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Panoramic Resources Limited: Wilsons Project Area and Proposed Manakado to Howards Haul Road, Flora and Vegetation Assessment March 2013




This document describes the results of a single phase flora and vegetation assessment carried out by Maia Environmental Consultancy (Maia) in March 2013 for Panoramic Resources Limited (Panoramic). The survey was carried out at Panoramic's Wilsons project area on tenement M53/153 and along a proposed haul road linking Panoramic's Howards and Manakado mines.

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Acronyms and Abbreviations

ARRP Act	*Agriculture and Related Resources Protection Act 1976*
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BIF	Banded ironstone formation
BoM	Bureau of Meteorology
CALM	Former Department of Conservation and Land Management – now DEC.
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DEWR	Department of Environment and Water Resources
DRF	Declared Rare Flora
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally sensitive area
EWSWA	Environmental Weed Strategy of WA
ha	Hectare
HRC	Haul road corridor
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometres
LS	Land system
Ltd	Limited
Maia	Maia Environmental Consultancy Pty Ltd
MUR1	Eastern Murchison Subregion
MUR2	Western Murchison Subregion
MVA	Maia vegetation association
NRS	National Reserve System
NVIS	National Vegetation Information System
P (1-5)	Priority 1 to Priority 5 flora species
Panoramic	Panoramic Resources Pty Ltd
PEC	Priority Ecological Community
SLIP	Shared Landform Information Platform
sp.	Species
SPAC	Species accumulation curve
subsp.	Subspecies
T	Threatened species
TEC	Threatened Ecological Community
TOI	Taxa of interest
var.	Variety
VSA	Vegetation system association
WA	Western Australia
WA Herb	Western Australian Herbarium
WAOL	Western Australian Organism List
WC Act	*Wildlife Conservation Act* 1950
WoNS	Weed of National Significance

Summary

Introduction

- Panoramic Resources Limited (Ltd) (Panoramic) proposes to mine gold from the Wilsons deposit on tenement M 53/153; this area is referred to as Wilsons in this report. A haul road is also planned to link Panoramic's Howards and Manakado mines (tenements M57/236 and M57/250 respectively); this area is referred to as the Haul Road Corridor (HRC) in this report. Two HRC options have been proposed; HRC Route 1 and HRC Route 2. Wilsons and HRC are collectively referred to as the Survey Area in this report.
- The Survey Area lies in the Sandstone and Wiluna Shires in the Mid West administrative region of Western Australia (WA). Wilsons lies in the Shire of Wiluna and the HRC in the Shire of Sandstone.
- Panoramic engaged Maia Environmental Consultancy Pty Ltd (Maia) to carry out a single phase survey of the flora and vegetation of the Survey Area. This report presents the results of the survey, which was carried out in autumn 2013. A desktop review was carried out before the survey.
- The single phase flora and vegetation assessment was carried out in March 2013. The survey was carried out by two botanists on March 19 and 20, 2013 (four person days).
- Eleven quadrats and one relevé were assessed at Wilsons and 10 quadrats and nine relevés along the HRC. Transects were walked over each of these areas in addition to the quadrats and relevés.
- The vegetation was mapped at a scale of 1:10,000 using information collected from the quadrats, relevés and transects and the results of pattern analysis carried out on the data collected at quadrats.

Survey Results - Flora

- One hundred and twenty-six taxa from 29 families and 58 genera were recorded during the survey.
- The families with the highest number of taxa were Fabaceae (25), Scrophulariaceae (21) and Poaceae (19). The genera with the highest number of taxa were *Eremophila* (21), *Acacia* (17) and *Senna* (6).
- Annual taxa comprised 11.11% of the species list and perennial taxa 88.89%.
- The species accumulation analysis indicates that 81% of the flora estimated to be in the Survey Area was recorded. However, this estimation is based on the 101 taxa recorded in the 21 quadrats assessed and does not include the 25 additional taxa recorded opportunistically and at relevés.
- No species listed under the EPBC Act were located at the Survey Area.
- No species listed under the WC Act were recorded at the Survey Area.
- Two range extension species were collected from the Survey Area – *Bursaria occidentalis* and *Eremophila fraseri* subsp. *parva*. These collections mark range extensions of 231 km and 165 km respectively.
- Four priority (P) species were recorded at Wilsons – *Stenanthemum mediale* (P1; eight locations), *Acacia burrowsiana* (P3; four locations), *Calytrix praecipua* (P3) and *Sauropus ramosissimus* (P3; eight locations).
- No priority species were located within the HRC.
- No weeds on any of the national weeds lists were recorded at the Survey Area.
- No plant pests declared in WA were recorded at the Survey Area.
- One general environmental weed was recorded within the HRC – *Portulaca oleracea* (Purslane) – and no environmental weeds were recorded at Wilsons.

Survey Results - Vegetation

- Eight vegetation associations were mapped in the Survey Area: Mixed Chenopod Shrubland (CSL); *Eremophila* Shrubland (SL1); *Acacia* Open Shrubland (SL2); *Eremophila* Open Shrubland (SL3); *Acacia* Sparse Woodland (WL1); *Acacia* Open Woodland (WL6); *Acacia* Sparse Woodland (WL7); and, *Acacia* Open Woodland / Shrubland (WL8). Four of these associations were mapped at Wilsons – SL1, SL2, WL7 and WL8 – and four within the HRC – CSL, SL3, WL1 and WL6.
- One of the woodland associations (WL7) is statistically floristically similar to the DEC's community type 4 which is part of the Priority 1 PEC - the Montague Range Vegetation Complexes (banded ironstone formation). DEC's community type 4 is widespread across the Montague Range and occurs on a variety of habitats.
- Vegetation condition at Wilsons is rated as Excellent and the main disturbance (aside from the already cleared areas) is from cattle grazing.
- Vegetation condition within the HRC was mainly Excellent, however, small patches were rated as Very Good to Good. The main disturbance is from cattle grazing.

Conservation Significance

- The conservation significance of the priority species and vegetation associations recorded in the Survey Area is discussed in Section 7 of this report.

Panoramic Resources Ltd: Wilsons Project Area and Proposed Manakado to Howards Haul Road, Flora and Vegetation Assessment, March 2013

1 Project Scope and Location

1.1 Project Scope of Work

Panoramic Resources Ltd (Panoramic) proposes to mine gold from the Wilsons deposit on tenement M 53/153; the area is referred to as Wilsons in this report. A haul road is also planned to link Panoramic's Howards and Manakado mines (tenements M57/236 and M57/250 respectively); the area is referred to as the Haul Road Corridor (HRC) in this report. Two HRC options have been proposed HRC Route 1 and HRC Route 2. Wilsons and HRC are collectively referred to as the Survey Area in this report (Map 10.1, Section 10).

Panoramic engaged Maia Environmental Consultancy Pty Ltd (Maia) to carry out a single phase survey of the flora and vegetation of the Survey Area. This report presents the results of the survey, which was carried out in March 2013.

1.2 Location and Size of the Survey Area

The Survey Area lies in the Sandstone and Wiluna Shires in the Mid West administrative region of Western Australia (WA). Wilsons lies in the Shire of Wiluna and is located approximately 63 km south-west and 95 km north of Yeelirrie Station and Sandstone, respectively. The HRC lies in the Shire of Sandstone and is located 55 km south-west and 63 km north of Yeelirrie Station and Sandstone, respectively.

The area covered by Wilsons and the HRC are listed in Table 1.1.

Table 1.1: Wilsons and HRC Areas

Description	Option	Area (ha)
Wilsons		132.71
HRC	Both HR routes combined, excluding overlap	312.21
	HRC Route 1	232.69
	HRC Route 2	223.46
Total Area	Wilsons & HRC (excluding overlap)	444.92

2 BACKGROUND INFORMATION

A literature search was carried out to collate information on the bioregion, climate, geology, landforms and soils, land systems and pre-European vegetation. Available information on any flora and vegetation surveys previously carried out in the general area was also searched for.

This information is presented in the following sub-sections of this report.

2.1 BIOREGIONAL SETTING

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies the land surface of Australia from a range of environmental attributes into bioregions. The bioregions have been developed at the national level to assess and plan for the protection of biological diversity (Thackway and Cresswell, 1995). IBRA 7 defines 89 bioregions and 419 subregions in Australia (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC], 2013b).

Twenty-six bioregions occur in WA and the Survey Area lies within the Murchison bioregion. Subregions are defined based on finer differences in geology, vegetation and other landform patterns which are related systems within each bioregion. The Murchison bioregion is divided into two subregions – Western and Eastern Murchison. The Survey Area lies within the Eastern Murchison subregion (Map 10.2, Section 10) which is characterised by internal drainage, elevated red desert sand plains with minimal dune development, extensive salt lake systems, broad plains of red-brown soils and breakaway complexes. The vegetation of this subregion is dominated by *Acacia aneura* (mulga) woodlands, hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (Cowan, 2001).

2.2 CLIMATE

The Survey Area lies approximately 60 km west of Yeelirrie Station and meteorological data collected at Yeelirrie has been used to provide background climate information. Rainfall data recorded at both Yeelirrie and Youno Downs stations (approximately 20 km west-north-west of Wilsons and 44 km north-west of the HRC) have been used as an indication of actual and long-term rainfall at the Survey Area in the months before the survey.

The average annual maximum temperature at Yeelirrie Station is 28.7˚C while the average annual minimum temperature is 12.8˚C. The maximum daytime temperature in summer has reached 46˚C and the minimum winter night time temperature has dropped to - 5.1˚C (BoM, 2013a).

Long-term average monthly and total annual rainfall data for Yeelirrie and Youno Downs stations are listed in Table 2.1 along with monthly totals for 2012 and for January to March 2013 (BoM, 2013a).

Table 2.1: Rainfall Data Yeelirrie and Youno Downs Stations (BoM, 2013a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Yeelirrie (site number 12090, 1978–2013)													
L-t	29.0	31.4	31.7	24.8	24.8	23.1	17.4	12.7	4.6	9.5	10.1	20.4	240.9
2012	91.5	15.1	50.1	21.1	22.8	13.2	0.0	0.0	0.0	6.1	8.9	NA	-
2013	41.4	0.0	8.4										
Youno Downs (site number 7194, 1983–2013)													
L-t	40.6	45.3	38.4	30.5	23.7	30.7	23.3	13.4	6.1	11.0	15.3	32.4	315.7
2012	112.6	54.0	80.0	0.0	21.8	16.6	5.6	0.8	2.4	2.2	5.8	44.0	345.8
2013	112.0	0.0	0.0										

Note: information by month for 2012 and 2013 is total rainfall (mm); L-t = long-term mean monthly and annual rainfall (mm); Tot = total rainfall for year (actual and long-term); NA = not available.

Yeelirrie's total rainfall for the three months preceding the survey cannot be compared with the long-term mean for the same three months because the December data is not available; however, the total rainfall for January and February 2013 was below the long-term mean for the same two months – 41.4 mm compared with 60.4 mm. January 2013 rainfall was above average (41.4 mm compared with the long-term mean of 29.0 mm) (BoM, 2013a).

Rainfall at Youno Downs Station for the three months preceding the survey (December 2012 to February 2013) was higher than the long-term mean for the same three months (156 mm compared with the long-term mean of 118.3). January rainfall was above average (112.0 mm compared with the mean of 40.6 mm) (BoM, 2013a).

The total rainfall received at the Survey Area for three months prior to the survey is likely to be similar to that recorded at Yeelirrie and Youno Downs stations. The Survey Area (red dots) has been plotted on the BoM's rainfall decile map for WA for December 1 2012 to February 28 2013 (Figure 2.1; BoM, 2013b), and it lies just within the boundary of a polygon that received average rainfall from 1 December 2012 to 28 February 2013.

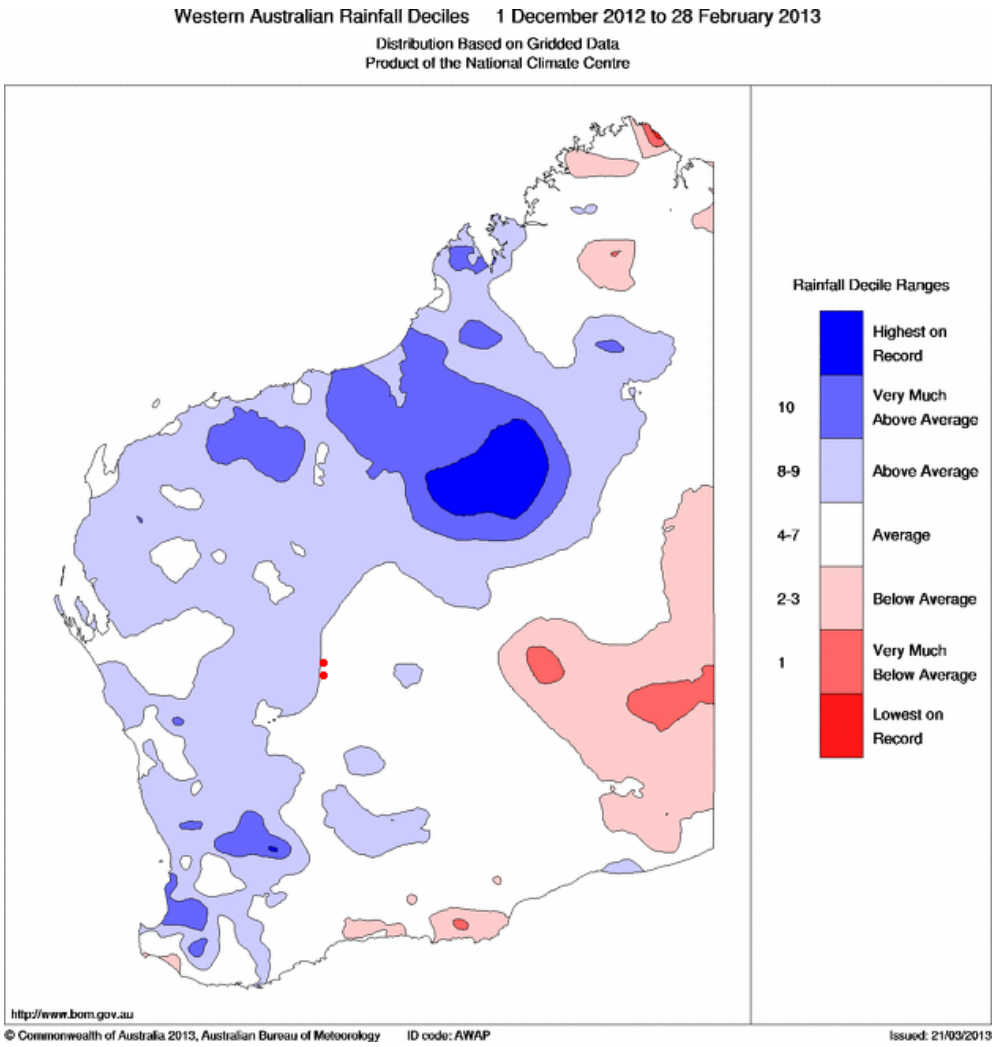


Figure 2.1: Western Australian Rainfall Deciles, 1 December 2012 to 28 February 2013 (BoM, 2013b)

2.3 Geology, Landforms and Soils

Six main geological units are described within the Survey Area as part of the Sandstone 1:250 000 geological series (Department of Resources and Energy, 1984):

- Ab - Fine-grained metabasalt, pillow structures locally preserved, minor intercalated coarse grained metagabbro, possible komatitic basalt;
- Ad - Medium to coarse grained amphibolite: metamorphosed dolerite or gabbro;
- Qa - Poorly sorted clay to gravel deposits along drainage lines;
- Qc - Poorly sorted silt to sand sheet wash over pebbly clay hardpan;
- Qz - Red-brown silt to sand sheet-wash over pebbly clay hardpan; and
- Tl - Ferruginised deep weathering profile, ferruginuous duricrust, massive pisolitic limonite developed over greenstone.

The surface geology of the Survey Area is mapped into six units by Stewart *et al.* (2008):

- Aby – basalt, komatitic basalt, agglomerate, mafic schist, dolerite;
- Aty – amphibolite;
- Czk – calcrete;
- Czl – lateritic duricrust;
- Qa – alluvial sediment; and
- Qrc – Colluvial sediment.

These units are shown on Map 10.3 (Section 10).

Tille (2006) compiled available detailed mapping information of WA's rangelands and arid interior into a hierarchy of soil-landscape units providing descriptions of soil-landscape regions, provinces and zones. The Murchison Province is mapped in the mid-west and northern goldfields between Three Springs, the Gascoyne River, Wiluna, Cosmo Newberry and Menzies and is described by Tille (2006) as hardpan wash plains and sand plains (with some stony plains, hills, mesas and salt lakes) on granitic rocks and greenstone of the northern third of the Yilgarn Craton (Tille, 2006).

The Murchison Province is divided into seven soil-landscape zones and the Survey Area lies within the Salinaland Plains Zone, located in the northern goldfields from Lake Barlee and Lake Ballard to Wiluna and Laverton. This zone is described by Tille (2006) as sand plains (with hardpan plains and some mesas, stony plains and salt lakes) on granitic rocks (and some greenstone). Soils include red sandy earths, red deep sands, red shallow loams and red loamy earth with some red-brown hardpan shallow loams, salt lake soils and red shallow sandy duplexes (Tille, 2006).

2.4 Land System Mapping

Land systems (LS) are described as discreet units of landforms, soils, vegetation and geology. LS are an important tool in assessing the potential risks to biodiversity by quantifying the extent and condition of potential habitat for conservation significant species and vegetation complexes. The Department of Agriculture and Food Western Australia (DAFWA) has mapped the LS across a large area of WA. The LS of the Murchison have been mapped and sub-divided into land units based on the landforms on which they occur (Payne *et al.*, 1998).

Five LS are mapped in the Survey Area, and these are described in Table 2.2 (information sourced from Payne *et al.* (1998)) and shown on Map 10.4 (Section 10). Wilsons lies within the Bevon LS and the HRC within the Jundee, Monitor, Rainbow and Tango LS. Both HRC options lie in the same four LS.

Table 2.2: Land Systems, Associated Land Forms and Vegetation of the Survey Area

Land System (LS) and Area Mapped in WA / Murchison bioregion (DAFWA, 2012a) and in Sandstone-Yalgoo-Paynes Find area (Payne *et al.*, 1998) (ha)	Land Forms, Vegetation and Land Type
Bevon 240,185.33 ha / 224,793.23 ha 31,400 ha	Dissected uplands with mulga shrublands. Land Type 1: Hills with acacia shrublands.
Jundee 661,729.56 ha / 585,378.17 ha 133,300 ha	Hardpan plains with ironstone gravel mantles supporting mulga shrublands. Land Type 13: Wash plains on hardpan with mulga shrublands.
Monitor 63,016.59 ha / 62,629.55 ha 6,600 ha	Distributary alluvial fans and wash plains supporting mulga-halophytic shrublands. Land Type 15: Wash plains on hardpan with mixed halophytic and non-halophytic shrublands.
Rainbow 259,472.00 ha / 235,804.56 ha 66,600 ha	Hardpan plains supporting mulga shrublands. Land Type 13: Wash plains on hardpan with mulga shrublands.
Tango 8,620.31 ha / 7,595.12 ha 8,600 ha	Saline hardpan plains with ironstone gravel mantles supporting mulga tall shrublands with halophytic and non-halophytic understorey shrubs. Land Type 15: Wash plains on hardpan with mixed halophytic and non-halophytic shrublands.

Source: Payne *et al*. (1998).

2.5 Pre-European Vegetation Mapping

The vegetation of the Murchison was mapped at a scale of 1:1 000 000 by J.S. Beard in 1976. The Survey Area is located in Beard's Wiluna physiographic region of the Murchison region within the Austin Botanical District of the Eremaean Province of WA. Beard's vegetation mapping has been digitised and updated by DAFWA (2012b), and the vegetation of the Survey Area is mapped as two broad structural vegetation associations (Table 2.3); Map 10.5 (Section 10) shows these vegetation associations in the Survey Area and surrounds. Wilsons lies within an area mapped as vegetation association 18 and the HRC within an area mapped as association 39 (sub-association 39.2).

The pre-European and current extent of the two vegetation associations in the Murchison IBRA region overall is also listed in Table 2.3 along with the percentage remaining of each, the amount in reserves (Government of Western Australia, 2013) and the prioritisation for reservation of each in the Eastern Murchison subregion (Cowan, 2001).

The two vegetation associations of the Survey Area are estimated to have more than 99.10% of their pre-European extent remaining (Table 2.3). Less than 0.4% of the extent of both of these vegetation associations is

protected for conservation. Neither vegetation association has a high rating for preservation in the Eastern Murchison subregion; vegetation association 18 is rated as moderate priority and 39 as low (Cowan, 2001).

Table 2.3: Beard Vegetation Associations Mapped in the Survey Area

Vegetation Association Number (DAFWA, 2012b) and (Beard Code)	Physiographic Region	Broad Description	Pre-European Extent (ha) by Murchison IBRA Region	Current Extent (ha) by Murchison IBRA Region	Remaining (%)	Current Extent Protected (IUCN 1-4) for Conservation (proportion of pre-European	Prioritisation for Reservation of Ecosystem in the Eastern Murchison Subregion (Cowan, 2001)
18 (a1Li)	Wiluna	Low woodland; mulga (*Acacia aneura*)	12,403,172.32	12,363,252.47	99.68	0.37	Moderate
39 (a1Si)	Wiluna	Shrublands; mulga scrub	1,148,400.31	1,138,064.63	99.10	0.02	Low

2.6 Previous Biological Surveys

A number of biological surveys have been carried out for other mining projects in the area and also on banded iron formation (BIF) ranges in surrounding areas (Map 10.6, Section 10). The results from selected surveys are included below.

Maia (2011) conducted a detailed Level 1 Flora and Vegetation assessment at three discrete areas at Panoramic's Gidgee project area: O'kearys, Swan Bitter and Howards. A small area of the eastern section of the haul road lies within the northern section of Howards. Four confirmed and one unconfirmed conservation significant flora species were recorded during the survey (Table 2.4). Thirteen vegetation associations were mapped over these areas. Three of the 13 vegetation associations (SL2, WL3 and WL8; Table 2.5) were considered to be locally conservation significant because of the small area mapped, restriction to a particular habitat and the priority species located within them. The three associations were mapped over the O'kearys Survey Area and not at Swan Bitter and Howards.

In 2008 Western Botanical (2009) carried out a flora and vegetation survey for the proposed BHP Billiton Yeelirrie project. Niche Environmental Services (2011) carried out a flora and vegetation survey for the proposed Toro Energy Wiluna uranium project in 2010. The conservation significant flora species located during these surveys are listed in Table 2.4.

The Department of Environment and Conservation (DEC) surveyed the flora and vegetation of a number of BIF and greenstone ranges around the Survey Area. These include the Montague Range (Thompson & Sheehy, 2011a), Booylgoo Range (Markey & Dillon, 2010), Herb Lukin Ridge (Markey & Dillon, 2009), the Lake Mason zone of the Gum Creek Greenstone Belt (Thompson & Sheehy, 2011b), and the Perseverance Greenstone Belt (Meissner & Wright, 2010). The conservation significant flora species located during these surveys are listed in Table 2.4.

Ten quadrats surveyed at Montague Range by the DEC are located within 1 km of Wilsons: MNTG8, MNTG9, MNTG10, MNTG11, MNTG12, MNTG18, MNTG19, MNTG20, MNTG21, MNTG22 (DEC, 2007a).

None of the floristic community types on the two BIF ranges closest to the Survey Area – Montague Range and the Lake Mason zone of the Gum Creek Greenstone Belt – are specifically described as conservation significant by the DEC. Rather, they are described as important repositories of taxa of conservation significance (Montague Range and Lake Mason) and distinct floristic communities (Lake Mason).

Table 2.4: Priority Flora Recorded in the Surrounding Area

Taxa	Priority	Maia (2011)	DEC MR	DEC BR	DEC HLR	DEC LM	DEC PGB	WB (2009)	Niche (2011)
Beyeria lapidicola	1				•				
Eremophila congesta	1				•				•
Stenanthemum mediale	1		•			•			
Tecticornia sp. Lake Way (P. Armstrong 05/961)	1								•
Acacia burrowsiana	3	•	•			•			
Baeckea sp. London Bridge (M.E. Trudgen 5393)	3					•			
Bossiaea eremaea	3							•	
Calytrix praecipua	3		•						
Calytrix uncinata	3			•	•				
Eremophila arachnoides subsp. *arachnoides*	3							•	•
Euryomyrtus inflata	3	•							
Homalocalyx echinulatus	3			•	•				•
Hybanthus floribundus subsp. chloroxanthus	3	•							
Olearia mucronata	3				•				
Ptilotus luteolus	3	•			•				
Sauropus ramosissimus	3		•			•			
Sida ?picklesiana	?3	•							
Stackhousia clementii	3								•
Grevillea inconspicua	4			•		•	•		
Olearia arida	4							•	

Note: MR = Montague Range (Thompson & Sheehy, 2011a); BR = Booylgoo Range (Markey & Dillon, 2010); HLR = Herb Lukin Ridge (Markey & Dillon, 2009); LM = Lake Mason (Thompson & Sheehy, 2011b); PGB = Perseverance Greenstone Belt (Meissner & Wright, 2010); WB = Western Botanical.

Table 2.5: Conservation Significant Vegetation Associations Mapped at O'kearys, Swan Bitter and Howards

Vegetation Association Code	Vegetation Association Description	Typical Habitat
SL2	Open Tall Shrubland of *Acacia xanthocarpa* with a Sparse Mid Shrubland of *Eremophila exilifolia* and *E. forrestii* with a Sparse Low Shrubland of *Ptilotus obovatus.*	Outcrops and hillslopes of dolerite and laterite at the O'kearys Survey Area
WL3	Sparse Low Woodland of *Acacia aneura* complex with a Sparse Mid Shrubland of *Eremophila jucunda* subsp. *jucunda* and *E. forrestii*.	Hillslopes and undulating plains of ironstone and laterite at the O'kearys Survey Area
WL8	Open Low Woodland of *Acacia aneura* complex with an Open Tall Shrubland of *A. quadrimarginea* with an Open Low Shrubland of *Sida ectogama* and *Prostanthera althoferi*.	Minor flow lines throughout the O'kearys Survey Area

3 Database Searches, Survey and Reporting Methods

3.1 Database Searches

To gather information on the conservation significant flora species and ecological communities occurring in and around the Survey Area the sources listed in Table 3.1 were used or searched; the areas over which these searches were carried out are shown on Map 10.7 (Section 10).

Table 3.1: Databases Used or Searched

Database	Reference or Reference Number	Buffer(s) (km)
EPBC Act Protected Matters Search Tool	DSEWPaC (2013a)	20
DEC's NatureMap	DEC (2007-)	20
DEC's Threatened and Priority Flora database (TPFL)	Reference #26-1111FL	Not applicable
DEC's Threatened and Priority Flora List (TP)	Reference #26-1111FL	Not applicable
The Western Australian Herbarium	Reference #26-1111FL	Not applicable
DEC's Threatened Ecological Communities database	Reference #20-1111EC	Not applicable
Co-ordinates used for EPBC Act and NatureMap searches for HRC: 27^0 7' 54" S and 119^0 27' 56" E, from the central point of the Survey Area. **Co-ordinates used for EPBC Act and NatureMap searches for Wilsons:** 27^0 27' 8" S and 119^0 30' 54" E, from the central point of the Survey Area. **Co-ordinates used for DEC searches:** (corner 1) 26^0 42' 0" S and 119^0 15' 43.7" E, (corner 2) 26^0 41' 46.75" S and 119^0 30' 5.84" E, (corner 3) 27^0 16' 29.55" S and 119^0 31' 38.89" E, (corner 4) 27^0 16' 15" S and 119^0 41' 54.70" E, (corner 5) 27^0 32' 52.11" S and 119^0 42' 19.33" E, (corner 6) 27^0 33' 3.06" S and 119^0 29' 24.78" E, (corner 7) 27^0 22' 17.14" S and 119^0 29' 11.10" E, and (corner 8) 27^0 22' 25.36" S and 119^0 16' 30.23" E		

The DEC Threatened and Priority Flora and Threatened Ecological Communities databases and Threatened and Priority Flora List searches were carried out in 2011, before an earlier survey was carried out in the area.

Relevant lists were searched to determine whether any weeds listed in the NatureMap and EPBC Act Protected Matters Search Tool search results were any of the following:

- Weeds of National Significance (Australian Government, 2012);
- National Environmental Alert List (Australian Government, 2000);
- Sleeper Weed List (Bureau of Rural Sciences, 2003);
- Species Targeted for Eradication (Natural Resources Management Ministerial Council, 2012);
- Species Targeted for Biological Control (Natural Resource Management Standing Committee, 2012); and
- Declared Pests in Western Australia (DAFWA, 2013c).

The following shape files were sourced from DAFWA and mapped using ArcGIS:

- Land System Mapping (DAFWA 2012a);
- Pre-European Vegetation (DAFWA, 2012b); and
- Native Vegetation Current Extent (DAFWA, 2012c).

Information from the following sources was downloaded from Landgate's Shared Land Information Platform (SLIP Enabler) (Landgate, 2013) and mapped using ArcGIS:

- DEC Managed Lands and Waters (DEC, 2012a);
- Clearing Regulations - Environmentally Sensitive Areas (ESA) (DEC, 2012b);
- Environmental Protection Authority (EPA) Redbook Areas (EPA, 2010);
- Schedule One Areas (DEC, 2012c).

The results of the database and literature searches are discussed in Section 4 of this report. A list of conservation significant flora collated from the different database searches are included as Tables A1.1 (Appendix 1).

