyphlops grypus</i>					x			x	
<i>Rhynchoedura ornata</i>	Beaked Gecko				x			x	
<i>Simoselaps anomalus</i>								x	
<i>Strophurus ciliaris abberans</i>	Northern Spiny-tailed Gecko							x	x
<i>Varanus acanthurus</i>	Spiny-tailed Monitor				x				x
<i>Varanus eremius</i>							Airstrip	x	
<i>Varanus giganteus</i>							A	x	x
<i>Varanus gouldii</i>	Bungarra or Sand Monitor				x			x	
<i>Varanus panoptes subsp. rubidus</i>					x			x	
<i>Varanus pilbarensis</i>								x	
<i>Varanus tristis</i>	Black-headed Monitor							x	x

APPENDIX 8 Significant Fauna Species Locations (GDA 94)

Common Name	Scientific Name	Zone	Easting	Northing
Australian Bustard	<i>Ardeotis australis</i>	51K	215940	7718617
Rainbow Bee-eater	<i>Merops ornatus</i>	51K	217712	7717829
Northern Quoll	<i>Dasyurus hallucatus</i>	51K	216462	7719249
Western Pebble-mound Mouse	<i>Pseudomys chapmani</i>	51K	216404	7719287
Western Pebble-mound Mouse	<i>Pseudomys chapmani</i>	51K	215763	7718508
Western Pebble-mound Mouse	<i>Pseudomys chapmani</i>	51K	215699	7718571
Potential Mulgara burrow	<i>Dasyercus cristicauda / D. blythi</i>	51K	217356	7717697
Potential Mulgara burrow	<i>Dasyercus cristicauda / D. blythi</i>	51K	217400	7717722
Potential Mulgara burrow	<i>Dasyercus cristicauda / D. blythi</i>	51K	217328	7717756
Potential Mulgara burrow	<i>Dasyercus cristicauda / D. blythi</i>	51K	216433	7718864
Potential Mulgara burrow	<i>Dasyercus cristicauda / D. blythi</i>	51K	201349	7739025

Appendix 9 Habitat Assessments

	Artificial Waterbody	Major Drainage Line	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain
UnitID	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP
Date	9/10/2010	9/11/2010	9/10/2010	9/11/2010	9/11/2010	9/11/2010	9/12/2010
Durationopen							
Sitename	3	6	2	7	8	9	10
Describingpersons	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;	
Siteposition	51K 0217666 7717517	51K 0216561 7719343	51K 0217426 7717669	51K 0216470 7718982	51K 0215547 7718987	51K 0216338 7718619	51K 0200824 7738683
Slope	Level	Very gently inclined	Level	Level	Level	Level	Level
Landformtype	Drainage depression	Drainage depression	Plain	Plain	Plain	Plain	Plain
Disturbance	Heavy grazing by hoofed mammals; Limited clearing;	Light grazing by hoofed mammals; Limited clearing;	Light grazing by hoofed mammals;	Light grazing by hoofed mammals;	Heavy grazing by hoofed mammals; Fire damage (5-10 years ago);		
VegetationConditionGrowthStage	Uneven age	Mature phase	Mature phase	Mature phase	Advanced regeneration	Mature phase	Mature phase
Leaflitter	0.10%	3%	3%	1%	3%	3%	1%
Twiglitter	0.10%	5%	1%	1%	5%	3%	0
Woodlitter	1	3	2	-	2	2	0
DeadStags per 2500m2	0	15	4	7	5	2	0
Hollowbearingtrees per 2500m2	0	2	1	-	0	0	0
Broadfloristicformation	-	Eucalyptus woodland	open Acacia shrubland	Triodia open hummock grassland	Acacia open shrubland	Triodia open hummock grassland	Triodia open hummock grassland
TreestructureTall							
TreestructureMid							
TreestructureLow		Open woodland	Isolated trees	Isolated trees	Isolated trees		
ShrubstructureTall			isolated clumps of shrubs	Isolated shrubs	Open shrubland	Open shrubland	

	Artificial Waterbody	Major Drainage Line	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain
ShrubstructureMid	Isolated shrubs	Open shrubland	Open shrubland	Sparse shrubland	Open shrubland	Open shrubland	
ShrubstructureLow	Isolated shrubs	Open shrubland	Open shrubland	Isolated shrubs	Open shrubland	Sparse shrubland	Open shrubland
GrassstructureTall				Isolated clumps of grasses		Sparse grassland	
GrassstructureMid	Isolated clumps of grasses	Isolated clumps of grasses	Open grassland	Open grassland	Isolated grasses	Open grassland	
GrassstructureLow	Isolated clumps of grasses	Isolated clumps of grasses	Open grassland	Open grassland	Isolated grasses	Open grassland	Open grassland
Dominanttreespp		Eucalyptus victrix	Cory sp.	Euc sp.	Cory sp		
Dominantshrubsp	Acacia sp.	Acacia sp.	Acacia sp.	Acacia sp	Acacia spp.	Acacia spp.	Acacia spp.
Dominantgrasssp	Triodia sp.	Triodia sp.	Triodia sp	Triodia	Triodia sp.	Triodia sp.	Triodia sp.
Microrelief	Gilgai microrelief, not deep						
Sheeterosion			Minor sheet erosion				
Rillerosion		Minor rill erosion					
Gullyerosion		Minor gully erosion					
Gullydepth		1.5-3.0 m					
Abundanceofcoarsefragments	Very slightly or very few on edges	Very or abundant	Very slightly or very few	No coarse fragments	Slight or few	No coarse fragments	No coarse fragments
Sizeofcoursefragments	Coarse gravelly or large pebbles and below	Stony or stones and below	Fine gravelly or small pebbles		Fine gravelly or small pebbles		
Abundanceofrockoutcrop		No rock outcrop			No rock outcrop		
WaterBodies	yes, 60x60m	seasonal	occasional floods?				
Comments	Many birds						
SoilTexture	Silty clay loam	Loamy sand	Silty clay loam	Sand	Sand	Sandy loam	Sandy loam
Soilcolour	Red / Brown	Red / Brown	Red / Brown	Orange	Red / Brown	Orange/brown	Orange
Soilwaterstatus	Wet to dry	Dry		Dry			Moderately moist
Soilstrength	Very firm	Very weak	Weak	Very weak	Very weak	Weak	Very weak
SoilComments							
Existanceofsubstrateform	Course fragments;	Course fragments;					
RockType	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone

	Sandy Plain	Sandy Plain	Stoney Plain	Stoney Plain	Slopes / Outcropping				
UnitID	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP	TomsHP
Date	9/12/2010	9/12/2010	9/12/2010	9/12/2010	9/13/2010	9/13/2010	9/11/2010	9/10/2010	9/10/2010
Durationopen									
Sitename	11	12	13	14	15	16	5	1	4
Describingpersons	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;	T. Rasmussen;				
Siteposition	51K 0200979 7739103	51K 0202238 7738889	51K 0202728 7738492	51K 0201464 7738717	51K 0216012 7718374	51K 0216296 7718232	51K 0217712 7717829	51K 0217373 7717732	51K 0217846 7717808
Slope	Level	Level	Level	Level	Level	Level	Very gently inclined	Level	Steep
Landformtype	Plain	Plain	Plain	Plain	Plain	Plain	Plain, lower slope	Creek	Ridge
Disturbance	Fire damage (1-5 years ago);	Fire damage (1-5 years ago);			Light grazing by hoofed mammals;	Light grazing by hoofed mammals;		Light grazing by hoofed mammals;	
VegetationConditionGrowthStage	Early regeneration	Early regeneration	Mature phase	Mature phase	Mature phase	Mature phase	Mature phase	Mature phase	Mature phase
Leaflitter	0	0.1	3%	1	1.50%	4%	0	5%	1
Twiglitter	0	1%	3%	2	0.50%	5%	0	5%	1
Woodlitter	0	3	5	2	3	7	0	7	4
DeadStags per 2500m2	20	20	0	1	0	0	1	3	2
Hollowbearingtrees per 2500m2	0	0	0	1	0	0	0	1	0
Broadfloristicformation	Triodia open hummock grassland	Triodia scattered hummock grassland	Triodia open hummock grassland	Triodia open hummock grassland	Triodia open hummock grassland				
TreestructureTall									
TreestructureMid									
TreestructureLow	Isolated trees				Isolated trees			Isolated trees	Isolated trees
ShrubstructureTall			Open shrubland		Isolated shrubs	Shrubland		Open shrubland	

	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Stoney Plain	Stoney Plain	Slopes / Outcropping
ShrubstructureMid			Sparse shrubland		Isolated shrubs	Shrubland		Open shrubland	Isolated shrubs
ShrubstructureLow		Isolated shrubs	Isolated shrubs		Isolated shrubs		Isolated shrubs	Open shrubland	Isolated shrubs
GrasstructureTall			Isolated clumps of grasses		Open grassland	Isolated clumps of grasses			
GrasstructureMid			Open grassland	Open grassland	Open grassland	Open grassland	Isolated grasses	Grassland	Isolated clumps of grasses
GrasstructureLow	Sparse grassland	Isolated grasses	Open grassland	Open grassland	Sparse grassland	Sparse grassland	Sparse grassland	Grassland	Open grassland
Dominanttreespp	hakea sp.				Grevillea pyramidalis			Corymbia sp.	Corymbia sp.
Dominantshrub spp		Senna sp.	Acacia spp.		Acacia spp.	Acacia spp.	Acacia spp.	Acacia sp.	Acacia sp.
Dominantgrass spp	Triodia sp.	Triodia sp.	Triodia sp.	Triodia sp.	Triodia sp.	Triodia sp.	Triodia	Triodia sp.	Triodia sp.
Microrelief									
Sheeterosion									
Rillerosion									
Gullyerosion								Minor gully erosion	
Gullydepth								1.5 m -	
Abundanceofcoarsefragments	No coarse fragments	No coarse fragments	No coarse fragments	No coarse fragments	No coarse fragments	No coarse fragments	Very or abundant	Very or abundant	Very or abundant
Sizeofcoursefragments							Cobbly or cobbles and below	Cobbly or cobbles and below	Bouldery or boulders and below
Abundanceofrockoutcrop		No rock outcrop		No rock outcrop	No rock outcrop	No rock outcrop	No rock outcrop	No rock outcrop	Rockland
WaterBodies									
Comments									
SoilTexture	Sandy loam	Sandy loam	Sandy loam	Sandy clay loam	Loamy sand	Loamy sand	Sandy loam	Loamy sand	Silty loam
Soilcolour	Red / Orange	Red / Orange	Red / Orange	Red / Orange	Red / Orange	Red / Orange	Red / Brown	Red / Brown	Red / Brown
Soilwaterstatus					Dry	Dry	Dry		
Soilstrength	Very weak	Very weak	Very weak	Very weak	Very weak	Very weak	Weak	Very weak	Weak

	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Sandy Plain	Stoney Plain	Stoney Plain	Slopes / Outcropping
SoilComments									Skeletal
Existanceofsubstrateform	No surface exposure;	No surface exposure;		No surface exposure;	No surface exposure;	No surface exposure;	Course fragments(Boulders, etc);	Course fragments(Boulders, etc);	Vertical exposure (Outcropping); Course fragments(Boulders, etc);
RockType	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone	Iron stone