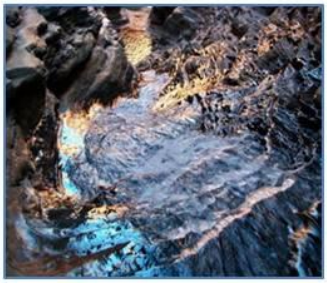


Metals X Limited

Wingellina Nickel Project

Level 1 Flora and Vegetation Survey of the Cobb Depression Borefield and Pipeline Route

May 2013

DRAFT REPORT

METALS X LIMITED

Outback Ecology (MWH Australia Pty Ltd)
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Level 1 Flora and Vegetation Survey of the Cobb Depression Borefield and Pipeline Route

Distribution:

Company	Copies	Contact Name
Metals X Limited	One electronic	Richard Coles

Document Control for Job Number: WING-FS-12001

Document Status	Author	Reviewer	Signature	Date of Issue
Draft Report	A. Sleep	V. Yeomans	VY	
		L. Stewart	LS	
Final Report				

F:\Wingellina\FS\WING-FS-12001\3. Reporting\Flora\WING-FS-12001 Flora and Veg Draft.docx –

Executive Summary

Metals X Limited (Metals X) is currently evaluating the potential of developing the Cobb Depression Borefield and an associated pipeline route as part of the proposed Wingellina Nickel Mine. The Project is located approximately 218 kilometres (km) east of Warburton, near the junction of the Western Australia, South Australia and Northern Territory borders. As part of the initial scoping phase for the Project, Metals X commissioned Outback Ecology to undertake a Level One Flora and Vegetation assessment for the Project.

The purpose of this Assessment was to gather background biological information on the terrestrial flora and vegetation of the Study Area, in order to support future permit and approvals documentation for Metals X. The specific objectives of the Assessment were to:

- undertake a desktop study to develop inventories of flora species identified in the Study Area or likely to be present in the Study Area;
- provide a description of vegetation communities expected to occur within the Study Area, based on the outcomes of the desktop study;
- verify the results of the desktop study within the Study Area via a Level One survey; and
- assess the findings of the reconnaissance survey in a regional context by making comparisons with available data from other localities within the bioregion.

The survey was a Level One reconnaissance survey which involved selective, low intensity sampling of the flora and vegetation and opportunistic targeted searching for species of conservation significance known from the vicinity of the Study area and the objectives and methods were aligned with the:

- EPA Position Statement No. 3, *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002) ;
- EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004); and
    - International Union for the Conservation of Nature (IUCN) Red List Categories and Criteria.

A total of 126 flora species (including subspecies and variants) from 30 families and 69 genera were recorded from within the Study area during the March 2013 Level One Flora and Vegetation Survey. A total of three introduced species were recorded within the Study area, none of these are listed as Declared Plants under the *Agriculture and Related Resources Protection Act 1976*.
No Threatened Flora species as listed under the *EPBC Act 1999*, or Threatened Flora species listed under the *Wildlife Conservation Act 1950* (WA) were recorded within the Study area. One individual Priority Flora species (*Calotis latiuscula* – Priority Three*)* was recorded from within the study area at approximately 459557 mE and 7149396 mN. No species of 'Other Conservation

Significance' as described in *Guidance Statement 51* (EPA, 2004) were recorded within the Study area.

Eight broad vegetation associations were identified as occurring within the Study area. This included:

1. Desert Oak (*Allocasuarina decaisneana*) Woodland;
2. Scattered Tall Shrubs over *Aluta maisonneuvei* Heath on Dune Mid and Lower Slopes;
3. Open *Acacia* Shrubland over Tussock Grassland on loam plains;
4. Open *Acacia* Shrubland/Woodland over Hummock Grassland on flats between Sand dunes;
5. Open Tree Mallee of *Eucalyptus* spp. and Mixed *Acacia* Shrubland over Hummock Grasses;
6. Tall Open Shrubland dominated by *Grevillea* spp. over a tussock grassland on dune crests;
7. Mulga Woodland or Tall Shrubland of variable *Acacia aneura* group species; and
8. Isolated shrubs over *Triodia schinzii* Hummock Grassland with mixed herbland.

Vegetation associations AdLOW (1), ATOS/AhEhTG (3) and TsHG (8) are considered to be locally significant in the context of the Study area. Mulga (7) vegetation within the Study area is considered to be Regionally Significant due to its role as a resource (water, nutrients) hot spot within arid landscapes.

Vegetation condition of the Study area ranged from Very Good to Excellent. There is a mosaic of vegetation in different stages of recovery from fire, from as recent as a fire occurring only a few months prior to the survey. Given the isolated location of the site, many of the recently burnt areas were given the same rating as adjacent unburnt vegetation as it is generally expected that the vegetation would recovery to a similar condition given the adaptability of these vegetation types to fires in the absence of additional anthropogenic disturbance.

It is recommended that the knowledge of vegetation within the Study area be further refined and broadened with a Level Two Flora and Vegetation survey of the confirmed zone of impact, including a targeted search for *Calotis latiuscula* (Priority Three) within the outwash plains – vegetation association ATOS/AhEhTG (3). With regard to the determination of the pipeline route, from a flora and vegetation perspective it is recommended that the pipeline be aligned as closely as possible with the existing road to lessen the amount of vegetation that will be impacted.

Table of Contents

TABLES

FIGURES

PLATES

APPENDICES

1. INTRODUCTION

1.1. Project Background And Location

Metals X Limited (Metals X) is currently evaluating the potential of developing the Cobb Depression Borefield and an associated pipeline route (the Project) as part of the proposed Wingellina Nickel Mine. The Project is located approximately 218 km east of Warburton, near the junction of the Western Australia, South Australia and Northern Territory borders (**Figure 1)**. As part of the initial scoping phase for the Project, Metals X commissioned Outback Ecology to undertake a Level One Flora and Vegetation assessment (this Assessment) for the Project. The area assessed (the Study Area) overlies miscellaneous licence L69/19 and the Giles-Mulga Park Road, and is located on the Ngaanyatjarra Aboriginal Lands.

The Study Area encompasses the proposed Cobb Depression borefield, with a perimeter buffer of 250 metres (m), as well as the Giles-Mulga Park Road between the borefield and the Blackstone-Warburton Road, with a 50 m buffer either side (**Figure 2**). The total size of the Study Area is approximately 14,377 hectares (ha). The Study Area contains exclusion zones, identified by the Ngaanyatjarra people as areas of cultural significance **(Figure 2)**. Outback Ecology did not survey inside the exclusion zones.

1.2. Report Scope And Objectives

The purpose of this Assessment was to gather background biological information on the terrestrial flora and vegetation of the Study Area, in order to support future permit and approvals documentation for Metals X. The specific objectives of the Assessment were to:

- undertake a desktop study to develop inventories of flora species identified in the Study Area or likely to be present in the Study Area;
- provide a description of vegetation associations expected to occur within the Study Area, based on the outcomes of the desktop study;
- verify the results of the desktop study within the Study Area via a reconnaissance survey; and
- assess the findings of the reconnaissance survey in a regional context by making comparisons with available data from other localities within the bioregion.

The objectives and methods adopted for the Flora and Vegetation Survey were aligned with the:

- EPA Position Statement No. 3, *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002);
- EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004),* specifically – Appendix 2 of Guidance Statement 51 referring to Level 1 Survey ; and
- International Union for the Conservation of Nature (IUCN) Red List Categories and Criteria (IUCN Species Survival Commission 2012).

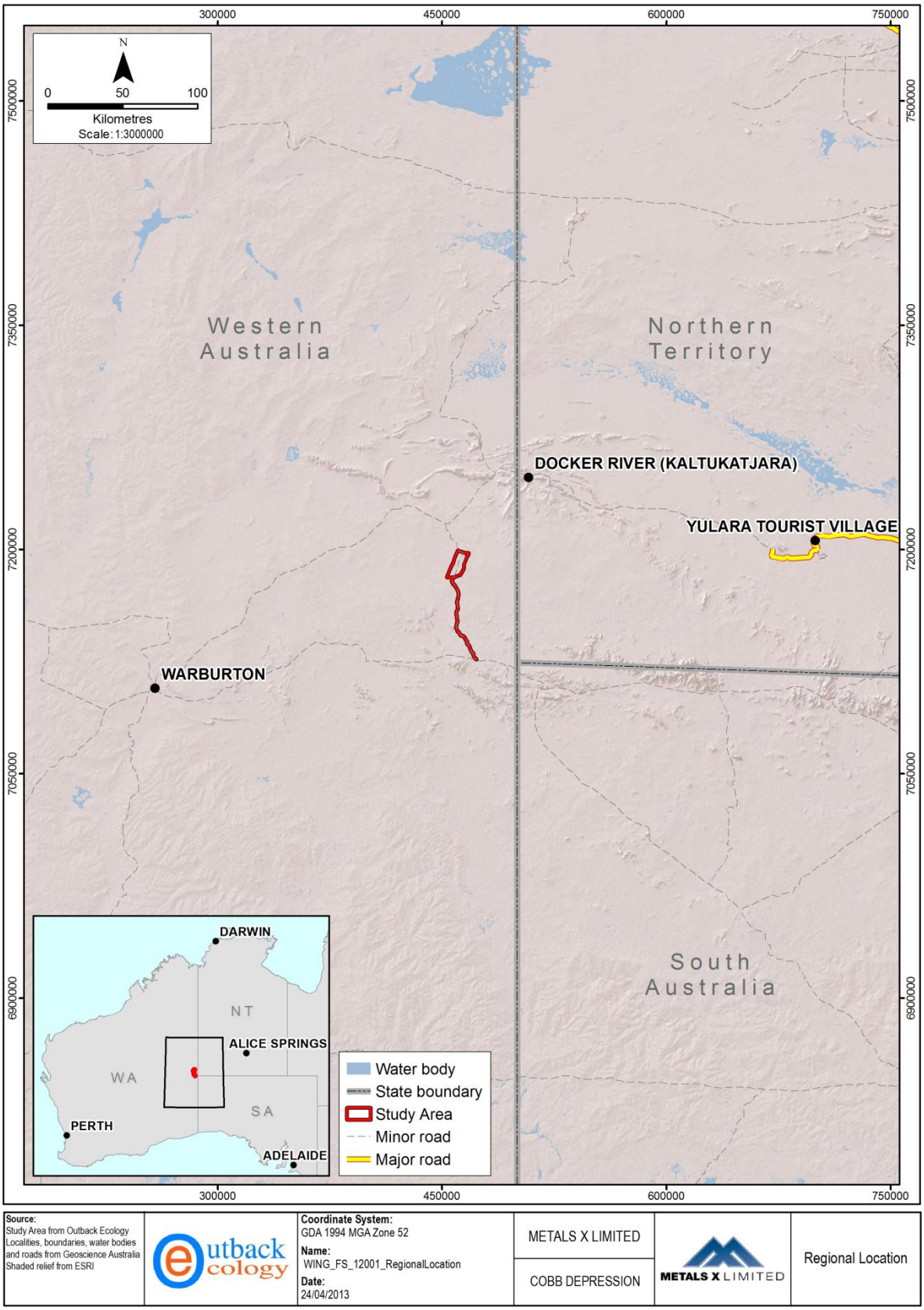


Figure 1: Regional Location of the Cobb Depression Study area

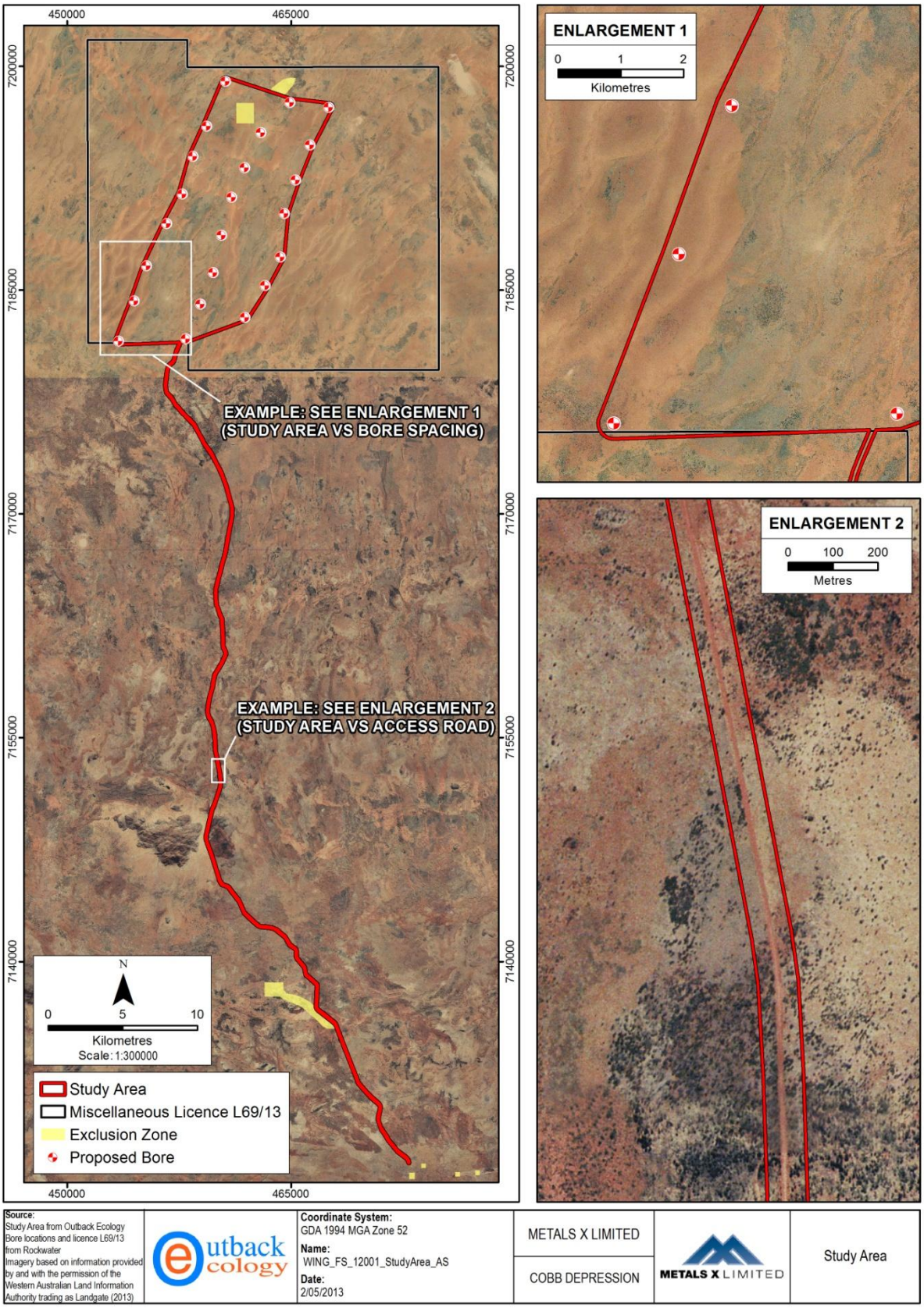


Figure 2: Cobb Depression Study area

2. EXISTING ENVIRONMENT

2.1. Biogeographic Region

The Study Area occurs in the Central Ranges bioregion, as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (McKenzie, May et al. 2003) (**Figure 3**). The Central Ranges bioregion encompasses approximately 101,200 km^2 of land within Western Australia, the Northern Territory and South Australia, and is characterised by the east-west trending rocky ranges of the Petermann, Musgrave and Mann Ranges. The climate is arid, with hot to extremely hot summers during which daytime temperatures can exceed 50°C, but cool to cold winters (ANRA, 2009a).

The Study Area lies within the Mann-Musgrave Block subregion of the Central Ranges bioregion (**Figure 3**). The Mann-Musgrave Block subregion is the largest subregion in the Central Ranges bioregion, with a size of approximately 91,734 km^2. In Western Australia, the Mann-Musgrave Block subregion is characterised by a high proportion of volcanic and quartzite Proterozoic ranges and derived soil plains, interspersed with red Quaternary sand plains with some Permian exposure (Graham and Cowan 2002). The sand plains support low open woodlands of either Desert Oak or Mulga over hummock grasslands, the ranges are often fringed by low open woodlands of *Acacia estrophiolata* and *Hakea* spp over grasslands, and the ranges themselves typically support mixed *Acacia* spp scrub or *Callitris glaucophylla* woodlands over grasslands (Graham and Cowan 2002).

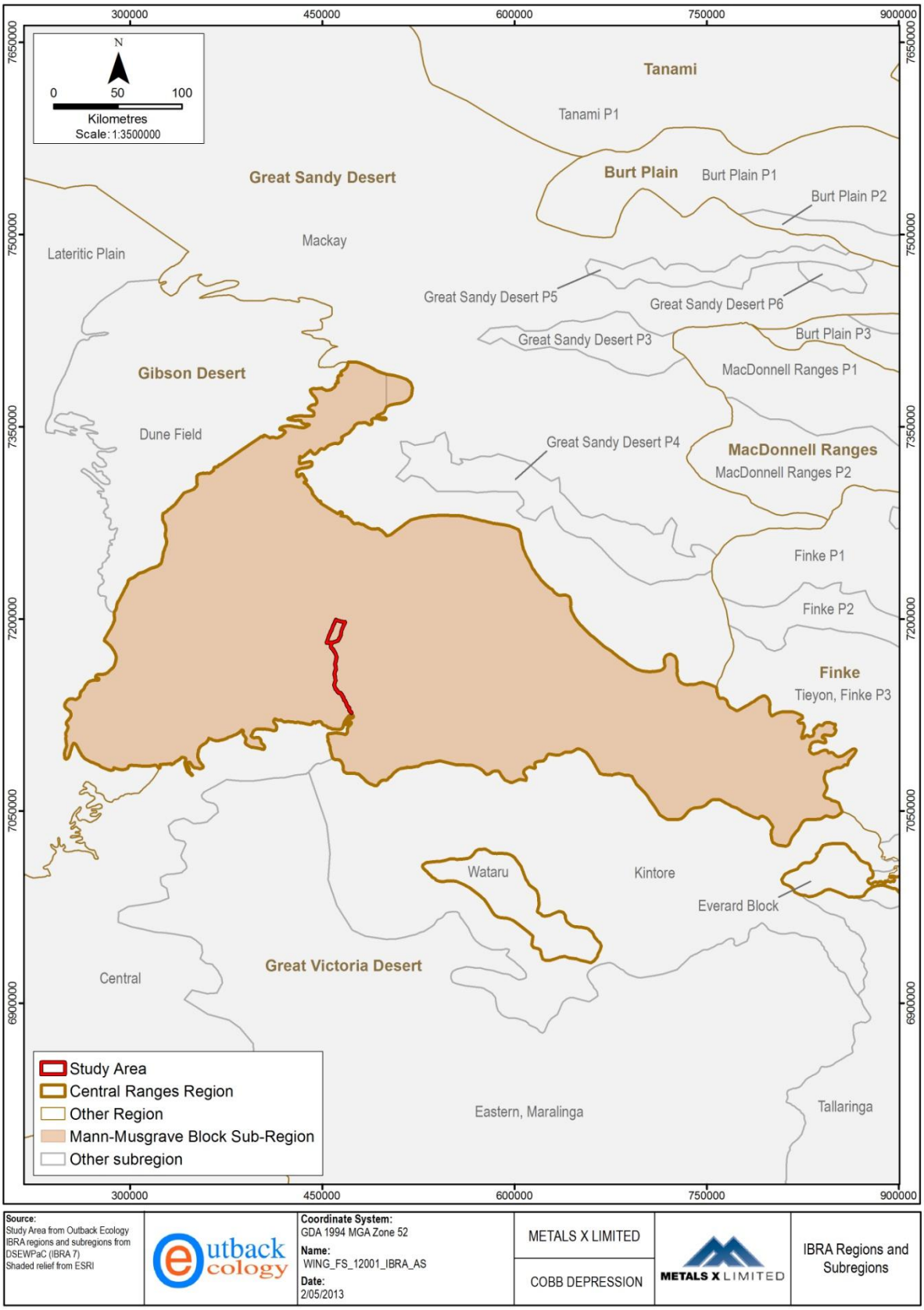


Figure 3: Biogeographic Region of the Cobb Depression Study area

2.2. Climate

The Central Ranges bioregion is characterised by having an arid climate, with low, variable rainfall (ANRA 2009a). The bioregion is influenced by a northern tropical/summer climatic pattern, with the majority of rain falling during the summer months due to the movement of low-pressure troughs and tropical lows associated with monsoon troughs moving south in the bioregion (ANRA 2009a).

The closest Bureau of Meteorology (BOM) weather station to the Study Area is the Giles Meteorological Office, which is approximately 45 km to the northwest. The Giles Meteorological Office has a long term mean annual rainfall of 285.6 mm, with the bulk of this rain falling between November and March (**Figure 4**). The Giles Meteorological Office experiences a mean of 32 rain days per annum (BOM, 2013). The November to March period of maximum rainfall coincides with a period of peak temperatures, with mean maximum temperatures ranging from 20.0°C in July to 37.3°C in January, and mean minimum temperatures ranging from 6.8°C in July to 23.5°C in January (**Figure 4**).