3.2 Survey Methodology, Coverage Achieved, Team and Limitations

3.2.1 Survey Methodology

The survey methodology was designed to comply with the following:

- Environmental Protection Authority (EPA) Guidance Statement 51, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004); and,
- EPA Position Statement 3, Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002).

Before undertaking the surveys the botanists familiarised themselves with the conservation significant species produced by the database searches.

A detailed Level 1 survey was carried out within the Survey Area by two botanists on March 19 and 20 (four person days).

The botanists assessed 21, 20 m x 20 m quadrats within the Survey Area; 11 quadrats at Wilsons and 10 quadrats along the HRC. One relevé was assessed at Wilsons and nine along the HRC.

Quadrat locations were selected before the survey using aerial imagery and tenement boundaries. Quadrats were placed to capture the habitats visible on the aerial imagery. Quadrats were also positioned in each LS mapped in the Survey Area. The final location of the quadrats was selected by the botanists while at site. The following information was recorded at each quadrat:

- Location details including GPS co-ordinates.
- Site parameters such as soil description, topography and general habitat description, rock type and cover.
- A photograph of the site.
- Vegetation condition using the scale and criteria developed by Trudgen (1988) and modified by Keighery (1994).
- Notes on any disturbance to the vegetation of the Survey Area.
- Fire history.
- A description of the vegetation structure including the height, percentage cover and dominant species within each stratum.
- The name, height, percentage cover and any other significant recording details for each species located around the site.

If quadrats were located in linear habitats (e.g. a narrow band of vegetation or along creek beds and banks) where a 20 m x 20 m quadrat could not be assessed the area surveyed was amended to fit into that habitat, however, the same area (400 m^2) was assessed.

Transects were walked between sites during the survey and the alignment of these transects was chosen from aerial imagery before going to the field. When walking transects each botanist surveyed a band of vegetation approximately 15 m wide. Conservation significant species known to occur in the area and surrounds any novel or introduced species were targeted while walking transects. The botanists also recorded information when any apparently different vegetation associations were encountered along transects.

When known or suspected conservation significant or weed species were encountered their numbers were either counted or estimated (when populations were large).

At least one specimen of each species encountered was collected. A plant taxonomist verified the identifications of the species collected on both surveys and liaised with relevant experts at the WA Herbarium as necessary.

Coordinates for quadrats and relevés assessed are listed in Table A2.1 (Appendix 2). Transects walked and quadrats and relevés assessed at Wilsons are shown on Map 10.8, Section 10 and along the HRC on Map 10.9, Section 10.

3.2.2 Coverage Achieved

The coverage achieved at Wilsons, along the HRC and over the Survey Area as a whole is listed in Table 3.2. Coverage has been calculated using the total area surveyed at quadrats (the number of quadrats multiplied by 0.04 ha, the area of each quadrat), the total length of transects walked multiplied by 15 m (which is the approximate width of the band of vegetation the botanists surveyed while walking transects) and the area of the polygon being surveyed.

Approximately 17% of both the Wilsons and HRC areas (and the Survey Area as a whole) was assessed by the botanists.

Table 3.2: Area Surveyed and Coverage Achieved at Wilsons, Haul Road Corridor (HRC) and the Survey Area

Survey Time	Assessment Area	Area Assessed at Wilsons	Area Assessed along the HRC
March 2013	Quadrats	0.44 ha	0.40 ha
	Transects	21.94 ha	52.45 ha
Area surveyed at Wilsons and HRC		**22.38 ha**	**52.85 ha**
Area of Wilsons and HRC polygons		**132.71 ha**	**312.21 ha**
Proportion of Wilsons and HRC polygons surveyed		**16.86%**	**16.93%**
Coverage achieved over Survey Area as a whole			
Total area surveyed at Wilsons and HRC		**75.23 ha**	
Combined Area of Wilsons and HRC polygons		**444.92 ha**	
Total coverage achieved		**16.91%**	

3.2.3 Project Team

The project team botanists and their roles are listed in Table 3.3.

Table 3.3: Project Team

Project Team			
Name	**Qualification**	**Project Role**	**DEC Flora License Number**
Christina Cox	PhD	Botanist –report	Not applicable
Scott Hitchcock	BSc	Botanist – field survey & report	SL009969 (exp. April 2013)
Rochelle Haycock	BSc	Botanist – field survey & report	SL009968 (exp. April 2013)
Pali Jayasekara	PhD	Taxonomist – plant identifications	Not applicable

3.2.4 Survey Limitations

Guidance Statement 51 (EPA, 2004) states that reports produced on flora and vegetation surveys for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. A suggested list of constraints (limitations) that these may cover is provided in Guidance Statement 51. Table 3.4 lists each of these constraints and includes a comment on each with respect to this survey.

Table 3.4: Survey Limitations

Limitation	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material)	Information is publicly available on detailed flora and vegetation surveys conducted in areas around the Survey Area. Land systems mapping and Beard's vegetation mapping are also available for the Survey Area. Searches of the DEC's databases and NatureMap were carried out.
The scope (i.e. what life forms, etc., were sampled)	Vascular flora species were sampled.
Proportion of flora collected and identified (based on sampling, timing and intensity)	Twenty-one quadrats were assessed and transects were walked within the Survey Area. The botanists assessed 75.23 ha / 16.91% of the Survey Area while at site. The botanists recorded 126 taxa from 29 families and 58 genera from the Survey Area. Of these, 11.11% were annuals and 88.89% perennials. Six taxa could not be identified beyond genus. Flowering material was used to identify 19.84% of the species list, fruiting material 11.90% and both flowering and fruiting material 1.59% of the species list. A combined NatureMap species list for the two areas searched resulted in a list of 341 species for the wider area (approximately 251,000 ha). The species list produced was acceptable given the area surveyed. More than 10% of this species list comprised annual species. The proportion of the flora collected and identified based on sampling, time and intensity was good. The SPAC analysis indicates that more than 81% of the flora expected to be in the area was recorded during the survey. A comparison with the results of other surveys carried out in the surrounding area indicates that the species list is good given the area surveyed and the coverage achieved.

Limitation	Comment
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed?)	The Survey Area was relatively easily accessible via existing tracks and the Sandstone-Wiluna Road. Given the coverage achieved and the species list that resulted from the survey, and the conservation significant flora species located a second phase survey is not needed. Additional targeted flora surveys should be carried out at Wilsons before clearing commences to define impacts to conservation significant flora species.
Mapping reliability	The vegetation of the Survey Area was mapped at a scale of 1:10,000 using aerial imagery taken in 2009. Information on vegetation association boundaries and habitat changes were noted while traversing the Survey Area. The mapping reliability is considered to be excellent given the coverage achieved. Some areas around existing waste dumps and stockpiles at Wilsons could not be accessed as it was not safe to do so.
Timing, weather, season, cycle	The survey was conducted during the first month of autumn. Based on the mean monthly rainfall for Youno Downs Station and Yeelirrie the survey was conducted during months where the mean monthly rainfall is greatest (January to March). At Youno Downs Station total rainfall in the three months (December 2012 to February 2013) before the mid-march survey was higher than the long-term average for those same three months (37.7 mm more). Total Rainfall at Yeelirrie was below the average for the six months prior to the survey (September 2012 to February 2013) (48.6 mm less). However, rainfall during January 2013 for both Yeelirrie and Youno Downs Station was above average (12.4 mm and 71.4 mm more, respectively). The Survey Area lies within an area that received average rainfall for the period from December 1 2012 to February 28 2013. .
Disturbances (fire, flood, accidental human intervention etc.)	No disturbances were evident or noted during the survey or occurred in the weeks before the survey was carried out.
Intensity (in retrospect, was the intensity adequate?)	A combined total of 16.91% of the 444.92 ha Survey Area was sampled by the botanists over four person days Approximately 16.86% of Wilsons and 16.93% of the HRC was surveyed. The coverage achieved over the Survey Area is considered to be excellent.
Resources	Adequate resources were employed during the surveys. Four person days were spent on the Survey Area by two botanists on March 19 and 20. The two botanists who carried out the survey have excellent experience of the flora and vegetation of the Murchison and carried out an earlier survey on neighbouring Panoramic tenements.

Limitation	Comment
Access problems	All areas were relatively easily accessible on foot: the only areas not accessed were those areas at Wilsons where it was not safe to do so.
Experience levels (e.g. degree of expertise in plant identification to taxon level)	Scott Hitchcock and Rochelle Haycock have conducted numerous surveys in the Murchison region over the past five years. At least one specimen of all species recorded during the surveys was collected. The specimens were identified by Dr. P. Jayasekara, a taxonomist with more than five years of experience in the taxonomy of the flora of the Murchison. Dr. Jayasekara also liaised with staff at the WA Herbarium as necessary.

3.3 Taxonomy and Nomenclature

At least one specimen of every taxon encountered during the survey was collected for verification by a taxonomist. In many cases multiples of flowering or fruiting specimens were collected to assist with identification. Most specimens collected were identified by Dr. P. Jayasekara using taxonomic keys and reference specimens at the WA Herbarium. Specialists at the WA Herbarium were consulted as necessary. The following people assisted with the identification of some taxa:

Mr Rob Davis (WA Herbarium, taxonomist) – provided advice on challenging *Eremophila* specimens.

Mr Michael Hislop (WA Herbarium, taxonomist) – provided advice on the Priority Three taxon *Calytrix praecipua*.

Species names used in this report are those adopted by the WA Herbarium and they have been checked against current FloraBase records (WAH, 1998 -).

3.4 Statistical Analysis

Version 3.12 of the multivariate statistical analysis package PATN (Belbin, 1989; Belbin, 2004) was used to analyse the floristic data collected at quadrats. The analysis was run three times:

1. Using the data collected during this survey only, and referred to as the 'single analysis' in the results section.
2. Using the data collected during this survey combined with quadrat data collected during Maia's 2011 survey carried out at Panoramic's O'kearys, Howards and Swan Bitter project areas, and referred to as the 'combined analysis' in the results section.
3. A third analysis using the combined analysis data along with data collected by the DEC at 10 of the Montague Range quadrats lying closest to the Wilsons area and referred to as the 'DEC analysis' in the results section.

The results of the DEC analysis were used to determine any floristic similarities between the DEC's quadrats and the quadrats assessed during this survey. The results of these analyses are discussed in Section 7.

The presence and absence of perennial taxa and Pearson complete linkage analysis with the Bray Curtis association measure was used to group sites with similar species composition and to define the vegetation associations of the Survey Area. As per the methodology followed by the DEC, annual, singleton and weed species were removed from the data before running the analyses. Species that could not be positively identified due to lack of reproductive material were combined with the confirmed species e.g. *Boerhavia* ?*repleta* was combined with *Boerhavia repleta*. Other species were combined before analyses based on their similarity, the number of

subspecies, or due to current taxonomic uncertainty. The taxa combined for the analyses are listed in Table 3.5 along with the reason for combining them.

Table 3.5: Taxa Amendments and Combinations pre PATN Analysis

Taxa Combined	Combined Name – Maia (this survey), Maia (2011) and DEC (Thompson & Sheehy, 2011a) Analysis	Reasoning
Solanum lasiophyllum and *Solanum ashbyae*	*Solanum lasiophyllum/ashbyae*	These were combined for the Maia/DEC analysis as the DEC combined them during their analysis. Maia did not record *Solanum ashbyae* during this survey.
Acacia aneura, Acacia aptaneura, Acacia caesaneura, Acacia fuscaneura, Acacia incurvaneura and *Acacia macraneura*	*Acacia aneura*	These species were combined into a complex during Maia's 2011 analysis and have been combined for this survey for consistency.
Aluta maisonneuvei subsp. *auriculata* and *Aluta maisonneuvei* subsp. *maisonneuvei*	*Aluta maisonneuvei*	These sub species were combined for the Maia/DEC analysis as different sub species were recorded.
Eremophila forrestii, Eremophila forrestii subsp. *forrestii, Eremophila forrestii* subsp. *hastieana*	*Eremophila forrestii*	Sterile material was identified to species level and the subspecies share similar habitats and were therefore combined.
Eremophila jucunda and *Eremophila jucunda* subsp. *jucunda*	*Eremophila jucunda*	The DEC specimens could not be identified to sub-species level so these were combined for the Maia/DEC analysis.
Rhagodia eremaea and *Rhagodia drummondii*	*Rhagodia eremaea/drummondii*	Both of these species occur in similar habitats and often co-occur particularly in saline areas.

An indicator species analysis was run on the data collected at quadrats. PC-Ord (McCune & Mefford, 2010) was used selecting the Dufrêne and Legendre (1997) analysis option to determine indicator species for each vegetation community. A Monte Carlo Permutation Test was used to determine the significance of the indicator species resulting from this test and is included as Table A3.2, Appendix 3.

Species accumulation curves (SPAC) are used to measure the estimated sampling adequacy of an area. In essence, as sampling intensity increases the incidence of new taxa recorded will decrease and eventually all species in a survey area will be recorded. This is represented by the total records (vertical axis) becoming asymptotic (levelling out) and remaining level as new sample sites are added. A SPAC was generated for the data collected from the Survey Area using the software package EstimateS and the methodology outlined in Colwell (2006); the analysis was run using the information collected at quadrats only. The results of the species accumulation analysis are used to estimate the percentage of the flora of the area that was sampled. This estimate is calculated using the last Sobs (Mao Tau) result divided by the last Chao2 Mean listed in the results table (where: Sobs is the total number of species observed in a sample or set of samples; Sobs (Mao Tau) is the number of samples expected in the pooled quadrat samples given the empirical data; and, the Chao2 Mean is the Chao2 richness estimator (mean

among runs) (Colwell, 2006)). By dividing the species richness observed (Sobs (Mao Tau)) by the species richness predicted (Chao2 Mean) the sampling effort can be estimated.

3.5 Vegetation Mapping

The results of the floristic analyses were used to define and map the boundaries of the vegetation associations of the Survey Area.

Aerial photography captured in 2009 was used to map the vegetation at a scale of 1:10,000. Vegetation descriptions and the presence / absence of taxa recorded at sites assessed by Maia during the current survey along with those assessed by Maia in 2011 were used to describe the vegetation associations.

Information in notes on vegetation association boundaries recorded whilst traversing the area, along with notes on vegetation structure and habitat (e.g. fire age and topography) that were recorded during the survey, was also used to map the vegetation associations.

The growth forms, height classes and cover characteristics of the vegetation are described using the current National Vegetation Inventory System (NVIS) methodology at the association level. At this level up to three strata and a maximum of three taxa per stratum are used to describe the association (ESCAVI, 2003). This methodology is outlined in Appendix 7.

3.6 Vegetation Condition

Vegetation condition was mapped using data collected from quadrats, relevés and notes recorded while walking from site to site. The field assessments were updated as necessary once the plant identifications had been confirmed and the invasiveness of any weed species determined. Aggressive weed species are considered to be those rated as having a rapid invasiveness, extensive distribution and a high environmental impact rating. Vegetation condition ratings are based on the scale developed by Trudgen (1988) and modified and adapted by Keighery (1994). The vegetation condition scale and criteria are provided in Table 3.6.

Table 3.6: Vegetation Condition Scale and Criteria Used

Condition Scale	Description
(E) Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
(VG) Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
(G) Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
(P) Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
(VP) Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
(CD) Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; ie areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

4 RESULTS - DATABASE SEARCHES

4.1 CONSERVATION SIGNIFICANT FLORA

The significant flora species results from the database (and additional literature) searches are listed in Table A1.1 (Appendix 1) and shown on Map 10.10 (Section 10). A comment on the likelihood of the listed species occurring in the Survey Area is also included in Table A1.1.

4.1.1 Threatened Flora

4.1.1.1 *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999*

Some flora species are protected by Australian Government legislation based on the perceived levels of threat to the species population at a national level. These species are placed within one of six conservation categories (Table A5.1, Appendix 5) and four of these categories are specially protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DSEWPaC, 2013c).

Two species protected by the EPBC Act occur in the Murchison bioregion; *Eremophila rostrata* subsp. *rostrata* (Threatened (T), Critically Endangered) and *Ricinocarpos brevis* (T, Endangered).

The results of the search carried out using the EPBC Act Protected Matters Search Tool listed no flora species protected by the EPBC Act as occurring within 20 km of the Survey Area (DSEWPac, 2013a).

The results of the search carried out using the NatureMap search listed no flora species protected by the EPBC Act as occurring within 20 km of the Survey Area (DEC, 2007-).

No EPBC Act flora species were listed in the results of the DEC database searches.

4.1.1.2 *WILDLIFE CONSERVATION ACT 1950*

All flora species native to WA are protected under the State's *Wildlife Conservation Act 1950*. Under this act, the Minister for the Environment may declare species of flora to be protected if they are considered to be in danger of extinction, rare or otherwise in need of special protection: Schedules 1 and 2 deal with those species that are threatened or presumed extinct respectively (DEC, 2013a).

In WA the term Threatened Flora (T) is applied to extant declared rare flora (DRF) and Presumed Extinct Flora to extinct DRF (DEC, 2013a and defined in Table A5.2, Appendix 5). The most recent DRF list was published on November 6, 2012 (Government of Western Australia, 2012). Currently, three FloraBase records exist for threatened species in the Murchison bioregion – *Atriplex* sp. Yeelirrie Station (L. Trotter & A. Douglas LCH 25025), *Eremophila rostrata* subsp. *rostrata* and *Ricinocarpos brevis* (WAH, 1998-).

The NatureMap search results listed no threatened species as occurring within 20 km of the Survey Area (DEC, 2007-).

No threatened species were listed in the results of the DEC database searches.

4.1.2 Priority Flora

Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List under priorities (P) 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in P4; these species require regular monitoring. Conservation Dependent species are placed in P5 (DEC, 2013a).

Definitions for each of the categories discussed above are included in Table A5.3 (Appendix 5). The most recent Priority Flora List was published on December 20, 2012 (Smith, 2012).

In March 2013, 190 Priority Flora species were listed on FloraBase (WAH, 1998-) for the Murchison bioregion. Of these 190, 152 occur in the Eastern Murchison subregion.

Results from the DEC database, NatureMap and literature searches identified 28 Priority Flora species that have been recorded in the area. These are: six P1 species, 20 P3 species, and two P4 species (Table A1.1, Appendix 1).

Additional information on the flowering period, typical habitat and recorded locations for these species is listed in Table A1.1 (Appendix 1). Eighteen of these species could possibly occur in the Wilsons area and seven in the HRC area based on the similarity of habitat and distance from known records around the Survey Area.

4.2 Introduced Flora

A weed is defined in the Australian Weeds Strategy (DEWR, 2007) as 'a plant which has, or has the potential to have, a detrimental effect on economic, social or conservation values'. Weeds can include species that have proliferated in bushland without direct human intervention or assistance (referred to as naturalised alien species).

4.2.1 Weeds of National Significance

A number of lists of weeds of national interest are currently recognised (DEC, 2013b). The nature of the weeds and the resulting actions required determine on which list a species may appear. Some weeds are of particular concern and, as a result, have been listed for priority management or in legislation e.g. weeds of national significance (WoNS).

The searches using the EPBC Act Protected Matters Search Tool (DSEWPaC, 2013b) produced no weeds on these weeds lists as having been recorded previously in the vicinity of the Survey Area.

The NatureMap search (DEC, 2007-) produced one weed on these weed lists as having been recorded previously in the vicinity of the Haul Road – *Marrubium vulgare* (Horehound). It is listed as a species targeted for biological control (DAFWA, 2013).

4.2.2 Plant Pests Declared in Western Australia

Before 30 April 2013, plants known to adversely affect agriculture (or have the potential to) were known as declared plants and were listed as one or more of five priority category weeds under the *Agriculture and Related Resources Protection Act 1976* (ARRP Act) (APBWA, 2013).

On May 1 2013 the *Biosecurity and Agriculture Management Act 2007* (BAM Act) and regulations came into force. Legislation to be repealed is now covered by the BAM Act and its regulations (DAFWA, 2013a).

The Western Australian Organism List (WAOL) has been created to easily find out the declared status of organisms that have now been classified as part of the enactment of the BAM Act (DAFWA, 2013b).

Organisms are grouped into four main classifications: Declared pests; Permitted; Prohibited; and, Permitted requiring a permit.

Under the BAM Act, all declared pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management) (DAFWA, 2013b). These three categories are described in Table A6.1, Appendix 6.

- No declared pest plant species was listed in the results of the EPBC Act Protected Matters Search Tool search for either area.

- No declared pest plant species was produced in the Wilsons NatureMap search results. Two plant species listed as declared pests were included in the NatureMap search results for the HRC: *Emex australis* (Doublegee) and *Marrubium vulgare* (Horehound). Both plants are listed as C3 declared pests. *E. australis* is prohibited plant for the South West Land Division while *M. vulgare* is prohibited for the portion of the State south of the 26th parallel of latitude (DAFWA, 2013c).

4.2.3 Environmental Weeds

Environmental weeds are introduced plants that establish themselves in natural ecosystems and adversely modify natural processes, resulting in the decline of the communities they invade (DEC, 2013c).

The EPBC Act Protected Matters Search Tool (DSEWPaC, 2013a) indicated that two invasive species (weeds) could occur in the HRC and Wilsons areas: *Carrichtera annua* (Ward's Weed) and *Cenchrus ciliaris* (Buffel Grass).

The NatureMap search (DEC, 2007-) listed no weed species which have been recorded in the Wilsons area previously and six weed species as recorded in the HRC area previously: *Erodium aureum*, *Lysimachia arvensis* (Pimpernel), *Portulaca oleracea* (Purslane), *Rostraria pumila*, *Sisymbrium orientale* (Indian Hedge Mustard) and *Spergularia rubra* (Sand Spurry).

In WA the Environmental Weed Strategy for Western Australia (EWSWA) (CALM, 1999) provides details of management priorities and general control measures and monitoring for environmental weeds. The EWSWA is still relevant but Appendix 3 of the document - the 'List of Environmental Weed Species of Actual and Potential Significance in WA' is now out of date and the Invasive Plant Prioritisation Process for DEC has been developed (DEC, 2013d). Workshops have been held in each DEC Region to prioritise weed species according to their threat to the natural environment and these weed assessments are now available. Most of the weeds listed are rated for their invasiveness, distribution and ecological (environmental) impacts among other attributes.

The Goldfields region weed assessment spread-sheet (DEC, 2013e) lists 99 environmental weeds for the Murchison bioregion while FloraBase (WAH, 1998-) lists 124 weeds generally (including DPs).

4.3 Ecological Communities, Environmentally Sensitive Areas, Schedule One Areas, EPA Redbook Areas and Conservation Areas/Reserves

Some ecological communities are protected by Commonwealth and / or WA legislation (Threatened Ecological Communities – TECs). Others are listed as Priority Ecological Communities (PECs) in WA. The conservation significance rankings for these TECs and PECs are listed in Table A5.4 and A5.5 in Appendix 5 (DEC, 2010). The most recent TEC list is correct to May 2013 and includes one TEC in the Murchison bioregion (DEC, 2013f). The most recent PEC list was released on March 26, 2013 (DEC, 2013g) and includes 60 PECs in the Goldfields region. Information produced by searches for TECs or PECs occurring in the Survey Area follows:

- No TECs protected by Commonwealth legislation are listed for the Murchison bioregion.
- The WA listed TEC in the Murchison does not occur in the vicinity of the Survey Area.
- The buffer in place around a Priority 1 PEC – the Montague Range Vegetation Complexes (banded ironstone formation) lies over the Survey Area (search reference # 20-1111 EC).

The PEC buffers lying over and in the vicinity of the Survey Area are shown on Map 10.11, Section 10.

Some areas in WA are listed as environmentally sensitive areas (ESAs). These are areas requiring special protection of rare or threatened flora, sites that have high conservation, scientific or aesthetic values and/or Aboriginal or European cultural sites.

- Search results indicated that no ESAs occur within or close to the Survey Area (Map 10.12, Section 10).

The National Reserve System (NRS) is a network of protected areas managed for conservation and restoration of the natural environment, the protection, care and study of indigenous flora and fauna, and the preservation of any feature of archaeological, historic or scientific interest (DEC, 2013h).

- Search results indicated that no conservation estates occur within or close to the Survey Area (Map 10.12, Section 10).

A Schedule One Area requires a permit for vegetation clearing resulting from low impact mineral or petroleum activities.

- Search results indicated that some of the eastern section of the HRC is located within a Schedule One Area, ex Lake Mason (Map 10.12, Section 10).

Former leasehold areas were previously pastoral leases or parts of pastoral leases that have been acquired for conservation and are managed under interim arrangements prior to their reservation as conservation reserves (DEC, 2012c).

- Search results indicated that approximately 14 ha of the eastern section of the HRC are located within former leasehold ex Lake Mason (Map 10.12, Section 10).

An EPA Redbook Area is an area recommended by the EPA for conservation (EPA, 2010).

- Search results indicated no EPA Redbook Area occurs in the Survey Area (Map 10.12, Section 10).

5 SURVEY RESULTS - FLORA

A complete list of the flora species recorded during the survey is included in Table A4.2 (Appendix 4).

5.1 GENERAL FLORA

One hundred and twenty-six taxa from 29 families and 58 genera were recorded from the Survey Area. The identities of six of these taxa could not be confirmed beyond genus due to a lack of flowering or fruiting material: *Boerhavia* ?*repleta, Bothriochloa* sp., *Eragrostis* sp., *Hibiscus* sp. 1, *Maireana* ?*thesioides* and *Sida* sp. 1.

The families with the highest number of taxa were Fabaceae (25), Scrophulariaceae (21) and Poaceae (19). The genera with the highest number of taxa were *Eremophila* (21), *Acacia* (17) and *Senna* (6).

Flowering specimens were used to identify 19.84% of the species list, fruiting material 11.90% and both flowering and fruiting material 1.59%. Flowering and fruiting specimens are indicated in the species list (Table A4.2, Appendix 4).

Annual taxa comprised 11.11% of the species list and perennial taxa 88.89%.

Of the 126 taxa recorded during the survey, 101 were recorded at quadrats, three taxa at relevés and 22 were collected opportunistically, while walking from site to site, and were not recorded within the quadrats or relevés assessed.

Of the 126 taxa recorded during the survey, 77 taxa were recorded within the HRC and 92 taxa at Wilsons.

A site by species matrix is included as Table A3.1 (Appendix 3).

The species accumulation analysis indicates that 81% of the flora estimated to be in the Survey Area was recorded. However, this estimation is based on the 101 taxa recorded in the 21 quadrats assessed and does not include the 25 additional taxa recorded opportunistically and at relevés. The results of the analysis are included in Table A4.1 (Appendix 4) and the SPAC is included as Figure 5.1.

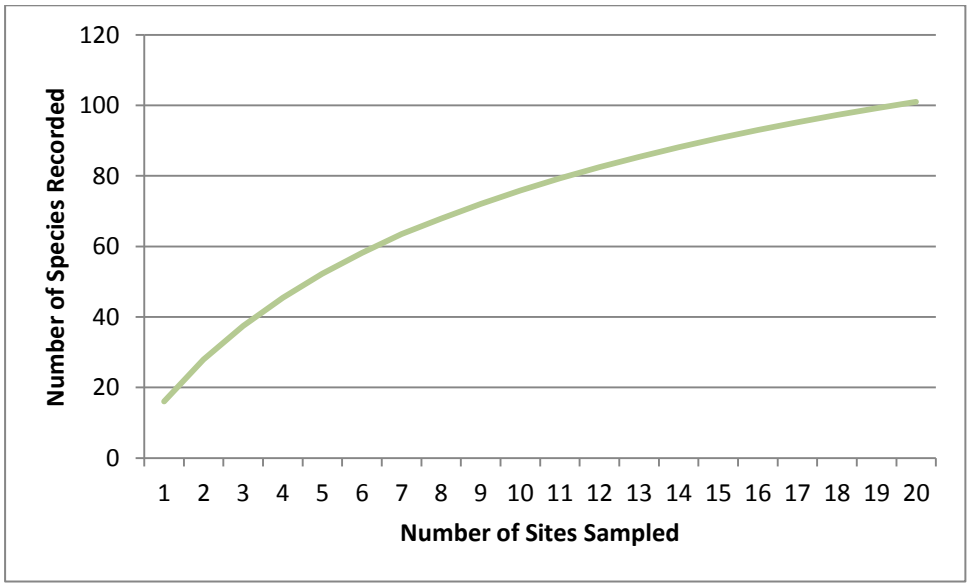


Figure 5.1: Species Accumulation Curve Produced using Quadrat Data

5.2 Range Extensions

Species have a typical range which is indicated by their known distribution records. Sometimes species are recorded in areas where they have not been found previously and these species are described as range extensions. A range extension can reflect a paucity of surveys in a particular area or non-lodgement of flora records to the WA Herbarium.

Two species with range extensions of more than 100 km were collected from the Survey Area (Table 5.1).

Table 5.1: Range Extension Species Located in the Survey Area

Species	Closest WAH (1998-) Record from Survey Area	Distance and Direction from Survey Area
Bursaria occidentalis	Dalgaranga Station (Murchison bioregion).	231 km west.
Eremophila fraseri subsp. *parva*	Belele Station (Murchison bioregion).	165 km north-west.

5.3 Conservation Significant Flora

5.3.1 Threatened Flora

No species protected by the EPBC Act were located in the Survey Area.

No species protected by the WC Act were located in the Survey Area.

5.3.2 Priority Flora

Four priority (P) species were recorded in the Survey Area – *Stenanthemum mediale* (P1), *Acacia burrowsiana*, *Calytrix praecipua* and *Sauropus ramosissimus* (all P3). The locations for the plants recorded are listed in Table A5.6, Appendix 5.

***Stenanthemum mediale* (P1)**

S. mediale is an erect shrub growing to 0.4 m high (Plate 5.1) (WAH, 1998-). The leaf margins are entire and the leaves have an apex (Plate 5.2) (Rye, 2007). It produces flowers from April to August (Plate 5.2), and plants were flowering during the March survey. *S. mediale* grows on red-clayey sand (WAH, 1998-).

S. mediale was recorded at eight locations at Wilsons (Map 10.13, Section 10). It was found on ironstone-laterite substrate hills.

Plate 5.1: Growth habit

Plate 5.2: Close-up of leaves and flowers

***Acacia burrowsiana* (P3)**

A. burrowsiana is a stout shrub growing to 5 m high (Plate 5.3). The leaves are erect, coarsely pungent with three distinct veins. It produces yellow cylindrical flowers (Plate 5.4), but was not flowering during the survey. *A. burrowsiana* grows on flats adjacent to watercourses, crests of low rises and breakaways on calcrete, laterite and quartz (WAH, 1998-).

A. burrowsiana was recorded at four locations at Wilsons (Map 10.13, Section 10). It was found on quartz and calcrete hillslopes.

Plate 5.3: Growth habit

Plate 5.4: Close-up of leaves and flowers

***Calytrix praecipua* (P3)**

C. praecipua is a shrub growing to 0.7 m high (Plate 5.5). The leaves are angular. It is noted as producing pink to white flowers from June to July or September to November (Plate 5.6); however, plants were flowering during the March survey. *C. praecipua* grows on skeletal sandy soils over granite or laterite on breakaways and outcrops (WAH, 1998-).

C. praecipua was recorded at 10 locations at Wilsons (Map 10.13, Section 10). It was found on laterite breakaways and outcrops.

Plate 5.5: Growth habit

Plate 5.6: Close-up leaves and flower

***Sauropus ramosissimus* (P3)**

S. ramosissimus is a slender, many-branched shrub growing to 0.3 m high (Plate 5.7) (WAH, 1998-). This species often appears to be leafless (Plate 5.8), and the leaves on the branches appear normal, reduced in size or scale-like with a mixture of normal and/or leaves reduced in size over the plant. It is covered in a sticky substance (Hunter & Bruhl, 1997). *S. ramosissimus* grows on lateritic and granite breakaways and gravel over ironstone-laterite substrate hills (WAH, 1998-).

S. ramosissimus was recorded at eight locations at Wilsons (Map 10.13, Section 10). It was found on laterite breakaways and growing on hills with a laterite substrate.

Plate 5.7: Growth habit

Plate 5.8: Close-up of branches and branching

5.3.3 Taxa of Interest

No taxa of interest (TOI) were located during the survey.

5.4 Introduced Flora

5.4.1 Weeds on National Weeds Lists

No weeds on any of the national weeds lists were located during the survey.

5.4.2 Plant Pests Declared in Western Australia

No plant pests declared in WA were located during the survey.

5.4.3 Environmental Weeds

One environmental weed species was located within the HRC: *Portulaca oleracea* (Purslane) and the locations are shown on Map 10.14, Section 10. No environmental weed species were recorded at Wilsons. The locations for the weeds recorded along the HRC are listed in Table A6.1, Appendix 6.

The invasiveness, distribution and ecological impact rankings (DEC, 2013e) for the one weed species recorded during the survey are listed in Table 5.2. The overall aggressiveness score is the product of the scores for invasiveness and ecological impact. The ratings for invasiveness follow along with a score for each rating: rapid (4); moderate (3); slow (2); and, unknown (1). The ratings for ecological impacts for the species follow along with a score for each rating: high impact (4); medium impact (3); low impact (2); and, unknown (1).

Table 5.2. Ecological Ratings (score) for Weeds Recorded in the Survey Area

Species	Invasiveness	Distribution	Ecological Impact	Aggressiveness Score
Portulaca oleracea	Unknown	Low	Unknown	2

This species is considered to be non-aggressive based on the score; however, some of the ratings for *Portulaca oleracea* are unknown.

6 RESULTS - VEGETATION

6.1 VEGETATION ASSOCIATIONS

The vegetation associations of the Survey Area were defined predominantly using the 'single analysis' pattern analysis results rather than the 'combined analysis' or the 'DEC analysis' results (see Section 3.4 for explanation of different analyses). The results of the 'combined analysis' were used to determine the level of similarity between the associations from this survey and Maia's 2011 survey carried out at O'kearys, Swan Bitter and Howards, and the 'single analysis' results were used to amend the previous association descriptions as well as to describe associations recorded in 2013 but not recorded in 2011. Two outlier sites from association SL1 in the 'single analysis' (W05 and W06) were mapped based on their dominant species and also based on where they grouped in the results of the 'combined analysis' (see Section 3.4 for information on the three different analyses run).

The pattern analysis results divided the 'single analysis' data into two broad groups at the 1.04 similarity scale. It further divided the data into five groups at approximately the 0.7 similarity scale with a final stress value of 0.16, which is considered excellent for this level of analysis.

The overall and group dendrograms produced by the 'single analysis' and the overall dendrogram for the 'combined analysis' and 'DEC analysis', along with the statistical methodology (PATN recipes), used to generate a site by species classification are included as Figures A3.1 to A3.7 (Appendix 3). The site by species matrix for the 'single analysis' is included as Table A3.1 (Appendix 3).

The results of the indicator species analysis are included as Table A3.2 (Appendix 3) and the indicator species resulting from the analysis are shown in bold font in Table 6.1.

Eight vegetation associations were mapped in the Survey Area and these are described and shown in Table 6.1. Seven of these associations were also mapped in the O'kearys, Swan Bitter and Howards areas surveyed by Maia in 2011. One new association, SL3, has been mapped in the HRC.

Information collected at each quadrat, Appendix 8, is included as a separate document.

The vegetation associations of the Survey Area are shown on Maps 10.15 and 10.16 (Section 10) and the legend in Figure 10.1, Section 10.

Vegetation descriptions have been written using the dominant cover class as the indicator and not the dominant stratum in order to correlate with the broad floristic formation descriptions e.g. Chenopod Shrubland of *Sclerolaena cuneata* and *Maireana triptera* with a Sparse Low Shrubland of *Eremophila maculata* subsp. *brevifolia* and Scattered trees of *Acacia aneura* complex.

The codes used for each association are based on the broad floristic formation e.g. CSL for Chenopod Shrubland, WL for Woodland and SL for Shrubland.

Areas already cleared within the Survey Area (for tracks and drill lines) have been mapped as C (cleared).

The conservation significance of these vegetation associations is discussed in Section 7.

Table 6.1: Vegetation Associations of the Survey Area

CSL: Mixed Chenopod Shrubland

This association was recorded on stony plains at the north end of the HRC. A quadrat was not assessed in the area because it had been heavily grazed and trampled by cattle. It was mapped over a relatively small area (35.99 ha) and occurred in small patches within association WL6 in the north-west of the HRC.

Vegetation condition recorded at the relevés assessed ranged from Very Good to Good and the main disturbances were cattle grazing and trampling.

Association Description	Associated Species/Species Richness	Sites
Sparse to Open Chenopod Shrubland of *Sclerolaena cuneata* and *Maireana triptera* with a Sparse Low Shrubland of *Eremophila maculata* subsp. *brevifolia* and Scattered trees of *Acacia aneura* complex.	*Acacia tetragonophylla*, *Atriplex codonocarpa, Dissocarpus paradoxus* and *Solanum lasiophyllum.*	PH12, P14, P15 and P16

SL1: *Eremophila* Shrubland.

This vegetation association occurs on outcrops and low isolated hills of laterite and quartz mainly in the centre of Wilsons adjacent to previously disturbed areas. The sites in this association group at the very top of the dendrogram in both the 'single' and 'combined' analyses. Site W07 grouped with this association but has been mapped as WL7 based on the dominant species. Based on its associated species, site W07 appears to have been established in a transitional zone between WL7 and SL1. *Acacia burrowsiana* (P3) and *Calytrix praecipua* (P3) were recorded in this association, which was mapped over a relatively small area (14.82 ha).

Vegetation condition was rated as Excellent and the main disturbances were from mining activities and cattle grazing.

Association Description	Associated Species/Species Richness	Sites
Sparse Mid Shrubland of ***Eremophila oppositifolia* subsp. *angustifolia*** and *+/- E. pantonii* with a Sparse Low Shrubland of *Solanum lasiophyllum* and *Ptilotus obovatus* and Scattered Low Trees of *Acacia aneura* complex and/or *A. tetragonophylla*.	***Acacia balsamea*, *A. burkittii*, *A. burrowsiana*** (P3), *Dodonaea microzyga* var. *acrolobata*, *Eucalyptus carnabyi*, *Ptilotus schwartzii*, ***Scaevola spinescens*** and *Sida ectogama*. The average species richness for this association was 15.5 ± 0.71.	W03 and SH10

SL2: *Acacia* Open Shrubland.

This vegetation association occurs on dolerite and basalt outcrops and hill slopes at Wilsons. It was recorded at a single site and grouped with sites from association SL2 in the 'combined analysis'. In the 'single analysis' W05 grouped with W06, which was recorded on a minor gully between the rolling hills. In the 'combined analysis' W06 grouped with site GN24 which was mapped as association WL8 (drainage) in the previous survey areas and it has been mapped as that association in this Survey Area. *Acacia burrowsiana* (P3) was recorded in this association. The association was mapped over a relatively small area (13.07 ha).

Vegetation condition was rated as Excellent and the main disturbances were from mining activities and cattle grazing.

Association Description	Associated Species/Species Richness	Sites
Open Tall Shrubland of *Acacia xanthocarpa* with a Sparse Mid Shrubland of *Eremophila exilifolia* with a Sparse Low Shrubland of +/- *Aluta maisonneuvei* subsp. *maisonneuvei*.	*Acacia macrocneura, Aristida contorta*, *Prostanthera althoferi* subsp. *althoferi* and *Solanum lasiophyllum*. The species richness for this association was 9.0.	W05

SL3: *Eremophila* Open Shrubland.

This vegetation association occurred on seasonally inundated flats in the central section of the HRC and was represented by a single quadrat. Quadrat H09 grouped as an outlier in the 'single analysis' and with sites GC03 and GC04, from association CSL, in the 'combined analysis'. CSL is characterised as a Chenopod Shrubland, however, based on the dominance of *Eremophila malacoides* in the lower shrub layer, this site has been mapped as SL3. This association was not recorded in 2011. It was mapped over a relatively small area (8.53 ha).

Vegetation condition was rated as Excellent and the main disturbance was from cattle grazing.

Association Description	Associated Species/Species Richness	Sites
Low Open Shrubland of *Eremophila malacoides* and *Cratystylis subspinescens*.	*Acacia victoriae* subsp. *victoriae*, *Atriplex codonocarpa*, *Ptilotus divaricatus*, *Scaevola spinescens* and *Solanum lasiophyllum*. Species richness was 14.0.	H09, P12 and P13

WL1: *Acacia* Sparse Woodland

This association was noted on hardpan and sandy plains at the western extent of the HRC. The boundaries of this association are difficult to determine on the aerial photograph as structurally it resembles WL6. It was mapped over a relatively small area (3.89 ha). No quadrats were surveyed in this association but it was noted at a point of interest while walking transects.

Vegetation condition was rated as Excellent and the main disturbance was from cattle grazing.

Association Description	Associated Species/Species Richness	Sites
Sparse Low Woodland of *Acacia aneura* with a Sparse to Open Tall Shrubland of *A. ramulosa* var. *linophylla* and a mixed Sparse Low Shrubland.	*Enchylaena tomentosa* var. *tomentosa, Eragrostis eriopoda, Eremophila forrestii* subsp. *forrestii*, *Maireana* ?*thesioides*, *Ptilotus obovatus* and *Solanum lasiophyllum*.	Point of interest

WL6: *Acacia* Open Woodland

This association occurred along the HRC on stony and sandy plains. *Acacia ayersiana*, which was a dominant in sites from the previous survey, was not recorded in this area and the description has been updated to reflect the data collected during this survey. It was mapped over a relatively large area of the HRC (259.22 ha).

Vegetation condition was rated as Excellent and the main disturbance was from cattle grazing.

Association Description	Associated Species/Species Richness	Sites
Open Low Woodland of *Acacia aneura* complex with a Sparse Mid Shrubland of ***A. tetragonophylla*** and/or *A. craspedocarpa* and a Sparse Low Shrubland of *Ptilotus obovatus*.	*Aristida contorta*, ***Eremophila longifolia***, *Maireana thesioides*, *Rhagodia drummondii*, *R. eremaea*, *Ptilotus obovatus*, *Sclerolaena cuneata* and ***Solanum lasiophyllum***. The average species richness for this association was 14.22 ± 2.48.	H01, H02, H03, H04, H05, H06, H07, H10, H11, P04, P07 and P11

WL7: *Acacia* Sparse Woodland

This association occurred on ironstone hills at Wilsons and was mapped over 103.96 ha. The original description for this association has been amended to incorporate data collected in March 2013 quadrats.

The mid stratum, which was dominated by *Acacia tetragonophylla* at the earlier areas surveyed, was dominated by *A. quadrimargineae* in the March 2013 Survey Area and *Eremophila jucunda* subsp. *jucunda* in the low shrubland layer. This association resembles the DEC's community type 4 of the Priority 1 PEC – the Montague Range Vegetation Complexes (banded ironstone formation (BIF)) but was not recorded on BIF at Wilsons. Three priority species were recorded in this association, *Stenanthemum mediale* (P1), *Calytrix praecipua* and *Sauropus ramosissimus* (both P3).

Vegetation condition was rated as Excellent and the main disturbances were from cattle grazing and mining activities.

Association Description	Associated Species/Species Richness	Sites
Sparse Low Woodland of *Acacia aneura* complex with a Sparse Tall Shrubland of *A. aneura* and ***A. quadrimarginea*** and Sparse Low Shrubland of ***Eremophila jucunda* subsp. *jucunda*** +/- *E. latrobei* subsp. *latrobei.*	*Acacia tetragonophylla, A. balsamea,* ***Dodonaea petiolaris***, ***Eremophila conglomerata***, *E. latrobei* subsp. *latrobei*, *Ptilotus obovatus* and *P. schwartzii*. The average species richness for this association was 14.16 ± 2.48.	W01, W02, W04, W07, W08, W10, W11 and P02

WL8: *Acacia* Open Woodland / Shrubland

This association occurs in minor gullies between the rolling hills at Wilsons and was mapped over a relatively small area (0.86 ha). This site groups with W05 (SL2) in the 'single analysis', but groups with site GN24 in the 'combined analysis'. Quadrat GN24 was mapped as WL8 based on its occurrence on minor drainage channels at O'kearys. The original description for this association has been amended to incorporate data collected at quadrats in March 2013. *Acacia quadrimarginea*, which was a dominant in the mid shrub layer of GN24, has been replaced with *Acacia xanthocarpa* which was the dominant species at site W06.

Vegetation condition was rated as Excellent and the main disturbances were from cattle grazing and previous mining activivities.

Association Description	Associated Species/Species Richness	Sites
Open Low Woodland / Tall Shrubland of *Acacia xanthocarpa* with Isolated Low Trees of *Acacia aneura* complex and Isolated Low Shrubs of *Prostanthera althoferi* subsp. *althoferi* and *Eremophila exilifolia.*	*Abutilon oxycarpum*, *Acacia burkittii*, *Cheilanthes sieberi* subsp. *sieberi*, *Eriachne helmsii*, *Psydrax latifolia*, *P. rigidula* and *Sida ectogama*. The species richness for this association was 31.0.	W06

6.2 Vegetation Condition

The condition of the vegetation at the Survey Area ranged from Excellent (90.88%) to Completely Degraded (1.03%).

The condition of the vegetation at Wilsons was rated as Excellent. Wilsons encompasses a previously mined area and pits, waste dumps and access tracks already exist in the area. These previously disturbed areas were excluded from the Survey Area supplied by Panoramic and have not been included in the percentage calculations. Cattle were common in the previously cleared areas and were observed walking along existing tracks. The vegetation adjacent to these areas showed signs of grazing and trampling.

The condition of the vegetation along the HRC was mostly rated as Excellent. Damage to taller shrubs and some grazing of the lower shrubs was noted in some areas but this was in isolated small areas and it wasn't widespread. Notes taken at points of interest along the HRC identified areas that had been extensively grazed by cattle and had little to no lower shrub layer remaining. These areas were generally rated as Very Good or Good and have been mapped as Very Good/Good (8.09%).

Additional information on vegetation condition in the Survey Area is included in Table 6.2 and the average vegetation condition is shown on Maps 10.17 and 10.18, Section 10.

Table 6.2: Vegetation Condition at the Survey Area

Vegetation Condition	Area (ha)	Cover (%)	Comment
Excellent	404.36	90.88	The majority of the Survey Area was rated as Excellent. There were obvious signs of grazing but the vegetation structure remained intact.
Very Good/Good	35.99	8.09	These areas were identified at points of interest while walking transects along the HRC. They were isolated patches of Chenopod Shrublands that had little to no lower shrub layer remaining. Large numbers of cattle were also observed in these areas.
Completely Degraded	4.57	1.03	The areas mapped as Completely Degraded are those that have been cleared for roads, tracks and mining infrastructure.

6.3 Vegetation Association Cover in Survey Area

The area of each of the vegetation associations mapped within the Survey Area as a whole and separately within Wilsons and the HRC is listed in Table 6.3. Four of the associations are mapped over Wilsons only (SL1, SL2, WL7 and WL8) and four within the HRC only (CSL, SL3, WL1 and WL6).

The smallest associations mapped are WL8 and WL1 (0.86 and 3.89 ha respectively), while the largest are WL6 and WL7 (259.22 and 103.96 ha respectively). WL8 is mapped only within Wilsons and WL1 only within the HRC, while WL6 is mapped only within the HRC and WL7 is mapped only within Wilsons.

Cleared areas constitute approximately 4.7 ha (1.03%) of the area mapped.

Table 6.3: Area and Cover of Vegetation Associations Mapped over the Survey Area as a Whole and within Wilsons and the HRC Separately

Vegetation Association Code	Broad Floristic Formation	Survey Areas Combined		Wilsons		HRC	
		Area (ha)	Cover (%)	Area (ha)	Cover (%)	Area (ha)	Cover (%)
CSL	Mixed Chenopod Shrubland	35.99	8.09	0	0	35.99	11.53
SL1	*Eremophila* Shrubland	14.82	3.33	14.82	11.17	0	0
SL2	*Acacia* Open Shrubland	13.07	2.94	13.07	9.85	0	0
SL3	*Eremophila* Open Shrubland	8.54	1.92	0	0	8.54	2.74
WL1	*Acacia* Sparse Woodland	3.89	0.87	0	0	3.89	1.25
WL6	*Acacia* Open Woodland	259.22	58.26	0	0	259.22	83.03
WL7	*Acacia* Sparse Woodland	103.96	23.37	103.96	78.34	0	0
WL8	*Acacia* Open Woodland / Shrubland	0.86	0.19	0.86	0.65	0	0
Cleared	Not applicable	4.57	1.03	0	0	4.57	1.46
Total	-	444.92	100	132.71	100	312.21	100

6.4 Ecological Communities and Vegetation of the Survey Area

The vegetation of the Survey Area is not similar to any currently-listed TEC.

The Montague Range is listed as a Priority 1 PEC (Montague Range vegetation complexes (banded ironstone formation)). One vegetation association (WL7) is similar to community type 4 described by the DEC as occurring on Montague Range. Community type 4 was described as occurring on a range of habitats and as being relatively widespread across Montague Range.

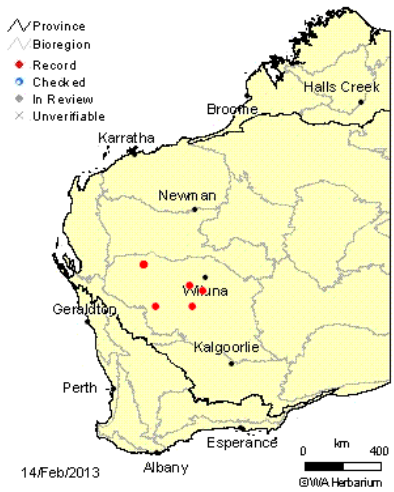
7 DISCUSSION

The conservation significance of the flora and vegetation of the Survey Area is discussed below.

7.1 CONSERVATION SIGNIFICANCE - FLORA

The regional conservation significance of the four priority species recorded at Wilsons is discussed below. No priority species were recorded within the HRC. Significance ratings (low, moderate or high) are based on the regional distribution, the number of bioregions a species is located in, the spread of FloraBase records for each species and its priority rank. For example if a species is restricted to one bioregion and has fewer than 10 records on FloraBase and is a Priority 1 species it is rated as having high regional significance; however, if it occurs in four bioregions, has more than 30 records on FloraBase and is a Priority 4 it is rated as having low regional significance.

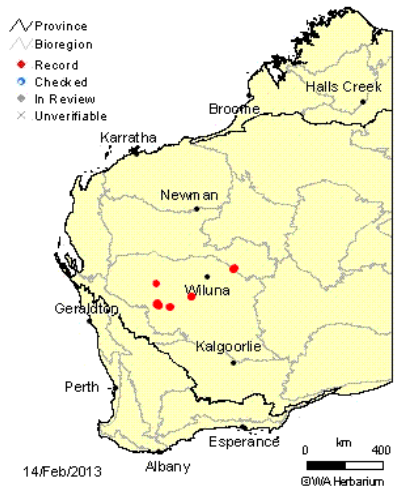
Stenanthemum mediale



Stenanthemum mediale (P1) has nine records on FloraBase. All records are located within the Murchison bioregion but mostly within the Eastern Murchison subregion. Twenty plants are noted for one of the nine records. Two of the records list the plants to be occasional and frequent while the remaining records have no information on plant numbers or abundance.

Given the few records on FloraBase and its P1 listing the populations located at Wilsons are regarded as having high regional significance.

Acacia burrowsiana



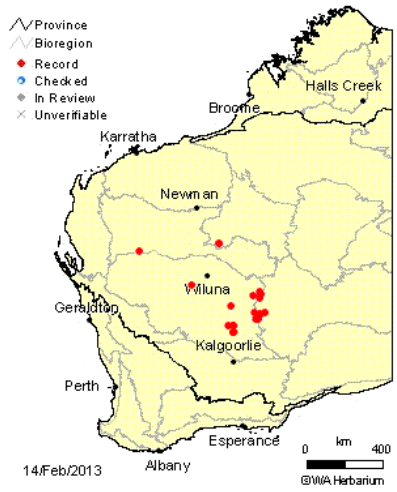
Acacia burrowsiana (P3) has 21 records on FloraBase. Most records are located centrally in the Murchison bioregion with a few records within the Gascoyne bioregion. The number of plants at each recorded location varies from 10 to 3000 plants while the populations are described as being localised small populations to large populations. Maia recorded this species during a survey at O'Kearys (Maia, 2011).

Based on its wide distribution in the Murchison bioregion, the number of records on FloraBase and its P3 listing, the populations located at Wilsons are rated as having moderate regional significance.

Calytrix praecipua (P3) has 23 records on FloraBase. The majority of records are located within the Murchison bioregion while a few records are in the Great Victoria Desert, Gascoyne and Little Sandy Desert bioregions. Most records are located in the Eastern Murchison subregion. The number of plants recorded varies from six to 30 plants and abundance is described as occasional to abundant.

Given its wide distribution, number of records on FloraBase and P3 listing, the populations located at Wilsons are rated as having low regional significance.

Calytrix praecipua

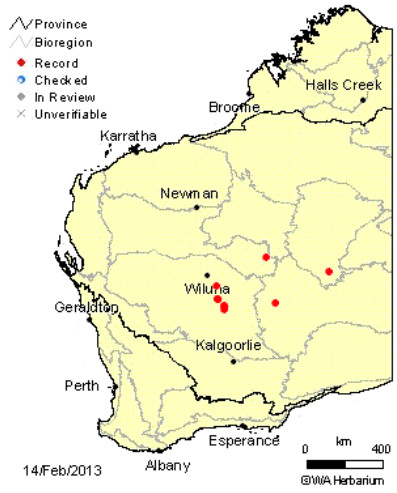


Sauropus ramosissimus (P3) has 11 records on FloraBase from the Murchison, Gascoyne, Great Victoria Desert and Gibson Desert bioregions. The number of plants at each recorded location varies from two to 100 plants and frequency from infrequent to locally patchy.

The distribution map for this species on FloraBase for this species is not up to date with NatureMap (DEC, 2007-) as the NatureMap search results indicated that *S. ramosissimus* has been recorded previously on tenement M53/153.

Given its distribution, number of records on FloraBase and P3 listing the populations located at Wilsons are rated as having low regional significance.

Sauropus ramosissimus



The local conservation significance of the four priority species recorded at Wilsons is discussed below. Significance ratings (low, moderate or high) are based on: the number of populations recorded; the number or cover of plants in each population; the priority rank of the species; their distribution within Wilsons (limited or widespread); and, the cover of the vegetation association in which they occur. To achieve the significance ratings each attribute was scored.

Stenanthemum mediale (P1) was recorded at eight locations at Wilsons. It was recorded in low numbers (1-10 plants) at each location. It was found on ironstone and laterite substrate hills and occurs in vegetation association WL7. These populations of *S. mediale* are rated as having moderate local significance. This species has records on tenement M 53/153 outside Wilsons.

Acacia burrowsiana (P3) was recorded at four locations at Wilsons. Only one plant was recorded at each location. It was located on quartz and calcrete hillslopes in vegetation associations SL1 and SL2. These populations of *A. burrowsiana* are rated as having moderate local significance.

Calytrix praecipua (P3) was recorded at 10 locations at Wilsons. It was recorded in moderate numbers (2-20 plants) at each location. This species has been recorded just outside the boundary of tenement M53/153 previously. It was found growing on laterite breakaways and outcrops in vegetation associations SL1 and WL7. These populations of *C. praecipua* are rated as having low local significance.

Sauropus ramosissimus (P3) was recorded at eight locations at Wilsons. It was recorded in low numbers (1-3 plants) at each location. It was located on laterite breakaways and growing on hills with a laterite substrate and in

vegetation association WL7. These populations of *S. ramosissimus* are rated as having low local significance. According to NatureMap this species has been recorded on tenement M53/153 (DEC, 2007-).

These local significance ratings are calculated using the distribution and number of plants in the local area. Usually this includes areas outside of those proposed to be cleared for a project. However, only the areas where impacts are proposed were surveyed at Wilsons. Given the distribution and number of plants located at Wilsons, and the fact that the same vegetation can be seen on the aerial photographs outside Wilsons, it is highly likely that these four conservation significant species occur in similar numbers outside the boundaries of Wilsons.

The regional and local conservation significance assessment is summarised in Table 7.1.

Table 7.1: Summary of Regional and Local Significance – Conservation Significant Flora

Species (Priority Rank)	Regional Significance	Local Significance
Stenanthemum mediale (P1)	High	Moderate
Acacia burrowsiana (P3)	Moderate	Moderate
Calytrix praecipua (P3)	Low	Low
Sauropus ramosissimus (P3)	Low	Low

7.2 Conservation Significance - Vegetation

The significance of the vegetation associations mapped by Maia in the Survey Area is discussed below.

Four of the MVAs mapped over the Survey Area were mapped over Wilsons only (SL1, SL2, WL7 and WL8) and four along the HRC only (CSL, SL3, WL1 and WL6) (Table 7.2). The first four MVAs discussed below were mapped at Wilsons and the last four within the HRC.

The 'DEC analysis' results grouped Wilsons sites WO8, 11 and 10 of MVA WL7 with DEC's sites MNTG10, 11, 12, 18, 19 and 20. These DEC sites belong to community type 4 on the Montague Range (Thompson and Sheehy, 2011a & 2011b). Thompson and Sheehy describe community type 4 as being widespread across the Montague Range and occurring over a variety of habitats. Maia mapped 889.5 ha of this association at Panoramic's O'kearys and Howards project areas approximately 33 km north of Wilsons (O'kearys) and at the eastern end of the HRC (Howards) (Maia, 2011). This association therefore occurs away from the Montague Range itself and appears to be a relatively widespread association in the area.

Maia's WL8 association has similar species to those in Payne *et al*.'s (1998) greenstone hill mixed woodland or shrubland (GHMW) and granite hill mixed shrubland (GRHS). However, these habitats are not listed as occurring in the Bevon LS within which Wilsons lies, and Payne *et al.* describe no other habitats for drainage lines / minor gullies in the Sandstone-Yalgoo-Paynes Find area. Following the earlier survey carried out by Maia, WL8 was mapped over 174.3 ha at O'kearys (Maia, 2011). Maia (2011) described WL8 as being locally significant at O'kearys because: it occurred along minor flow lines in the area, was mapped over a relatively small area and two priority species were located within it. However, *Acacia xanthocarpa* and *Prostanthera althoferi* subsp. *althoferi,* along with nine other species recorded in WL8 at Wilsons occur in DEC's community type 3 sites on the Montague Range and WL8 is very similar to community type 3. While Thompson and Sheehy note that community type 3 was identified from only four of their survey locations (on the steeper upper slopes to the pediments at the base of the range), they also note that community type 3 is closely allied to community type 4, which is the most widespread of the community types identified. Community type 3 is not mentioned as a particularly significant community by Thompson and Sheehy.

The species in SL1 are similar to those of the stony acacia eremophila shrubland habitat (SAES) described by Payne *et al*. (1998). This habitat is common on nearly level stony plains below areas of greater relief in both greenstone and granite-dominated landscapes. It is confined mostly to the north-eastern sections of Payne *et al.*'s survey area including the Sandstone area. It occurs most extensively on eight LS (not including the Bevon LS) but is said to be present in most upland land systems. Four of the LS in which SAES is a relatively common habitat occur north of Sandstone and in the vicinity of Wilsons – Sherwood, Violet, Gransal and Jundee. Association SL1 is therefore not uncommon in the surrounding areas. SL1 was mapped over 137.1 ha at O'kearys, in the earlier survey carried out by Maia at O'kearys, Swan Bitter and Howards (Maia, 2011).