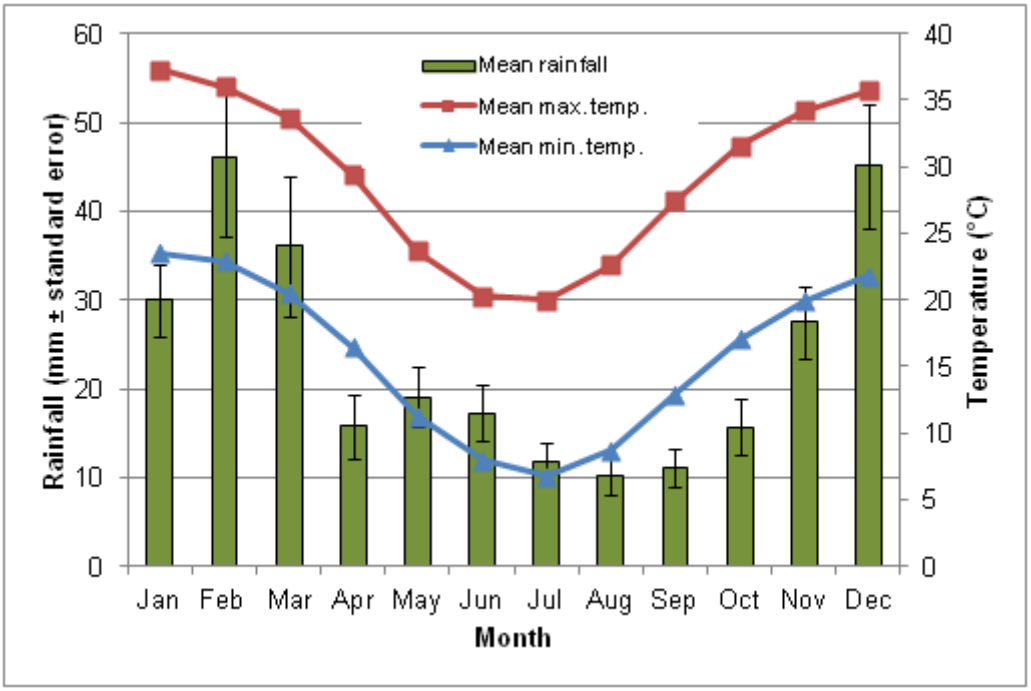


Figure 4: Average annual rainfall and average maximum temperature

2.3. Land Use

Aboriginal land, including current and proposed Indigenous Protected Areas (IPAs), is the dominant category of land use in and surrounding the Study Area (**Figure 5**). Aboriginal lands occupy the entirety of the Central Ranges bioregion and a large proportion of the surrounding landscape. The largest aboriginal reserves in the vicinity are the Anangu Pitjantjatjara lands and the Ngaanyatjarra lands, with the Study Area located in the latter (**Figure 5**). The Ngaanyatjarra lands have a high level of biodiversity and represent the traditional country of the Yarnangu people, who live on the Lands in 11 autonomous, incorporated communities represented by the Ngaanyatjarra Council (DSEWPaC 2012). The Lands contain the Ngaanyatjarra Lands IPA, declared in August 2002 under World Conservation Union *Category IV – Managed Resource Protected Area: Protected Area Managed Mainly for the Sustainable use of Natural Ecosystems* and currently the largest declared IPA in Australia (DSEWPaC 2012).

Conservation reserves are another major land use in the vicinity of the Study Area. The Gibson Desert, Neale Junction and Great Victoria Desert Nature Reserves, and the Mamungari Conservation Park, are all found within 350 km of the Study Area (**Figure 5**). The Mamungari Conservation Park contains the Serpentine Lakes, which are a significant wetland refuge (ANRA 2009b). The Uluru-Kata Tjuta National Park, a federally-managed National Park listed under the World Heritage Convention for both natural and cultural values, is located approximately 245 km east of the Study Area.

Although not part of the conservation estate the Walter James Range, approximately 90 km north of the Study Area, represents an area of important conservation value. The Range contains two permanent rock pools, each at the base of a waterfall, which collectively are a wetland of national significance (DSEWPaC 2010). The pools represent good examples of the few permanent rock pools in the Central Ranges bioregion; the area is a permanent breeding site for frogs, a permanent source of water for birds and has significant cultural and social values (Graham and Cowan 2002). Aboriginal paintings in the Walter James Range, as well as colourful and spectacular scenery and the presence of endemic and rare flora and fauna, qualified the broader Ranges of the Western Desert for listing on the Register of the National Estate in 1978 (DSEWPaC 2013).

The majority of the remainder of the land in the vicinity of the Study Area is unallocated crown land (**Figure 6**). Pastoral development has occurred, but has been confined to a few peripheral areas to the far south and east of the Study Area, where water and feed are available in some years. Mineral exploration, also to the far south and east, has been extensive since the 1970s, and seismic shot lines and survey lines persist in the landscape; searches for uranium, coal and petroleum in the Eucla basin and exploration for gold and base metals within the Gawler Craton have been unsuccessful, however (ANRA 2009b). Immediately to the southeast of the Study Area, the Wingellina Nickel Project lease area (E69/535) was opened for mineral exploration in the 1960s by Inco, and a number of abandoned chrysophase pits and drill holes are still present in the area. Metals X purchased the tenement from Acclaim Exploration in 2006 (Outback Ecology 2009).

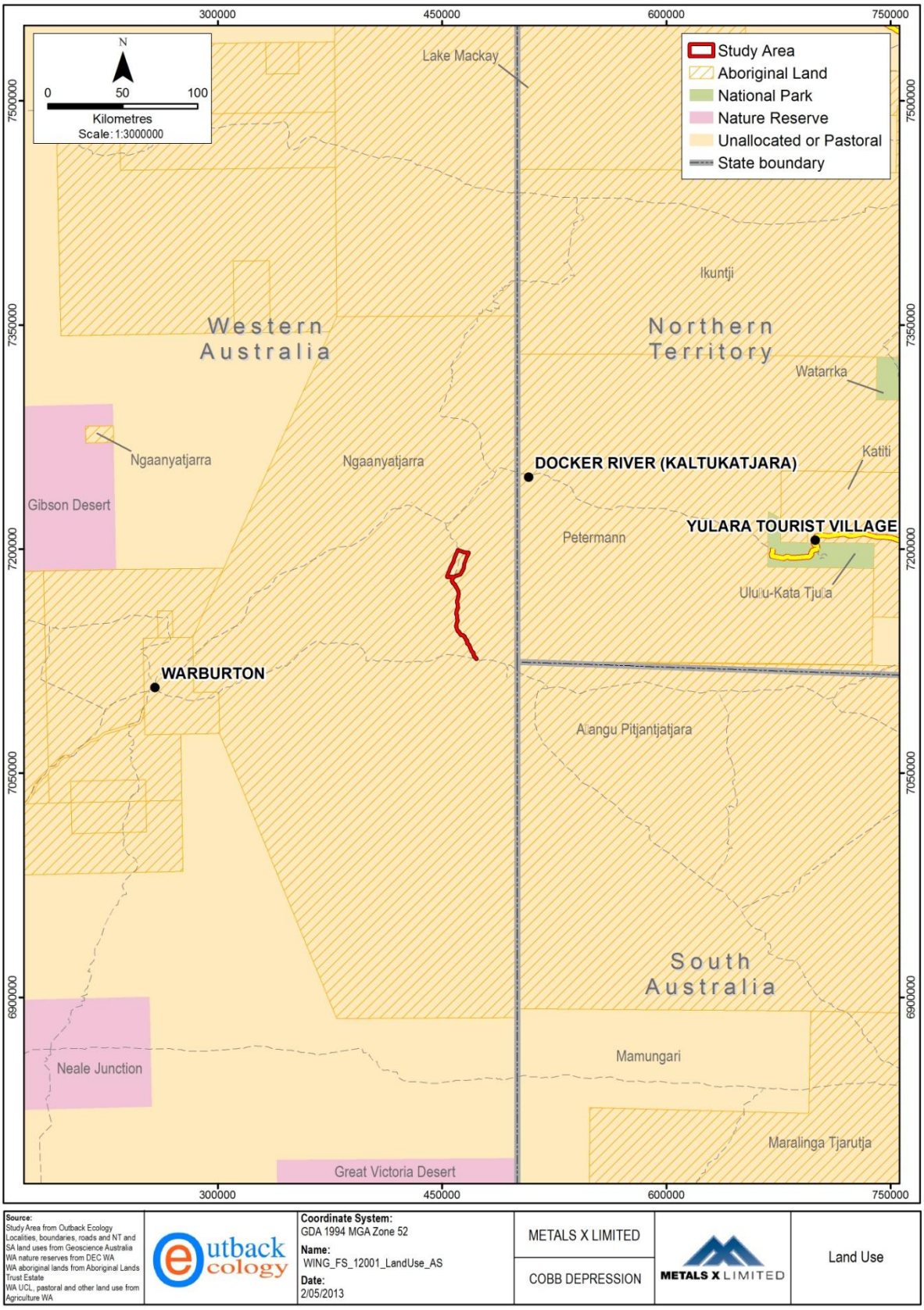


Figure 5: Land Use

2.4. Pre-European Vegetation Of The Study Area

Pre-European vegetation mapping of the Study area was obtained from the Department of Agriculture (2005) dataset, which has used the mapping of J.S. Beard as source data. Three mapped vegetation associations intersect the Project area and all have greater than 99.9% or 100% of their pre-European extent remaining **(Table 1**, **Figure 6)** (Shepherd 2002). The EPA's Position Statement No.2 (EPA 2000) lays out a series of constraints that relate to biodiversity. One of them is to protect at least 30% of the original extent of vegetation complexes in unconstrained areas (EPA 2000).

Table 1: Pre-European Vegetation and Extent Remaining of the Cobb Depression Study area (Department of Agriculture, 2005)

Vegetation Assocation	Beard Code	% Pre European Extent Remaining	Description
19	a1Li	99.9	Low woodland; mulga between sandridges
39	a1Si	100	Shrublands; mulga scrub
230	c1Mp/t2Hi	100	Mosaic: Medium sparse woodland; desert oak between sand dunes / Hummock grasslands, grass steppe; hard spinifex, *Triodia basedowii*

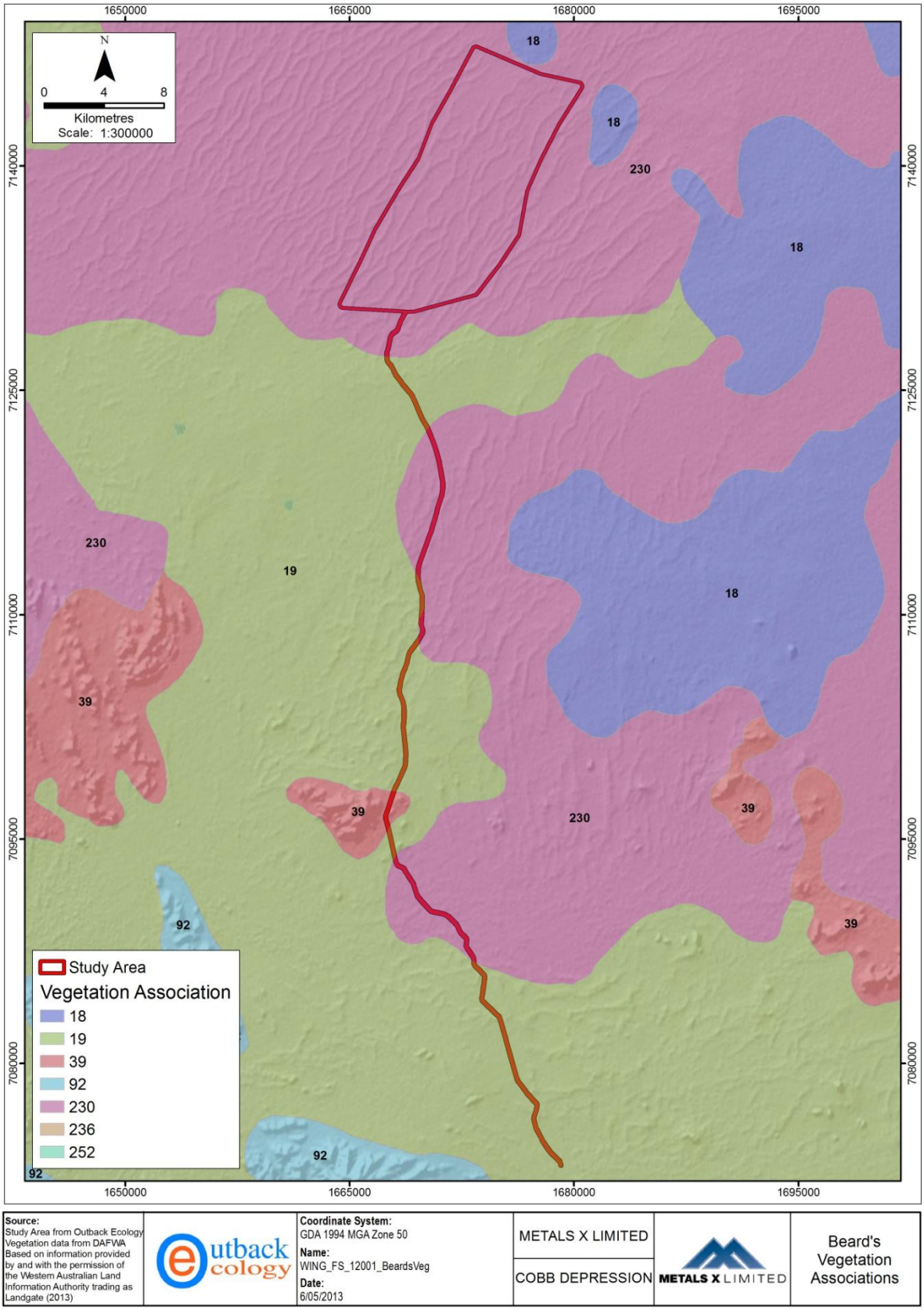


Figure 6: Pre-European Vegetation of the Cobb Depression Study area

2.5. Land Systems

Regional surveys conducted by the WA Department of Agriculture and Food have contributed to a comprehensive description of biophysical resources present within the state, and the condition of these resources with respect to human impacts. This information has been used to classify and map the land systems of Western Australia based on landforms, soils, vegetation, geology and geomorphology. An assessment of these land systems provides an indication of the occurrence and distribution of relevant natural resources present within and surrounding the Study area. The Study traverses five different land systems (**Figure 6**), as described in Table 2. Land System AB60 (plains of many dunes) is the most extensive covering 96.62% of the Study area.

Table 2: Land Systems of the Cobb Depression Study area

Land System	Description	Area within Study area (Ha)	% of Study Area
BA21	Steep hills and ranges on sedimentary and some metamorphic, volcanic, and granitic rocks; bare rock outcrop is common; some gorges	24.68	0.17%
AB65	Sandy plains generally flanking granitic ranges; some tors and outcrops of sandstones and quartzites, and also some laterite and silcrete-capped ridges, may occur sporadically	0 (occurs adjacent to Study area)	0.00%
AB60	Plains with many dunes often relatively short and of irregular shape	13890.43	96.62%
My109	Outwash plains and dissected fan and terrace formations flanking ranges of sedimentary and some metamorphic, volcanic, and granitic rocks	112.88	0.79%
My112	Extensive plains with numerous dunes which are often short and of irregular shape and orientation	134.17	0.93%
My111	Extensive plains with a few low dunes; occasional low stony residuals	214.60	1.49%

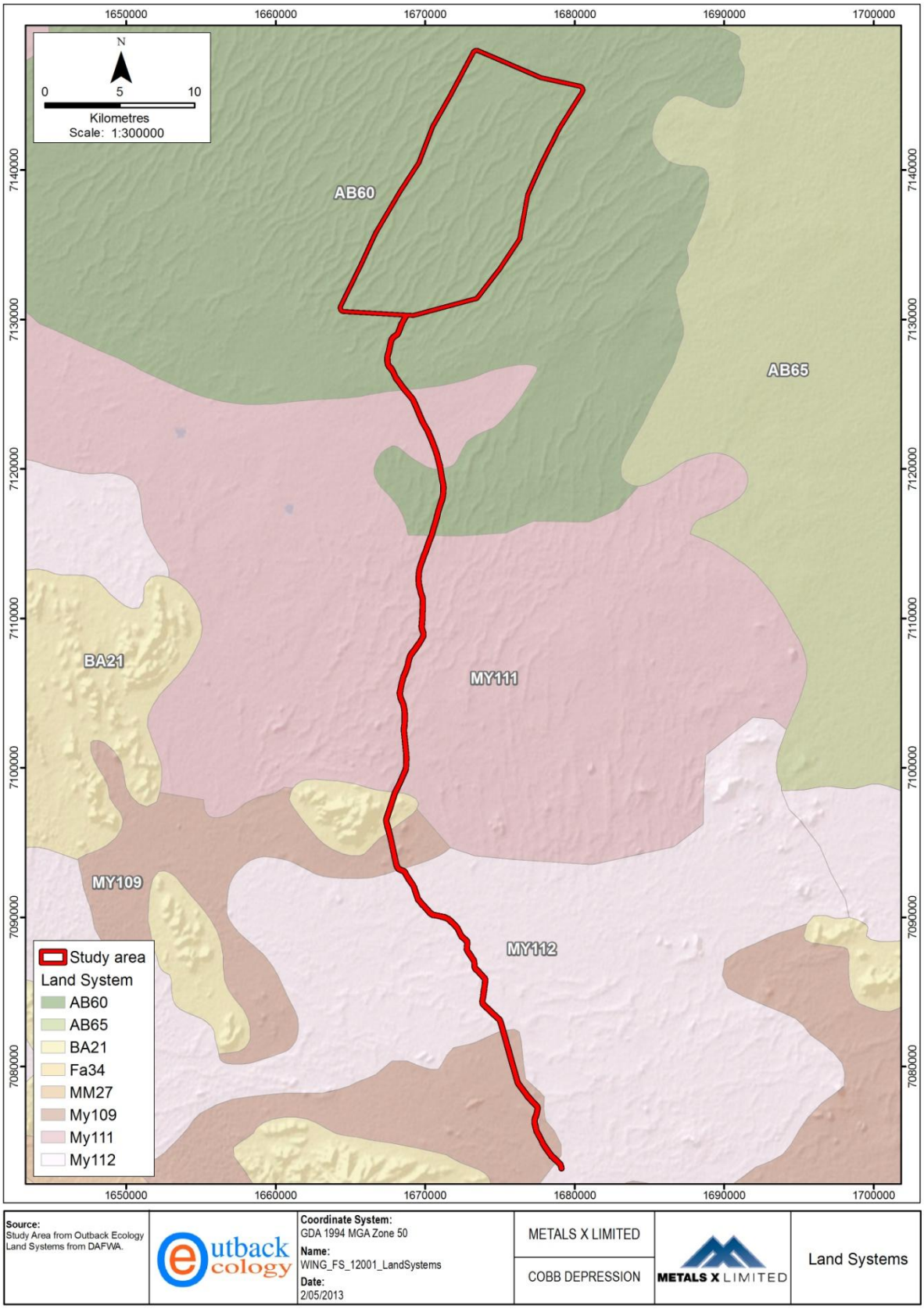


Figure 7: Land Systems of the Cobb Depression Study area

3. DESKTOP REVIEW

Database searches and a literature review were undertaken prior to the field survey, to help identify any flora and vegetation of conservation significance which potentially occur in the Study Area. The key results of the database searches and literature review are presented in (**Table 3**) and (**Table 4**).

3.1. Database Searches

For the purpose of database searching, the Study Area was defined as a central point with coordinates 460667 mE 7188249 mN (GDA 1994, UTM 52J). The databases and search areas used were:

- the WA DEC's NatureMap database (DEC 2013a), with a search area consisting of the central point surrounded by a circular buffer zone of 40 km radius;
- the WA DEC's Threatened and Priority Flora Database (DEC 2013b), with a search area consisting of the central point surrounded by a circular buffer zone of 135 km radius;
- the WA DEC's Communities Datatabse (DEC, 2013c). with a search area consisting of the central point surrounded by a circular buffer zone of 135 km radius; and
- the Protected Matters Search Tool (DSEWPaC 2013), with a search area consisting of a square box of side length 270 km – the box surrounded the central point and was delineated by the coordinates (clockwise, from the north-west corner) 325667 mE 7323249 mN, 595667 mE 7323249 mN, 595667 mE 7053249 mN and 325667 mE 7053249 mN;

A total of 33 flora species of conservation significance were identified by the database searches (as above) (**Appendix A** provides full definitions of conservation significance). All are listed as DEC Priority Flora species with none listed as Endangered under the *EPBC Act 1999* or Threatened under the *Wildlife Conservation Act 1950* (**Table 3**) (**Figure 8**). Based on an analysis of habitat requirements and locations of previously records, it was determined that one of the 33 species does occur in the Study area and nine may occur in the Study area (**Table 3**) (DEC, 2013b, DEC, 2013d).

The DEC Threatened and Priority Ecological Communities database identified no known conservation significant ecological communities (or their buffers) as occurring within 100 km of the Study area. The *EPBC Act 1999* Protected Matters Search did not identify any significant ecological communities occurring within 100 km of the Study Area, however it did identify one nationally important wetland (Rock Pools of the James Walter Range). This wetland is located approximately 90 km north of the Study area and is therefore not discussed further.

3.2. Literature Review

The literature review identified four previous studies of relevance (**Table 4**) Previous studies in the vicinity of the Study Area reported a total of two flora species of conservation significance and one undescribed flora species.

- *Stackhousia clementii* (Priority Three - P3)
- An undescribed species of *Goodenia* – *G.* sp. Quasilibera (L. Ransom 868); and

- *Neurachne lanigera* (Priority One - P1).

No vegetation communities of conservation significance were identified, however Halpern Glick Maunsell (HGM) (2002) note that cracking clay soils appeared to be restricted in distribution.

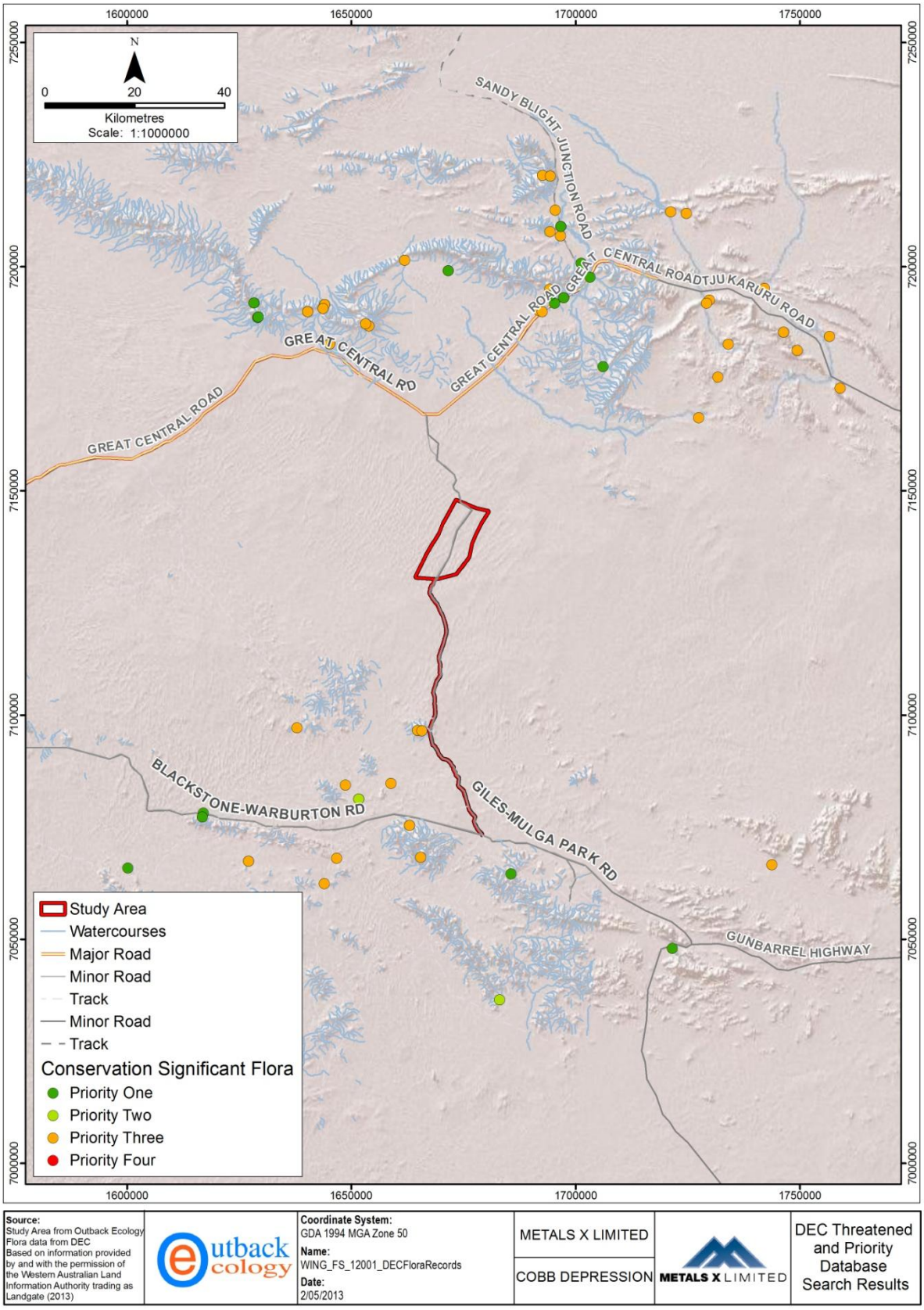


Figure 8: Conservation significant flora species previously recorded within 100 km of the Cobb Depression Study area

Table 3: Conservation Significant Flora Species identified within 100 km of the Cobb Depression Study area by Desktop Assessment (DEC, 2013b, 2013d)

Taxon	Status	DEC Database	Previous Reports	Description	Likelihood of Occurrence
Abutilon sp. Warburton (A.S. George 8164)	P1	+		Many stemmed shrub, ca 0.8 m high. Fl. yellow, Sep to Oct. Red sandy loam. Along creekline.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Acacia auricoma	P3	+		Erect, sparsely branched shrub, to 2.5 m high. Fl. yellow, Jul. Rocky hills	**Unlikely to Occur** -The Study area does not support suitable habitat for this species. The nearest record occurs 62 km north of the Study area.
Acacia calcicola	P4	+		Rounded shrub or tree, 1.5-4(-6) m high. Fl. yellow, Sep to Nov	**Unlikely to Occur** - There is only one record of this little known species housed at the WA Herbarium, thus little is known of its habitat. Given that it was not collected from within the near vicinity of the Study area it is considered unlikely to occur.
Amaranthus centralis	P3	+		Grows in red sand in ephemeral watercourses, sandy to clayey loam on river banks and edges of permanent pools in eucalypt lined channels, or Acacia shrubland. It also occurs in areas of permanent watering, e.g. bore overflows, gardens and cultivation.	**Unlikely to Occur** -The Study area does not support suitable habitat for this species.
Brunonia sp. Long hairs (D.E. Symon 2440)	P1	+		Erect herb, to 0.07 m high, with long spreading hairs on the leaves; spike to 0.3 m high. Along creeklines.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 58 km north of the Study area.
Calotis latiuscula	P3	+		Erect herb, to 0.5 m high. Fl. yellow, Jun to Oct. Sand, loam. Rocky hillsides, floodplains, rocky creeks or river beds	**Likely to Occur** - This species is known from a variety of habitats which may occur in the Study area, is common within the Northern Territory and South Australia and has been previously recorded 2.5 km west of the Study area.

Taxon	Status	DEC Database	Previous Reports	Description	Likelihood of Occurrence
Comesperma viscidulum	P4	+		Multi-stemmed erect shrub, 0.5 m high x 0.5 m wide, yellow stems, blue flowers. Yellow sand dunes, buckshot plains.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 52 km north east of the Study area.
Daviesia arthropoda	P3	+		Spiny, bushy shrub, to 1 m high. Fl. yellow-brown. Dunes	**May Occur** - Suitable habitat for this species occurs in the Study area, however the nearest record is 67 km north of the Study area.
Dicrastylis subterminalis	P1	+		Small shrub. Red sand. By creeklines.	**May Occur** - Suitable habitat for this species occurs in the Study area, however the nearest record is 50 km north of the Study area.
Eucalyptus sparsa	P3	+		Mallee, ca 3 m high, bark rough, fibrous to flaky, smooth above. Fl. white, Jan to Feb. Red sand. Sand dunes.	**May Occur** - Suitable habitat for this species occurs in the Study area, however the nearest record is 22 km west of the Study area.
Euphorbia parvicaruncula	P1	+		Short-lived annual or perennial, herb, to 0.2 m high. Rocky habitats	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 48 km south east of the Study area.
Fuirena nudiflora	P1	+		Tufted annual, grass-like or herb (sedge), 0.05-0.2 m high, perianth absent; stamen 1. Fl. brown, Apr to May or Jul. Sand. Swamps, creek beds.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 62 km north west of the Study area.
Goodenia gibbosa	P1	+		Prostrate to decumbent herb, stems, often stoloniferous, to 40 cm. Fl. yellow, Jul. Sandy soils.	**May Occur** - Suitable habitat for this species occurs in the Study area, however the nearest record is 48 km north of the Study area.
Goodenia grandiflora	P1	+		Erect, viscid shrub, 0.4-1.6 m high. Fl. yellow/white, May to Dec. Sandy, gravelly soils. Rocky slopes & breakaways.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 52 km north west of the Study area.
Goodenia modesta	P3	+		Herb, to 0.5 m high. Fl. yellow, probably Jan to Dec. Red loam, sand.	**May Occur -** Suitable habitat for this species occurs in the Study area, however the nearest record is 50 km north of the Study area.
Grevillea aspera	P1	+		Low, spreading to erect shrub, 0.6-2.5 m high. Fl. red, May to Nov. Loam, clay-loam, laterite, quartzite. Rocky slopes, open heathland.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.

Taxon	Status	DEC Database	Previous Reports	Description	Likelihood of Occurrence
Indigofera sp. Gilesii (M.E. Trudgen 15869)	P3	+		Spindly shrub to 1.4 m with single stem; few leaves and pods clustered towards ends or branches. Creeklines, gullies, rocky sites.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 44 km north east of the Study area.
Isotropis winneckei	P1	+		Perennial, herb. Fl. pink-purple, Jan or Jul or Oct. Skeletal soils. Sandstone ranges, rocky rises.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 41 km north of the Study area.
Lythrum paradoxum	P3	+		Woody erect herb, 0.6-1 m high, plants glabrous, inflorescence of (1-)2-7 flowers, stamens 8-12, exserted. Fl. pink/purple.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. It has previously been recorded in rocky gullies on Mount Fanny 1.5 km west of the Study area.
Melaleuca apostiba	P3	+		Spreading shrub, to 2 m high, with grey fissured bark and dull green leaves. Fl. red, Jun. Clay pan, edge of salt lake	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Menkea lutea	P1	+		Erect or prostrate annual, herb. Fl. yellow, Jul. Red loam.	**May Occur** - Suitable habitat for this species occurs in the study area and it has been previously recorded 10 km south east of the Study area.
Neurachne lanigera	P1	+	Outback Ecology (2009)	Tufted perennial, grass-like or herb, 0.15-0.3 m high. Fl. other, Jul to Aug or Oct. Red sand, laterite. Rocky outcrops, plains.	**May Occur** - Some broadly suitable habitat for this species occurs in the Study area, however there are no records in the near vicinity.
Prostanthera centralis	P3	+		Erect shrub, 0.3-1 m high. Fl. blue-purple, Jul to Oct. Gravelly soils, red sand. Rocky quartzite scree slopes.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 42 km north of the Study area.
Sauropus ramosissimus	P3	+		Slender, much-branched shrub, to 0.3 m high. Gravelly, ironstone soils. Skeletal Soils	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Schoenus centralis	P1	+		Tufted annual, grass-like or herb (sedge), 0.05 m high. Fl. brown, Jul. Red sand. Rocky creek beds, seepage areas.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 62 km north west of the Study area.

Taxon	Status	DEC Database	Previous Reports	Description	Likelihood of Occurrence
Sporobolus blakei	P3			Tufted perennial, grass-like or herb, 0.45-0.6 m high. Fl. green-purple, Mar or Jun to Jul. Red sandy clay, loam. Creeks.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Stackhousia clementii	P3		Outback Ecology (2012)	Dense broom-like perennial, herb, to 0.45 m high. Fl. green/yellow/brown. Skeletal soils. Sandstone hills.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Teucrium grandiusculum subsp. grandiusculum	P2			Perennial, herb or shrub, to 0.8 m high. Fl. white, Jun to Sep. Red sand. Rocky slopes, along watercourses.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species. The nearest record occurs 36 km south of the Study area.
Thysanotus sp. Desert East of Newman (R.P. Hart 964)	P2			Self supporting perennial, herb (with tuberous roots), distinguished by the long, equal anthers and pseudo-cymose branching. Fl. Aug to Oct. Red-brown loamy sand or red sand, sometimes silty. Sand plain, pisolitic buckshot plain.	**May Occur** - Some broadly suitable habitat for this species occurs in the Study area, however there are no records in the near vicinity.
Verticordia jamiesonii	P3			Shrub, 0.2-0.6 m high. Fl. white/pink, Sep to Oct. Sandy clay soils. Lateritic breakaways	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Verticordia mirabilis	P1			Shrub, to 0.6(-1) m high. Fl. red, Sep to Oct. Skeletal soil, laterite, sandstone, shale. Rocky outcrops.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.
Vittadinia pustulata	P2			Low annual, herb (sometimes persisting as an under-shrub), 0.1-0.3 m high. Fl. Sep. Flats adjacent to sand dunes.	**May Occur** -Broadly suitable habitat for this species occurs in the Study area, and there is one record 23 km west of the study area.
Wedelia stirlingii	P1			Perennial, herb or shrub, to 0.8 m high. Fl. yellow, Apr or Jun. Stony ridges.	**Unlikely to Occur** - The Study area does not support suitable habitat for this species.

Table 4: Literature Review

Reference	Study Details	Proximity to Study Area	Methods	Vegetation Units	Flora Recorded	Vegetation Condition	Species/Communities of Conservation signficance
Outback Ecology (2012)	Project : Wingellina Borefield Client: Metals X Limited Type: Level One Flora and Vegetation Date: April 2012	Immediately adjacent to the Study area, to the south.	Level One Survey plus targeted searches around previously recorded DEC records	Five vegetation units recorded including; three shrub mallee units and two Mulga Tall Shrubland Units	162 taxa from 87 genera and 31 families	No weed species recorded, vegetation across the study area was in Pristine condition.	*Stackhousia clementii* and *Goodenia* sp. affin. Quasilibera (L. Ransom 868). No significant communities.
Outback Ecology (2011)	Project : Wingellina Borefield Client: Metals X Limited Type: Level One Flora and Vegetation	Approximately 112 km south of the Study area	Data gathered from 12 quadrats, not all areas could be observed due to sensitive cultural issues	Six vegetation units recorded including: one woodland, three Shrub Mallees and two Mulga Tall Shrublands	163 taxa from 32 families and 87 genera	Excellent to Pristine. three weed species Cenchrus ciliaris and Tribulus terrestris and Portulaca oleracea	*Neurachne lanigera* (P1), undescribed *Goodenia* species (Goodenia sp. affin. quasilibera (L. Ransom 868) Also 2 range extensions (*Acacia acanthoclada* and *Thryptomene longifolia*)

Reference	Study Details	Proximity to Study Area	Methods	Vegetation Units	Flora Recorded	Vegetation Condition	Species/Communities of Conservation signficance
	Date: July 2011						
Outback Ecology (2009)	Project Wingellina Nickel Project Client: Metals X Limited Type: Level Two Flora and Vegetation Date: April 2009	Approximately 55 km south-east of the Study area.	Data gathered from 30 quadrats	Seven vegetation units recorded including: three *Eucalyptus* Shrub Mallees, one Mulga Tall Shrubland, Hakea Low Woodland, Acacia-Hakea Tall Shrubland and Codonocarpus Woodland.	100 taxa from 40 genera and 24 families	Varied from Excellent to Degraded. Cenchrus ciliaris recorded	None
Halpern Glick Maunsell (2002)	Project: Wingellina Nickel Project Client: Acclaim Exploration NL Type: Level One Flora and Fauna	Approximately 60 km north-east of the Study Area	Reconaissance survey Level 1	Seven vegetation units recorded including one *Hakea* and *Senna* Shrubland, one Grassland on cracking clay, three *Eucalyptus* woodlands, one *Acacia* and *Senna* Shrubland and one Low Scrub over *Triodia* Hummock Grassland	188 taxa from 87 genera and 37 families	6 introduced species recorded inlcuding *Acetosa vesicaria, Cenchrus ciliaris, Chloris virgata* and *Eragrostis tenuifolia, Malvastrum americanum* and *Solanum hystrix*. Vegetation close the the Wingellina	No vegetation communities of conservation significance, however cracking clay soils appear to be restricted in distribution.

Reference	Study Details	Proximity to Study Area	Methods	Vegetation Units	Flora Recorded	Vegetation Condition	Species/Communities of Conservation signficance
	Date: December 2002					township was significantly disturbed. Some disturbances from previous mining	

4. METHODS

4.1. Field Survey

The field survey was carried out from 26 to 30 March 2013 by Alex Sleep (botanist) from Outback Ecology. The survey was a Level One reconnaissance survey which involved selective, low intensity sampling of the flora and vegetation and opportunistic targeted searching for species of conservation significance known from the vicinity of the Study area.

4.2. Survey Timing And Weather

Rainfall recorded for the Giles Meteorological Office prior to the field survey was below average for the months of January and February (**Plate 1**), with some rainfall recorded in early March. It is likely that this early March rainfall was significant enough to start the growing process of annual species and flowering of perennials so a significant proportion of species were able to be identified during the survey.

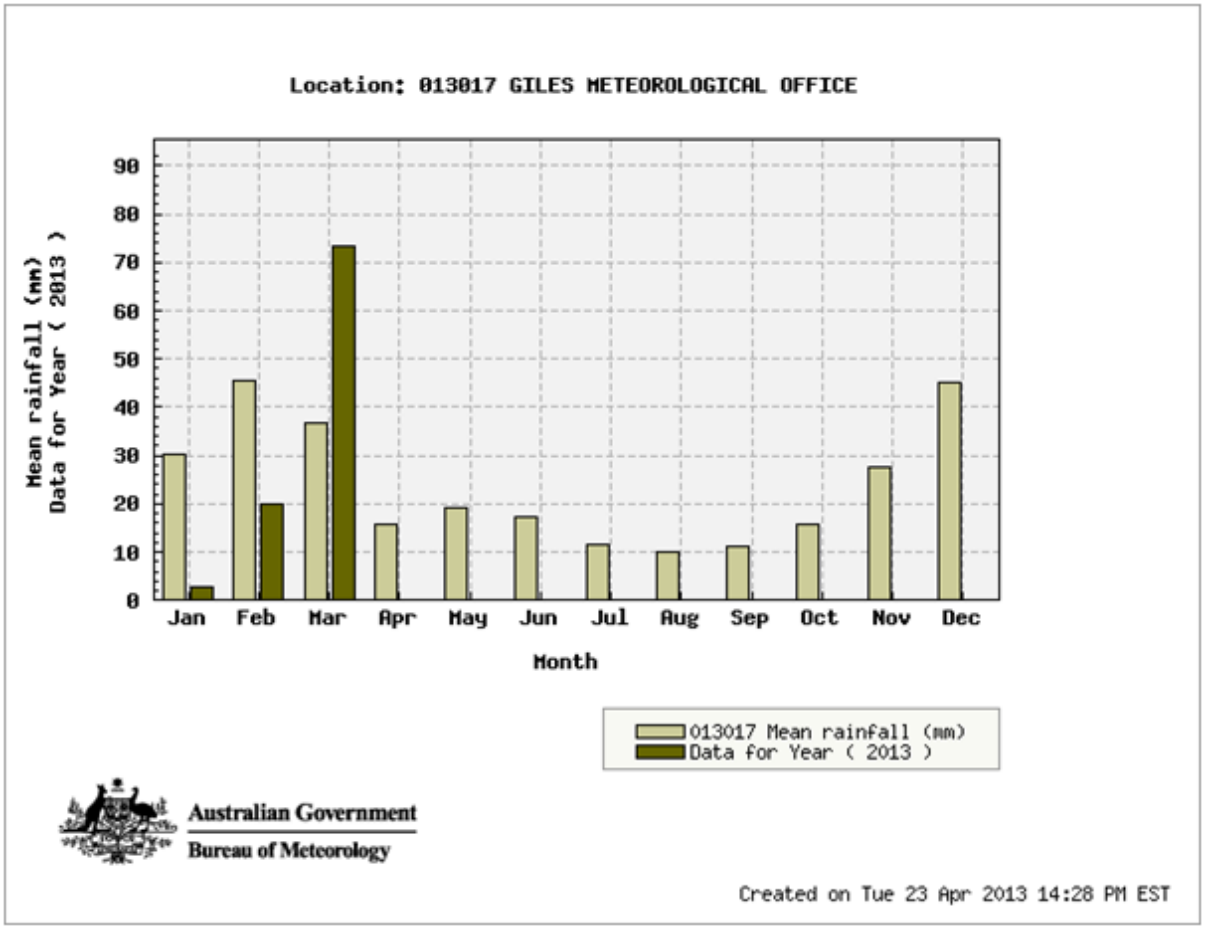


Plate 1: Comparison of 2013 Monthly Rainfall with Average Monthly Rainfall - Giles Meteorological Office. Source: (BOM,2013b).

4.3. Survey Design and Rationale

Prior to the field survey, relevant supporting information was reviewed, which included database searches (**Section 3**), previous vegetation surveys/mapping in the general area, topography and land system mapping.

The distribution of vegetation communities and subsequent placement of data collection points was planned using aerial photography, with alterations made following an on-ground review of the Study area. Data was collected from 53 unbounded relevés (locations included in **Appendix E**), six transects and opportunistic collections.

A relevé is a description of a homogenous stand of vegetation without the boundaries imposed by a quadrat, the results of which are not used in statistical analysis. Relevés allow for the dominant species and unique features of a site to be captured quickly, allowing for a more accurate representation of the vegetation to be mapped and anomalies across the site to be captured.

For each relevé, the following information was recorded:

- GPS Location (recorded in GDA94 UTM 50K);
- a photograph taken of the vegetation; (**Appendix B**)
- habitat type;
- vegetation condition;
- vegetation description, based on the vegetation structural table of Keighery (1994) (adapted from Muir (1977) and Aplin (1979) (**Appendix B**);
- dominant species present;
- topographic position;
- slope and aspect;
- soil type;
- presence of outcropping and exposed rock type;
- bare ground and litter percentages;
- estimated time since fire; and
- disturbance level and description.

4.4. Survey For Flora of Conservation Significance

Likely habitats of listed Threatened and Priority Flora species were identified prior to undertaking the field survey to ensure that all habitats potentially supporting significant species within the Study area could be targeted. The habitat preferences for conservation significant flora species were assessed in **Section 3.1.**

4.5. Identification of Flora Specimens

Common species well known to the survey botanists were identified in the field. Voucher specimens of all other species were collected and pressed in the field, and assigned a unique number to facilitate

tracking of data. These vouchers were then identified by using taxonomic keys, reference to appropriate publications and use of voucher reference collections held at the WA Herbarium. A number of specimens were identified by Mike Hislop and Bruce Maslin at the WA Herbarium.