The species in SL2 are similar to those of the stony ironstone mulga shrublands habitat (SIMS) described by Payne *et al*. (1998). This habitat is common on the hillslopes and low rises in greenstone-dominated terrain. It occurs on 10 LS and the Bevon LS is one of these. SIMS is a relatively common habitat on the hills to the north of Sandstone.

Maia's CSL association comprises similar species to the hardpan plain mulga shrubland (HPMS) with scattered chenopods described by Payne *et al.* (1998). It is noted that this association occurs in a variety of LS in the region, including the Rainbow LS in which it is a major unit. It is known to occur on reserved lands and was observed on Mt Elvire Station (Payne *et al.*, 1998). CSL was also mapped over 81 ha at Swan Bitter (which lies approximately mid-way between Wilsons and the HRC (Maia, 2011). This association appears to be common in the area.

Maia's SL3 association comprises similar species to the plain mixed halophyte shrubland (PXHS) habitat described by Payne *et al.* (1998). It is described as having variable dominant low shrub species, changing between each reference site sampled. This habitat commonly occurs in Payne *et al*.'s survey area and in adjacent survey areas.

Maia's WL1 association is similar to Payne *et al*.'s lateritic hardpan plain mulga shrublands (LHMS) habitat. The habitat occurs in the Jundee LS and Payne *et al*. (1998) note that it does not have particularly high conservation value as it is an extensive habitat.

Maia's WL6 association is similar to Payne *et al*.'s hardpan plain mulga shrubland (HPMS) habitat. This is one of the most widely distributed habitats in the arid zone (Payne *et al*., 1998). It occurs in many LS as a minor unit or as a major unit and is listed as a habitat of the Jundee, Monitor, Rainbow and Tango LS.

The eight associations mapped in the Survey Area are therefore similar to other associations mapped in the surrounding areas and regionally.

None of the floristic community types on the two BIF ranges closest to the Survey Area – Montague Range and the Lake Mason zone of the Gum Creek Greenstone Belt – are specifically described as conservation significant by the DEC. Rather, they are described as important repositories of taxa of conservation significance (Montague Range and Lake Mason) and distinct floristic communities (Lake Mason).

An assessment of the local significance of the MVAs mapped in the Survey Area has been carried out. The following attributes were considered during this assessment: the cover of each vegetation association in the Survey Area (i.e. the local area); the significance or rarity of a habitat in which the association occurs; the condition of the vegetation in a particular association; and, the presence of conservation significant species in the association and the similarity of the association to any significant ecological communities.

The local conservation significance of one of the MVAs is rated as high, five as moderate and two as low (Table 7.2).

Table 7.2: Extent, Condition and Local Significance of Vegetation Associations of the Survey Area

		Area Mapped (ha)		Proportion of the Total Area Mapped (%)						
MVA	Total Area Mapped (ha)	Wilsons	HRC – total no overlap	Wilsons	HRC – total no overlap	Conservation Significant Flora in MVAs	Vegetation Condition	Any Other Key Attributes Increasing Conservation Value?	Local Conservation Significance	Occurs outside Survey Area
CSL	35.99	0	35.99	0	11.53	No	VG/G	No	Low	Yes
SL1	14.82	14.82	0	11.17	0	*Ab, Cp*	E	PEC	Moderate	Yes
SL2	13.07	13.07	0	9.85	0	*Ab*	E	PEC	Moderate	Yes
SL3	8.53	0	8.54	0	2.74	No	E	Seasonally inundated	Moderate	Yes
WL1	3.89	0	3.89	0	1.25	No	E	Sheet flow dependant?	Moderate	Yes
WL6	259.22	0	259.22	0	83.03	No	E	Sheet flow dependant?	Low	Yes
WL7	103.96	103.96	0	78.34	0	*Cp, Sr, Sm*	E	PEC	High	Yes
WL8	0.86	0.86	0	0.65	0	No	E	PEC	Moderate	Yes
Cleared	4.57	0	4.57	0	1.46	No	CD	Not assessed		
Total	444.92	132.71	312.21	100	100					

Notes: MVA = Maia vegetation association; *Ab* = *Acacia burrowsiana* (P3)*; Cp* = *Calytrix praecipua* (P3), *Sr* = *Sauropus ramosissimus* (P3), *Sm* = *Stenanthemum mediale* (P1), E = Excellent, V G = Very Good, G = Good, CD = Completely Degraded, PEC = possibly within boundaries of PEC.

7.3 Ecological Communities and Ecosystems

The buffer in place around a Priority 1 PEC – the Montague Range Vegetation Complexes (banded ironstone formation) lies over the Survey Area. Given the proximity of the Wilsons area to the DEC's Montague Range sites, it is possible that the Wilsons area lies within the boundaries of the Montague Range PEC proper. The actual boundary of the PEC is not publically available only the boundary of the buffer in place around the PEC.

If the Wilsons area lies within the boundaries of the PEC proper all vegetation within the boundaries is considered conservation significant. However, no exposed areas of BIF were observed at Wilsons by the botanists. Of the four MVAs mapped at Wilsons one (WL7) is floristically similar to the DEC's community type 4 on the Montague Range, WL8 shares some species occurring in DEC's community type 3 and SL1 and SL2 are not similar to the floristic communities of the PEC (and are not uncommon in the surrounding areas). WL7 was described as being the most widespread of the six communities of the Montague Range occurring over a variety of habitats and community type 3 as very similar to community type 4 (Thompson & Sheehy, 2011a). Both MVA WL7 and WL8 have been mapped in Panoramic's project areas to the north (O'kearys – WL7 and WL8) and south (Howards – WL7) of Wilsons (Maia, 2011) and are therefore not endemic to and found only on the Montague Range.

The Montague Range falls within the Gum Creek Greenstone belt in the Yilgarn Craton (Thompson & Sheehy, 2011a). It is not specifically listed in the Strategic Review of the Banded Iron Formation Ranges of the Midwest and Goldfields (DEC & Department of Industry and Resources (DIR), 2007). However, it could fall in the area listed

as Wiluna West, which was listed as an area requiring further investigation at the time of publication of the Strategic Review.

Thompson & Sheehy (2011a) note that the Montague Range has lower species richness than other BIF ranges in the Yilgarn. This is attributed to the long history of grazing, mineral exploration and mining and the authors note that the range is still an important repository of taxa of conservation significance and taxonomic uncertainty, which is similar to other areas on the BIF ranges of the Yilgarn.

None of the ecosystems at risk noted for the Eastern Murchison subregion (Cowan, 2001) occur in the Survey Area.

8 CONCLUSIONS

Dot points follow on the main findings regarding the flora and vegetation of the Survey Area. Overall conclusions are also included in the dot points.

8.1 FLORA

- One hundred and twenty-six taxa from 29 families and 58 genera were recorded during the survey. The Survey Area is not particularly diverse or species rich.
- Four priority species - *Stenanthemum mediale* (P1), *Acacia burrowsiana*, *Calytrix praecipua* and *Sauropus ramosissimus* (all P3) were recorded at Wilsons. No priority species were recorded within the HRC.
- Two range extension species were collected from the Survey Area – *Bursaria occidentalis* and *Eremophila fraseri* subsp. *parva*. These collections mark range extensions of 231 km and 165 km respectively.
- One environmental weed was recorded in the HRC – *Portulaca oleracea* (Purslane). No weeds were recorded at Wilsons. The Survey Area is therefore relatively weed-free.

8.2 VEGETATION

- Eight vegetation associations were mapped in the Survey Area: Mixed Chenopod Shrubland (CSL); *Eremophila* Shrubland (SL1); *Acacia* Open Shrubland (SL2); *Eremophila* Open Shrubland (SL3); *Acacia* Sparse Woodland (WL1); *Acacia* Open Woodland (WL6); *Acacia* Sparse Woodland (WL7); and, *Acacia* Open Woodland / Shrubland (WL8). Four of these associations were mapped at Wilsons – SL1, SL2, WL7 and WL8 – and four within the HRC – CSL, SL3, WL1 and WL6.
- Vegetation condition ratings recorded in the Survey Area ranged from Excellent to Completely Degraded (cleared areas). The condition of approximately 90.88% of the vegetation of the Survey Area is rated as Excellent, 8.09% Very Good / Good and 1.03% as Completely Degraded.

8.3 CONSERVATION SIGNIFICANCE FLORA AND VEGETATION

- Regional significance ratings for the four priority species located in the Survey Area were high (*Stenanthemum mediale*), moderate (*Acacia burrowsiana*) and low (*Calytrix praecipua* and *Sauropus ramosissimus*). While the local significance of the four priority species was rated as moderate (*Stenanthemum mediale* and *Acacia burrowsiana*) or low (*Calytrix praecipua* and *Sauropus ramosissimus*).
- Given the distribution of these species at Wilsons and the similar vegetation in the surrounding area it is highly likely that these four species occur in the surrounding areas in similar numbers.
- One of the eight MVAs mapped at the Survey Area is rated as having high (WL7), five as having moderate (SL1, SL2, SL3, WL1, WL8) and two as having low local significance (CSL and WL6). These local significance ratings are based on the cover of the association in the Survey Area (i.e. the local area), the condition of the vegetation of the association, the conservation significant species located in the association and whether the association occurs in a significant habitat or ecological community e.g. a PEC. The more significant associations are those mapped over a small area, providing habitat for Priority Flora species and regarded as a significant ecological community.
- It is possible that the associations mapped at Wilsons fall within the actual boundaries of the Montague Range PEC (rather than only within the PEC buffer) and the vegetation at Wilsons should be regarded as significant because of this. However, no exposed areas of BIF were observed at Wilsons and none of the vegetation associations mapped at Wilsons occur only in that area, they also occur away from the range.

9 REFERENCES

Agriculture Protection Board of Western Australia (APBWA) (2013). Agriculture and Related Resources Protection Act 1976 (Version 03-n0-01). Available at: http://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_13_homepage.html. Accessed: March, 2013.

Australian Government (2000). National Environmental Alert List. Department of Environment and Heritage and Cooperative Research Centre for Australian Weed Management.

Australian Government (2012). Weeds in Australia. About Weeds. Weeds of National Significance. Available: http://www.weeds.gov.au/weeds/lists/wons.html. Accessed: March & April 2013.

Beard (1976). Vegetation Survey of Western Australia – Murchison 1:1,000,000 Vegetation Series. University of Western Australia Press.

Belbin, Lee (1989). PATN Technical Reference. CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, ACT, 2602. 167p.

Belbin, L. (2004). PATN - Version 3. Developed by Belbin, L., CSIRO and Griffith University.

Bureau of Rural Sciences (BRS) (2003). Sleeper Weed List. Bureau of Rural Sciences, through consultation with the Australian Weeds Committee.

Bureau of Meteorology (BoM) (2013a). Daily Weather Observations, Commonwealth of Australia. Online: www.bom.gov.au/climate . Accessed: March 2013.

Bureau of Meteorology (BoM) (2013b). Three-monthly rainfall deciles for Western Australia. Available: http://www.bom.gov.au/jsp/awap/rain/index.jsp?colour=colour&time=latest&step=0&map=decile&period=month&area=wa. Accessed: March, 2013.

Colwell, R.K. (2006). EstimateS: Statistical estimation of species richness and shared species from samples. User's guide and application, Version 8.4.2. Available: http://purl.oclc.org/estimates.

Cowan, M. (2001). Murchison 1 (MUR 1 – Eastern Murchison) In: A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002.

Department of Agriculture and Food Western Australia (DAFWA) (2012a). Land System Mapping of Western Australia. Department of Agriculture and Food, Perth Western Australia. June, 2012.

Department of Agriculture and Food Western Australia (DAFWA) (2012b). Pre-European Vegetation – Western Australia (NVIS compliant version - 20110715). Department of Agriculture and Food, Perth Western Australia. April, 2012.

Department of Agriculture and Food Western Australia (DAFWA) (2012c). Native vegetation current extent – Western Australia (NVIS compliant version). July, 2012. Department of Agriculture and Food, Perth, Western Australia.

Department of Agriculture and Food Western Australia (DAFWA) (2013a). Declared plants in Western Australia. Declared Plants Database. Available at: http://www.agric.wa.gov.au/dps/version02/01_plantsearch.asp. Accessed: June 2013.

Department of Agriculture and Food Western Australia (DAFWA) (2013b). Western Australian Organism List (WAOL). Available at: http://www.biosecurity.wa.gov.au/western-australian-organism-list-waol. Accessed: June 2013.

Department of Agriculture and Food Western Australia (DAFWA) (2013c). WAOL Download List – Declared Pest (s22). Available at: http://www.biosecurity.wa.gov.au/organisms/export/PER-DP. Accessed: June 2013.

Department of Conservation and Land Management (CALM) (1999). The Environmental Weed Strategy for Western Australia. Available: http://www.dec.wa.gov.au/content/view/847/2282/. Accessed: March, 2013.

Department of Environment and Conservation (DEC) (2007-). NatureMap: Mapping Western Australia's Biodiversity. Department of Environment and Conservation. URL: http://naturemap.dec.wa.gov.au/default.aspx. Version: NatureMap V1.5.0.10. Accessed: March & April 2013.

Department of Environment and Conservation (DEC) (2010). Definitions, Categories and Criteria for Threatened and Priority Ecological Communities. December 2010. Available: http://www.dec.wa.gov.au/management-and-protection/threatened-species/wa-s-threatened-ecological-communities.html. Accessed: March, 2013.

Department of Environment and Conservation (DEC) (2012a). Lands and waters managed by the Department of Environment and Conservation. Department of Environment and Conservation, Kensington, Perth, Western Australia. Accessed and downloaded through Landgate (2013).

Department of Environment and Conservation (DEC) (2012b). Clearing Regulations – Environmentally Sensitive Areas (ESA) (last updated: 20120709). Department of Environment and Conservation, Kensington, Perth, Western Australia. Accessed and downloaded through Landgate (2013).

Department of Environment and Conservation (DEC) (2012c). Clearing Regulations – Schedule One Areas (last updated: 20121024). Department of Environment and Conservation, Kensington, Perth, Western Australia. Accessed and downloaded through Landgate (2013).

Department of Environment and Conservation (DEC) (2013a). Conservation Codes for Western Australian Flora. Available: http://florabase.dec.wa.gov.au/conservationtaxa. Accessed: March, 2013.

Department of Environment and Conservation (DEC) (2013b). National weed lists. (Published DEC 2009). Available: http://www.dec.wa.gov.au/content/view/5495. Accessed: March, 2013.

Department of Environment and Conservation (DEC) (2013c). What is a weed and why are they a problem? (Published DEC 2009). Available: http://www.dec.wa.gov.au/content/view/5494. Accessed: March, 2013.

Department of Environment and Conservation (DEC) (2013d). Invasive Plant Prioritisation Process for DEC. (Updated December 2012). Available: http://www.dec.wa.gov.au/management-and-protection/plants/invasive-plants/invasive-plant-prioritisation-process.html?showall=1&limitstart=. Accessed: March 2013.

Department of Environment and Conservation (DEC) (2013e). DEC Goldfields Region – Environmental Weed List. Available: http://www.dec.wa.gov.au/content/view/6295/2358/1/1/.

Department of Environment and Conservation (DEC) (2013f). List of Threatened Ecological Communities Endorsed by the Minister for the Environment. Species and Communities Branch (Correct to May 2013). Available: http://www.dec.wa.gov.au/management-and-protection/threatened-species/wa-s-threatened-ecological-communities.html. Accessed: July 2013.

Department of Environment and Conservation (DEC) (2013g). Priority Ecological Communities for Western Australia - Version 18. Species and Communities Branch, Department of Environment and Conservation, 26 March, 2013. Available: http://www.dec.wa.gov.au/management-and-protection/threatened-species/wa-s-threatened-ecological-communities.html. Accessed: July 2013.

Department of Environment and Conservation (DEC) (2013h). Tenure Descriptions. Available at: http://www.dec.wa.gov.au/content/view/88/1930/. Accessed: March, 2013.

Department of Environment and Conservation (DEC) and Department of Industry and Resources (DIR) (2007). Department of Environment and Conservation & Department of Industry and Resources. Strategic Review of the Banded Iron Formation Ranges of the Midwest and Goldfields.

Department of Environment and Water Resources (DEWR) (2007). Australian Weeds Strategy – A national strategy for weed management in Australia. Natural Resource Management Ministerial Council (2006), Australian Government Department of the Environment and Water Resources, Canberra ACT.

Department of Resources and Energy (DRE) (1984). Sandstone Geological Survey of Western Australia. 1:250:000 Geological Series, Sheet SG 50-16. D.O.R.E. Australia.

Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) (2013a). *EPBC Act* Protected Matters Search Tool. Available: http://www.environment.gov.au/arcgis-framework/apps/pmst/pmst.jsf. Accessed: March 2013.

Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) (2013b). Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Subregions), Last Updated: 20120418. Available: http://www.environment.gov.au/metadatae xplorer/explorer.jsp. Accessed: January 2013.

Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) (2013c). Threatened species under the EPBC Act. Available: http://www.environment.gov.au/biodiversity/threatened/species.html. Accessed: March, 2013.

Dufrêne, M., & Legendre, P. (1997). Species Assemblages And Indicator Species: The Need For A Flexible Asymmetrical Approach. Ecological Monographs 67: pp 345-366.

Environmental Protection Authority (EPA) (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3. EPA, Perth, Western Australia.

Environmental Protection Authority (EPA) (2004). Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. EPA, Perth, Western Australia.

Environmental Protection Authority (EPA) (2010). EPA Redbook Recommended Conservation Reserves 1976-1991. Accessed and downloaded through Landgate (2013).

Executive Steering Committee for Australian Vegetation Information (ESCAVI) (2003). Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0. Department of the Environment and Heritage, Canberra.

Government of Western Australia (2012). Wildlife Conservation (Rare Flora) Notice 2012(2). Western Australian Government Gazette. No. 204, 6 November 2012, pp 5305-5311.

Government of Western Australia (2013). 2012 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of October 2012. WA Department of Environment and Conservation, Perth. https://www2.landgate.wa.gov.au/web/guest/downloader.

Hunter, J.T., Bruhl, J.J. (1997). New *Sauropus* (Euphorbiaceae: Phyllanthaceae) taxa for the Northern Territory and Western Australia and notes on other *Sauropus* occurring in these regions. Nuytsia, 11(2), pp 165-184.

Keighery, B.J. (1994). Bushland Plant Survey: a Guide to Plant Community Survey for the *Community*. Wildflower Society of WA (Inc.), Nedlands, Western Australia.

Landgate (2013). SLIP Enabler Spatial Database [online] available: https://www2.landgate.wa.gov.au/slip/portal/home/home.html. Accessed: February, 2013.

Maia (2011). Panoramic Resources: Gidgee Project Area. Level 1 Flora and Vegetation Assessment, Nov 2011. Unpublished Report for Panoramic Resources.

Markey, A. S. & Dillon, S.J. (2009). Flora and Vegetation of the Banded Iron Formations of the Yilgarn Craton: Herb Lukin Ridge (Wiluna). Conservation Science Western Australia 7(2): 391-412.

Markey, A. S. & Dillon, S.J. (2010). Flora and Vegetation of the Banded Iron Formations of the Yilgarn Craton: the Booylgoo Range. Conservation Science Western Australia 7(3): 503-529.

McCune, B., & Mefford, M.J. (2010). PC-ORD. Multivariate Analysis of Ecological Data. Version 6. MjM Software, Gleneden Beach, Oregon, USA.

Meissner, R. & Wright, J. (2010). Flora and Vegetation of the Banded Iron Formations of the Yilgarn Craton: Perseverance Greenstone Belt. Conservation Science Western Australia 7(3): 593-604.

Natural Resource Management Ministerial Council's (NRMMC) (2012). Species Targeted for Eradication. Available: http://www.weeds.gov.au/weeds/lists/eradication.html. Accessed: March, 2013.

Natural Resource Management Standing Committee (NRMSC) (2012). Target Species for Biological Control. Available: http://www.weeds.org.au/management.htm. Accessed: March, 2013.

Niche Environmental Services (2011). Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project: Lake Way, Centipede and West Creek borefield. Report prepared for Toro Energy Limited.

Payne, A.L., Van Vreeswyk, A.M.E., Pringle, H.J.R., Leighton, K.A., and Hennig, P. (1998). An Inventory and Condition Survey of the Sandstone-Yalgoo-Paynes Find Area, Western Australia: Technical Bulletin Number 90. Department of Agriculture and Food, Government of Western Australia, Perth Western Australia.

Rye, B.L. (2007). New species and keys for *Cryptandra* and *Stenanthemum* (Rhamnaceae) in Western Australia. Nyutsia, 16(2), pp 325-382.

Smith, M.G. (2012). Declared Rare and Priority Flora List for Western Australia, 20 December 2012. Department of Environment and Conservation. Como, W.A.

Stewart, A.J., Sweet, I.P., Needham, R.S., Raymond, O.L., Whitaker, A.J., Liu, S.F., Phillips, D., Retter, A.J., Connolly, D.P., and Stewart, G. (2008). Surface geology of Australia 1:1,000,000 scale, Western Australia [Digital Dataset]. Canberra: The Commonwealth of Asutralia, Geoscience Australia. http://www.ga.gov.au. Accessed and downloaded through Landgate (March, 2012).

Thackway, R., and Cresswell, I.D. (1995) (Eds). An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves. Version 4.0. Australian Nature Conservation Agency, Canberra.

Thompson, W.A. & Sheehy, N.B. (2011a). Flora and Vegetation of the Banded Iron Formations of the Yilgarn Craton: the Montague Range Zone of the Gum Creek Greenstone Belt. Conservation Science Western Australia 8(1): 95-111.

Thompson, W.A & Sheehy, N. (2011b). Flora and Vegetation of Banded Ironstone Formations of the Yilgarn Craton: the Lake Mason Zone of the Gum Creek Greenstone Belt. Conservation Science Western Australia 8(1): 77-94.

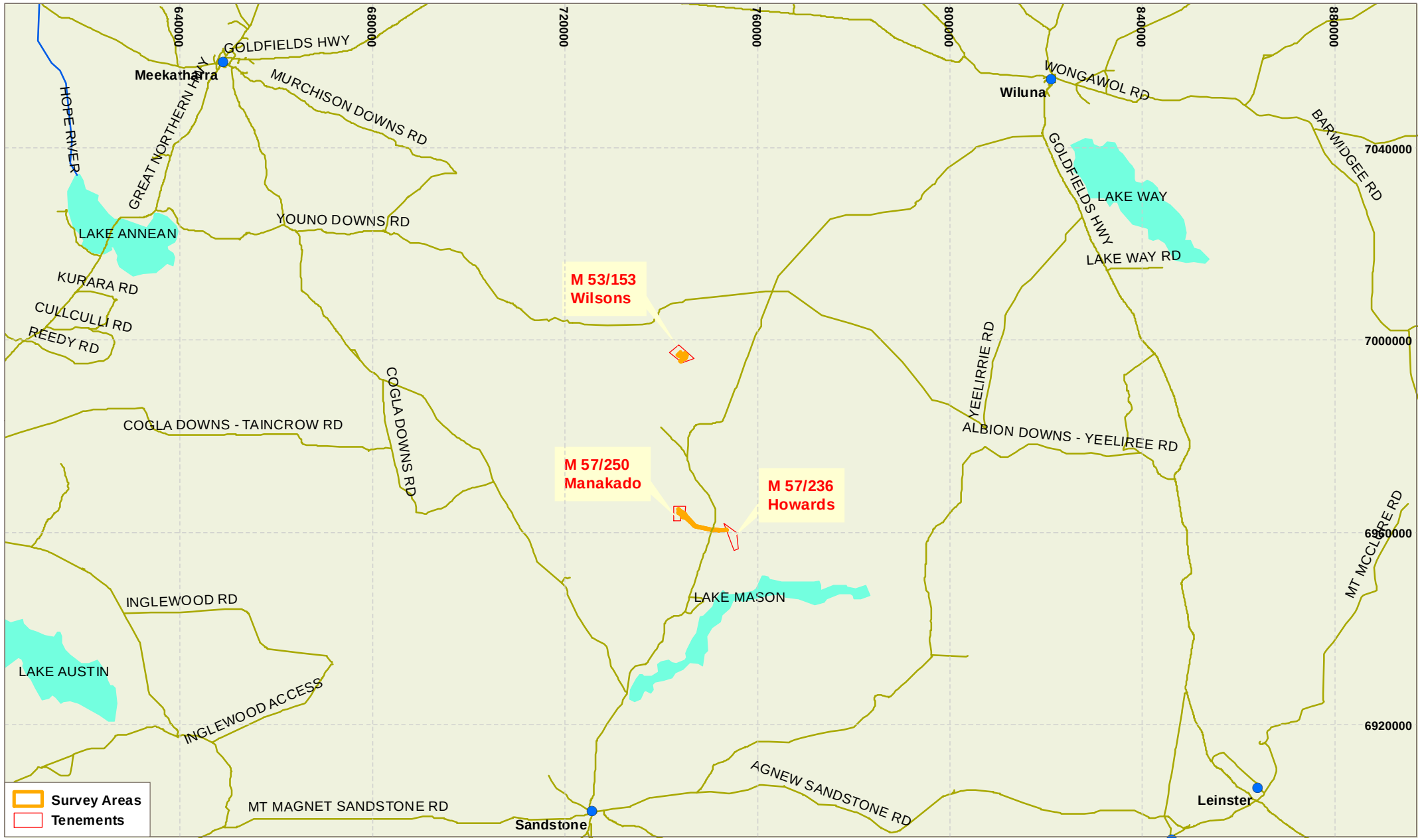
Tille (2006). Soil-landscapes of Western Australia's Rangelands and Arid Interior - Resource Management Technical Report 313. Department of Agriculture and Food, Government of Western Australia. Available: http://www.agric.wa.gov.au/. Accessed: February, 2011.

Trudgen, M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth.

Western Australian Herbarium (WAH) (1998-). FloraBase - the Western Australian Flora. Department of Environment and Conservation. Available: http://florabase.dec.wa.gov.au/. Accessed: March, 2013.

Western Botanical (2009). Flora and Vegetation Assessment of Portion of Proposed Confirmation Drilling Program – Part 1: Yeelirrie Uranium Deposit, December 2008. Prepared for URS Corporation Pty Ltd.