4.6. Vegetation Mapping and Condition

Prior to the survey, vegetation units were identified as far as practicable on aerial photographs of the Study area in conjunction with information collected in the desktop review. Relevé data and field observations were used to refine vegetation association mapping boundaries. Vegetation associations were described using a vegetation classification based on height and estimated cover as described by Keighery (1994) (**Appendix B**). Vegetation condition was defined using the Keighery Scale (Keighery 1994) (**Appendix B**).

4.7. Survey and Flora Identification Personnel

Field survey, collection of specimens and identification was conducted by Alex Sleep (botanist) from Outback Ecology. The personnel held current collecting licences as required under S23C and 23F of the *WC Act 1950* (WA) (License number SL010216). Some flora specimens (including the Priority taxon *Calotis latiuscula*) were identified by Mike Hislop and Bruce Maslin at the WA Herbarium.

4.8. Constraints and Limitations

A number of factors can influence the design and intensity of a flora survey. All flora surveys are limited to some degree by time and seasonal factors, and ideally a number of surveys should be undertaken over a number of years and appropriately timed with the flowering seasons. Possible survey constraints as identified by the EPA were addressed (**Table 5**), and no significant constraints were identified for the Survey.

Table 5: Summary of Survey Constraints

Aspect	Constraint	Comment regarding the flora and vegetation survey
Competency/experience of consultants	No	Members of the survey team are flora specialists employed by Outback Ecology, and have many years experience undertaking flora surveys of this kind within WA.
Scope	No	The scope was clearly defined and realistically achievable.
Proportion of flora identified	No	Of the 123 flora species recorded during this survey, specimens of 10 species could not be identified to species level, or at least not with confidence due to poor specimen material (either sterile or juvenile). Many species belonging to the *Acacia aneura* group were not able to be determined as they were sterile and/or hybrids. The Acacia aneura group is poorly known in the Wingellina area (pers comm. – Bruce Maslin)

Aspect	Constraint	Comment regarding the flora and vegetation survey
Information sources (e.g. historic or recent)	No	A number of regional studies have been carried out. Available data was reviewed prior to the commencement of the survey.
Completeness	No	This survey is considered complete for the purposes of a Level 1 reconnaissance survey as defined in EPA Guidance Statement 51 (EPA, 2004) as 'low intensity sampling of the flora and vegetation to produce maps of vegetation units and vegetation condition at an appropriate scale'.
Timing / weather / season / cycle	No	The timing of the field survey was appropriate to identify a large proportion of species present within the study area, however seasonal condition (ie lack of rain prior to field survey) meant that a number of annual and/or ephemeral species likely to be present in the study area were not visible at the time of survey, or were at a juvenile stage and unable to be identified. The species list recorded for the Study area should be considered as indicative rather than exhaustive.
Disturbances	No	N/A
Intensity	No	The survey effort satisfies the requirements of a Level One Survey according to Guidance Statement 51 (EPA, 2004). Data was collected from 53 relevés and six transects across the study area.
Resources	No	WA Herbarium specimens, taxonomic guides, DEC database searches and the Florabase database were all used to prepare for the survey and used for the confirmation of any species for which identification was uncertain.
Remoteness / access problems	No	All areas were accessible by four wheel drive vehicle and/or on foot. There was limited vehicle access within the bore field area, therefore selected transects were conducted on foot to ensure a representative coverage of these areas.
Availability of contextual information	No	Information was available for the IBRA Mann-Musgrave Block subregion of the Central Ranges Bioregion from Florabase, DEC and BOM.

5. RESULTS

5.1. Flora Composition

A total of 126 species (including subspecies and variants) from 30 families and 69 genera were recorded from within the Study area during the March 2013 survey. The most frequently occurring families within the Study area were Fabaceae, Poaceae and Myrtaceae. The most frequently occurring genera within the Study area were *Acacia, Eremophila* and *Senna.* This is a floristic composition typical of the regions of inland Australia. Moore, (2005) lists families with the highest representation in inland Australia as Myrtaceae, Asteraceae, Poaceae and Fabaceae and Chenopodiaceae. The complete flora species list can be found in **Appendix D**.

5.2. Conservation Significant Flora

No Threatened Flora species as listed under the *EPBC Act 1999*, or Threatened Flora species listed under the *WC Act 1950* (WA) were recorded within the Study area. One Priority Three flora species (*Calotis latuiscula)* was recorded from within the Study area.

5.2.1. Calotis Latiuscula – Priority Three

Calotis latuiscula was considered likely to occur in the Study given the information obtained during the desktop assessment. One individual *Calotis latiscula* was recorded from the Study area on the loamy outwash plains surrounding Mount Fanny (Appendix E). It was recorded along a transect at approximately 459557 mE and 7149396 mN. The specimen was submitted to the WA Herbarium for confirmation of the identification.

C. latiuscula is a Priority Three listed species in WA, however is common across the border and has a conservation ranking of 'Least Concern' in the Northern Territory. It is a herb to 0.5 m high, belonging to the Asteraceae family. There are currently 17 records of *C. latiuscula* housed at the WA Herbarium, with a total of 425 records listed Australia wide in Australia's Virtual Herbarium (Council of Heads of Australasian Herbaria 2013) (**Plate 3**).

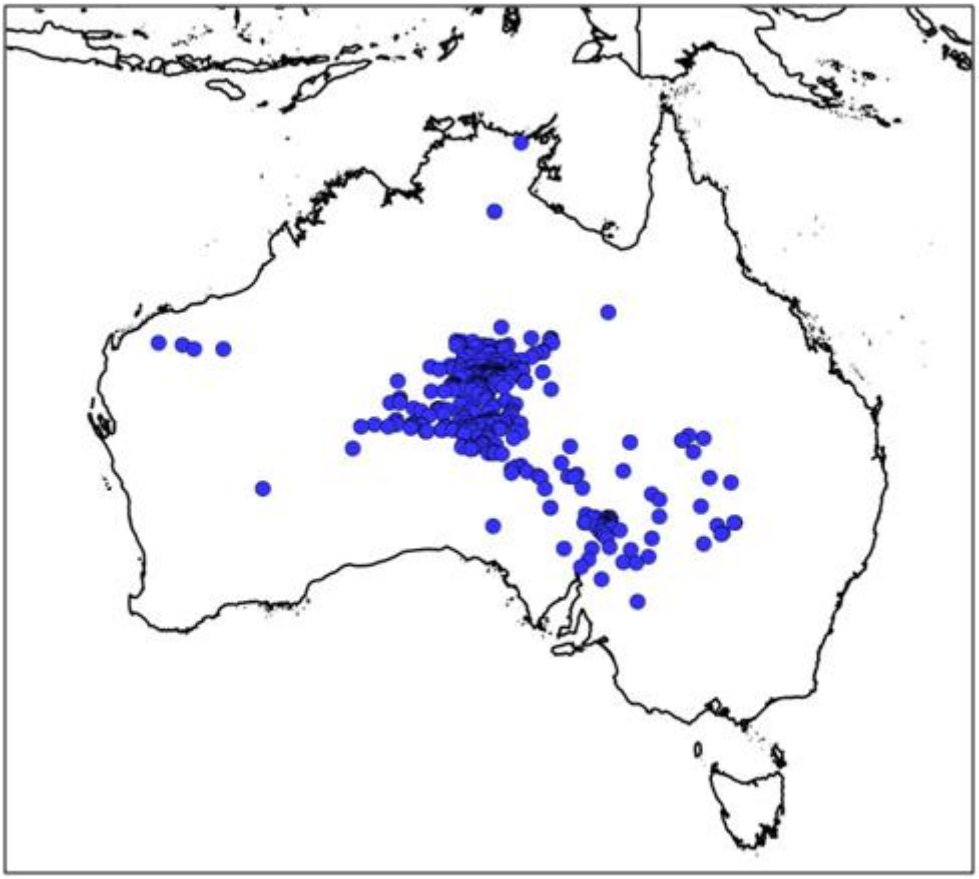


Plate 2: Australia wide distribution of *Calotis latiuscula* (Source: Australia's Virtual Herbarium)

5.3. Introduced Species

Three introduced flora species were recorded within the Study area, making up 2.5% of all taxa recorded (**Table 6**). The most significant occurrence of weeds was within the outwash plains (mapped as ATOS/AhEhTG) where frequent fires and disturbance from grazing (camels) have occurred. No Declared Plants were recorded as listed under the *Agriculture and Related Resources Protection Act 1976* (DAFWA, 1976).

Table 6: Introduced flora species recorded within the Cobb Depression Study area

Species	Common Name	Description	No of Sites Recorded At
Cenchrus ciliaris	Buffel Grass	Tufted or sometimes stoloniferous perennial, grass-like or herb, 0.2-1.5 m high. Fl. purple, Feb to Oct. White, red or brown sand, stony red loam, black cracking clay.	7
Citrullus colocynthis	Colocynth/Bitter Apple	Trailing perennial, herb or climber. Fl. yellow, Jan to Oct. Sandy, rocky, stony loam, clay soils, wet soils. In disturbed areas, floodplains	2
Portulaca oleracea	Purslane	Succulent, prostrate to decumbent annual, herb, to 0.2 m high. Fl. yellow, Apr to May. Clay loam, sand. Often disturbed sites	1

5.4. Vegetation Associations

Eight broad vegetation associations have been described within the Study area (**Table 8**, Appendix E). This included:

1. Desert Oak Woodland;
2. Scattered Tall Shrubs over *Aluta maisonneuvei* Heath on Dune Mid and Lower Slopes;
3. Open *Acacia* Shrubland over Tussock Grassland on loam plains;
4. Open *Acacia* Shrubland/Woodland over Hummock Grassland on flats between Sand dunes;
5. Open Tree Mallee and Mixed *Acacia* Shrubland over Hummock Grasses;
6. Tall Open Shrubland dominated by *Grevillea* over a tussock grassland on dune crests;
7. Mulga Woodland or Tall Shrubland of variable *Acacia aneura* group species; and
8. Isolated shrubs over *Triodia schinzii* Hummock Grassland with mixed herbland.

The vegetation assemblages of the Study area have been greatly influenced by the spatial and temporal distribution of fire in the landscape. *Triodia* spp. dominated vegetation (which occurs across much of the study area) is highly prone to frequent and intense fire (Moore 2005). The over-storey of these hummock grasslands is typically dominated by rapidly maturing species (such as some *Acacia* species) or those able to survive the fire by resprouting (such as mallee (*Eucalyptus*) species which resprout from a lignotuber). Mulga communities (which occur throughout the Study area) are sensitive to fire and generally require 10 to 20 years without fire to become mature and re-establish their soil and canopy held seed banks (Marsden-Smedley *et al*, 2012). Fire free intervals of less than 15 years will generally result in a decline in the Mulga component of the vegetation (Marsden-Smedley *et al* 2012). The classification of vegetation as woodland, shrubland or grassland in this environment may be a matter of time since fire. Marsden-Smedley *et al* (2012) note that unburnt patches of Spinifex (*Triodia* spp.) grassland tend to have denser and taller tree and shrub layers often dominated by fast growing *Acacia* species and re-sprouting species of *Eucalyptus* and *Corymbia,* with *Triodia* spp. also dying out from under long unburnt mulga.

Vegetation across the Study area predominantly consisted of dunefields which consistently comprised a Tall Open Shrubland of *Grevillea* and *Acacia* with occasional *Corymbia chippendalei* over a tussock grassland mostly dominated by *Aristida holathera* var. *holathera* on the dune crests, moving down slope into an Open Heath of *Aluta maisonneuvei* on mid to lower slopes then into a Open Acacia Shrubland/Woodland marked by the occurrence of scattered individuals of *A. pruinocarpa* and often dotted with small stands of *Allocasuarina decaisnei, Brachychiton gregorii* and *Corymbia opaca* over a hummock grassland of both *Triodia basedowii* and *T. schinzii* on the flats between sand dunes (*T. basedowii* typically dominated the flats, while *T. schinzii* mostly occurred on the dune slopes).

Mulga (Woodlands to Tall Shrublands of *Acacia aneura* complex) occur throughout the study area. Being sensitive to fire, it is likely that the boundaries between the Mulga association and *Triodia* hummock grassland based communities fluctuate as a consequence of fire and recovery from fire. This community is also prone to encroachment by hummock grasses after fire and if this eventuates,

higher and more flammable fuel loads will result and fire frequencies will increase resulting in an eventual shift to grassland (Marsden-Smedley *et al,* 2012).

A broad, tussock grass dominanted flat with sparse shrub layer occurs in the outwash plains surrounding rocky ranges (Vegetation association - ATOS/AhEhTG (3). This vegetation association is prone to weed invasion (particularly *Cenchrus cilliaris)* due to increased water and nutrient availability when compared to surrounding areas. A large proportion of this association within the Study area had been burnt recently (<1 year) or very recently (< 6 months) and in many of these areas it was noted that the shrub layer was not readily regenerating.

A list of flora species per vegetation association can be found in **Appendix G** and vegetation description and photograph recorded from each sampling site in **Appendix H**.

5.4.1. Mapping Units

Due to the fine scale mosaics of vegetation that occur within the Study area and the influences of fire, not all mapped areas consist of one pure vegetation association. The mosaics and dunefield vegetation types and what **v**egetation units these consist of are described in Table 7. In addition to this, approximately 2.4% of the study area consists of road, disturbed road shoulder, and un-mapped Aboriginal heritage exclusion zones.

Table 7: Mapping Units

Mapping Units	Number	Pure Vegetation Assocation/s	Description
Dunefields	2/4/6	AmOH ATOSTHG GsTOS	Large tracts of dune fields where GsTOS occurs at the crests of the dunes, AmOH occurs on the mid-lower slopes and ATOSTHG occurs on the flats between the sand dunes.
Cleared/Road	-	-	The road and associated cleared/disturbed shoulder (approximately 19 metres wide)
Exclusion Zone	-	-	Aboriginal heritage exclusion zones not surveyed.
Mosaic (AmOH/GsTOS)	2/6	AmOH GsTOS	Areas where small, crowded, non linear dunes occur across the corridor as a combination of GsTos at the crests and AmOH on the mid to lower slopes and foot of dunes.
Mosaic Mulga and ATOS/AhEhTG	7/3	Mulga ATOS/AhEhTG	Mosaic of Mulga and scattered tall *Acacia* shrubland over tussock grasses. Mulga patches are too small in area and/or too sparse possibly due to frequent fires in the area to map as a distinct vegetation unit.

Table 8: Vegetation associations of the Cobb Depression Study area

Number	Vegetation Association	Type	Description	Notes
1	AdLOW	Desert Oak Woodland	Low Open Woodland of *Allocasuarina decaisneana* over scattered Shrubs of *Acacia ? ayersiana* and *Exocarpos sparteus* over a Hummock Grassland of *Triodia basedowii* on red loam flats.	Small stands of Desert Oak occur sporadically throughout the dunefields, however this is the only broad section where they occur as a pure woodland assemblage.
2	AmOH	Scattered Tall Shrubs over *Aluta maisonneuvei* Heath on Dune Mid and Lower Slopes	Tall Open Shrubland to Scattered Tall Shrubs of *Grevillea stenobotrya* with mixed *Acacia* (*including A. melleodora, A. ligulata, A. helmsiana* and/or *A. aneura*) and occasional stands of *Allocasuarina decaisneana* over an Open Heath to Heath of *Aluta maisonneuvei* (+/- occasional *Micromyrtus flavifolia*) over an Open Hummock Grassland of *Triodia schinzii* and *T. basedowii* with occasional tussocks of *Aristida holathera* var. *holathera* on the mid to lower slopes of sand dunes.	Consistently dominates the lower and mid slopes of dunes. The mix of shrubs present as overstorey and their density appears to depend on the frequency of fire to which the area has been exposed.
3	ATOS/AhEhTG	Open *Acacia* Shrubland over Tussock Grassland on loam plains	Tall Open Shrubland to Isolated Shrubs of *Acacia aneura* and *A. ligulata* over an Open Shrubland to Scattered Shrubs of *Senna* spp. over a Tussock Grassland of *Aristida holathera* var*. holathera, Eragrostis eriopoda* and +/- *Cymbopogon obtectus* with patchy dominance by **Cenchrus ciliaris* over an Open Herbland of *Cleome viscosa, Chrysocephalum pterochaetum* and *Tribulus* sp. on red loam flats.	Occurs on outwash plains surrounding hills and ranges (Mount Fanny). Prone to invasion by Buffel Grass due to higher levels of nutrients and water.

Number	Vegetation Association	Type	Description	Notes
4	ATOSTHG	Open *Acacia* Shrubland/Woodland over Hummock Grassland on flats between Sand dunes.	Scattered Tall Shrubs to Tall Open Shrubland of *Acacia pruinocarpa* with other mixed *Acacia* species (A. *aneura, A. maitlandii, A. ligulata, A. minyura, A. pachyacra*) with occasional isolated trees or stands of *Allocasuarina decaisenei /Brachychiton gregorii/Corymbia opaca* and occasional patches of *Eucalyptus gamophylla* over a Low Open Shrubland to Scattered Shrubs of *Eremophila forrestii* subsp. *forrestii, Grevillea eriostachya* and +/- *Santalum lanceolatum* and *Aluta maisonneuvei* over a Hummock Grassland of *Triodia basedowii* and *T. schinzii* over an Open herbland of *Bonamia erecta, Leptosema chambersii* and *Androcalva loxophylla* on loam flats adjacent to sand dunes.	Occurs on the sandy loam flats between sand dunes. There is a gradual intergrade between this and AmOH where the *Aluta maisonneuvei* gradually thins out. This vegetation association is also interspersed with patches and groves of Mulga Woodland/shrubland. The density of composition of the upper storey is dependent on the frequency of fire, longer unburnt areas appeared to support a higher density of taller shrubs.
5	ETMATS	Open Tree Mallee and Mixed *Acacia* Shrubland over Hummock Grasses.	Open Tree Mallee of *Eucalyptus oxymitra (+/-) E. gamophylla* and *E. mannensis* subsp*. mannensis* with Scattered *Acacia* spp. (*Acacia aneura, A. maitlandii* and/*or A. ligulata*) over a Hummock Grassland of *Triodia pungens* and/or *T. schinzii* on red loam.	A mixed Shrubland dominated by Mallee Eucalypts over a hummock grassland which mostly occurs at the southern end of the Study area.
6	GsTOS	Tall Open Shrubland dominated by *Grevillea* over a tussock grassland on dune crests	Tall Open Shrubland to Scattered Shrubs of *Grevillea stenobotrya, Acacia ligulata*, (+/-) *Dodonaea viscosa* subsp. *angustissima, A. sericophylla* and *Corymbia chippendalei* over a Low Open Shrubland to Scattered Low Shrubs of *Santalum lanceolatum* and +/- *Indigofera georgei, Senna artemisioides* subsp. x *artemisioides* and *Aluta maisonneuvei* (which is more dominant on dune slopes, but occurs sparsely at crests) over an Open Tussock Grassland of *Aristida holathera* var. *holathera* (+/- *Eragrostis eriopoda* and *Triodia schinzii*) on crests of red sand dunes.	Consistently dominates the crests of dunes and differs from adjacent areas within the dune fields by the dominance of Grevillea spp. and tussock grasses rather than the Triodia spp.

Number	Vegetation Association	Type	Description	Notes
7	Mulga	Mulga Woodland or Tall Shrubland of variable species	Mulga Woodland to Tall Shrubland of variable species including *Acacia aneura, A. aptaneura, A. pteraneura* and *A. minyura, A. ?ayersiana* with hybridisation of these occurring (+/- *A. ligulata* and *A. pruinocarpa*) over a Low Open Shrubland to scattered shrubs of *Eremophila latrobei* subsp. *latrobei* (+/- *E. clarkei*) over a predominantly Open Tussock Grassland of *Eragrostis eriopoda* and *Eriachne helmsii*, with some dominance by Hummock Grasses (Triodia schinzii and T. basedowii) particularly at the interface with the dominant flats community on loamy clay to clay flats.	Occurs through the study area in variable sized patches and linear groves. Prone to encroachment by *Triodia* spp. after fire.
8	TsTHG	Isolated shrubs over *Triodia schinzii* Hummock Grassland with mixed herbland	Isolated Tall Shrubs to Shrubs (+/- *A. pruinocarpa, A. abrupta, A. ?aneura, A. pachyacra* and *A. melleodora* over a Hummock Grassland of *Triodia schinzii* with scattered tussocks of *Eragrostis lanflora* and *Eriachne helmsii* over an Low Open Shrubland/Herbland of *Leptosema chambersii*, *Goodenia mueckeana*, *Androcalva loxophylla* and *Chrysocephalum pterochaetum* on red loamy sand flats.	Similar in composition to ATOSTHG, however does not occur in the dune fields, has a more dominant herb layer and is closer to a pure *Triodia* spp. hummock grassland rather than a Shrubland over a hummock grassland.

5.5. Conservation Significant Ecological Communities

There are no currently known Threatened or Priority Ecological communities that occur within the Central Ranges IBRA region.