10 MAPS



Location Map

Towns
Major Roads
Rivers
Waterbodies

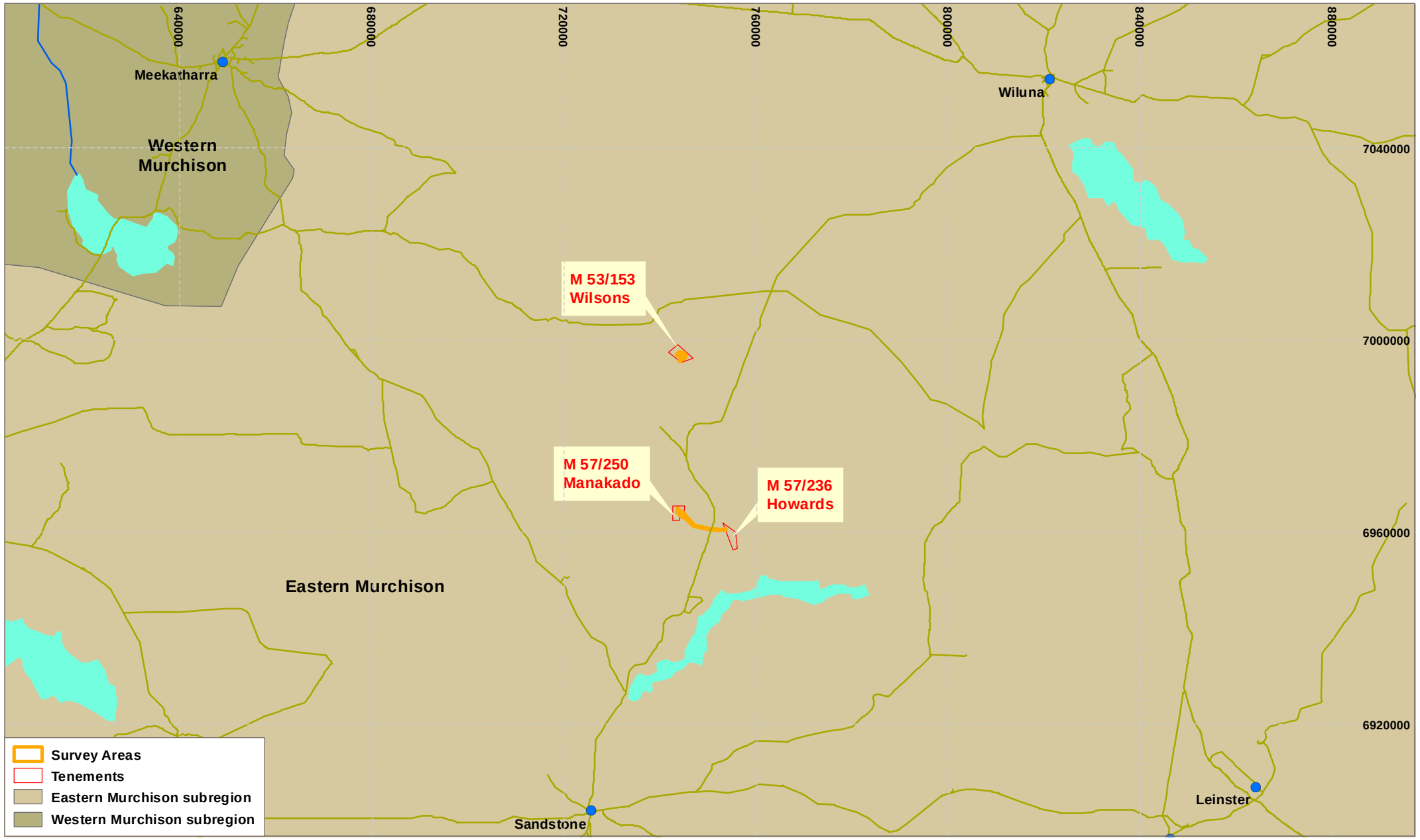
General Location of the Survey Areas

N

0 20
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.1
Prepared for: Pan. Res.
Drawn by: RH
Date: 26/03/2013
Version: 1



Towns
Major Roads
Rivers
Waterbodies

IBRA Subregions

maia

N

0 20
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.2
Prepared for: Pan. Res.
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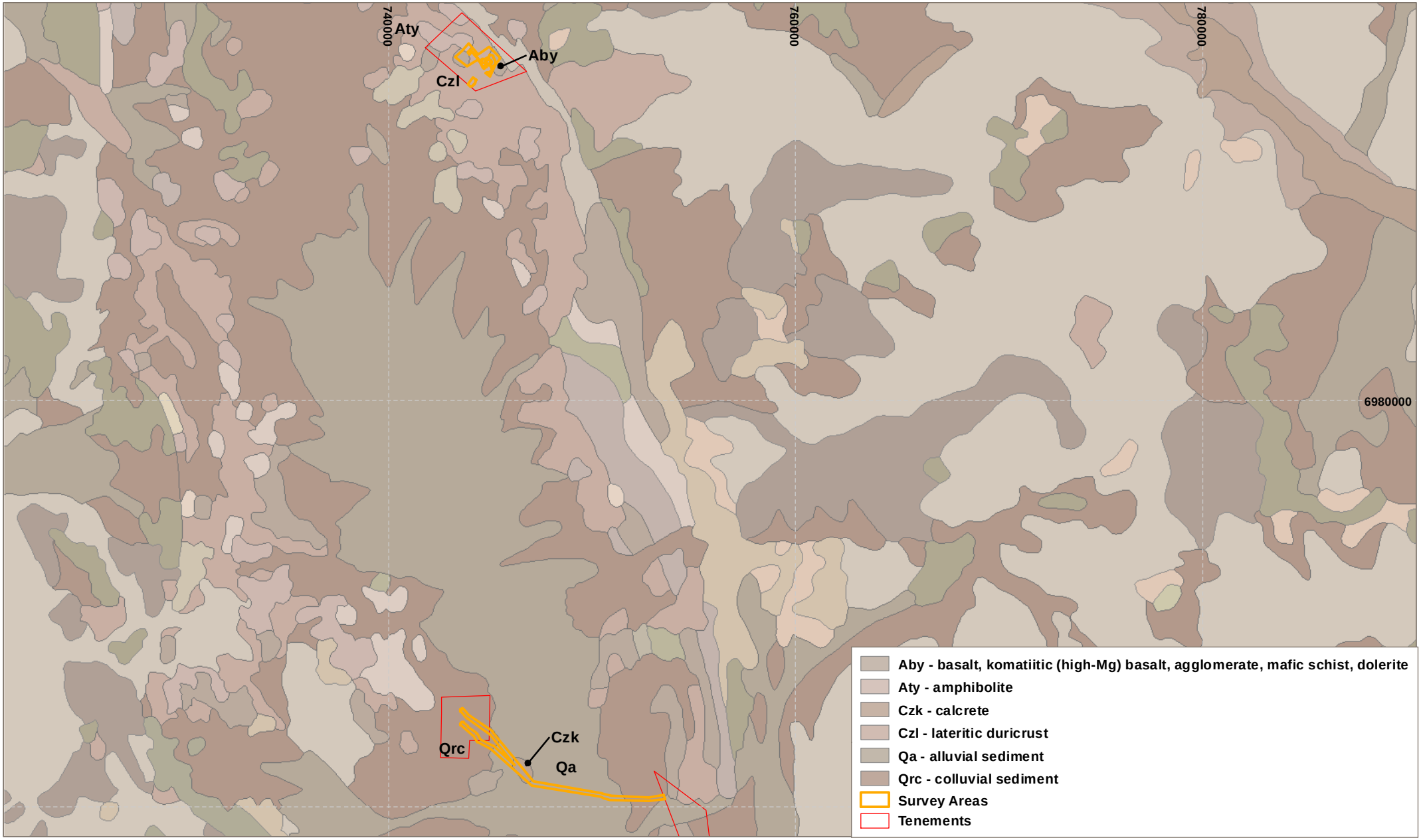
Version: 1



Geology

maia

N

0 5

Kilometres

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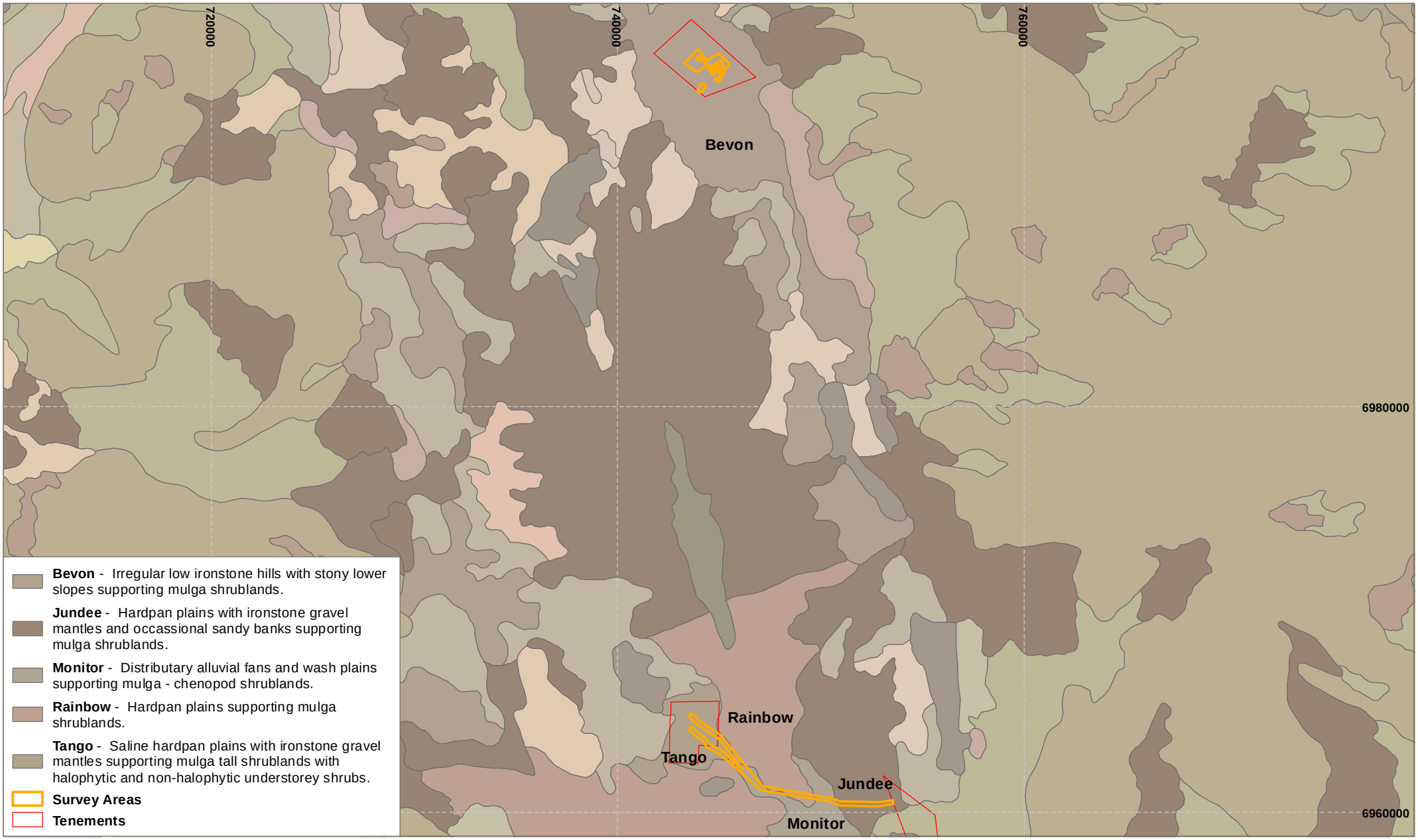
Map: 10.3

Prepared for: Pan. Res.

Drawn by: RH

Date: 17/06/2013

Version: 2



Land Systems

N

0 5

Kilometres

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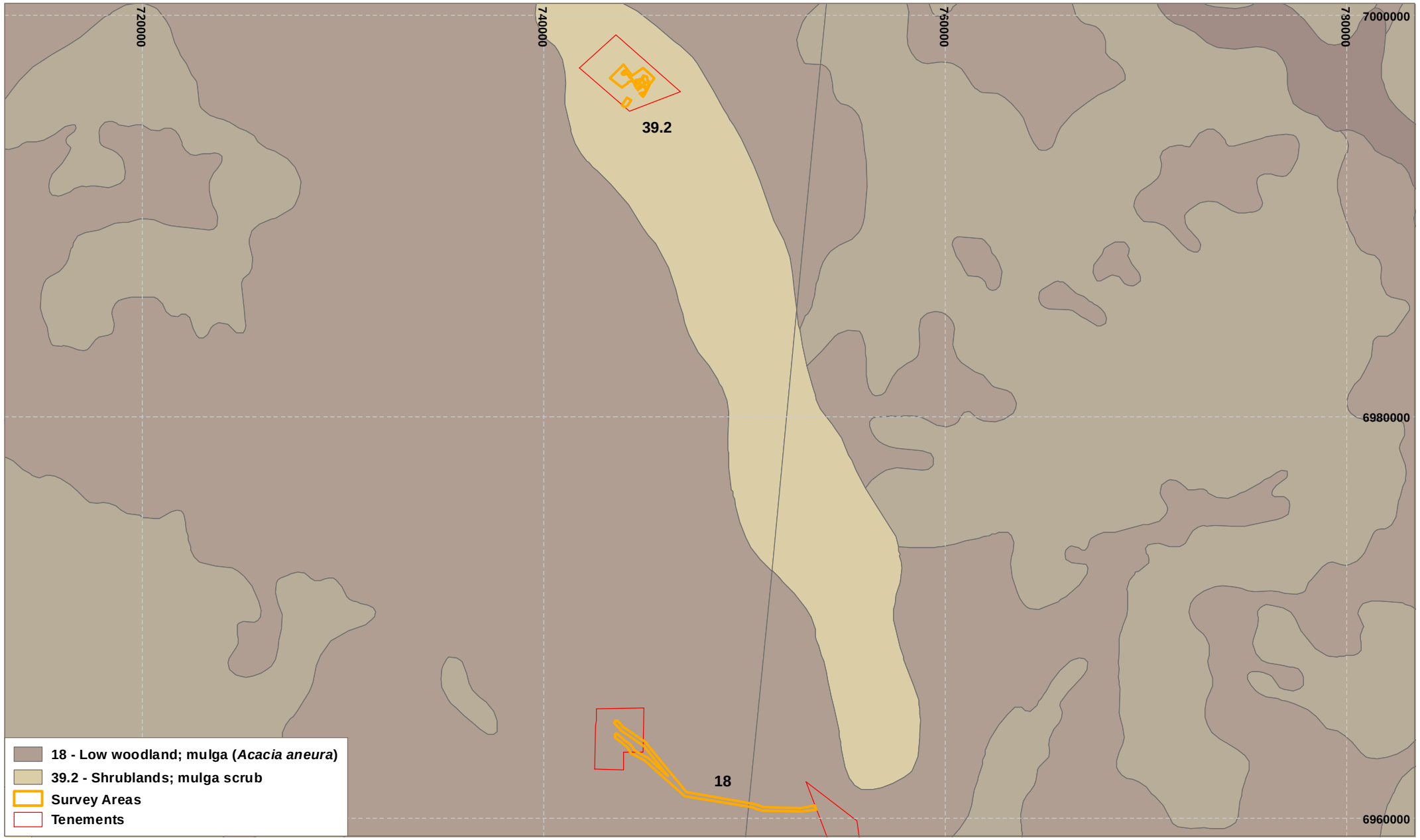
Drawn by: RH
Date: 17/06/2013
Version: 2



Location Map

- Port Hedland
- Newman
- Wiluna
- Geraldton
- Kalgoorlie
- Perth

Beard's Pre-European Vegetation Associations (Vegetation Sub-associations)

maia

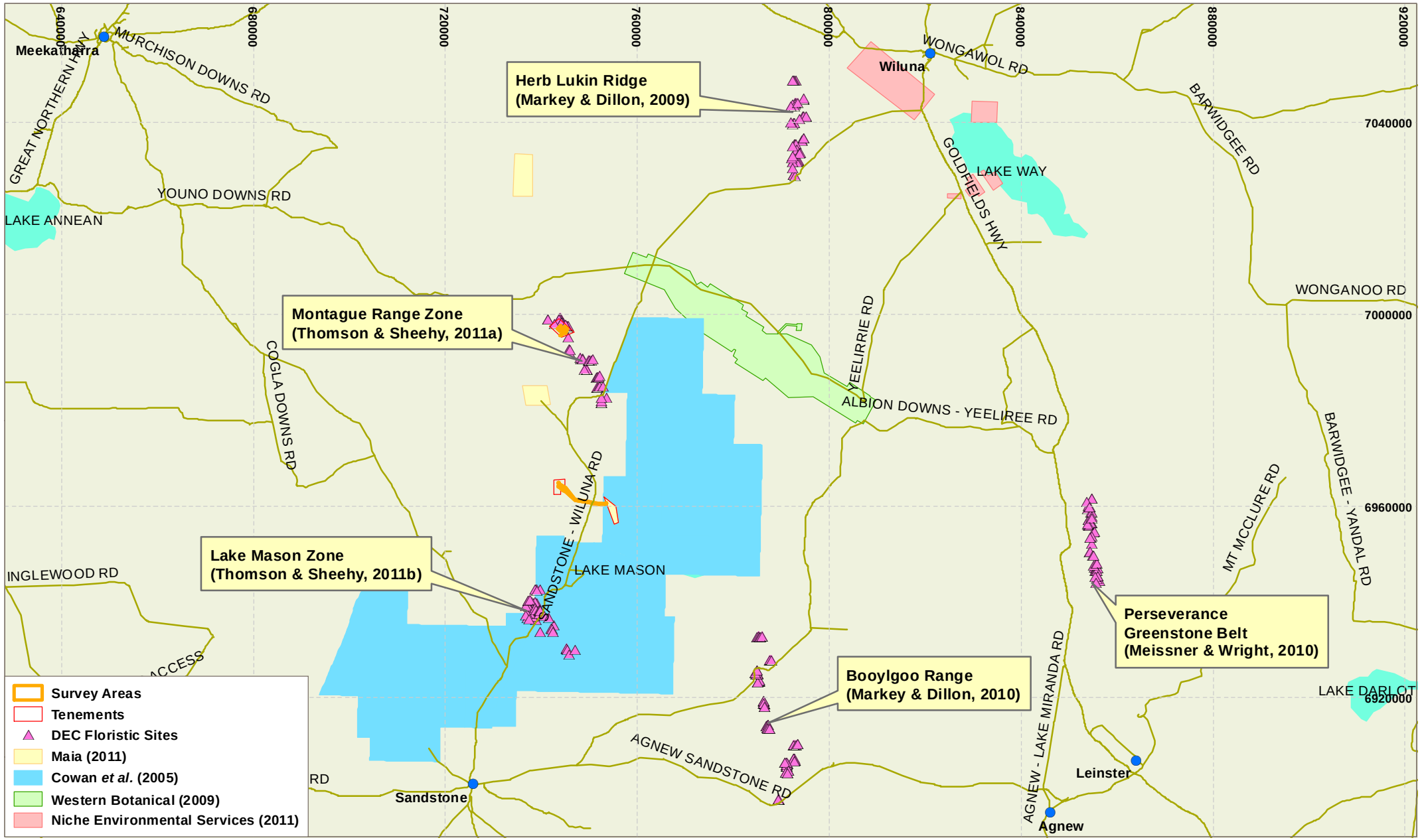
N

0 5

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.5
Prepared for: Pan. Res.
Drawn by: RH
Date: 17/06/2013
Version: 2



Location Map

Port Hedland
Newman
Wiluna
Kalgoorlie
Perth

Towns
Major Roads
Waterbodies

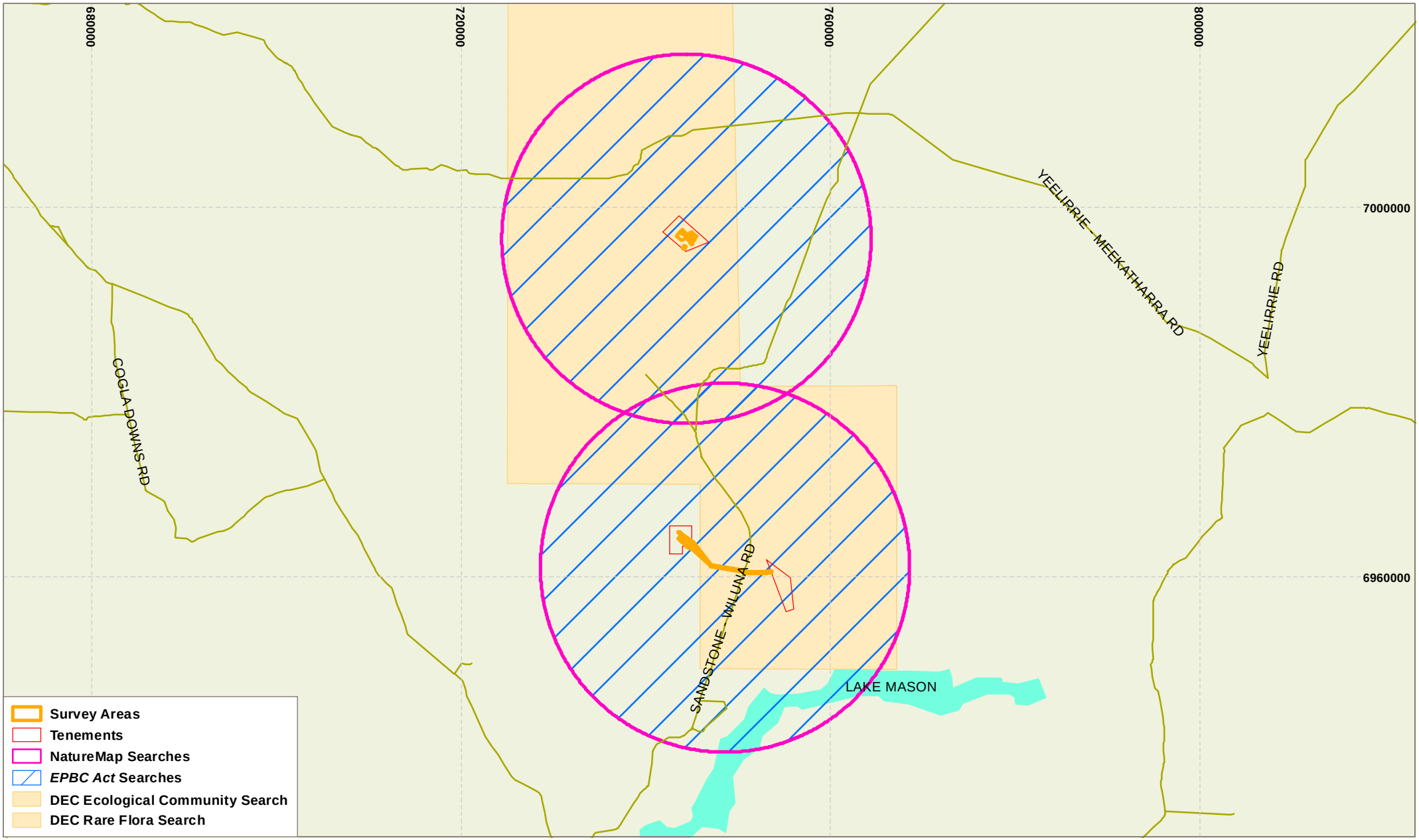
Previous Biological Surveys

N

0 20
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.6
Prepared for: Pan. Res.
Drawn by: RH
Date: 26/03/2013
Version: 1



Location Map

Major Roads

Waterbodies

Database Search Boundaries

maia

N

0 10

Kilometres

Datum: GDA 1994, MGA 50

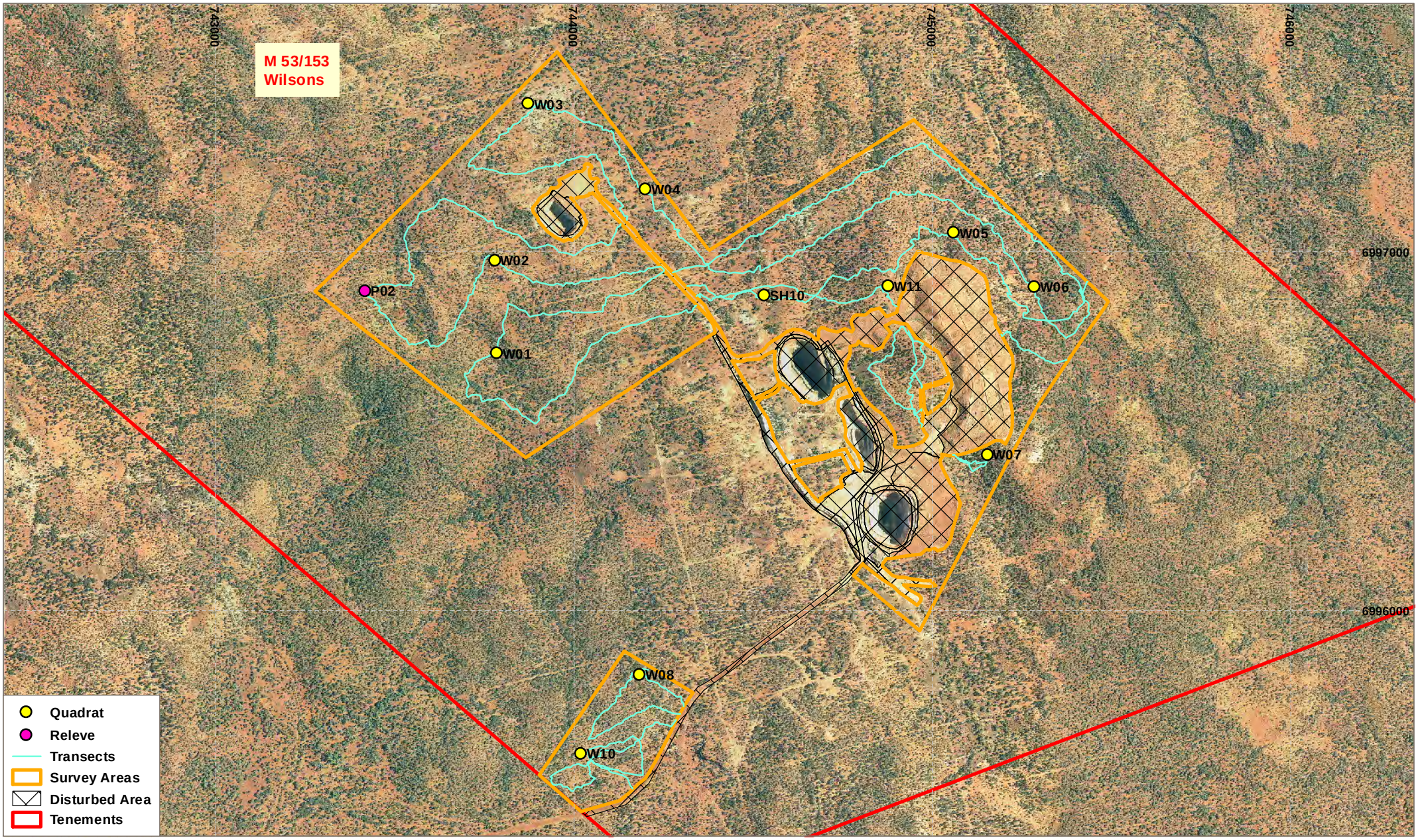
Map: 10.7

Prepared for: Pan. Res.

Drawn by: RH

Date: 26/03/2013

Version: 1



Location Map

- Port Hedland
- Newman
- Wiluna
- Kalgoorlie
- Perth

Quadrats, Releves and Transects
Wilsons Survey Area

maia

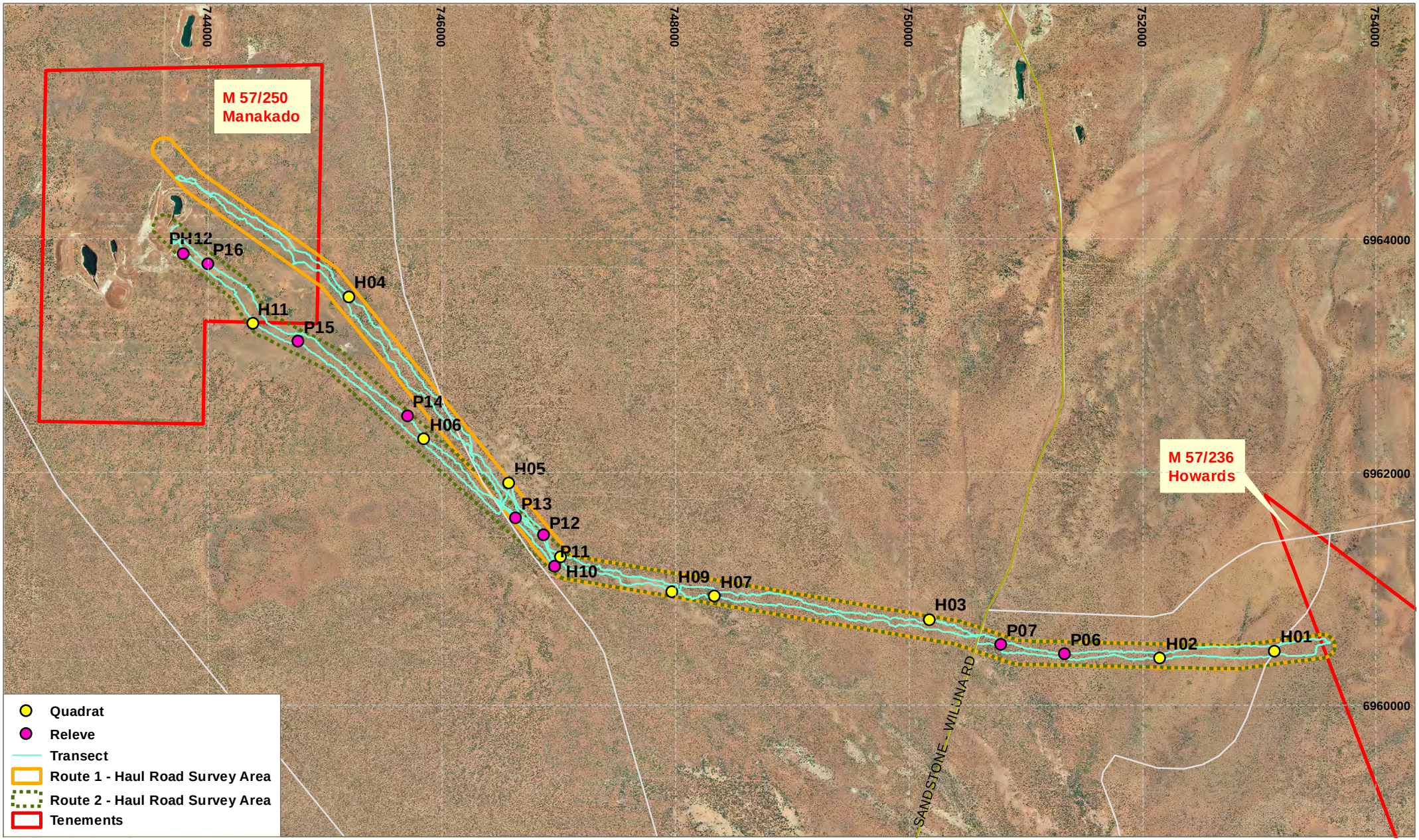
N

0 0.275

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.8
Prepared for: Pan. Res.
Drawn by: RH
Date: 26/03/2013
Version: 1