5.6. Local And Regional Significance of Vegetation

5.6.1. Locally Significant Vegetation

The local significance of vegetation is typically determined by comparing the percentages of each mapped unit across the Study area with the total area and examining vegetation types that make up the smallest percentage of the Study area as potential locally significant vegetation types. In this case, the shape of the study area has given skewed results in terms of simple percentages. If we look at vegetation types that make up less than 1% of the total area mapped, there would be seven associations or mosaics that could be considered locally significant (**Table 9**). For this study area, the broad borefield area at the northern end is dominated by dunefield and thus this makes up a significant percentage of the vegetation mapped. The other vegetation associations (with the exception of Mulga) only occur within the narrow pipeline road (100 metres wide) however the majority of these can be considered to be well represented in the local context in terms of their linear extent (Appendix E). Taking into account the mosaic of communities that occurs and the linear extent of these vegetation associations the following vegetation associations are considered to be locally significant (within the study area):

- AdLOW (1) – This is the only Woodland unit dominated by *Allocasuarina decaisnei* that occurs within the Study area. This species does occur within the dunefield mapping unit but only sporadically as isolated trees or small stands.
- ATOS/AhEhTG (3) – This scattered *Acacia* shrubland over Tussock Grassland appears to be restricted to the loamy outwash plains surrounding Mount Fanny. Invasion of this area by **Cenchrus ciliaris* has occurred due to greater amounts of moisture and nutrients. It differs from other vegetation associations in that it is dominated by tussock rather than hummock grasses and has a high number of annual and ephemeral species. This association can also be considered regionally significant as this is where the P3 species *Calotis latiuscula* was recorded.
- TsHG (8) – This is the only portion of the Study area where an almost pure Triodia hummock grassland occurs that is not in association with sand dunes and other shrublands.

5.6.2. Regionally Significant Vegetation

In a geographical sense, no vegetation within the Study area is considered regionally significant as all are considered to fall within the broad vegetation types that are widespread across the bioregion. In terms of regional significance for reasons other than geographical coverage, the Mulga vegetation unit can be considered to be of significance.

Mulga is a keystone group in the Australian arid zone and Mulga communities occupy over 150 million hectares or about 20% of the land surface in the continent (Sattler, 1986). Mulga communities are important to the ecology, functioning and viability of rangeland landscapes, acting as resource hotspots, due to the species ability to capture, retain and cycle scarce sediments, nutrients and water resources (Maslin and Reid 2012).

Table 9: Extent of mapped vegetation across the Cobb Depression Study area

Mapping Unit / Vegetation Association	Number	Area (Ha)	% of Total Study Area	Local and Regional Significance
AdLOW	1	11.75	0.08%	Locally Significant due to restricted distribution
ATOS/AhEhTG	3	37.50	0.26%	Locally Significant due to restricted distribution within the study area and presence of P3 species *Calotis latiuscula*
ATOSTHG	4	30.99	0.22%	Widespread across the bioregion
Cleared/Road	-	176.96	1.23%	N/A
Dunefield AmOH/GsTOS/ATOSThg	2/4/6	13073.26	90.82%	Widespread vegetation type – not considered to be significant
ETMATS	5	80.50	0.56%	Widespread vegetation type – not considered to be significant
Exclusion Zone	-	173.42	1.20%	N/A
Mosaic AMOH/GsTOS	2/4	17.44	0.12%	Widespread vegetation type – not considered to be significant
Mosaic Mulga and ATOS/AhEhTG	7/3	24.13	0.17%	Regionally significant due to importance as a resource hotspot in resource poor arid lands
Mulga	7	752.21	5.23%	Regionally significant due to importance as a resource hotspot in resource poor arid lands.
TsHG	8	16.73	0.12%	Locally Significant due to restricted distribution
TOTAL		**14394.89**	**100.00%**	

5.7. Vegetation Condition

Vegetation condition across the Study area varied from 'Very Good' to 'Excellent' with the majority of the Study area rated as 'Excellent' (**Table 10**). Approximately 1.4% of the Study area was not given a condition rating due to being within the road corridor (including disturbed shoulders) or within exclusion zones which were not surveyed.

There is a mosaic of vegetation in different stages of recovery from fire, from as recent as a fire occurring only a few months prior to the survey. Given the isolated location of the site, many of the recently burnt areas were given the same rating as adjacent unburnt vegetation as it is generally expected that the vegetation would recover to a similar condition given the adaptability of these vegetation types to fires in the absence of additional anthropogenic disturbance. The outwash plains (vegetation association ATOS/AhEhTG (3)) were mapped as 'Very Good' due to significant invasion in patches by Buffel Grass and the apparent transition from Shrubland to Grassland caused by a high frequency of fire. The majority of vegetation at the southern end of the Study area was rated as Very Good to Excellent due to edge effects from the road and associated road grading and drain maintenance and the possible decline of community structures caused by frequent fires.

Table 10: Varying Vegetation Condition across the Cobb Depression Study area

Condition	Area (Ha)	% of Total Area
Not rated (Cleared/Road)	176.96	1.23%
Not rated (Exclusion Zone)	173.42	1.21%
Excellent	13722.22	95.45%
Very Good to Excellent	242.53	1.69%
Very Good	61.63	0.43%

6. CONCLUSIONS AND RECOMMENDATIONS

A total of 126 flora species (including subspecies and variants) from 30 families and 69 genera were recorded from within the Study area during the March 2013 Level 1 Flora and Vegetation Survey. A total of three introduced species were recorded within the Study area, none of these are listed as Declared Plants under the *Agriculture and Related Resources Protection Act 1976*.

No Threatened Flora species as listed under the *EPBC Act 1999*, or Threatened Flora species listed under the *Wildlife Conservation Act 1950* (WA) were recorded within the Study area. One Priority Flora species (*Calotis latiuscula – P3)* was recorded from within the study area. No species of 'Other Conservation Significance' as described in *Guidance Statement 51* (EPA, 2004) were recorded within the Study area.

Eight broad vegetation associations were identified as occurring within the Study area. This included:

1. Desert Oak Woodland;
2. Scattered Tall Shrubs over *Aluta maisonneuvei* Heath on Dune Mid and Lower Slopes;
3. Open *Acacia* Shrubland over Tussock Grassland on loam plains;
4. Open *Acacia* Shrubland/Woodland over Hummock Grassland on flats between Sand dunes;
5. Open Tree Mallee and Mixed *Acacia* Shrubland over Hummock Grasses;
6. Tall Open Shrubland dominated by *Grevillea* over a tussock grassland on dune crests;
7. Mulga Woodland or Tall Shrubland of variable *Acacia aneura* group species; and
8. Isolated shrubs over *Triodia schinzii* Hummock Grassland with mixed herbland.

Vegetation associations AdLOW (1), ATOS/AhEhTG (3) and TsHG (8) are considered to be locally significant in the context of the Study area. Mulga (7) vegetation within the Study area is considered to be Regionally Significant due to its role as a resource (water, nutrients) hot spot within arid landscapes.

Vegetation condition of the Study area ranged from Very Good to Excellent. There is a mosaic of vegetation in different stages of recovery from fire, from as recent as a fire occurring only a few months prior to the survey. Given the isolated location of the site, many of the recently burnt areas were given the same rating as adjacent unburnt vegetation as it is generally expected that the vegetation would recover to a similar condition given the adaptability of these vegetation types to fire.

Based on the results of this survey the following recommendations are made:

- From a flora and vegetation perspective it is recommended that the pipeline route be aligned as closely as possible with the existing road to reduce the amount of vegetation that will be impacted;
- Once the project footprint has been further refined, the knowledge of the flora and vegetation of the Study area should be further refined and broadened with a follow up Level Two Survey; and

- *Calotis latiuscula* (P3) should be targeted within its known habitat of outwash plains in the Study area and surrounds to determine the status and size of this population and total impacts to the species.

7. REFERENCES

ANRA: Australian Natural Resources Atlas (2009a). "Rangelands overview - Central Ranges." from <http://www.anra.gov.au/topics/rangelands/overview/nt/ibra-cr.html>. .

ANRA: Australian Natural Resources Atlas. (2009b) *Rangelands overview - Great Victoria Desert.* Available online at http://www.anra.gov.au/topics/rangelands/overview/wa/ibra-gvd.html. Accessed on 20/01/2012.

Aplin, T. E. H. (1979). "The flora." Environment and Science: 53.

Bureau of Meteorology - BOM (2013). "Climate Statistics for Australian Locations - Monthly Climate Statistics Graph - Giles Meteorological Office." Retrieved 23 April, 2013, from http://www.bom.gov.au/jsp/ncc/cdio/cvg/av.

Bureau of Meteorology - BOM (2013). "Daily Rainfall - 2013 Rainfall - Giles Meteorological Office." Retrieved 23 April, 2013, from http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_display_type=dataDGraph&p_stn_num=013017&p_nccObsCode=136&p_month=13&p_startYear=2013.

Bureau of Meteorology, B. (2013). "Climate statistics for Australian Locations - Summary Statistics for Giles.". from http://www.bom.gov.au/climate/averages.

Council of Heads of Australasian Herbaria (2013). "Australia's Virtual Herbarium - Specimen Search Results for Calotis latiuscula (Leafy Burr Daisy)." Retrieved 23 April, 2013, from http://avh.ala.org.au/occurrences/search?taxa=calotis+lat*#mapView.

Department of Agriculture and Food Western Australia. (2005) Pre-European Vegetation – Western Australia.

DEC: Department of Environment and Conservation. (2013a) *Naturemap: Mapping Western Australia's Biodiversity.* Available online at http://naturemap.dec.wa.gov.au./default.aspx. Accessed on 14/01/2013.

DEC: Department of Environment and Conservation. (2013b) *Threatened and Priority Flora Database.* Accessed on 11/01/2013

DEC: Department of Environment and Conservation (2013c) *Threatened and Priority Ecological Communities Database*. Accessed on 11/01/2013.

Department of Environment and Conservation (DEC) (2013d). Flora Base - The Western Australian Flora, Department of Environment and Conservation.

DSEWPaC: Department of Sustainability, Environment, Water, Population and Communities. (2013) *Protected Matters Search Tool.* Available online at www.environment.gov.au/erin/ert/epbc/index.html. Accessed on 14/01/2013.

DSEWPaC: Department of Sustainability, E., Water, Population and Communities. (2012) *Ngaanyatjarra Lands Indigenous Protected Area.* Available online at http://www.environment.gov.au/indigenous/ipa/declared/ngaanyatjarra.html. Accessed on 28/02/2013.

DSEWPaC: Department of Sustainability Environment Water Population and Communities. (2010) *Directory of Important Wetlands in Australia: Rock Pools of the Walter James Range (WA014).* Available online at http://www.environment.gov.au/water/topics/wetlands/database/diwa.html. Accessed on 28/02/2013.

EPA (2000). Position statement No. 2 Environmental protection of native vegetation in Western Australia.

EPA (2004). Guidance for the Assessment of Environmental Factors. Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No 51.

EPA: Environmental Protection Authority (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection.

Graham, D. and M. Cowan (2002). Central Ranges 1 (CR1 - Mann Musgrave Block subregion) A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002., Department of Conservation and Land Management: 127-13.

HGM Maunsell. (2002) *Wingellina Baseline Biological Survey*, report prepared for Acclaim Exploration NL.

IUCN Species Survival Commission (2012). IUCN Red List Categories and Criteria - Version 3.1 - Second Edition. Gland, Switzerland.

Keighery, B. (1994). Bushland Plant Survey – A guide to Plant Community Survey for the Community, Wildflower Society of WA (Inc.).

Marsden-Smedley JB, Albrecht D, Allan GE, Brock C, Duguid A, Friedel M, Gill AM, King KJ, Morse J, Ostendorf B andTurner D. 2012. Vegetation–fire interactions in central arid Australia: towards a conceptual framework. Ninti One Research Report NR001. Ninti One Limited. Alice Springs

Maslin, B. and J. E. Reid (2012). "A taxonomic revision of Mulga (*Acacia aneura* and its close relatives: Fabaceae) in Western Australia." Nuytsia 22(4): 129-267.

McKenzie, N. L., J. E. May, et al., Eds. (2003). Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. Perth, Department of Conservation and Land Management.

Moore, P. (2005). A Guide to Plants of Inland Australia.

Muir, B. G. (1977). "Biological Survey of the Western Australian Wheatbelt. Pt. 2. Vegetation and habitat of the Bendering Reserve." Records of the Western Australian Museum Supp. 3

Outback Ecology (2012) *Wingellina Nickel Project: Level 1 Flora and Vegetation Assessment of the Wingellina Borefield.* Report prepared for Metals X Limited.

Outback Ecology (2011) *Wingellina Nickel Project: Level 1 Flora and Vegetation Assessment of the Wingellina Borefield.* Report prepared for Metals X Limited.

Outback Ecology. (2009a) *Wingellina Nickel Project: Terrestrial Fauna Assessment*, report prepared for Metals X Limited.

Outback Ecology. (2009b) *Wingellina Nickel Project: Baseline Flora and Vegetation Assessment.* Report prepared for Metals X Limited.

Sattler, P.S. (1986). Introduction.In: Sattler, P.S. (ed.)The Mulga lands. pp. 5–6. (Royal Society of Queensland: Brisbane.)

Shepherd, D. P., Beeston, G.R., and Hopkins, A.J.M. (2002). Native Vegetation in Western Australia. Extent, Type and Status. Resource Management Technical Report 249. Western Australia., Department of Agriculture.

APPENDIX A

Definition Of Codes And Terms Used To Describe Conservation Significance

Definitions for Threatened Flora		
Code	Name	Description
T	Threatened Flora (previously known as Declared Rare Flora)	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 of the Wildlife Conservation (Rare Flora) Notice under the Wildlife Conservation Act 1950).
X	Presumed Extinct Flora	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 of the Wildlife Conservation (Rare Flora) Notice 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. The IUCN Red List Criteria are also used to rank threatened flora under the *Environmental Protection and Biodiversity Conservation Act 1999*		
Code	Name	Description
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

Definitions for Priority Flora		
Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora. Taxa that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation Dependent species are placed in Priority 5.		
Code	Name	Description
P1	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.
P2	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.
P3	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
P4	Priority Four - Rare, Near Threatened and other taxa in need of monitoring	1. Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
		2. 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.
		3. Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Code	Name	Description
P5	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.

Definitions for Threatened Ecological Communities (TEC)

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) 0there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have

been reduced by at least 70% since European settlement and either or both of the following apply (i

or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, and one or more of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):

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.

Definitions for Priority Ecological Communities

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community List 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.

Code	Name	Description
P1	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 processes across their range.

Code	Name	Description
P2	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.
P3	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 with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4	Priority Four - Rare or Near Threatened	***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.
		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.
		Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	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.

APPENDIX B
Classification Of Vegetation Condition

Vegetation Condition Scale (Keighery, 1994)

Code	Description
Pristine	Pristine or nearly so. No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as ‘parkland cleared’ with the flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX C
Vegetation Structural Classification

Vegetation Structural Classification (Keighery, 1994)

Life Form/ Height Class	Canopy Cover (percentage)			
	100% - 70%	**70% - 30%**	**30% - 10%**	**10% - 2%**
Trees over 30m **Trees 10-30m** **Trees < 10m**	Tall Closed Forest Closed Forest Low Closed Forest	Tall Open Forest Open Forest Low Open Forest	Tall Woodland Woodland Low Woodland	Tall Open Woodland Open Woodland Low Open Woodland
Tree Mallee	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2m **Shrubs 1-2m** **Shrubs <1m**	Closed Tall Scrub Closed Heath Closed Low Heath	Tall Open Scrub Open Heath Open Low Heath	Tall Shrubland Shrubland Low Shrubland	Tall Open Shrubland Open Shrubland Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

APPENDIX D
Flora Species List

Family		Species	Common Name
Acanthaceae		*Rostellularia adscendens* var. *pogonanthera*	
Amaranthaceae		*Ptilotus helipteroides*	
		Ptilotus macrocephalus	Featherheads
		Ptilotus obovatus	Cotton Bush
		Ptilotus schwartzii var. *schwartzii*	
Asteraceae	^	*Asteraceae* sp.	
		Calotis latiscula (Priority 3)	Leafy Burr Daisy
		Chrysocephalum apiculatum	
		Chrysocephalum pterochaetum	
		Chrysocephalum puteale	
		Olearia subspicata	Spiked Daisy Bush
Boraginaceae		*Halgania erecta*	
		Heliotropium moorei	
Brassicaceae		*Lepidium phlebopetalum*	Veined Peppercress
Casuarinaceae		*Allocasuarina decaisneana*	Desert Oak
Chenopodiaceae		*Enchylaena tomentosa*	Barrier Saltbush
		Maireana tomentosa	Felty Bluebush
		Rhagodia eremaea	Thorny Saltbush
		Salsola australis	
Cleomaceae		*Cleome viscosa*	Tickweed
Convolvulaceae		*Bonamia erecta*	
Cucurbitaceae	*	*Citrullus colocynthis*	
Euphorbiaceae		*Euphorbia drummondii*	Caustic Weed
Fabaceae	^	*Acacia ? aneura* (hybrid)	
	^	*Acacia ?aptaneura*	
	^	*Acacia ?ayersiana*	
		Acacia abrupta	
		Acacia aneura	Mulga
		Acacia aptaneura	
		Acacia sericophylla	
		Acacia helmsiana	
		Acacia kempeana	Witchetty Bush
		Acacia ligulata	Umbrella Bush
		Acacia maitlandii	Maitland's Wattle
		Acacia melleodora	
		Acacia minyura	
		Acacia pachyacra	
		Acacia pruinocarpa	Gidgee
		Acacia pteraneura	
		Acacia tetragonophylla	Kurara
		Crotalaria cunninghamii	Green Birdflower
		Crotalaria eremaea subsp. *strehlowii*	
		Indigofera georgei	Bovine Indigo
		Kennedia prorepens	
		Leptosema chambersii	

Family		Species	Common Name
		Senna artemisioides subsp. *helmsii*	
		Senna artemisioides subsp. *petiolaris*	
		Senna artemisioides subsp. *x artemisioides*	
		Senna pleurocarpa var. p*leurocarpa*	
Goodeniaceae		*Dampiera roycei*	
		Goodenia centralis	
		Goodenia heterochila	
		Goodenia mueckeana	
		Scaevola parvifolia	Camel Weed
		Scaevola spinescens	Currant Bush
Gyrostemonaceae		*Codonocarpus cotinifolius*	Native Poplar
		Gyrostemon ramulosus	Corky Bark
Haloragaceae		*Glischrocaryon angustifolium*	
Hemerocallidaceae		*Corynotheca micrantha* var. *divaricata*	Sand Lily
Lamiaceae		*Dicrastylis doranii*	
		Newcastelia spodiotricha	
		Prostanthera sericea	
		Quoya loxocarpa	
Loganiaceae		*Logania centralis*	
Malvaceae		*Abutilon otocarpum*	Desert Chinese Lantern
		Androcalva loxophylla	
		Brachychiton gregorii	Desert Kurrajong
		Hibiscus burtonii	
		Hibiscus sturtii var. *truncatus*	Sturt's Hibiscus
		Sida cardiophylla	
	^	*Sida* sp.	
		Sida sp. Excedentifolia (J.L. Egan 1925)	
Myrtaceae		*Aluta maisonneuvei*	
		Calytrix carinata	
		Corymbia chippendalei	
		Corymbia opaca	Desert Bloodwood
		Eucalyptus gamophylla	Twin Leaf Mallee
		Eucalyptus mannensis subsp. *mannensis*	
		Eucalyptus oxymitra	Sharp-capped Mallee
		Melaleuca interioris	
		Micromyrtus flaviflora	
Nyctaginaceae		*Boerhavia coccinea*	Tar Vine
Poaceae		*Aristida contorta*	Bunched Kerosene Grass
		Aristida holathera var. *holathera*	
	^	*Aristida* sp.	
	*	*Cenchrus ciliaris*	Buffel Grass
		Cymbopogon obtectus	Silky Heads
		Dactyloctenium radulans	Button Grass
		Digitaria ammophila	Silky Umbrella Grass
		Digitaria brownii	Cotton Panic Grass

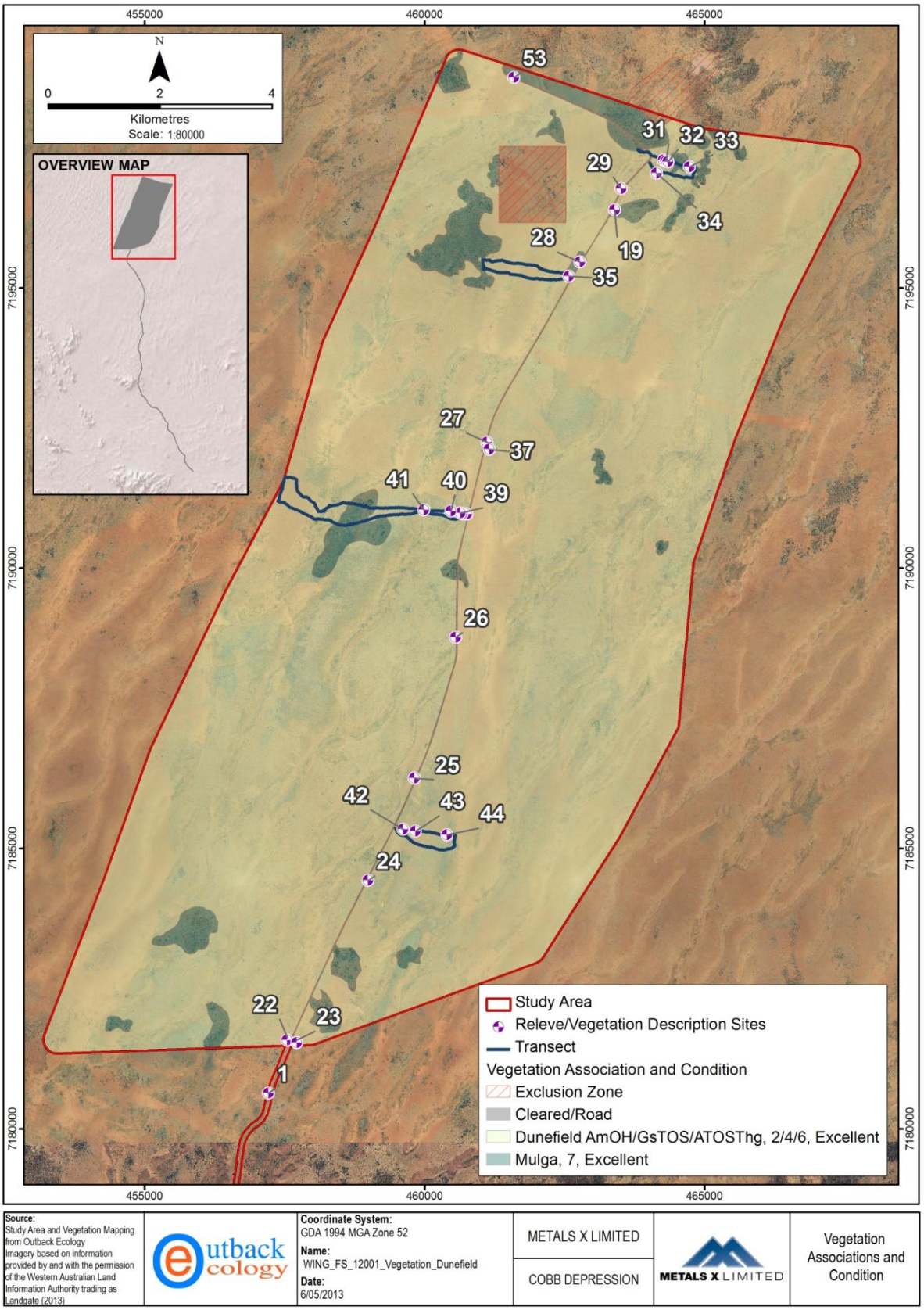
Family		Species	Common Name
		Eragrostis eriopoda	Woollybutt Grass
		Eragrostis laniflora	Hairy-flowered Woollybutt
	^	*Eragrostis* sp.	
		Eriachne aristidea	
		Eriachne helmsii	Buck Wanderrie Grass
	^	*Eriachne* sp.	
		Paraneurachne muelleri	Northern Mulga Grass
		Themeda triandra	
		Triodia basedowii	Lobed Spinifex
		Triodia pungens	Soft Spinifex
		Triodia schinzii	
	^	*Triodia* sp.	
Portulacaceae	*	*Portulaca oleracea*	Purslane
Proteaceae	^	*Grevillea ?juncifolia* subsp. *juncifolia*	Honey-suckle Grevillea
		Grevillea eriostachya	Flame Grevillea
		Grevillea stenobotrya	
		Hakea chordophylla	
		Hakea divaricata	Corkbark Tree
Pteridaceae		*Cheilanthes sieberi* subsp. *sieberi*	Mulga Fern
Santalaceae		*Anthobolus leptomerioides*	
		Exocarpos sparteus	Broom Ballart
		Santalum lanceolatum	Northern Sandalwood
Sapindaceae		*Dodonaea viscosa* subsp. *angustissima*	Sticky Hop-bush
Scrophulariaceae		*Eremophila clarkei*	Turpentine Bush
		Eremophila duttonii	
		Eremophila forrestii subsp. *forrestii*	Wilcox Bush
		Eremophila gilesii subsp. *gilesii*	Charleville Turkey Bush
		Eremophila latrobei subsp. *latrobei*	Warty Fuschia Bush
		Eremophila longifolia	Berrigan
		Eremophila platythamnos subsp. *exotrachys*	
	^	*Eremophila* sp.	
Solanaceae		*Solanum centrale*	Desert Raisin
		Solanum lasiophyllum	Flannel Bush
Zygophyllaceae	^	*Tribulus* sp.	

* denotes introduced (weed) species

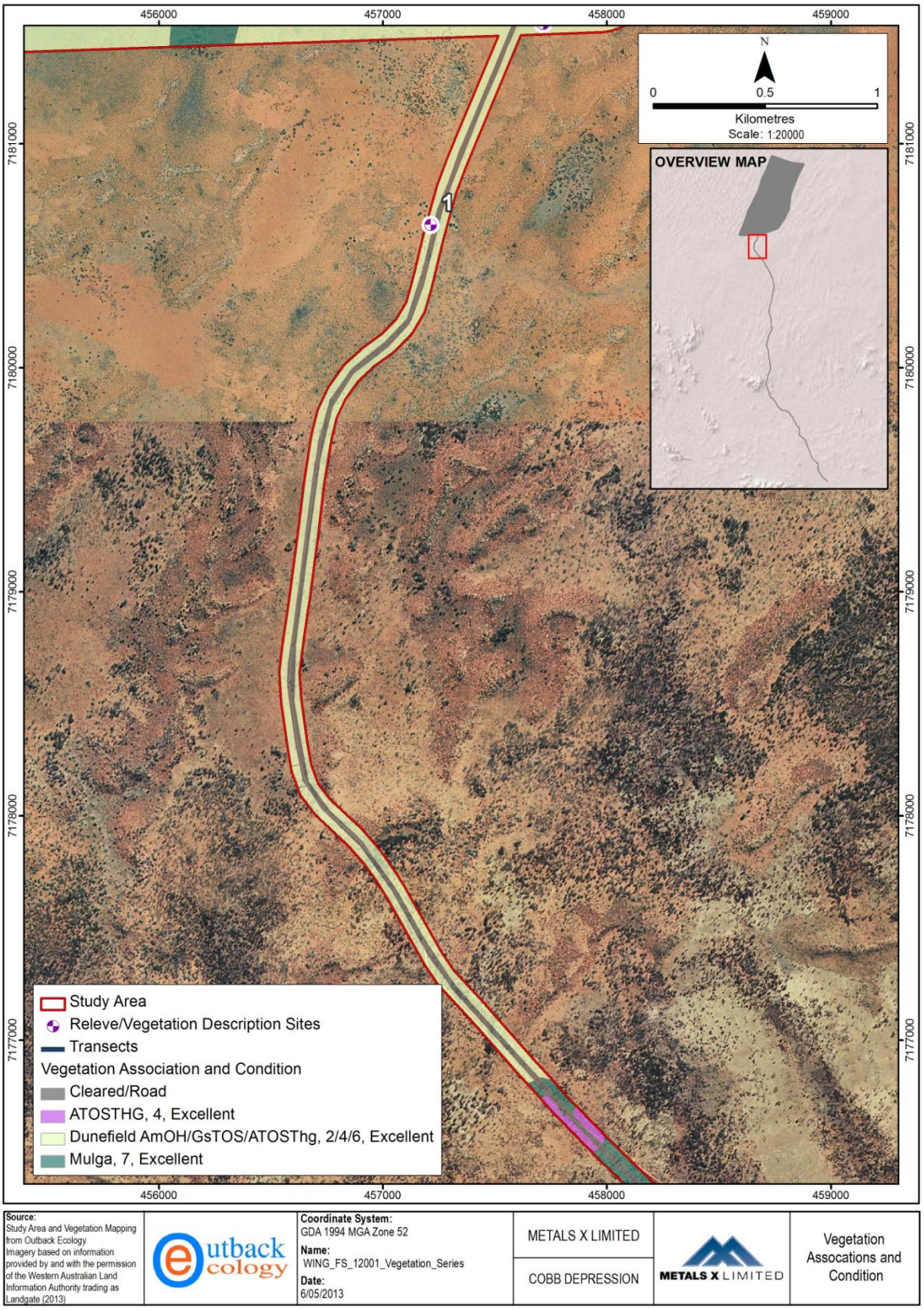
^ denotes taxon not identified to species level (or not 100% sure on id as denoted by ?) due to sterile or juvenile material.

APPENDIX E

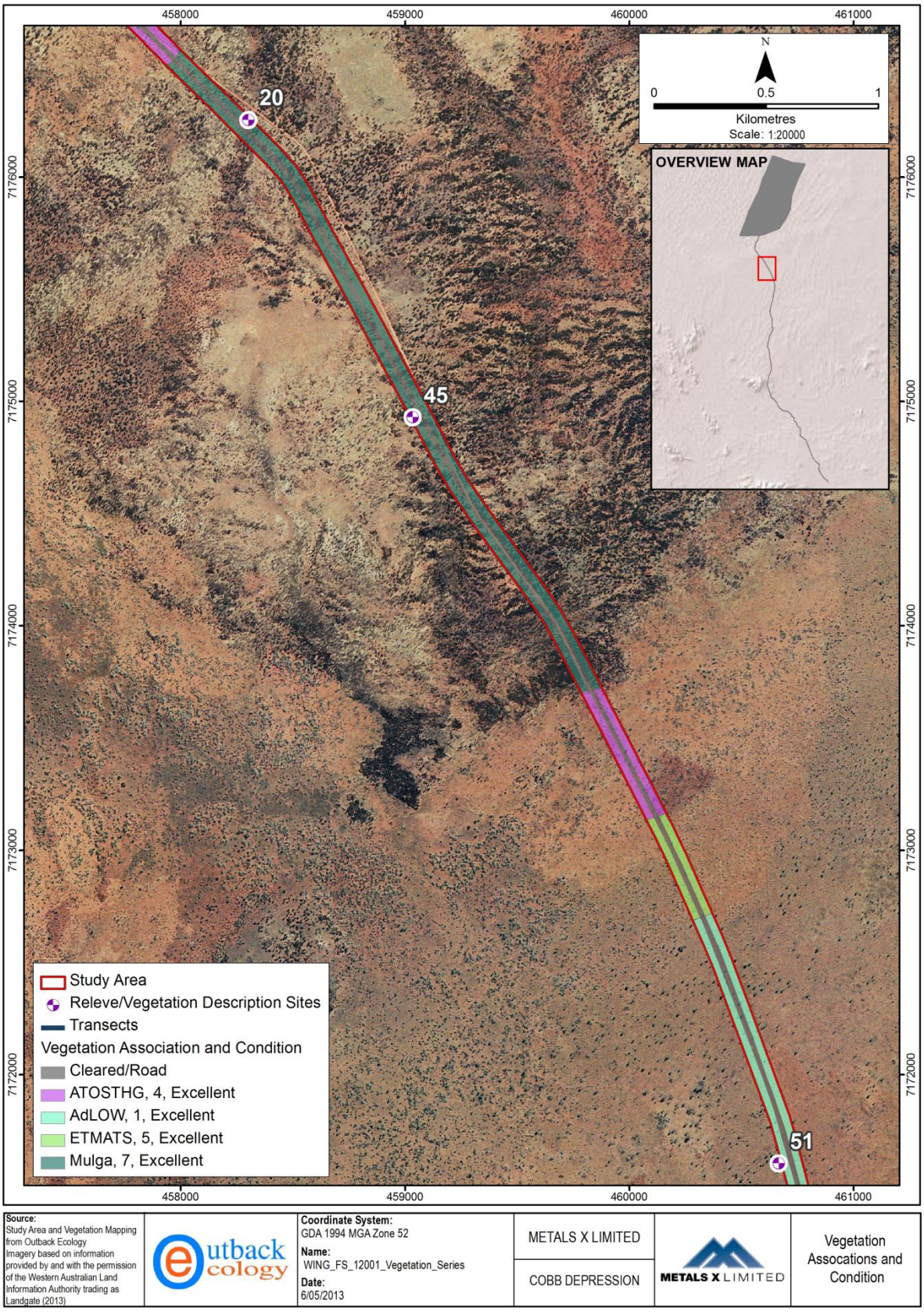
Mapping Of Vegetation Associations And Condition



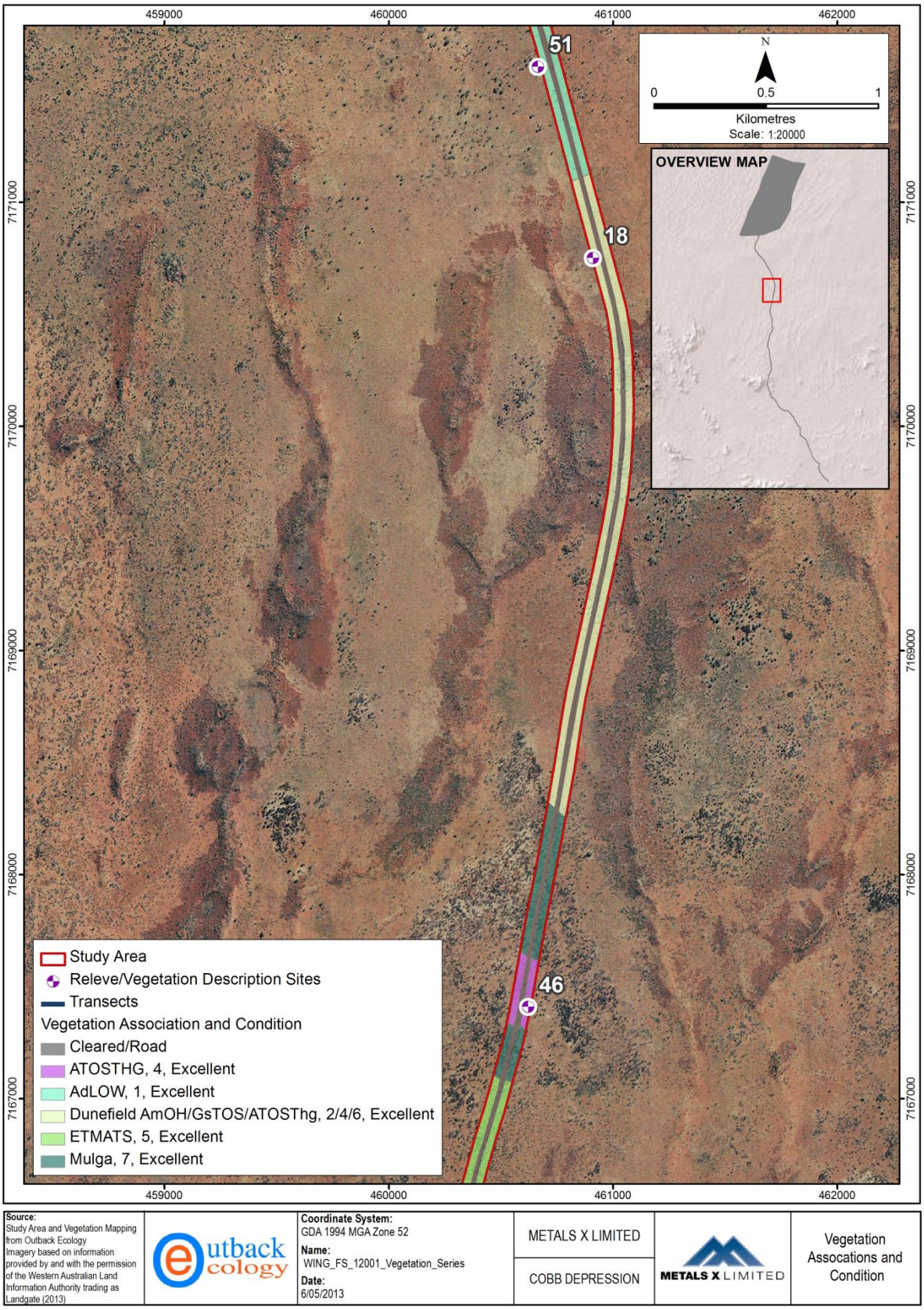
Vegetation Associations and Condition – Figure 1 of 13



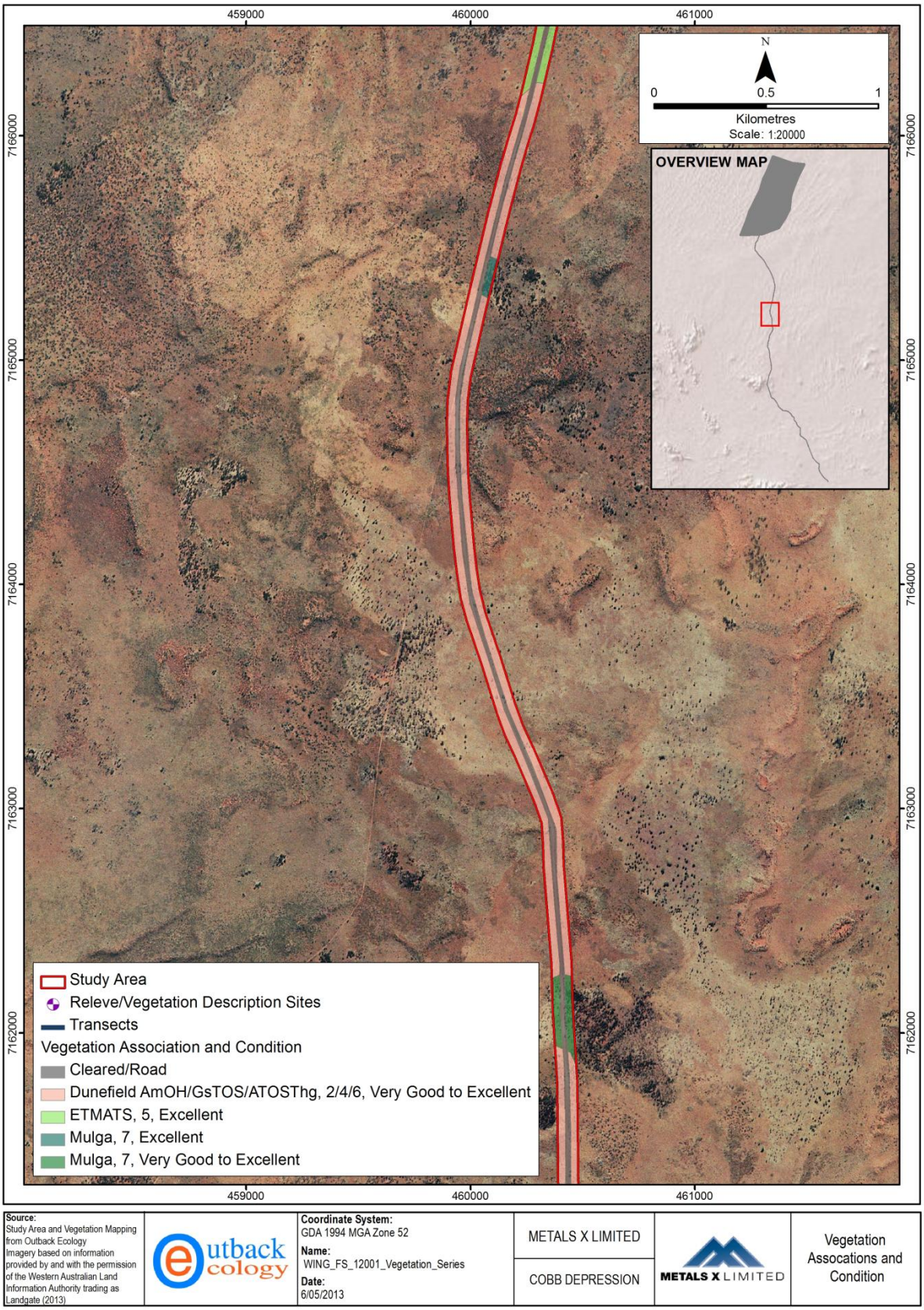
Vegetation Associations and Condition – Figure 2 of 13



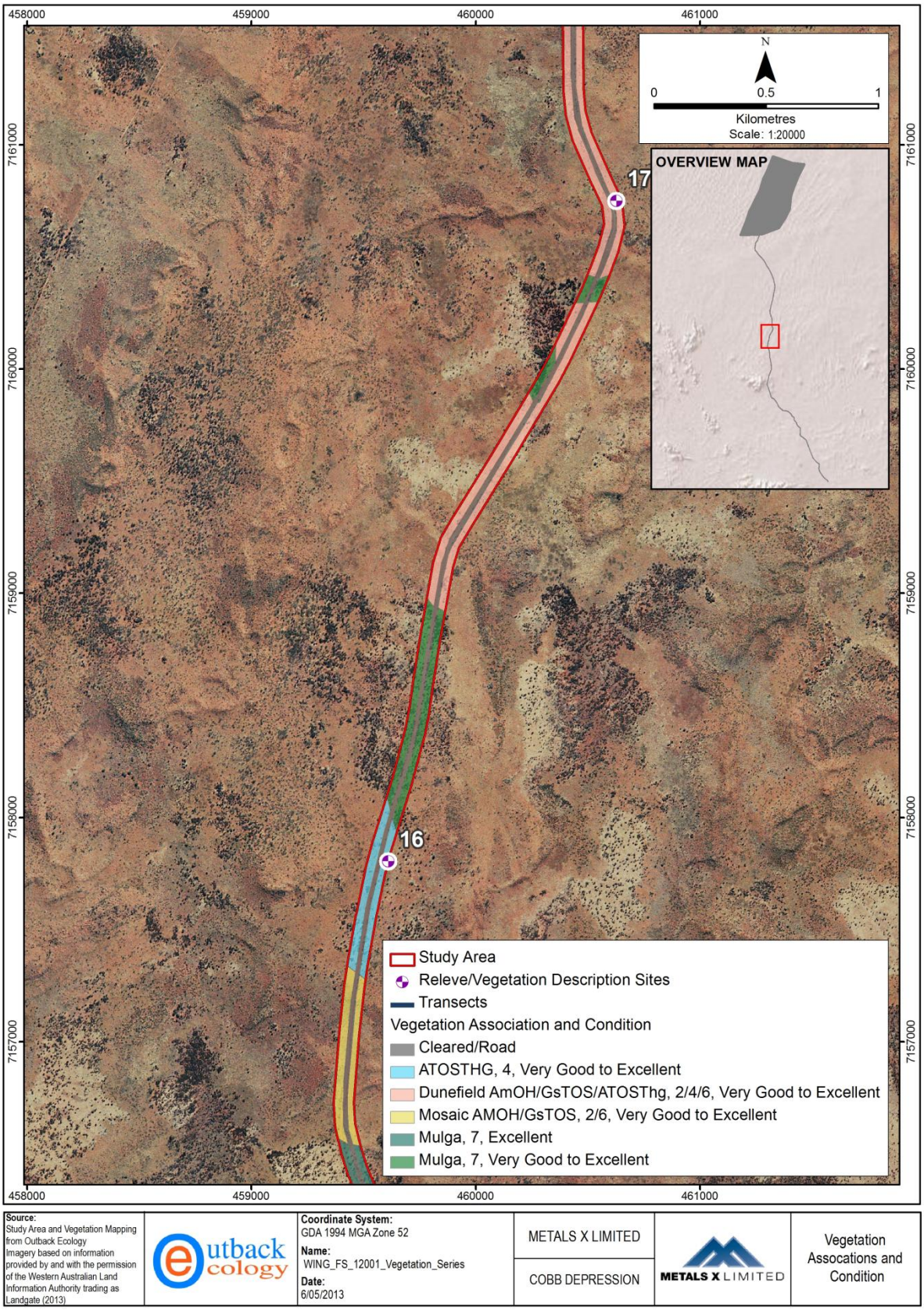
Vegetation Associations and Condition – Figure 3 of 13