Location Map

Port Hedland
Newman
Wiluna
Kalgoorlie
Perth

Major Roads
Other Roads and Tracks

Quadrats, Releves and Transects
Haul Road Survey Area

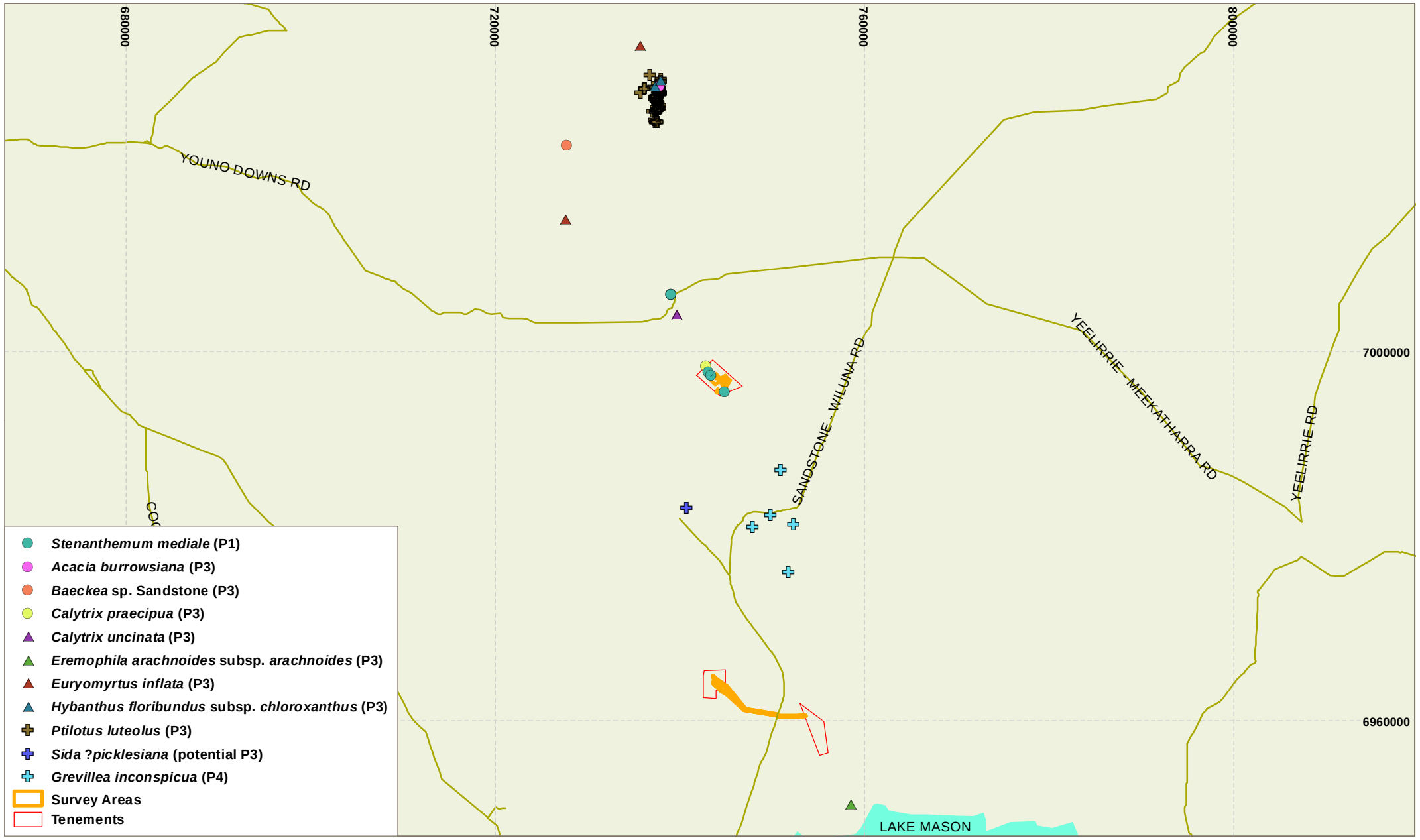
maia

N

0 0.75
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.9
Prepared for: Pan. Res.
Drawn by: RH
Date: 26/03/2013
Version: 1



Location Map

Port Hedland
Newman
Wiluna
Kalgoorlie
Perth

Major Roads
Waterbodies

Conservation Significant Flora (DEC WA Herb and TPFL Search Results and Maia (2011))

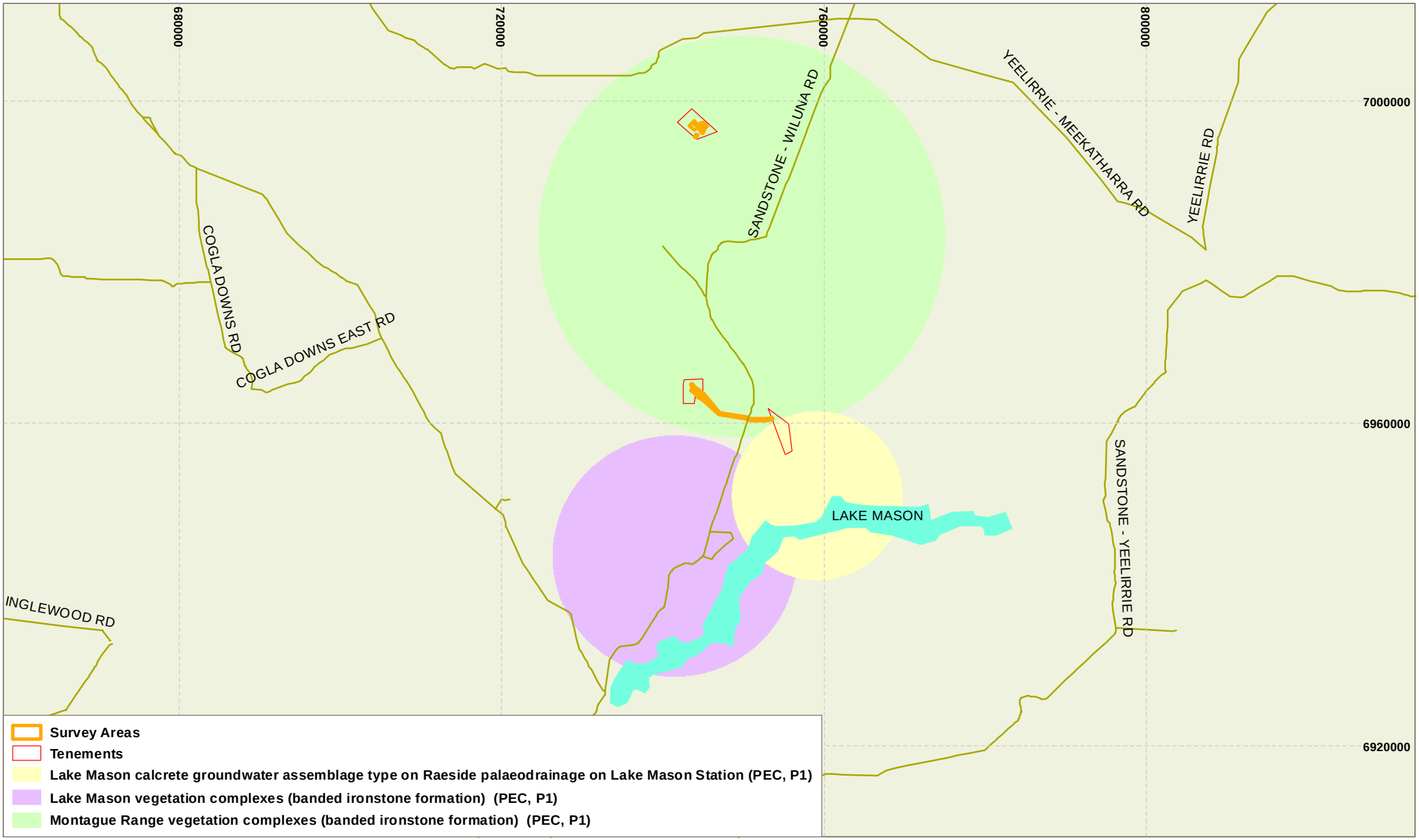
maia

N

0 10
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.10
Prepared for: Pan. Res.
Drawn by: RH
Date: 26/03/2013
Version: 1



Location Map

Major Roads

Waterbodies

Priority Ecological Community Buffers

maia

N

0 12.5

Kilometres

Datum: GDA 1994, MGA 50

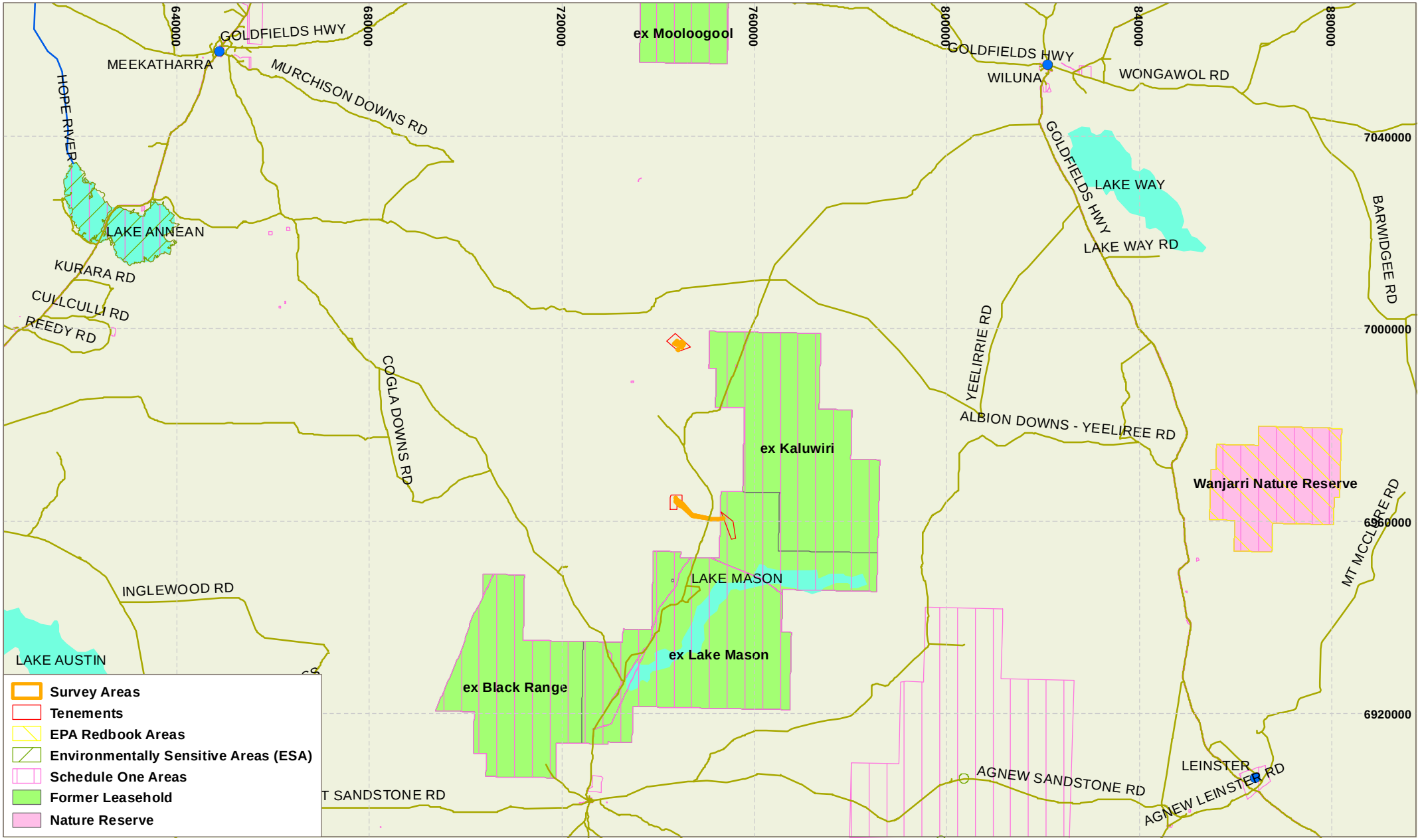
Map: 10.11

Prepared for: Pan. Res.

Drawn by: RH

Date: 26/03/2013

Version: 1



Location Map

Port Hedland
Newman
Wiluna
Kalgoorlie
Perth

Towns
Major Roads
Rivers
Waterbodies

Environmentally Sensitive Areas, Conservation Estates, Schedule One Areas and EPA Redbook Areas

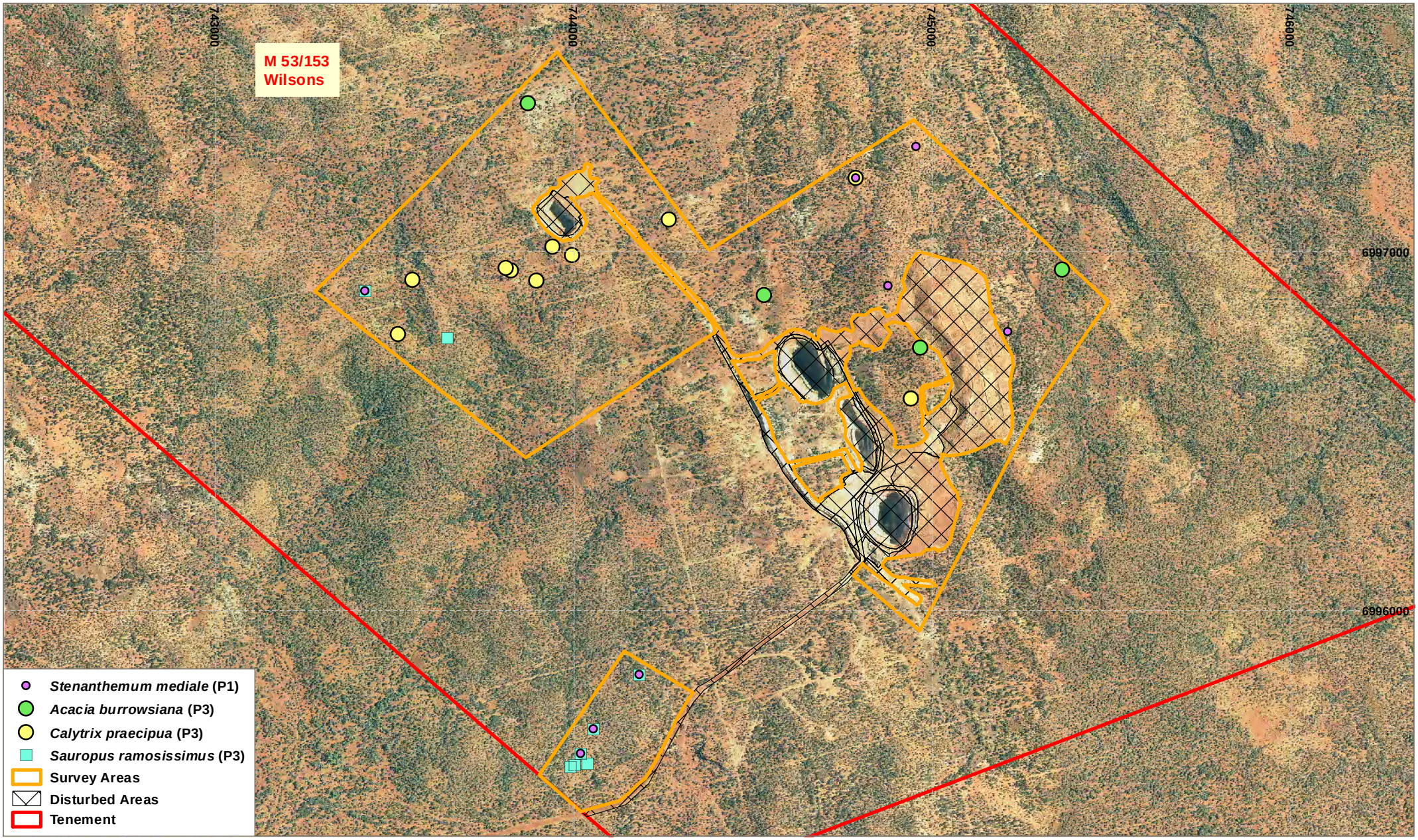
maia

N

0 20
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.12
Prepared for: Pan. Res.
Drawn by: RH
Date: 26/03/2013
Version: 1



Location Map

- Port Hedland
- Newman
- Wiluna
- Kalgoorlie
- Perth

Conservation Significant Flora Locations - Wilsons Survey Area

maia

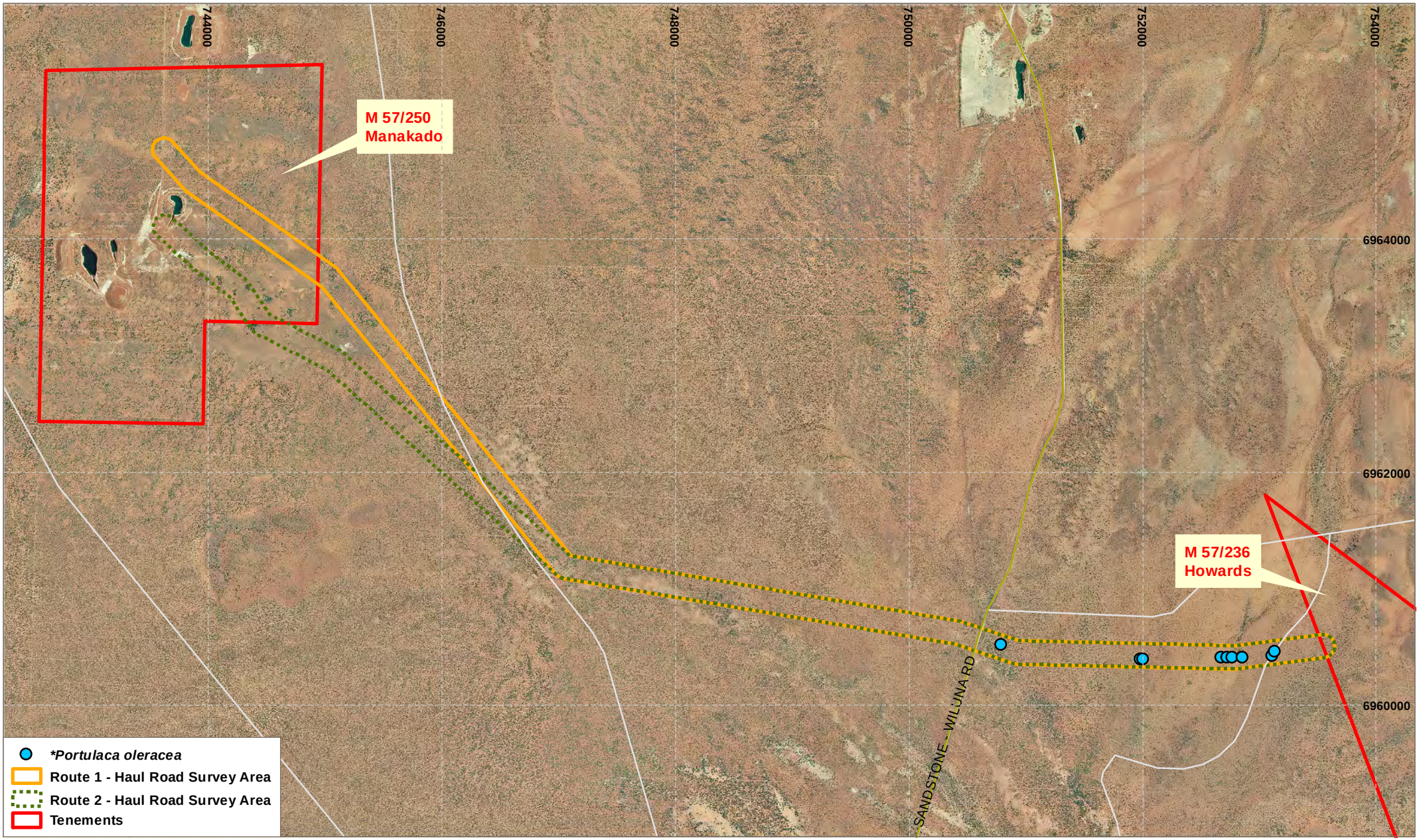
N

0 0.275

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.13
Prepared for: Pan. Res.
Drawn by: RH
Date: 5/04/2013
Version: 1



Location Map

- Port Hedland
- Newman
- Wiluna
- Kalgoorlie
- Perth

Major Roads

Other Roads and Tracks

General Environmental Weed Locations - Haul Road Survey Area

N

0 0.75

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.14

Prepared for: Pan. Res.

Drawn by: RH

Date: 5/04/2013

Version: 1

Figure 10.1: Vegetation Map Legend

	Code	Vegetation Association
	CSL	Sparse to Open Chenopod Shrubland of *Sclerolaena cuneata* and *Maireana triptera* with a Sparse Low Shrubland of *Eremophila maculata* subsp. *brevifolia* and Scattered trees of *Acacia aneura* complex.
	SL1	Sparse Mid Shrubland of *Eremophila oppositifolia* subsp. *angustifolia* and *+/- E. pantonii* with a Sparse Low Shrubland of *Solanum lasiophyllum* and *Ptilotus obovatus* and Scattered Low Trees of *Acacia aneura* complex and/or *A. tetragonophylla* .
	SL2	Open Tall Shrubland of *Acacia xanthocarpa* with a Sparse Mid Shrubland of *Eremophila exilifolia* with a Sparse Low Shrubland of +/- *Aluta maisonneuvei* subsp. *maisonneuvei* .
	SL3	Low Open Shrubland of *Eremophila malacoides* and *Cratystylis subspinescens* .
	WL1	Sparse Low Woodland of *Acacia aneura* with a Sparse to Open Tall Shrubland of *A . ramulosa* var. *linophylla* and a mixed Sparse Low Shrubland.
	WL6	Open Low Woodland of *Acacia aneura* complex with a Sparse Mid Shrubland of *A . tetragonophylla* and/or *A . craspedocarpa* and a Sparse Low Shrubland of *Ptilotus obovatus* .
	WL7	Sparse Low Woodland of *Acacia aneura* complex with a Sparse Tall Shrubland of *A. aneura* complex +/- *A . quadrimarginea* and Sparse Low Shrubland of *Eremophila jucunda* subsp. *jucunda* +/- E. *latrobei* subsp. *latrobei.*
	WL8	Open Low Woodland / Tall Shrubland of *Acacia xanthocarpa* with Isolated Low Trees of *Acacia aneura* complex and Isolated Low Shrubs of *Prostanthera althoferi* subsp. *althoferi* and *Eremophila exilifolia.*
	C	Cleared for Infrastructure

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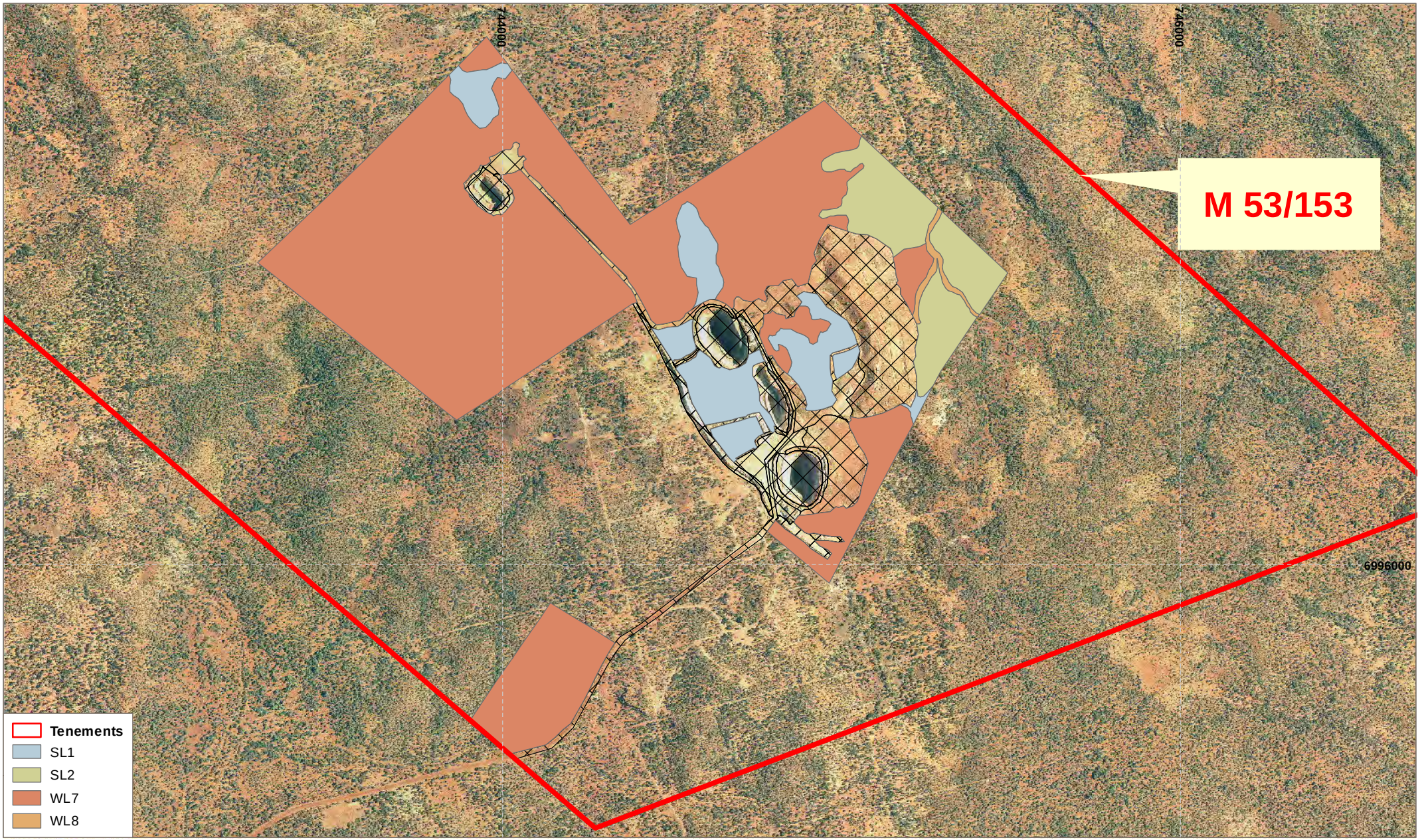


Location Map

Port Hedland
Newman
Wiluna
Kalgoorlie
Perth

Disturbed Area

Vegetation Mapping - Wilsons Survey Area

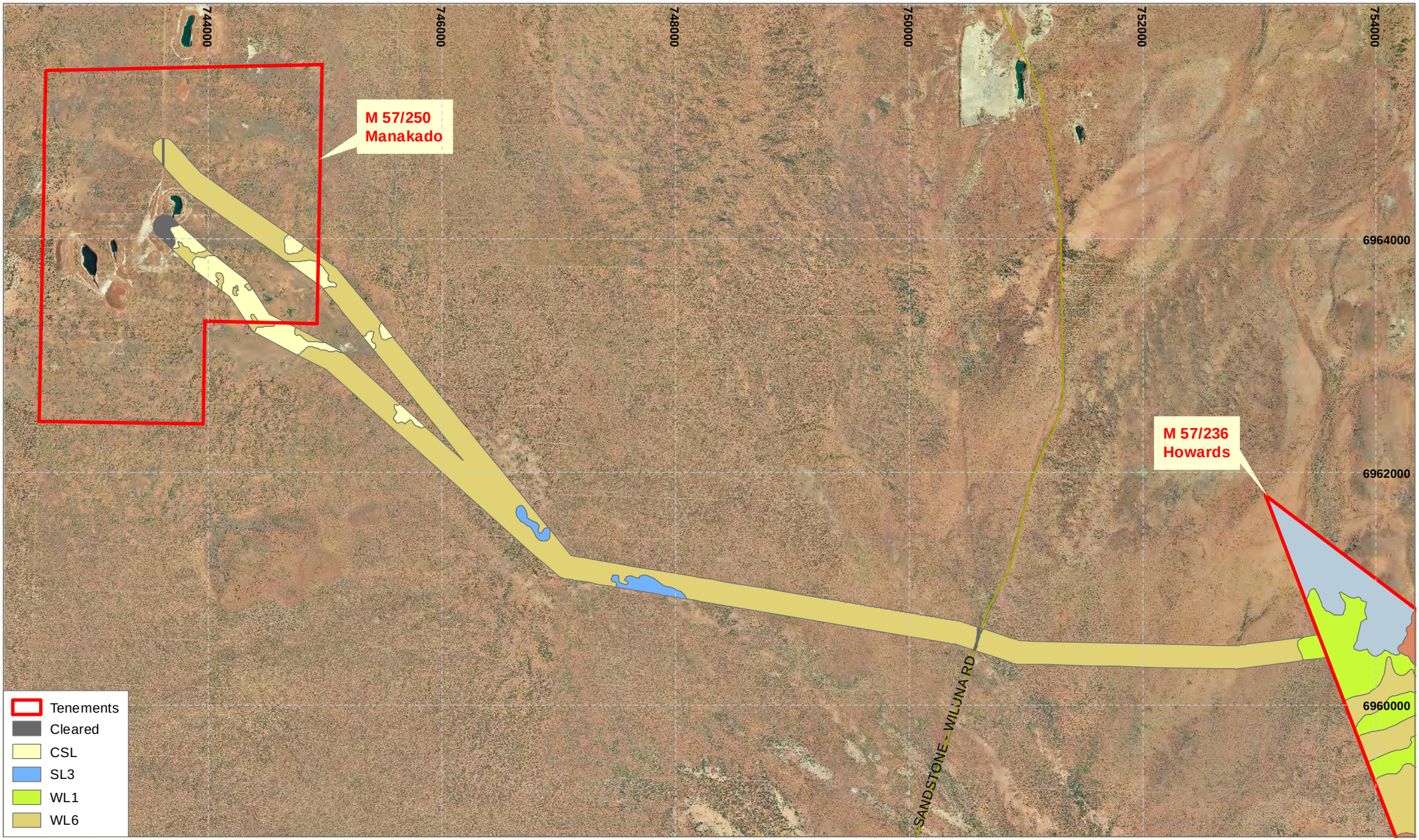
maia

N

0 0.3
Kilometres

Datum: GDA 1994, MGA 50

Map: 10.15
Prepared for: Pan. Res.
Drawn by: SH
Date: 8/05/2013
Version: 1



Location Map

Port Hedland
Newman
Wiluna
Geraldton
Kalgoorlie
Perth

Major Roads

Vegetation Mapping - Haul Road Survey Area

maia

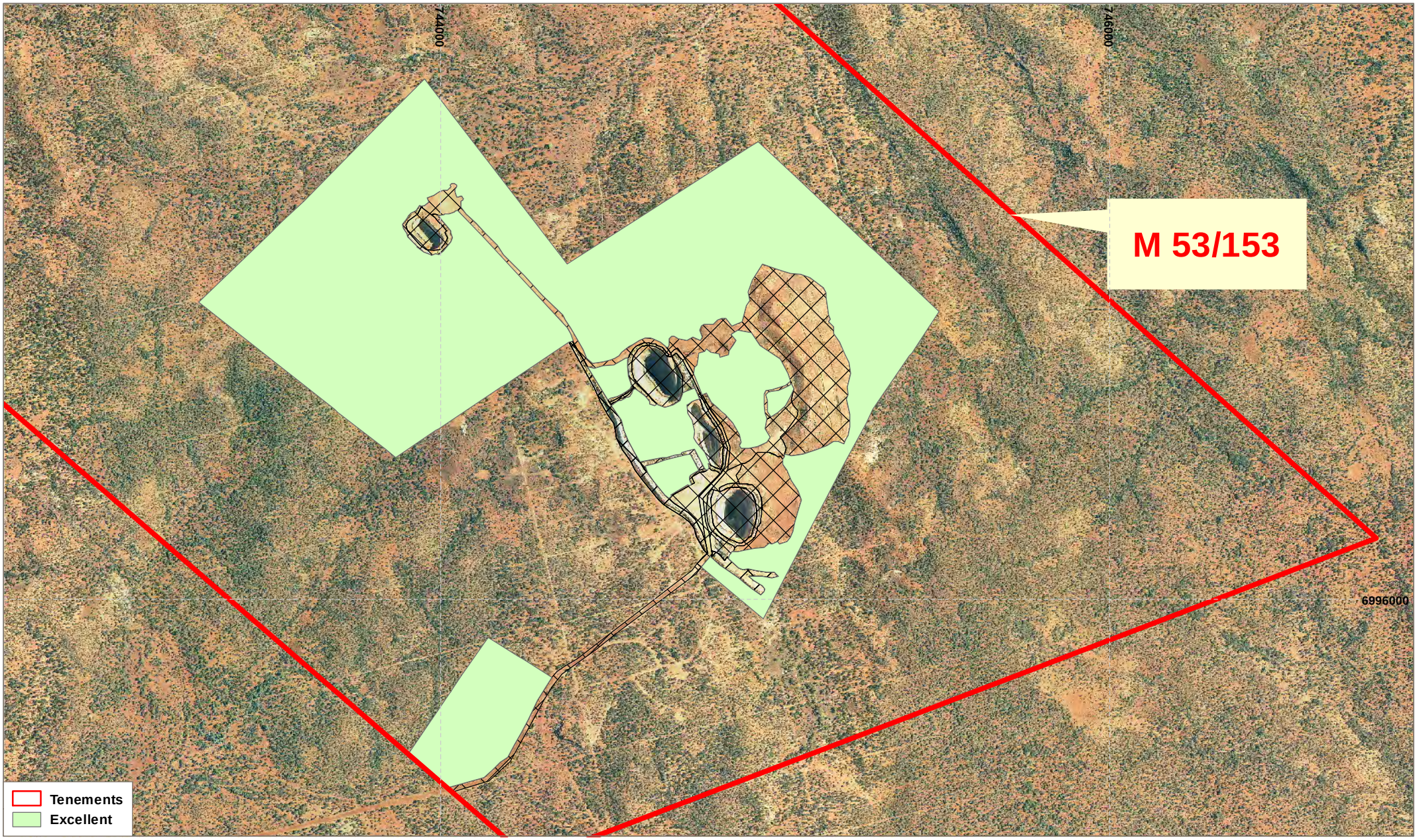
N

0 0.75

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.16
Prepared for: Pan. Res.
Drawn by: SH
Date: 8/05/2013
Version: 1