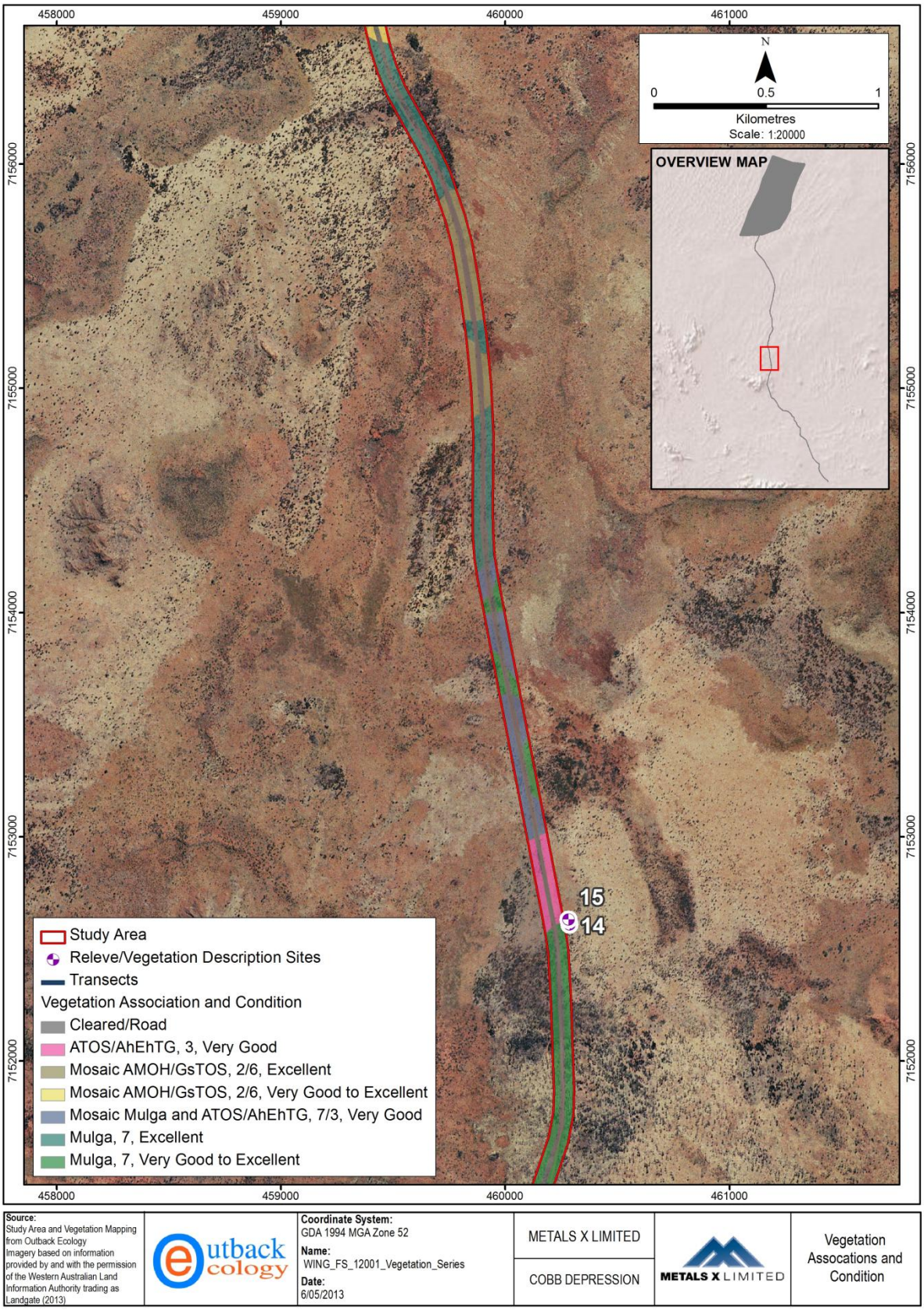
Vegetation Associations and Condition – Figure 4 of 13



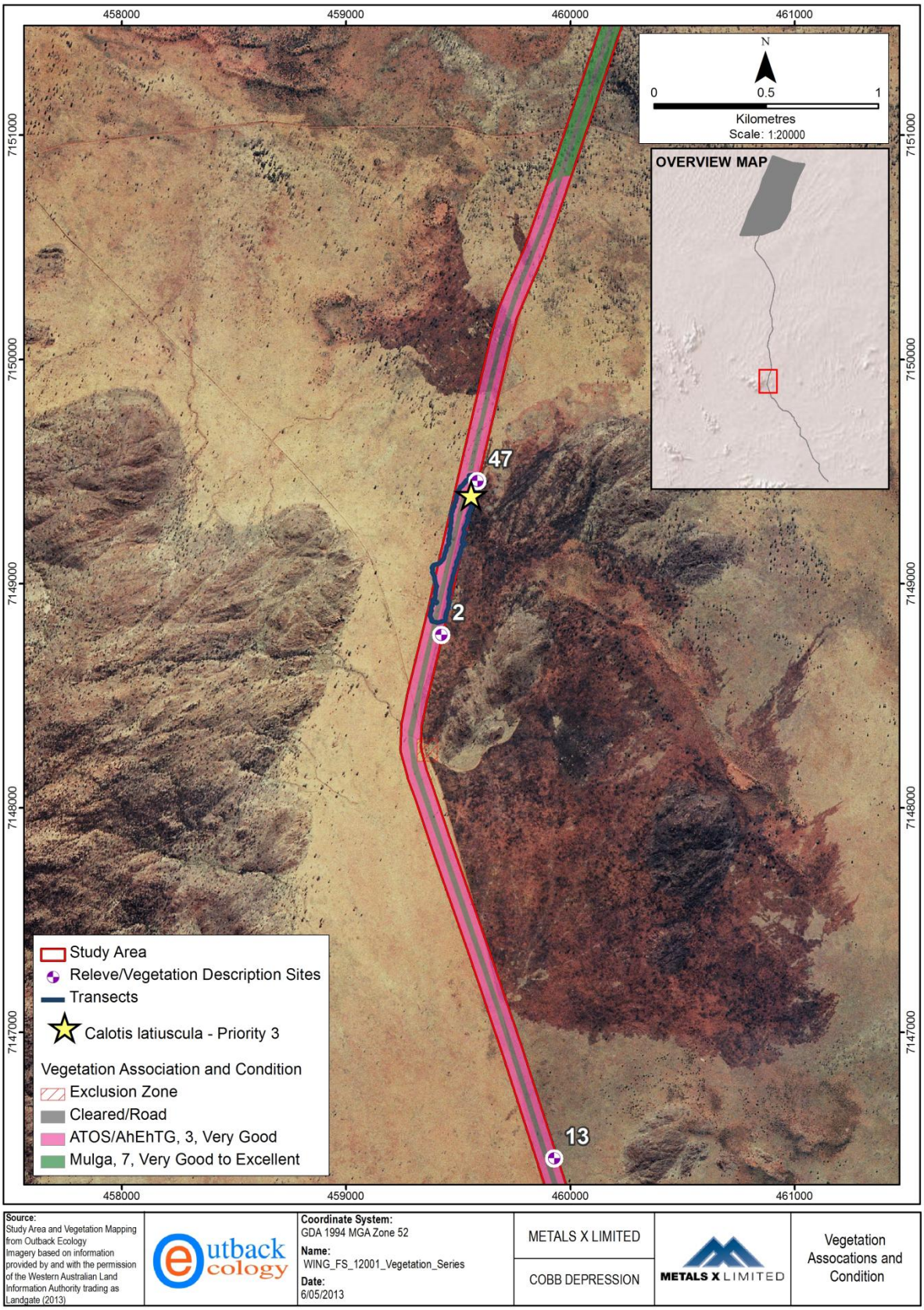
Vegetation Associations and Condition – Figure 5 of 13



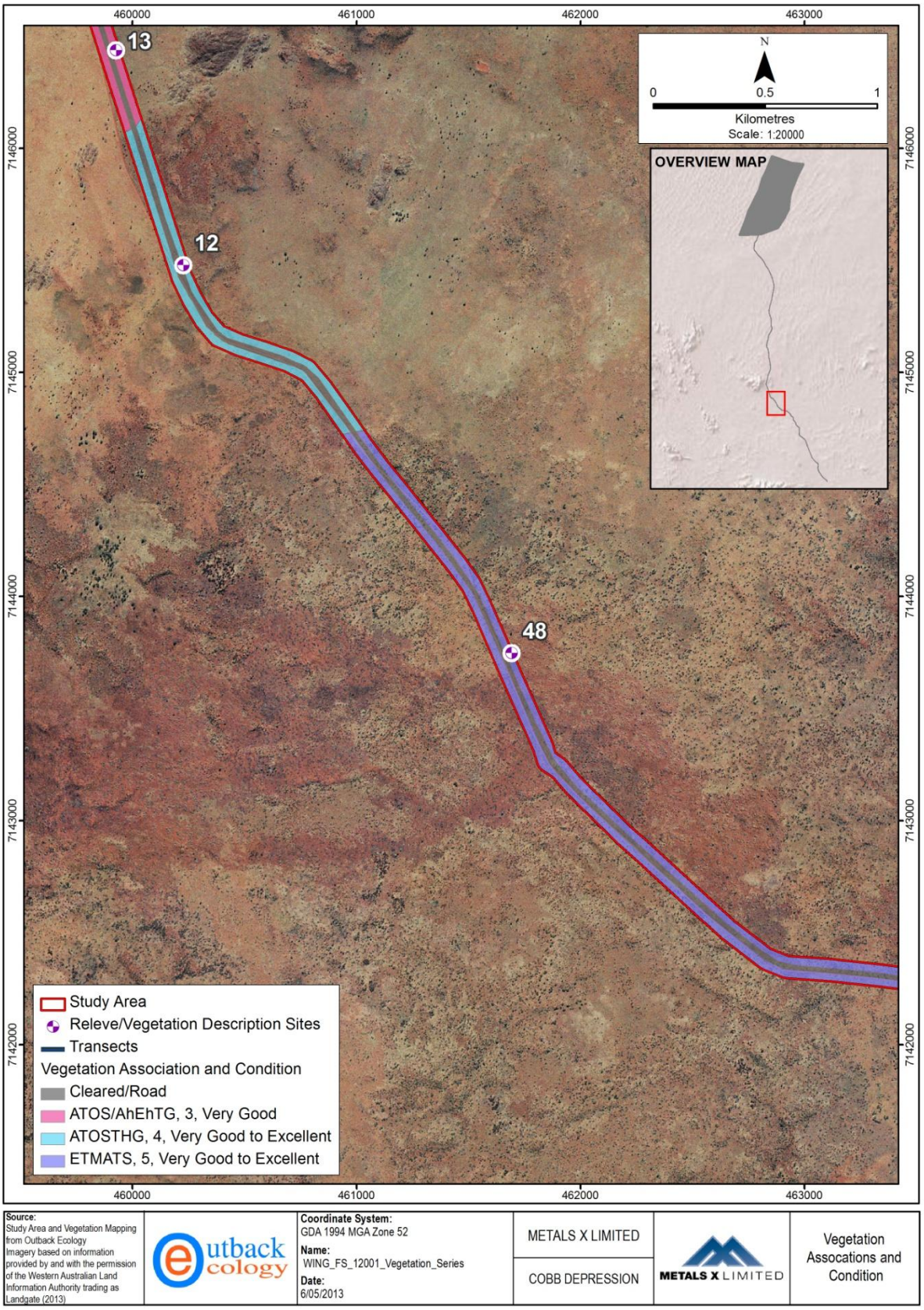
Vegetation Associations and Condition – Figure 6 of 13



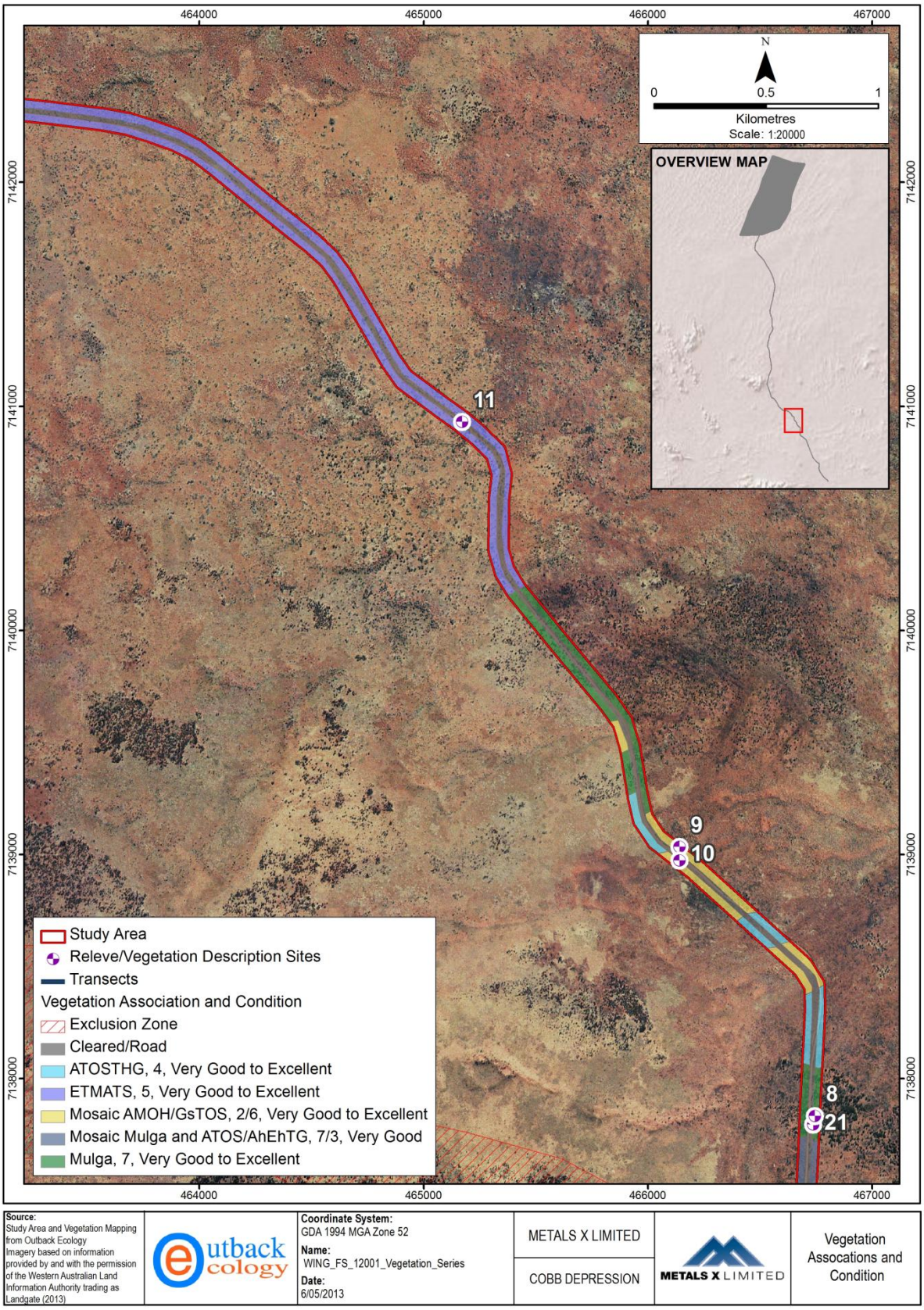
Vegetation Associations and Condition – Figure 7 of 13



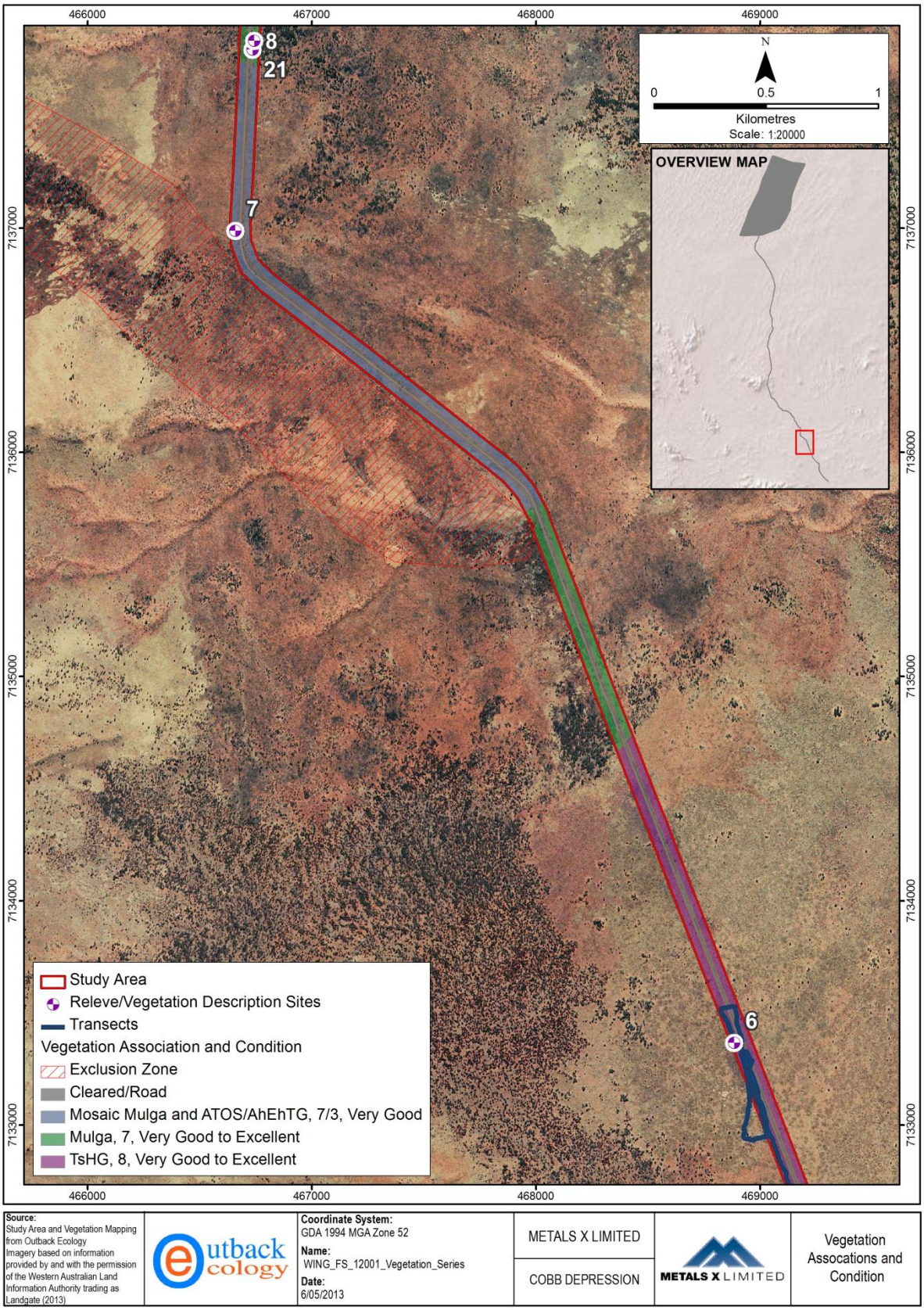
Vegetation Associations and Condition – Figure 8 of 13