Location Map

- Port Hedland
- Newman
- Wiluna
- Kalgoorlie
- Perth

Disturbed Area

Vegetation Condition - Wilsons Survey Area

maia

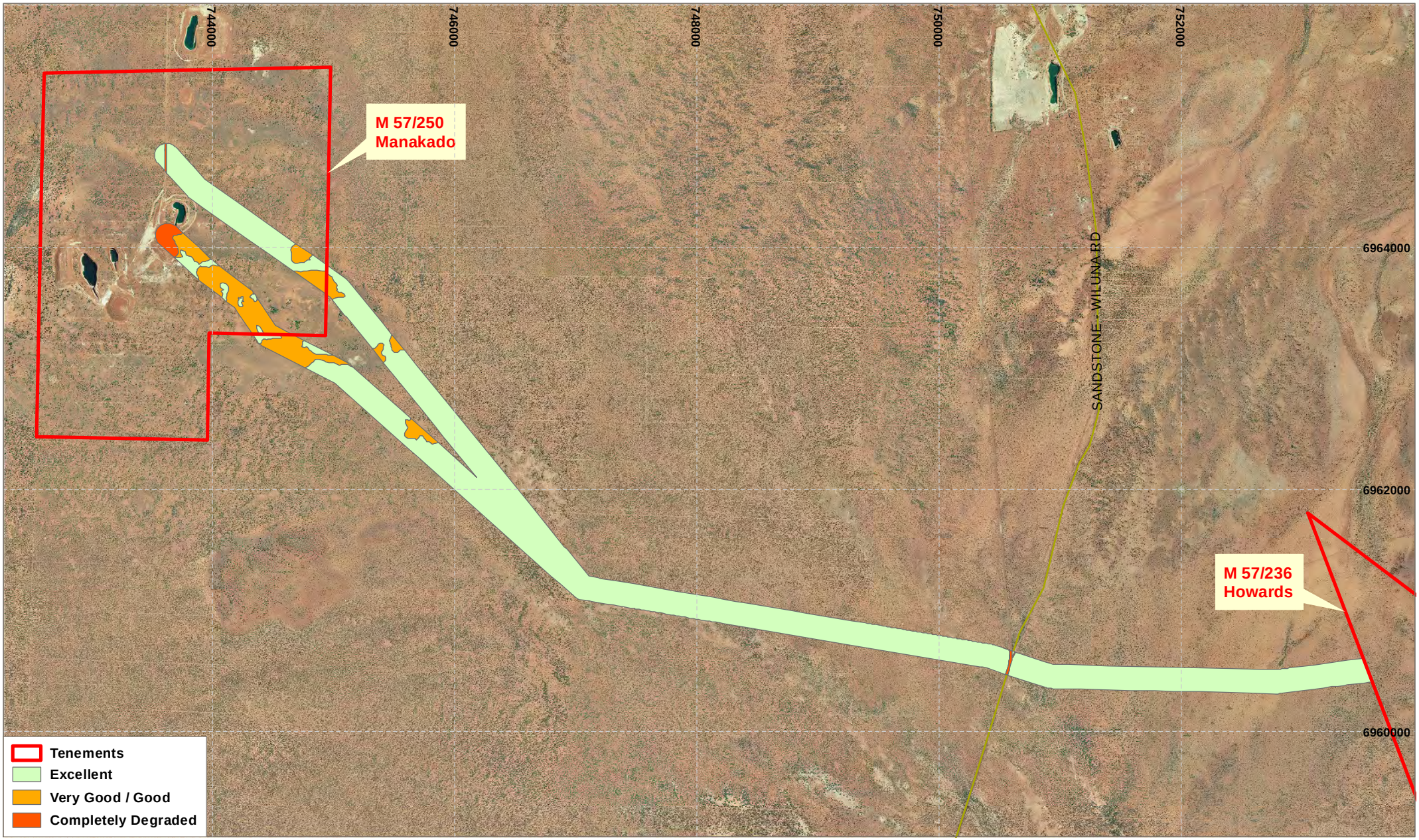
N

0 0.3

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.17
Prepared for: Pan. Res.
Drawn by: SH
Date: 8/05/2013
Version: 1



Location Map

- Port Hedland
- Newman
- Wiluna
- Kalgoorlie
- Perth

Major Roads

Vegetation Condition - Haul Road Survey Area

maia

N

0 0.75

Kilometres

Datum: GDA 1994, MGA 50

Map: 10.18
Prepared for: Pan. Res.
Drawn by: SH
Date: 8/05/2013
Version: 1

Appendix 1: Database and Literature Search Results

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Table A1.1: Conservation Significant Flora Species Previously Located in and in the Vicinity of the Survey Area

Species	Rank	Flowering	Habitat	Recorded Locations on FloraBase (WAH, 1998-)	Possibility of Occurrence – Wilsons	Possibility of Occurrence – Haul Road	Data Source
Dampiera plumosa	P1	October	Red sandy soils	Black Range Station, Sandstone, Lake Barlee, Coolgardie	Unlikely	Unlikely	TP
Eremophila congesta	P1	August to September	Lateritic outcrops in greenstone hills, stony quartzite slopes	Millgool outcamp, Wiluna, Magellan Pipeline	Possible	Unlikely	TP
Neurachne lanigera	P1	July to August, October	Red sand, laterite, rocky outcrops, plains	Yeelirrie Station, 80 km SW Warburton, Wiluna, Cunyu Homestead	Possible	Possible	TP
Pityrodia canaliculata	P1	June to September	Red sand	Sandstone, Windsor Station, Anketell	Unlikely	Unlikely	TP
Stenanthemum mediale	P1	April to August	Red clayey sand	Youno Downs, Mount Magnet, Jack Hills, Black Hill Station, Yeelirrie Station.	Possible and recorded	Unlikely	NM, TPFL, WAHerb, DRP
Tecticornia sp. Lake Way (P. Armstrong 05/961)	P1	N/A	Edges of salt lakes	40 km SE Wiluna, Lake Carey, Lake Raeside	Unlikely	Unlikely	TP
Acacia burrowsiana	P3	N/A	Red-brown loams with ironstone rubble on surface, calcrete soils, laterite, quartz, flats adjacent to watercourses, crests of low rises, breakaways	Lorna Glen Conservation Park, 50 km NW of Cue, 44 km N of Sandstone, Lennonville, Mount Magnet	Possible and recorded	Possible	NM, DRP
Baeckea sp. London Bridge (M.E. Trudgen 5393)	P3	October to November	Gravel, sandstone, rocky breakaways and hills	Sandstone, 80 km SW Sandstone, Challa Station, Paynes Find - Sandstone Road, London Bridge Breakaway	Possible	Unlikely	TP
Baeckea sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)	P3	October	Orange sand, flats	Tropicana, Great Victoria Desert, Barrambie, 26 SE Leinster, Agnew, Sandstone, Wiluna	Unlikely	Unlikely	WAHerb, TP

Species	Rank	Flowering	Habitat	Recorded Locations on FloraBase (WAH, 1998-)	Possibility of Occurrence – Wilsons	Possibility of Occurrence – Haul Road	Data Source
Bossiaea concinna	P3	June to September	White or red sand, gravel	Congelin Dam, NE Pithara, NW Jerramungup, Cunderdin, 65 km NE Coolgardie on Great Eastern Highway, 13 km S Woolgangie, 70 km SW Coolgardie	Unlikely	Unlikely	TP
Bossiaea eremaea	P3	July to September	Deep red sand	Yeelirrie Station, 60 km SE Laverton, 130 km E Mount Magnet, Lake Mason Station, SE Merolia Station, 17 km W Sandstone	Unlikely	Unlikely	TP
Calytrix praecipua	P3	June to July, September to November	Skeletal sandy soils over granite or laterite, breakaways, outcrops	10 km NE Gidgee, Banjawarn Pastoral Station, Niagra Dam, Carnarvon Range, De La Poer Range Nature Reserve, Laverton Downs Station, White Cliffs Station, Merolia Station, Melita Station, Laverton	Possible and recorded	Unlikely	NM, WAHerb, TP
Calytrix uncinata	P3	August to November	White or red sand, sandy clay, granite or sandstone breakaways, rocky rises	Wanjarri Nature Reserve, Leinster, Gnows Nest Range, 34 SW Wiluna, Murdaburia Hill, Booylgoo Range, Joyners Find Greenstone Belt, Yakabindie Station, Lake Mason Station, Blue Hills Range, Yakabindie Station, Meekatharra, Cogla Downs Station, Mount Edon, Maranalgo Station, Wanjarri, Nambi Station, Youno Downs, Mount	Possible	Unlikely	NM, WAHerb, TP

Species	Rank	Flowering	Habitat	Recorded Locations on FloraBase (WAH, 1998-)	Possibility of Occurrence – Wilsons	Possibility of Occurrence – Haul Road	Data Source
				Magnet			
Eremophila arachnoides subsp. *arachnoides*	P3	September	Shallow loam over limestone	Pinnacles Station, Lake Noondie, Yeelirrie Station, Lake Mason Homestead, 8km NE Bullen Hill, N of Cunyu-New Springs Road, Yarrabubba	Possible	Possible	NM, WAHerb, TP
Eremophila flaccida subsp. *attenuata*	P3	May	Stony clay over quartzite, hillslopes, ridges	Bilung Pool, Dairy Creek Homestead, 50 km N Byro, 90 km Gascoyne Junction	Possible	Unlikely	TP
Euryomyrtus inflata	P3	June to July	Deep red sand, flat plain	Gidgee, Lake Mason Station, 55 km N Sandstone, 11 km E Yeelirrie, Youno Downs Homestead, Sandstone-Wliuna Road	Unlikely	Unlikely	NM, WAHerb, TP
Homalocalyx echinulatus	P3	June to September	Laterite, breakaways, sandstone hills	27 km NW Longreach, 36 km SW Wiluna, Booylgoo Range, Joyners Find Greenstone Belt, Weld Range, Jack Hills, Carnegie Range, Princess Range, Ululla, Doolgunna Station, Mount Hale, Windidda, Wongawal Station, Meekatharra	Possible	Unlikely	TP
Labichea eremaea	P3	August to September	Red sand	Mount Dimer, Sandstone, Black Range Station, 95 km NE Beacon	Unlikely	Unlikely	TP
Mirbelia stipitata	P3	August	Red sandy loam	Cue-Sandstone Road, 104 km N Sandstone, 100 km N Laverton	Possible	Possible	TP
Olearia mucronata	P3	August to December, January	Schistose hills, along drainage channels	Joyners Find Greenstone Belt, Hamersley Ranges, Paraburdoo, Mount	Possible	Unlikely	TP

Species	Rank	Flowering	Habitat	Recorded Locations on FloraBase (WAH, 1998-)	Possibility of Occurrence – Wilsons	Possibility of Occurrence – Haul Road	Data Source
				Margaret, Witenoom			
Philotheca coateana	P3	August to September	Red sand	Goongarrie Station, 100 km SE Sandstone, Windarling Peak, Bulga Downs Station, W Old Gidgee	Unlikely	Unlikely	TP
Prostanthera ferricola	P3	N/A	Shallow red-brown skeletal sandy loam on banded ironstone, laterite, basalt or quartz. Gently inclined mid to upper slopes of hills, rocky crests, outcrops	Longreach, Mount Magnet, Moolagool Station, Robinson Ranges, Wiluna West Range, Doolgunna Homestead, Jack Hills, Weld Range	Possible	Unlikely	TP
Sauropus ramosissimus	P3	N/A	Skeletal red loam sand with lateritic gravel and outcropping	Leinster, 70 km SE Wiluna, Winduldarra Rockhole, NE Laverton, 70 km N Leonora, Carnegie Station	Possible and recorded	Unlikely	NM
Sida picklesiana (=*Sida* sp. Wiluna (A. Markey & S. Dillon 4126))	P3	N/A	Sandy loam with quartz and ironstone gravels and breakaways	30 km SW & 70 km SW Wiluna, Joyner Find, Doolgunna Station, Neds Creek Station, Joyners Find Greenstone Belt, Wiluna West Range, N Cue	Possible	Possible	TP
Stackhousia clementii	P3	N/A	Skeletal soils, sandstone hills	Dampier Peninsula, SE Warburton, Wiluna, Burrup Peninsula, Beyondie Station, Little Sandy Desert, Gnaraloo Homestead, E Meekatharra	Unlikely	Unlikely	TP
Tribulus adelacanthus	P3	N/A	Rocky hillslope	Mount Keith, Mount Magnet, Robinson Range, Joyners Find Greenstone Belt	Possible	Unlikely	TP

Species	Rank	Flowering	Habitat	Recorded Locations on FloraBase (WAH, 1998-)	Possibility of Occurrence – Wilsons	Possibility of Occurrence – Haul Road	Data Source
Eremophila pungens	P4	June to August	Sandy loam, clayey sand over laterite, plains, ridges, breakaways	Banjawarn Pastoral Station, Leinster, Lorna Glen Station, Mount Keith, 65 km E Wiluna, Banjawarn Pastoral Lease, Yakabindie Station, Wanjarri Nature Reserve, Imbin Rockhole, Barwidgee Station, Von Treur Tableland, Lorna Glen Station, Lakeway Station	Possible	Possible	TP
Grevillea inconspicua	P4	June to August	Loam, gravel, along drainage lines on rocky outcrops, creeklines	Yakabindi Station, 80 km SE & 60 km E Mount Magnet, Booylgoo Range, Leinster, Windimurra Homestead, 70 km N Sandstone, Barwidgee Station, Weebo Station, Glen Station, Montague Range, Lake Mason Station, Meekatharra, Cue, Weld Range, Sandstone-Wiluna Road, Wanjarri Nature Reserve	Possible	Possible	NM, TPFL, WAHerb, TP

Note: P1-P4 = Priority 1 to Priority 4 species; N/A = Not available; NM = NatureMap database result; TP = Threatened and Priority Flora List TPFL = Threatened and Priority Flora database; WAHerb = WA Herbarium database. DEC database search reference #26-1111FL.

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Appendix 2: Quadrat and Relevé Locations

Table A2.1: Quadrat and Relevé Locations (GDA94, MGA50)

Quadrat	Easting (mE)	Northing (mN)	Survey Area
H01	753132	6960462	Haul Road
H02	752151	6960402	Haul Road
H03	750174	6960731	Haul Road
H04	745203	6963497	Haul Road
H05	746571	6961901	Haul Road
H06	745848	6962278	Haul Road
H07	748337	6960931	Haul Road
H09	747975	6960971	Haul Road
H10	747018	6961265	Haul Road
H11	744381	6963266	Haul Road
W01	743786	6996715	Wilsons
W02	743780	6996975	Wilsons
W03	743874	6997412	Wilsons
W04	744201	6997173	Wilsons
W05	745061	6997052	Wilsons
W06	745286	6996901	Wilsons
W07	745154	6996432	Wilsons
W08	744184	6995818	Wilsons
W10	744021	6995598	Wilsons
W11	744878	6996903	Wilsons
SH10	744532	6996877	Wilsons
P02ʳ	743418	6996890	Wilsons
P06ʳ	751335	6960436	Haul Road
P07ʳ	750790	6960514	Haul Road
P11ʳ	746964	6961189	Haul Road
P12ʳ	746875	6961456	Haul Road
P13ʳ	746632	6961599	Haul Road
P14ʳ	745706	6962476	Haul Road
P15ʳ	744771	6963117	Haul Road
P16ʳ	743996	6963774	Haul Road
PH12ʳ	743791	6963868	Haul Road

Note: ʳ indicates relevé.

Appendix 3: Statistical Analysis Inputs and Outputs

Table A3.1: Single Analysis Site by Species Matrix

Taxa	SH10-(SL1)	H01-(WL6)	H02-(WL6)	H03-(WL6)	H04-(WL6)	H05-(WL6)	H06-(WL6)	H07-(WL6)	H09-(SL3)	H10-(WL6)	H11-(WL6)	W01-(WL7)	W02-(WL7)	W03-(SL1)	W04-(WL7)	W05-(SL2)	W06-(WL8)	W07-(SL1)	W08-(WL7)	W10-(WL7)	W11-(WL7)
Abutilon oxycarpum	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0
Acacia aneura	1	1	1	1	0	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1
Acacia balsamea	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0
Acacia burkittii	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0
Acacia burrowsiana	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Acacia craspedocarpa	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Acacia pruinocarpa	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Acacia quadrimarginea	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1
Acacia tetragonophylla	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	1	0	0	0
Acacia victoriae subsp. victoriae	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Acacia xanthocarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Aristida contorta	0	1	1	1	1	1	1	0	0	1	0	0	1	1	0	1	1	1	0	0	0
Atriplex codonocarpa	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cheilanthes sieberi subsp. sieberi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cratystylis subspinescens	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cymbopogon ambiguus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Dianella revoluta	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dodonaea microzyga var. acrolobata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Dodonaea petiolaris	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1
Duperreya commixta	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Duperreya sericea	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0
Enchylaena tomentosa var. tomentosa	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	1	1	0	0	0
Enneapogon polyphyllus	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1
Eragrostis eriopoda	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
Eragrostis setifolia	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Eremophila conglomerata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	1
Eremophila exilifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Eremophila fraseri subsp. parva	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eremophila gilesii	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eremophila jucunda subsp. jucunda	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	1
Eremophila latrobei subsp. latrobei	0	0	0	1	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	1
Eremophila longifolia	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Eremophila maculata subsp. brevifolia	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Eremophila malacoides	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Eremophila oppositifolia subsp. angustifolia	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0
Eremophila pantonii	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Eriachne helmsii	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Eriachne mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Grevillea berryana	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hakea recurva	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maireana thesioides	0	1	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Maireana triptera	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Monachather paradoxus	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Prostanthera albiflora	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Prostanthera althoferi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
Prostanthera campbellii	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Psydrax latifolia	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Psydrax rigidula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0
Psydrax suaveolens	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Ptilotus divaricatus	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ptilotus obovatus	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	0	1
Ptilotus schwartzii	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	1
Rhagodia drummondii/eremaea	0	0	0	1	1	0	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0
Santalum lanceolatum	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
Sauropus ramosissimus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Scaevola spinescens	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
Sclerolaena cuneata	1	1	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Sclerolaena eriacantha	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Taxa	SH10-(SL1)	H01-(WL6)	H02-(WL6)	H03-(WL6)	H04-(WL6)	H05-(WL6)	H06-(WL6)	H07-(WL6)	H09-(SL3)	H10-(WL6)	H11-(WL6)	W01-(WL7)	W02-(WL7)	W03-(SL1)	W04-(WL7)	W05-(SL2)	W06-(WL8)	W07-(SL1)	W08-(WL7)	W10-(WL7)	W11-(WL7)
Senna artemisioides subsp. filifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Senna artemisioides subsp. helmsii	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Senna artemisioides subsp. x artemisioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Senna glaucifolia	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Sida ectogama	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0
Sida fibulifera	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Sida sp. dark green fruits (S. van Leeuwen 2260)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1
Solanum lasiophyllum	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1	0	0	0
Spartothamnella teucriiflora	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Stenanthemum mediale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1

Figure A3.1: Single Analysis Dendrogram Produced by PATN Analysis

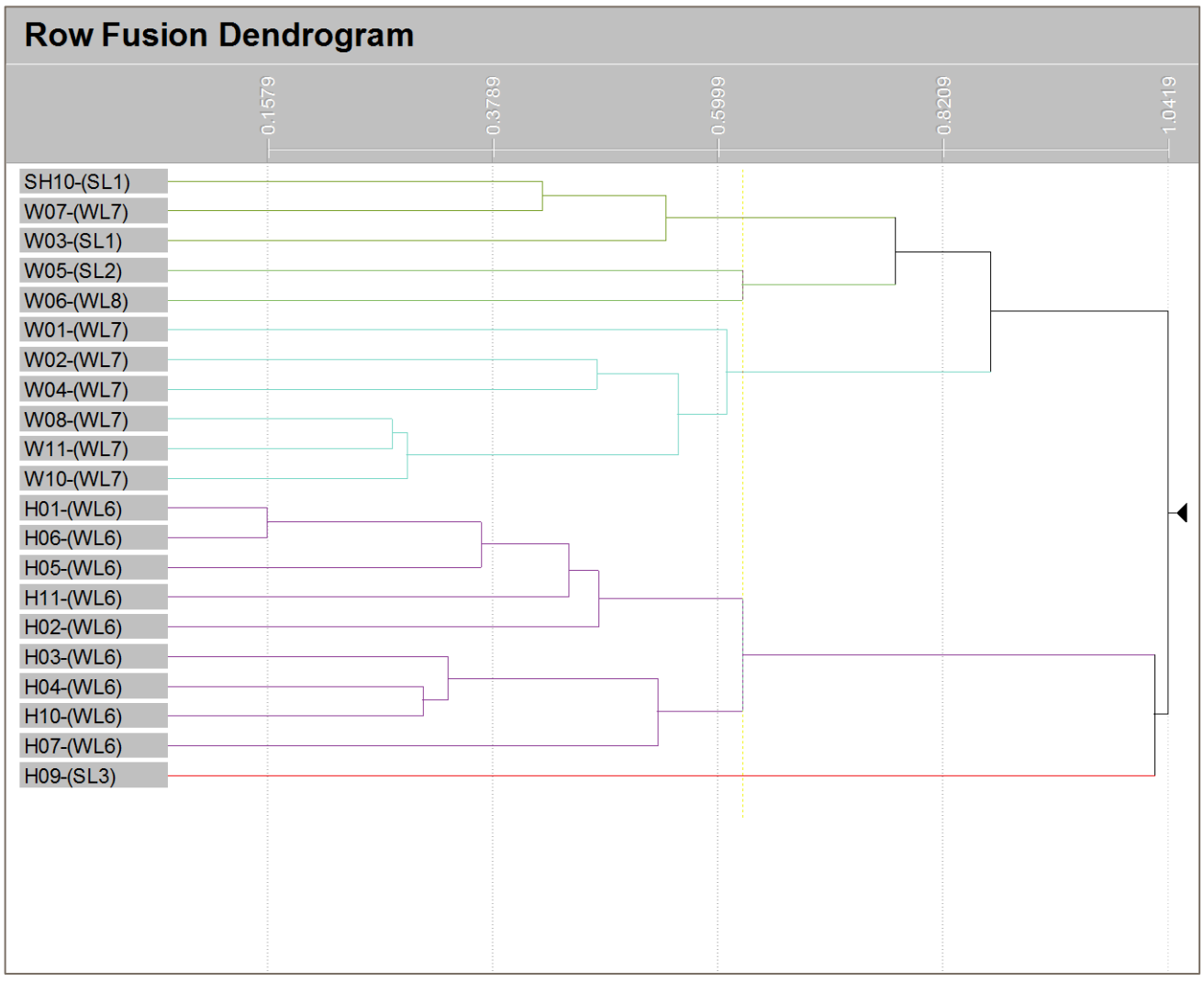

Figure A3.2: Single Analysis Group Dendrogram Produced by PATN Analysis

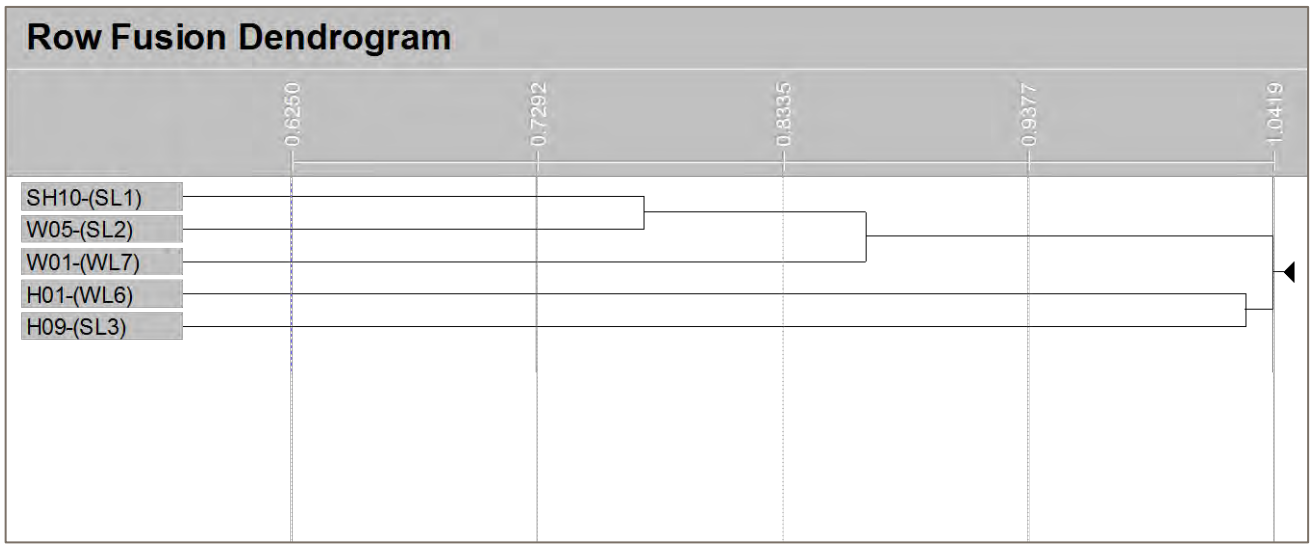

Figure A3.3: PATN Recipe for Single Analyses

PATN Recipe – Single Analyses

Analysis based on rows -

Association Measure: Bray Curtis
Classification Strategy: Agglomerative Hierarchical Fusion
Technique: Flexible UPGMA
Beta: -0.1000
Number of groups to produce: 5
Ordination Method: SSH
CutOff = 0.900
3 Dimensions
Number of random starts: 10
Max iterations: 50
Random Seed Value: 1235

Analysis based on columns -

Association Measure: Bray Curtis
Classification Strategy: Agglomerative Hierarchical Fusion
Technique: Flexible UPGMA
Beta: -0.1000
Number of groups to produce: 9

Figure A3.4: Combined Analysis Dendrogram Produced by PATN Analysis

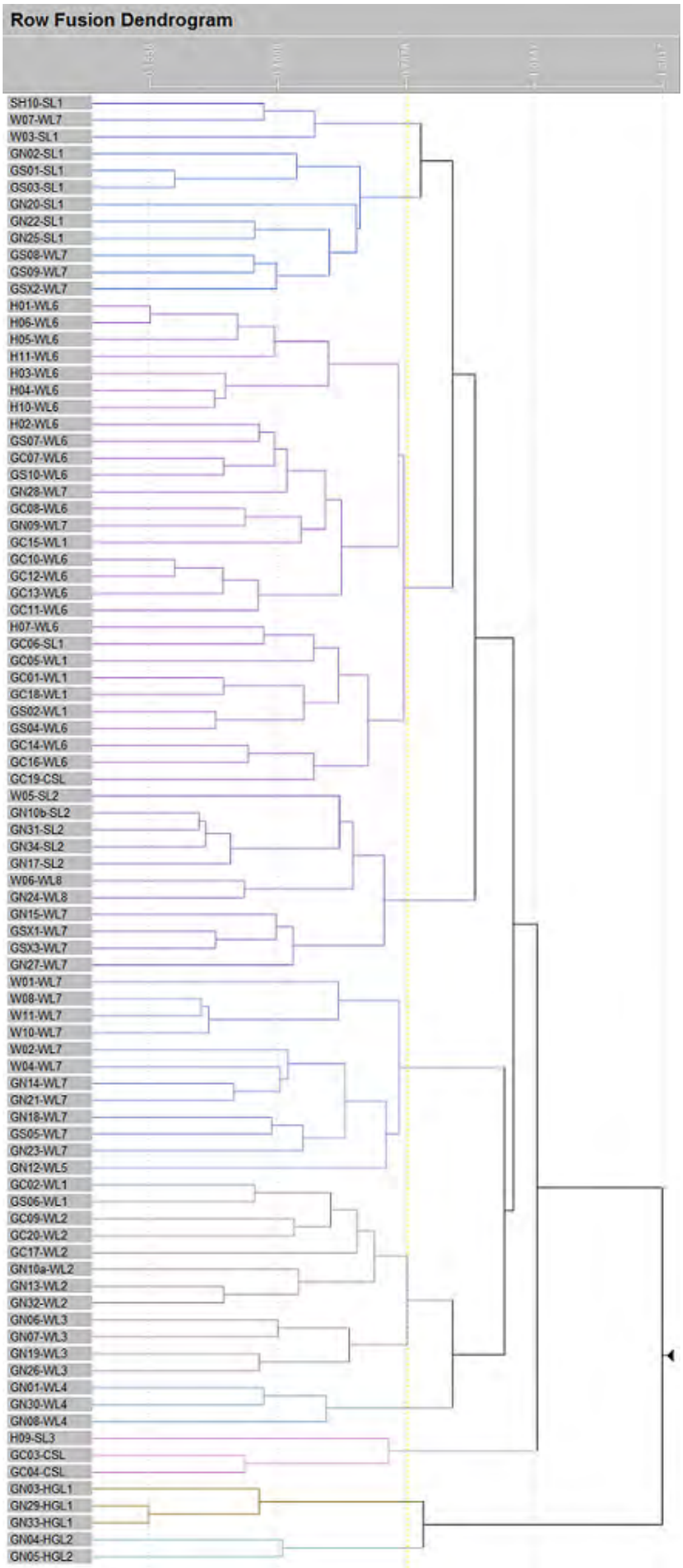

Figure A3.5: DEC Analysis Dendrogram Produced by PATN Analysis

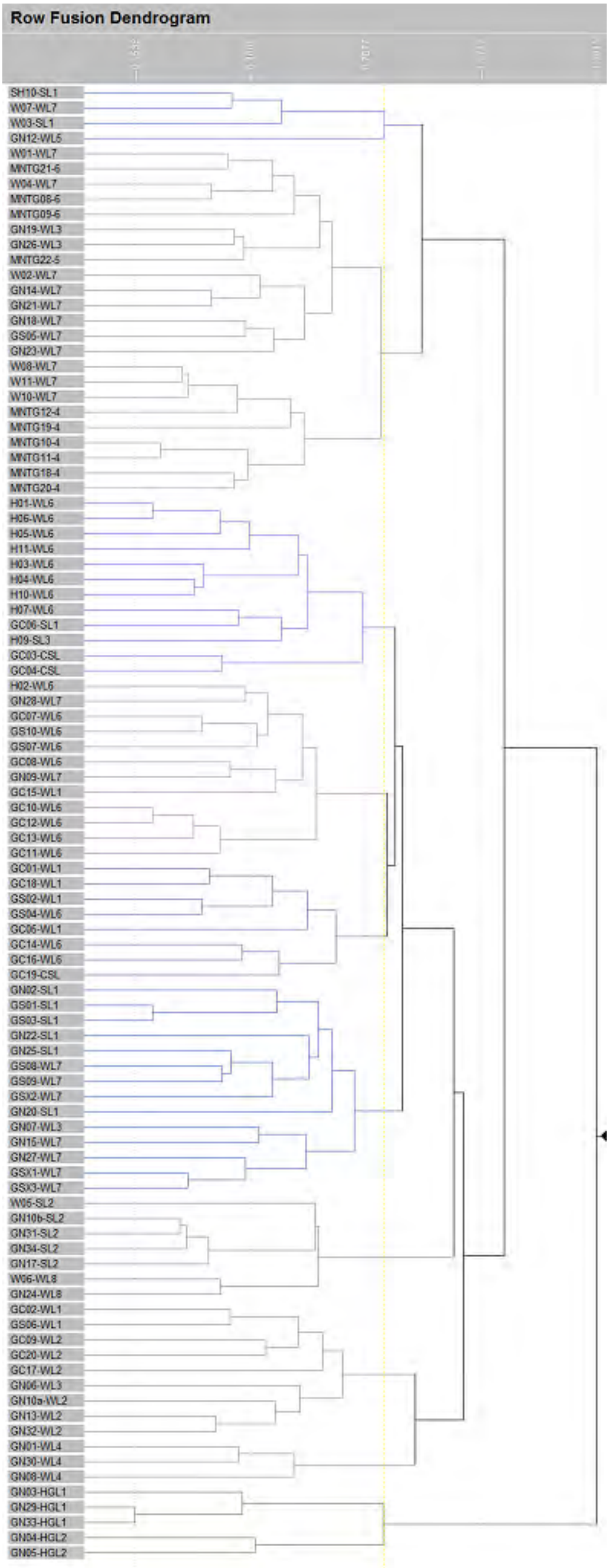

Figure A3.6: PATN Recipe for Combined Analyses

PATN Recipe – Combined Analyses

Analysis based on rows -

Association Measure: Bray Curtis
Classification Strategy: Agglomerative Hierarchical Fusion
Technique: Flexible UPGMA
Beta: -0.1000
Number of groups to produce: 10
Ordination Method: SSH
CutOff = 0.900
3 Dimensions
Number of random starts: 1000
Max iterations: 50
Random Seed Value: 1235

Analysis based on columns -

Association Measure: Bray Curtis
Classification Strategy: Agglomerative Hierarchical Fusion
Technique: Flexible UPGMA
Beta: -0.1000
Number of groups to produce: 12

Figure A3.7: PATN Recipe for DEC Analyses

PATN Recipe – DEC Analyses

Analysis based on rows -

Association Measure: Bray Curtis
Classification Strategy: Agglomerative Hierarchical Fusion
Technique: Flexible UPGMA
Beta: -0.1000
Number of groups to produce: 10
Ordination Method: SSH
CutOff = 0.900
3 Dimensions
Number of random starts: 1000
Max iterations: 50
Random Seed Value: 1235

Analysis based on columns -

Association Measure: Bray Curtis
Classification Strategy: Agglomerative Hierarchical Fusion
Technique: Flexible UPGMA
Beta: -0.1000
Number of groups to produce: 12

Table A3.2: Indicator Species for Vegetation Associations Recorded in the Survey Area

Species	SL1	WL6	WL7
*Acacia balsamea**	•		
*Acacia burkittii***	•		
*Acacia burrowsiana**	•		
Eremophila oppositifolia subsp. *angustifolia***	•		
*Eremophila pantonii**	•		
*Scaevola spinescens***	•		
*Acacia tetragonophylla***		•	
*Eremophila longifolia**		•	
*Solanum lasiophyllum**		•	
*Acacia quadrimarginea***			•
*Dodonaea petiolaris**			•
*Eremophila conglomerata**			•
Eremophila jucunda subsp. *jucunda***			•

Note: Indicator values are shown only for taxa which were significant at p<0.05 (Monte Carlo Permutation Tests); * = p<0.05, ** = p<0.01, *** = p<0.001.

Appendix 4: Species Accumulation Analysis and Species List

Table A4.1: Results from EstimateS Species Accumulation Analysis*

Samples	Individuals (computed)	Sobs (Mao Tau)	Sobs 95% CI Lower Bound	Sobs 95% CI Upper Bound	Sobs SD (Mao Tau)	Sobs Mean (runs)	Singletons Mean	Singletons SD (runs)	Doubletons Mean	Doubletons SD (runs)	Uniques Mean	Uniques SD (runs)	Duplicates Mean	Duplicates SD (runs)	ACE Mean	ACE SD (runs)	ICE Mean	ICE SD (runs)	Chao 1 Mean	Chao 1 95% CI Lower Bound	Chao 1 95% CI Upper Bound	Chao 1 SD (analytical)	Chao 2 Mean
1	16	16.01	12.8	19.22	1.64	16.27	16.27	4.76	0	0	16.27	4.76	0	0	151.82	99.02	145.04	94.3	151.82	72.04	351.26	65.62	145.04
2	32	27.91	23.16	32.67	2.43	28.16	24.01	6.4	4.15	2.52	24.01	6.4	4.15	2.52	174.1	129.91	303.21	250.67	111.58	56.66	275.51	49.86	107.41
3	48	37.46	31.76	43.16	2.91	37.75	29.01	6.9	7.04	2.56	29.01	6.9	7.04	2.56	112.2	55.69	148.85	81.45	99.26	61.04	201.25	32.62	96.19
4	64	45.41	39.07	51.74	3.23	45.66	32.01	6.58	9.62	3.29	32.01	6.58	9.62	3.29	103.92	34.11	126.06	45.24	100.55	67.66	183.37	27.18	97.8
5	80	52.21	45.42	58.99	3.46	52.54	34.22	6.34	11.67	3.57	34.22	6.34	11.67	3.57	105.69	27.92	122.66	34.57	103.61	73.86	175.39	24.02	101.05
6	96	58.17	51.06	65.28	3.63	58.35	35.68	5.94	13.35	3.76	35.68	5.94	13.35	3.76	108.99	23.98	122.61	28.45	106.34	78.88	170.95	21.87	103.94
7	112	63.51	56.18	70.84	3.74	63.55	36.53	5.54	14.9	3.84	36.53	5.54	14.9	3.84	111.92	20.51	123.14	23.65	108.03	82.91	166	19.8	105.8
8	128	67.89	60.38	75.4	3.83	68.16	37.17	5.07	15.98	3.82	37.17	5.07	15.98	3.82	115.56	18.09	125.19	20.47	110.89	86.94	165.57	18.77	108.75
9	144	72.05	64.4	79.71	3.91	72.2	37.49	4.76	16.82	3.83	37.49	4.76	16.82	3.83	118.67	16.24	127.08	18.11	113.34	90.39	165.39	17.92	111.28
10	160	75.83	68.06	83.6	3.96	76.05	37.74	4.52	17.55	3.82	37.74	4.52	17.55	3.82	121.89	14.96	129.37	16.48	115.88	93.75	165.86	17.25	113.89
11	176	79.28	71.4	87.15	4.02	79.46	37.98	4.31	17.94	4	37.98	4.31	17.94	4	124.7	13.95	131.43	15.25	119.15	97.13	168.72	17.13	117.16
12	192	82.45	74.48	90.42	4.07	82.53	38.18	4.08	18.22	3.87	38.18	4.08	18.22	3.87	126.49	12.69	132.52	13.78	121.99	100.14	171.03	16.97	120.01
13	208	85.39	77.33	93.45	4.11	85.53	38.25	3.81	18.8	3.85	38.25	3.81	18.8	3.85	127.69	11.21	133.09	12.12	123.79	102.65	171.14	16.4	121.88
14	224	88.11	79.96	96.27	4.16	88.29	38.28	3.61	19.34	3.84	38.28	3.61	19.34	3.84	129.27	9.92	134.18	10.68	125.69	105.04	171.87	16.01	123.82
15	240	90.64	82.39	98.9	4.21	90.85	38.08	3.48	19.98	3.58	38.08	3.48	19.98	3.58	130.55	8.95	135.03	9.59	126.45	106.8	170.38	15.23	124.67
16	256	93.01	84.65	101.36	4.26	93.13	37.75	3.33	20.75	3.34	37.75	3.33	20.75	3.34	131.2	7.86	135.27	8.4	126.67	108.14	168.12	14.36	124.99
17	272	95.21	86.75	103.68	4.32	95.32	37.55	3.02	21.37	2.93	37.55	3.02	21.37	2.93	131.62	6.69	135.32	7.13	127.2	109.57	166.69	13.68	125.61
18	288	97.27	88.69	105.86	4.38	97.41	37.19	2.53	22.21	2.35	37.19	2.53	22.21	2.35	131.44	5.43	134.77	5.78	127.13	110.66	164.14	12.8	125.65
19	304	99.2	90.48	107.92	4.45	99.32	36.68	1.8	23.12	1.63	36.68	1.8	23.12	1.63	131.35	3.65	134.37	3.87	126.76	111.48	161.26	11.91	125.39
20	320	**101**	92.14	109.86	4.52	101	36	0	24	0	36	0	24	0	132.06	0	134.86		126.2	112.07	158.34	11.05	**124.94**

Note: all variables beyond the Chao 2 Mean have been removed as they are not relevant.

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Table A4.2: Vascular Flora Species List

Family	Species	FlFr	HRC Quadrat	HRC Relevé	HRC OppColl	W Quadrat	W Relevé	W OppColl
Amaranthaceae	*Ptilotus divaricatus*		•					
Amaranthaceae	*Ptilotus obovatus*		•	•	•	•		•
Amaranthaceae	*Ptilotus roei*		•					
Amaranthaceae	*Ptilotus schwartzii*	Fl			•	•	•	•
Apocynaceae	*Sarcostemma viminale*					•		
Asteraceae	*Cratystylis subspinescens*		•	•	•			
Boraginaceae	*Halgania cyanea* var. Allambi Stn (B.W. Strong 676)	Fl				•		
Chenopodiaceae	*Atriplex codonocarpa*		•	•	•			
Chenopodiaceae	*Dissocarpus paradoxus*	Fr	•	•				
Chenopodiaceae	*Enchylaena tomentosa* var. *tomentosa*		•			•		
Chenopodiaceae	*Maireana* ?*thesioides*		•	•		•		
Chenopodiaceae	*Maireana triptera*	Fr	•	•	•	•		•
Chenopodiaceae	*Rhagodia drummondii*	Fl	•	•	•	•		
Chenopodiaceae	*Salsola australis*				•			
Chenopodiaceae	*Sclerolaena cuneata*	Fr	•	•	•		•	
Chenopodiaceae	*Sclerolaena eriacantha*	Fr				•		
Convolvulaceae	*Duperreya commixta*		•					•
Convolvulaceae	*Duperreya sericea*		•	•		•		
Dilleniaceae	*Hibbertia arcuata*	Fr						•
Euphorbiaceae	*Euphorbia drummondii*	Fl	•	•		•		
Fabaceae	*Acacia aneura*		•	•	•	•		
Fabaceae	*Acacia aptaneura*	Fl				•	•	
Fabaceae	*Acacia balsamea*	Fl				•	•	•
Fabaceae	*Acacia burkittii*		•	•	•	•	•	•
Fabaceae	***Acacia burrowsiana* (P3)**					•	•	•
Fabaceae	*Acacia caesaneura*		•	•	•	•		•
Fabaceae	*Acacia craspedocarpa*		•	•	•			•
Fabaceae	*Acacia fuscaneura*	Fl	•	•	•	•	•	
Fabaceae	*Acacia incurvaneura*					•		
Fabaceae	*Acacia macraneura*		•	•		•		
Fabaceae	*Acacia pruinocarpa*				•	•		•
Fabaceae	*Acacia quadrimarginea*					•	•	•
Fabaceae	*Acacia ramulosa* var. *linophylla*				•			

Family	Species	FlFr	HRC Quadrat	HRC Relevé	HRC OppColl	W Quadrat	W Relevé	W OppColl
Fabaceae	*Acacia rhodophloia*							•
Fabaceae	*Acacia tetragonophylla*		•	•	•	•	•	•
Fabaceae	*Acacia victoriae* subsp. *victoriae*		•					
Fabaceae	*Acacia xanthocarpa*					•		•
Fabaceae	*Indigofera georgei*			•	•			
Fabaceae	*Mirbelia microphylla*							•
Fabaceae	*Senna artemisioides* subsp. *filifolia*			•	•	•		•
Fabaceae	*Senna artemisioides* subsp. *helmsii*					•		
Fabaceae	*Senna artemisioides* subsp. *petiolaris*		•	•	•			
Fabaceae	*Senna artemisioides* subsp. x *artemisioides*					•		•
Fabaceae	*Senna glaucifolia*					•		•
Fabaceae	*Senna* sp. Meekatharra (E. Bailey 1-26)							•
Goodeniaceae	*Goodenia wilunensis*				•			
Goodeniaceae	*Scaevola spinescens*		•	•	•	•	•	
Lamiaceae	*Prostanthera albiflora*					•		
Lamiaceae	*Prostanthera althoferi* subsp. *althoferi*					•		•
Lamiaceae	*Prostanthera campbellii*					•	•	•
Lamiaceae	*Spartothamnella teucriiflora*	Fr	•	•	•	•		
Malvaceae	*Abutilon oxycarpum*	Fr	•	•	•	•		•
Malvaceae	*Brachychiton gregorii*							•
Malvaceae	*Hibiscus* sp. 1					•		
Malvaceae	*Lawrencia densiflora*		•		•			
Malvaceae	*Sida ectogama*		•	•	•	•		•
Malvaceae	*Sida fibulifera*	Fl	•	•	•			•
Malvaceae	*Sida* sp. 1					•		
Malvaceae	*Sida* sp. dark green fruits (S. van Leeuwen 2260)	FlFr			•	•	•	•
Myrtaceae	*Aluta maisonneuvei* subsp. *maisonneuvei*					•		
Myrtaceae	***Calytrix praecipua* (P3)**	Fl				•		•
Myrtaceae	*Eucalyptus carnei*	Fr					•	•
Nyctaginaceae	*Boerhavia ?repleta*		•					
Phormiaceae	*Dianella revoluta* var. *divaricata*		•		•			
Phrymaceae	*Peplidium muelleri*				•			
Phyllanthaceae	***Sauropus ramosissimus* (P3)**					•	•	•
Pittosporaceae	***Bursaria occidentalis* (RE)**							•

Family	Species	FlFr	HRC Quadrat	HRC Relevé	HRC OppColl	W Quadrat	W Relevé	W OppColl
Poaceae	*Aristida contorta*	Fl	•	•	•	•		
Poaceae	*Austrostipa elegantissima*		•	•				
Poaceae	*Austrostipa nitida*					•		
Poaceae	*Bothriochloa* sp.		•					
Poaceae	*Cymbopogon ambiguus*		•					
Poaceae	*Digitaria brownii*		•	•				
Poaceae	*Enneapogon polyphyllus*	Fl	•	•	•	•		
Poaceae	*Eragrostis dielsii*		•					
Poaceae	*Eragrostis eriopoda*		•		•	•		
Poaceae	*Eragrostis lacunaria*					•		
Poaceae	*Eragrostis setifolia*	Fl			•	•		•
Poaceae	*Eragrostis* sp.		•					
Poaceae	*Eriachne helmsii*	Fl	•	•		•	•	
Poaceae	*Eriachne mucronata*					•		•
Poaceae	*Eriachne pulchella* subsp. *pulchella*	Fl	•	•		•		
Poaceae	*Monachather paradoxus*	Fl	•	•	•	•		•
Poaceae	*Paraneurachne muelleri*	Fl						•
Poaceae	*Paspalidium basicladum*					•		
Poaceae	*Paspalidium clementii*							•
Portulacaceae	***Portulaca oleracea**		•	•				
Proteaceae	*Grevillea berryana*	Fr	•	•	•			
Proteaceae	*Hakea lorea* subsp. *lorea*		•	•	•			
Proteaceae	*Hakea preissii*	Fr	•	•	•			
Proteaceae	*Hakea recurva* subsp. *recurva*	Fr			•		•	•
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*					•		
Rhamnaceae	***Stenanthemum mediale* (P1)**	Fl				•	•	•
Rubiaceae	*Psydrax latifolia*					•		•
Rubiaceae	*Psydrax rigidula*				•	•		•
Rubiaceae	*Psydrax suaveolens*		•			•		
Santalaceae	*Exocarpos sparteus*	Fl			•	•		
Santalaceae	*Santalum lanceolatum*		•		•	•		•
Sapindaceae	*Dodonaea microzyga* var. *acrolobata*					•	•	•
Sapindaceae	*Dodonaea petiolaris*	Fl				•	•	•
Scrophulariaceae	*Eremophila conglomerata*					•	•	•

Family	Species	FlFr	HRC Quadrat	HRC Relevé	HRC OppColl	W Quadrat	W Relevé	W OppColl
Scrophulariaceae	*Eremophila eriocalyx*	Fr	•		•			
Scrophulariaceae	*Eremophila exilifolia*					•		
Scrophulariaceae	*Eremophila flabellata*				•			
Scrophulariaceae	*Eremophila foliosissima*				•			
Scrophulariaceae	*Eremophila forrestii* subsp. *forrestii*	Fl			•			•
Scrophulariaceae	***Eremophila fraseri* subsp. *parva* (RE)**	Fl	•	•	•			•
Scrophulariaceae	*Eremophila gilesii* subsp. *variabilis*	Fr	•		•			
Scrophulariaceae	*Eremophila glabra* subsp. *tomentosa*	Fr	•		•			
Scrophulariaceae	*Eremophila hughesii* subsp. *hughesii*							•
Scrophulariaceae	*Eremophila jucunda* subsp. *jucunda*	Fl			•	•	•	•
Scrophulariaceae	*Eremophila latrobei* subsp. *latrobei*		•		•	•	•	•
Scrophulariaceae	*Eremophila longifolia*	Fl	•	•	•			•
Scrophulariaceae	*Eremophila mackinlayi* subsp. *spathulata*					•		
Scrophulariaceae	*Eremophila maculata* subsp. *brevifolia*	Fr	•	•	•			
Scrophulariaceae	*Eremophila malacoides*	FlFr	•	•	•			
Scrophulariaceae	*Eremophila oppositifolia* subsp. *angustifolia*	Fl				•	•	
Scrophulariaceae	*Eremophila pantonii*					•	•	
Scrophulariaceae	*Eremophila phyllopoda*				•			
Scrophulariaceae	*Eremophila platycalyx*							•
Scrophulariaceae	*Eremophila punctata*							•
Solanaceae	*Solanum coactiliferum*					•		
Solanaceae	*Solanum lasiophyllum*	Fl	•	•	•	•	•	•
Solanaceae	*Solanum nummularium*							•
Solanaceae	*Solanum orbiculatum*				•			
Stylidiaceae	*Stylidium induratum*							•

Note: P1, P3 = Priority One, Priority Three, * = environmental weed, RE = range extension. Fl = flowering material, Fr = fruiting material. HRC = Haul Road Corridor, W = Wilsons. OppColl = opportunistic collections. Nomenclature based on current Western Australian Herbarium terminology and confirmed on FloraBase (WAH, 1998-).

Appendix 5: Conservation Significance – Flora and Ecological Communities

Commonwealth *Environment Protection and Biodiversity Act 1999*

Table A5.1: Categories and Definitions for Rare Flora

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

Source: DSEWPaC (2013c).

Western Australian *Wildlife Conservation Act 1950*

Table A5.2: Categories and Definitions for Rare Flora

Category	Definition
T: Threatened Flora (Declared Rare Flora – Extant)	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 (Schedule 1 under the Wildlife Conservation Act 1950). Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria: • CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild • EN: Endangered – considered to be facing a very high risk of extinction in the wild • VU: Vulnerable – considered to be facing a high risk of extinction in the wild.
X: Presumed Extinct Flora (Declared Rare Flora – Extinct)	Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950).

Source: DEC (2013a).

Table A5.3: Categories and Definitions for Priority Flora

Category	Definition
1: Priority One: Poorly-known taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
2: Priority Two: Poorly-known taxa	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
3: Priority Three: Poorly-known taxa	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4: Priority Four: Rare, Near Threatened and other taxa in need of monitoring	a. **Rare**. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. b. **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5: Priority Five: Conservation Dependent taxa	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Source: DEC (2013a).

Table A5.4: Categories, Definitions and Criteria for Threatened Ecological Communities (TECs)

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

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

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Table A5.5: Categories, Definitions and Criteria for Priority Ecological Communities (PECs)

Category	Definition and Criteria
Priority One: Poorly-known ecological communities	Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening
Priority Two: Poorly-known ecological communities	Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority Three: Poorly-known ecological communities	(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Category	Definition and Criteria
Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened or that have been recently removed from the threatened list. These communities require regular monitoring.	(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five: Conservation Dependent ecological communities	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Source for Table A5.4 and Table A5.5: DEC (2010).

Table A5.6: Conservation Significant Flora Taxa Located at Wilsons Survey Area – Coordinates (GDA94; MGA50)

Species	Location	Easting (mE)	Northing (mN)	Number of Plants
Stenanthemum mediale (P1)	Wilsons	745212	6996775	1
Stenanthemum mediale (P1)	Wilsons	744788	6997203	3
Stenanthemum mediale (P1)	Wilsons	744955	6997292	10
Stenanthemum mediale (P1)	Wilsons	744055	6995668	3
Stenanthemum mediale (P1)	Wilsons	743418	6996890	10
Stenanthemum mediale (P1)	Wilsons	744184	6995818	10
Stenanthemum mediale (P1)	Wilsons	744021	6995598	5
Stenanthemum mediale (P1)	Wilsons	744878	6996903	1
Acacia burrowsiana (P3)	Wilsons	744532	6996877	2
Acacia burrowsiana (P3)	Wilsons	744968	6996731	1
Acacia burrowsiana (P3)	Wilsons	745363	6996948	1
Acacia burrowsiana (P3)	Wilsons	743874	6997412	1
Calytrix praecipua (P3)	Wilsons	744942	6996589	20
Calytrix praecipua (P3)	Wilsons	744266	6997089	10
Calytrix praecipua (P3)	Wilsons	744788	6997203	3
Calytrix praecipua (P3)	Wilsons	743897	6996919	5
Calytrix praecipua (P3)	Wilsons	743827	6996946	3
Calytrix praecipua (P3)	Wilsons	743811	6996953	2
Calytrix praecipua (P3)	Wilsons	743512	6996768	3
Calytrix praecipua (P3)	Wilsons	743552	6996920	5
Calytrix praecipua (P3)	Wilsons	743942	6997013	10
Calytrix praecipua (P3)	Wilsons	743996	6996988	20
Sauropus ramosissimus (P3)	Wilsons	744004	6995568	1
Sauropus ramosissimus (P3)	Wilsons	743991	6995560	2
Sauropus ramosissimus (P3)	Wilsons	744038	6995570	1
Sauropus ramosissimus (P3)	Wilsons	743648	6996759	1
Sauropus ramosissimus (P3)	Wilsons	744055	6995668	3
Sauropus ramosissimus (P3)	Wilsons	743418	6996890	1
Sauropus ramosissimus (P3)	Wilsons	744184	6995818	1
Sauropus ramosissimus (P3)	Wilsons	744021	6995598	1

Note: P1 = Priority 1 species, P3 = Priority 3 species

Appendix 6: Declared Pests Categories

Table A6.1: Categories for Declared Pests

Category	Controls
C1 Category (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 Category (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 Category (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Source: DAFWA (2013b).

Table A6.2: General Environmental Weed Species Locations - Coordinates (GDA94, MGA50)

Species	Location	Easting (mE)	Northing (mN)	No. Plants
Portulaca oleracea	HRC	751979	6960393	10
Portulaca oleracea	HRC	752003	6960394	5
Portulaca oleracea	HRC	752674	6960409	10
Portulaca oleracea	HRC	752722	6960410	20
Portulaca oleracea	HRC	752766	6960406	20
Portulaca oleracea	HRC	752856	6960406	10
Portulaca oleracea	HRC	753105	6960421	10
Portulaca oleracea	HRC	753132	6960462	10
Portulaca oleracea	HRC	750790	6960514	10

Note: HRC = Haul Road Corridor.

Appendix 7: National Vegetation Information System Vegetation Classification

Table A7.1: NVIS Methodology used to Describe Vegetation Associations

Height Range (m)	Tree	Shrub	Mallee	Grass
>30	tall			
10-30	mid		tall	
<10	low		mid	
<3			low	
>2		tall		tall
1-2		mid		tall
0.5-1		low		mid
<0.5		low		low

		Structural Formation Classes					
		Foliage cover % (cover #)					
Growth Form	**Height (m)**	**70-100% (5)**	**30-70% (4)**	**10-30% (3)**	**<10% (2)**	**0-5% (1)**	**≈0% (N)**
Tree	**<10,10-30, >30**	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees
Tree mallee	**<3, <10, 10-30**	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees
Shrub	**<1,1-2,>2**	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs
Mallee shrub	**<3, <10, 10-30**	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs
Heath shrub	**<1,1-2,>2**	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs
Chenopod shrub	**<1,1-2,>2**	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs
Samphire shrub	**<0.5,>0.5**	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs
Hummock grass	**<2,>2**	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses
Tussock grass	**<0.5,>0.5**	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses
Sedge	**<0.5,>0.5**	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges
Rush	**<0.5,>0.5**	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes

Source: ESCAVI (2003).

Appendix 8: Site Data

Site data supplied as a separate document.

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