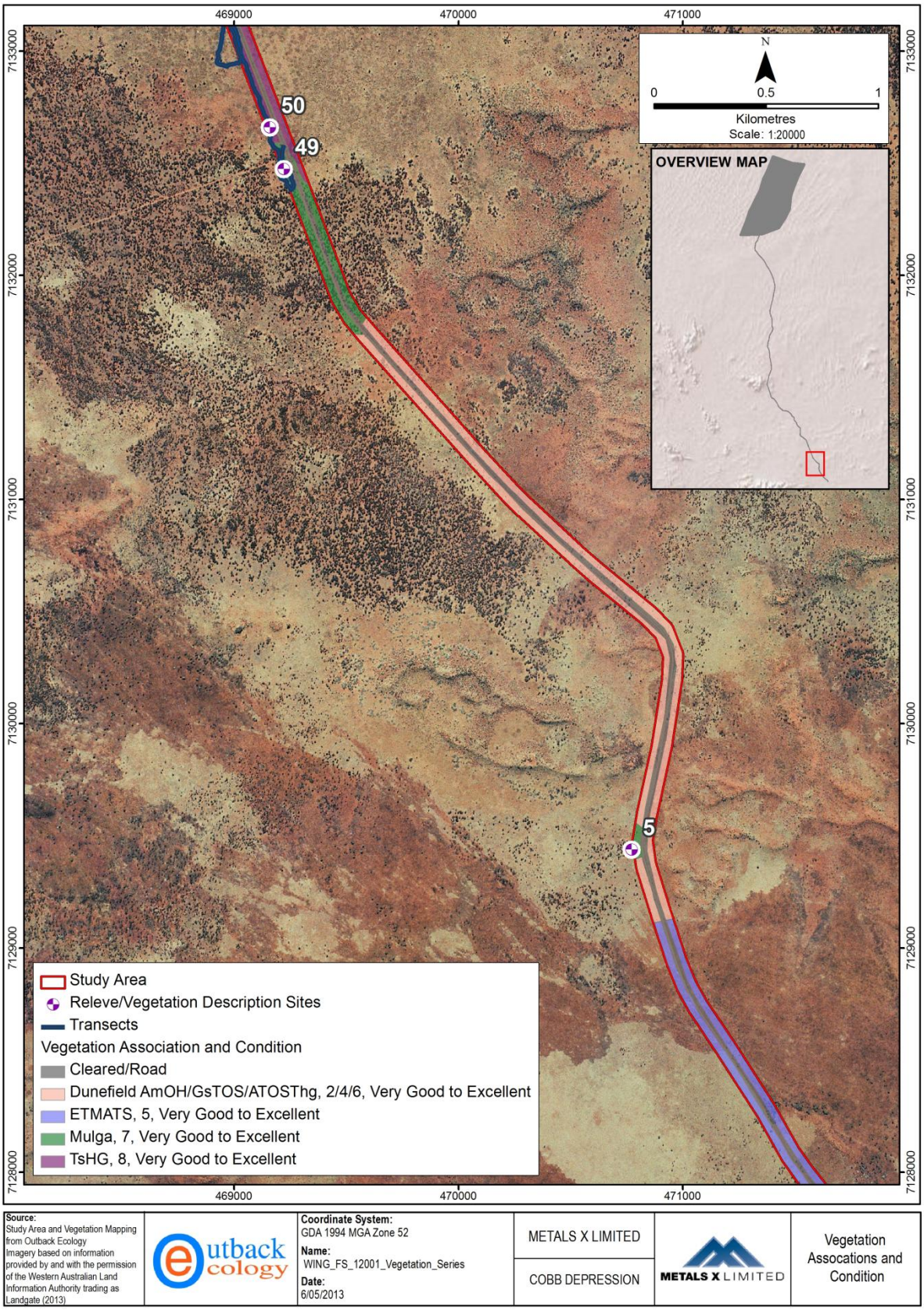
Vegetation Associations and Condition – Figure 9 of 13



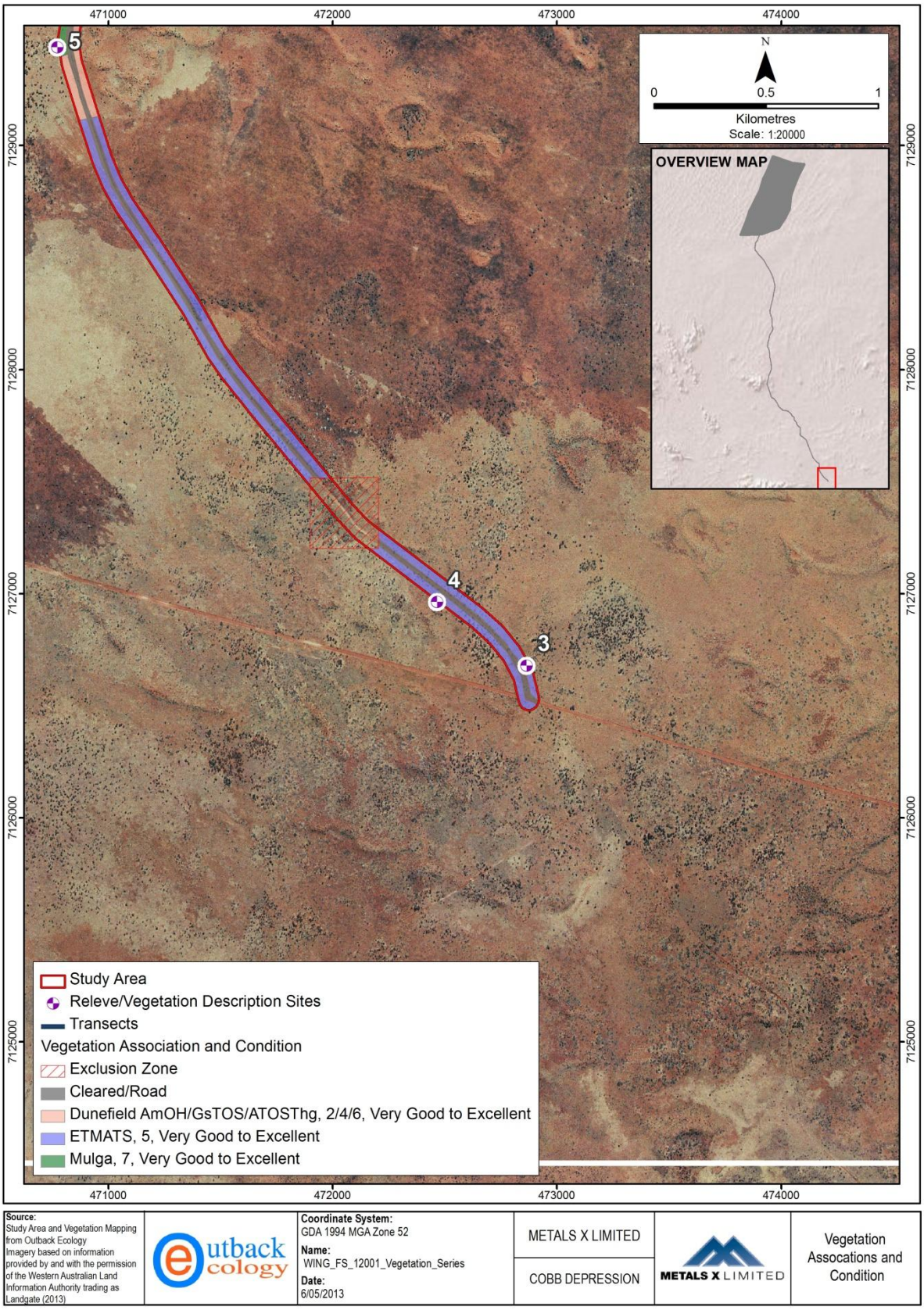
Vegetation Associations and Condition – Figure 10 of 13



Vegetation Associations and Condition – Figure 11 of 13



Vegetation Associations and Condition – Figure 12 of 13



Vegetation Associations and Condition – Figure 13 of 13

Relevé Site Descriptions

SITE	VEGETATION	
W01	Low Open Woodland of *Allocasuarina decaisneana* over a Shrubland of *Acacia melleodora* and *A. ligulata* over *Aluta maisonneuvei* over a Hummock Grassland of *Triodia schinzii* on the lower slopes of dunes.	
W02	Tall Open Shrubland of *Acacia aneura* over a scattered open Shrubland of *A. ligulata* over *Senna artemisioides* subsp*. helmsii* over a tussock grassland of *Aristida holathera* var. *holathera, Eragrostis eriopoda,* and *Cymbopogon obtectus* over an open herbland of *Cleome viscosa* and *Chrysocephalum pterochaetum* on red loamy sand flats.	
W03	Mixed Tall Open Shrubland and Mallee of *Eucalyptus oxymitra* and *Acacia aneura* over an Open Hummock Grassland of *Triodia pungens* with scattered tussocks of *Eragrostis eriopoda* on red sandy loam flats.	
W04	Tall Open Shrubland to Scattered tall shrubs and/or Mallees of *Eucalyptus oxymitra* and *Acacia aneura* over an Open Heath of *Aluta maisonneuvei* over an Open Hummock Grassland of *Triodia pungens* and *T. basedowii* on the lower slopes of dunes.	

SITE	VEGETATION	
W05	Tall Open Shrubland to Scattered Tall Shrubs *Acacia aneura* over a Shrubland *of A. pachyacra* over an Open Hummock Grassland *of Triodia basedowii* with scattered tussocks of *Eragrostis eriopoda* and *Eriachne helmsii* on loamy sand flats.	
W06	Isolated Tall Shrubs of *Acacia abrupta* and *Gyrostemon ramulosus* over a Mid to Dense Hummock Grassland of *Triodia schinzii* over a mixed herbland of *Leptosema chambersii*, *Goodenia mueckeana* and *Chrysocephalum pterochaetum* on red loam flats.	
W07	Tall Open Shrubland to Open Shrubland of *Acacia pachyachra, A. ?aneura* (hybrid) and *A. tetragonophylla* over an Open Tussock Grassland of *Aristida holathera* var. *holathera* and *Eragrostis eriopoda* on red sandy loam flats.	
W08	Tall Shrubland to Tall Open Shrubland (Mulga) of *Acacia aneura* over an Open Shrubland to Scattered Shrubs of *Eremophila latrobei* subsp. *latrobei* and *E. clarkei* over a Tussock Grassland of *Eragrostis eriopoda* on red loamy sand flats.	

SITE	VEGETATION	
W09	Scattered Tall Shrubs of *Grevillea stenobotrya* over an Open Heath of *Aluta maisonneuvei* over an Open Hummock Grassland of *Triodia schinzii* on lower dune slopes.	
W10	Tall Open Shrubland of *Gyrostemon ramulosus* and *Grevillea stenobotrya* over an Open Shrubland of *Acacia helmsiana* and Aluta *maisonneuvei* over a predominantly tussock grassland of *Aristida holathera* var. *holathera* with occasional dominance by hummock grasses (*Triodia schinzii*) on red sand dune lower to mid-slopes.	
W11	Tree Mallee to Open Tree Mallee of *Eucalyptus oxymitra, E. mannensis* subsp. *mannensis* and *E. gamophylla* over an Open Shrubland of *Acacia ligulata* and *Senna artemisioides* subsp. *petiolaris* over a Hummock Grassland of *Triodia pungens* on dune lower slopes to flats	
W12	Tall Open Shrubland of *Grevillea ?juncifolia* subsp. *juncifolia* over mixed *Acacia* species including *A. aneura, A. maitlandii* and *A. ligulata* over an Open Hummock Grassland of *Triodia pungens* with scattered tussocks of *Eragrostis eriopoda* on flats between sand dunes.	.

SITE	VEGETATION	
W13	Isolated Tall Shrubs of *Acacia aneura* over a Tussock Grassland of *Aristida holathera* var. *holathera, Eriachne helmsii* and *Cymbopogon obtectus* with some patches where invasion by **Cenchrus ciliaris* has occurred over an Open Herbland of *Cleome viscosa* on red loam flats.	
W14	Tall Shrubland (Mulga) of *Acacia aneura and A. pteraneura* with occasional *A. pruinocarpa* over a sparse tusscok grassland of *Eragrostis eriopoda* on clay flats.	
W15	Scattered *Acacia* spp. over a Tussock Grassland of *Eragrostis eriopoda*	
W16	Tall Open Shrubland of *Acacia pruinocarpa* and *A. ?aneura* (hybrid) over *A. minyura* and *Grevillea stenobotrya* over a Hummock Grassland of *Triodia schinzii* on red clay flats.	

SITE	VEGETATION	
W17	Tall Open Shrubland of mixed *Acacia* spp. including *A. pruinocarpa, A. ?aneura, A. ligulata* and *A. minyura* with *Grevillea stenobotrya* over a mid Hummock Grassland of *Triodia schinzii* on clay loam with silcrete nodules on small rise.	
W18	Mixed Tall Open Shrubland of *Grevillea ?juncifolia* subsp*. juncifolia* and *Acacia ?aneura* over a Low Open Shrubland of *Eremophila forrestii* subsp. *forrestii* over a Hummock Grassland of *Triodia basedowii* on red loam flats.	
W19	Tall Shrubland (Mulga) of *Acacia aptaneura* over a Shrubland to Open Shrubland of *Eremophila latrobei* subsp. *latrobei* over an Open Mixed Grassland of *Triodia basedowii* and *Eragrostis eriopoda* on red clay loam flats.	
W20	Tall Open Shrubland to Tall Shrubland of *Acacia pteraneura* over *A. tetragonophylla* and *A. kempeana* over an Open Shrubland of *Senna artemisioides* subsp. x *artemisioides* and *Eremophila latrobei* subsp. *latrobei* on red brown clay flats	

SITE	VEGETATION	
W21	Tall Open Shrubland to Tall Shrubland (Mulga) of *Acacia aneura* and over a tussock grassland of *Eragrostis eriopoda* and *Eriachne helmsii* on red clay flats.	
W22	Tall Isolated Shrubs of *Acacia aneura* and *A. minyura* over a Low Open Shrubland to Scattered Shrubs of *Aluta maisonneuvei* and *Melaleuca centralis* over a Hummock Grassland of *Triodia basedowii* on inter-dune flats.	
W23	Open Shrubland to Scattered Shrubs of *Grevillea eriostachya* over an Open Heath of *Aluta maisonneuvei* over an Open Hummock Grassland of *Triodia basedowii* on red sand dune lower to mid slopes.	
W24	Tall Open Shrubland to Open Shrubland of *Acacia pruinocarpa*, *A. aneura* and *A. maitlandii* over an Open Shrubland of *Aluta maisonneuvei* and *Micromyrtus flavifolia* over a Hummock Grassland of *Triodia schinzii.*	

SITE	VEGETATION	
W25	Isolated *Brachychiton gregorii* over scattered tall Shrubs of *Acacia pruinocarpa* and *Eucalyptus gamophylla* over an Open Shrubland of *Grevillea eriostachya* and *Aluta maisonneuvei* (with *Aluta* becoming more dominant towards the base of dunes) over a Low Open Shrubland of *Androcalva loxophylla* over a Hummock Grassland of *Triodia basedowii* on red loam flats between dunes.	
W26	Low Open Woodland to Scattered Trees of *Allocasuarina decaisenana* over a mixed Tall Shrubland of *Acacia pruinocarpa, A. ?aneura* and *Eucalyptus gamophylla* over *Grevillea eriostachya* over a Hummock Grassland of *Triodia basedowii* on red loam flats between dunes.	
W27	Scattered Tall Shrubs of *Acacia pruinocarpa* over *A. pachyachra* and *A. maitlandii* over a Low Open Shrubland of *Eremophila forrestii* subsp. *forrestii* over a Hummock Grassland of *Triodia basedowii* on red loam flats between dunes.	
W28	Tall Open Scrub (Mulga) of *Acacia aptaneura* over an Open Shrubland of *Eremophila clarkei* over an Open Tussock Grassland of *Eragrostis eriopoda* on clay loam flats.	

SITE	VEGETATION	
W29	Open Woodland of *Corymbia opaca* over a mixed *Acacia* shrubland on red loam flats (smaller shrubs and grasses have been recently burnt so unable to describe)	
W30	Tall Shrubland to Tall Open Shrubland of *Acacia ligulata* with occasional *Eucalyptus gamophylla* and *A. pruinocarpa* over a Low Open Shrubland of *Aluta maisonneuvei* over a Hummock Grassland of *Triodia basedowii* on dune lower slopes.	
W31	Mulga of *Acacia aneura* and *A. minyura* over a scattered Shrubland of *Eremophila clarkei* over a Hummock Grassland of *Triodia basedowii* on red loam flats.	
W32	Mixed Tall Shrubland to Tall Open Shrubland of *Acacia pruinocarpa, A. aneura, A. ligulata* and *A. minyura* over a Hummock Grassland of *Triodia basedowii.*	

SITE	VEGETATION	
W33	Mixed Tall Open Shrubland to Tall Shrubland of *Eucalyptus gamophylla*, *Acacia pruinocarpa, A. ?aneura* and *A. ligulata* over a Hummock Grassland of *Triodia basedowii* on red loam	
W34	Tall Open Shrubland of *Acacia ligulata* and *Grevillea stenobotrya* over scattered *Santalum lanceolatum* and *Corynotheca micrantha* var. *divaricata* over an Open Tussock Grassland of *Aristida holathera* var. *holathera* on red sand dune crests.	
W35	Tall Open Shrubland of *Acacia pruinocarpa* over *A. maitlandii* over a Low Open Shrubland of *Eremophila forrestii* subsp. *forrestii* and *Senna artemisioides* subsp. x *artemisioides* over a Hummock Grassland of *Triodia basedowii* and *T. schinzii* with scattered tussocks of *Eriachne helmsii.*	
W36	Occasional stand of *Allocasuarina decaisneiana* over a Tall Open Shrubland/Woodland of *Acacia pruinocarpa* over a Low Open Shrubland of *Grevillea eriostachya*, *Santalum lanceolatum* and *Aluta maisonneuvei* over a Hummock Grassland of *Triodia basedowii* and *Triodia schinzii* on flats between dunes.	

SITE	VEGETATION	
W37	Tall Open Shrubland/Mallee of *Acacia sericophylla* and *Eucalyptus gamophylla* over a Low Open Shrubland of *Eremophila forrestii* subsp. *forrestii* with scattered *Aluta maisonneuvei* over a Hummock Grassland of *Triodia schinzii* and *Triodia basedowii* on red loam flats.	
W38	Scattered Shrubs of *Acacia minyura*, *Grevillea eriostachya* and *Santalum lanceolatum* over an Open Heath of *Aluta maisonneuvei* and *Micromyrtus flavifolia* over an Open Hummock Grassland of *Triodia basedowii* on dune lower slopes	
W39	Tall Open Shrubland of *Acacia ligulata*, *Dodonaea viscosa* subsp*. angustissima* and *Grevillea stenobotrya* over a Low Open Shrubland of *Indigofera georgei* over an Open Tussock Grassland of *Aristida holathera* var. *holathera* on dune crests.	
W40	Isolated Tall Shrubs to Scattered Tall Shrubland of *Acacia pruinocarpa*, *Acacia maitlandii* and *Eucalyptus gamohphylla* over a Low Open Shrubland of *Aluta maisonneuvei* over *Androcalva loxophylla, Bonamia erecta* and *Leptosema chambersii* over a Hummock Grassland of *Triodia basedowii* and *Triodia schinzii* on red sandy loam flats.	

SITE	VEGETATION	
W41	Tall Open Shrubland of *Acacia sericophylla* with scattered *Corymbia chippendalei* over a Low Open Shrubland of *Indigofera georgei* and *Aluta maisonneuvei* over an Open Tussock Grassland of *Aristida holathera* var. *holathera* on red sand dunes.	
W42	Tall Open Shrubland to Open Shrubland of *Grevillea stenobotrya* and *Acacia ligulata* over a Low Open Shrubland of *Senna artemisioides* subsp. x *artemisioides* and *Santalum lanceolatum* over a mized grassland of *Eragrostis eriopoda, Aristida holathera* var. *holathera* and *Triodia schinzii* on dune crests.	
W43	Scattered Tall Shrubs to Tall Open Shrubland of *Acacia pruinocarpa, A. aneura* and *A. pachyacra* over a Low Open Shrubland to Scattered Low Shrubs of *Eremophila forrestii* subsp*. forrestii* over a Hummock Grassland of *Triodia basedowii* and *Triodia schinzii* on loam flats between dunes.	
W44	Scattered Tall Shrubs of *Acacia aneura* over an Open Heath of *Aluta maisonneuvei* over an Open Hummock Grassland of *Triodia schinzii* with *T. basedowii* on dune lower slopes.	

SITE	VEGETATION	
W45	Tall Open Shrubland (Mulga) of *Acacia aneura* over scattered *Eremophila* spp. over a sparse tussock grassland of *Eragrostis sp*. on clay flats.	
W46	Tall Open Shrubland of *Acacia pruinocarpa* and *A. ?aneura* over a Low Open Shrubland to Scattered low shrubs of *Eremophila forrestii* subsp. *forrestii* over a Hummock Grassland of *Triodia basedowii* on clay loam flats.	
W47	Tall Open Shrubland to Isolated Tall Shrubs of *Acacia aneura* over an Open Shrubland of *Senna artemisioides* subsp. x *artemisioides* over a mixed tussock grassland of *Cymbopogon obtectus, Aristida holathera* var. *holathera* with patchy dominance by *Cenchrus cilaris* over a mixed herbland of *Cleome viscosa*, *Tribulus* sp. and *Chrysocephalum pterochaetumon* loamy clay flats.	
W48	Occasional Tall Shrubs of *Acacia aneura* over an Open Tree Mallee of *Eucalyptus oxymitra* over scattered *Acacia maitlandii* over a Hummock Grassland of *Triodia schinzii* on red loamy sand flats.	

SITE	VEGETATION	
W49	Tall Open Shrubland to Tall Shrubland (Mulga) of *Acacia aneura* over a Low Open Shrubland of *Eremophila* spp. over a predominantly tussock grassland of *Eriachne helmsii* and *Eragrostis eriopoda* with patches of hummock grasses (*Triodia schinzii*) on red loamy clay flats.	
W50	Scattered Tall Shrubs to Shrubs of *Acacia pruinocarpa, A. pachyachra, A. ?aneura* and *A. melleodora* over a Hummock Grassland of *Triodia schinzii* (with scattered tussocks of *Eragrostis laniflora* and *Eriachne helmsii* over an Open Herbland of *Leptosema chambersii*, *Goodenia mueckeana*, *Androcalva loxophylla* and *Chrysocephalum pterochaetum* on red loamy sand flats.	
W51	Low Open Woodland of *Allocasuarina decaisneana* over scattered Shrubs of *Acacia ? aneura* and *Exocarpos sparteus* over a Hummock Grassland of *Triodia basedowii* on red loam flats.	
W52	Tall Open Shrubland of *Acacia kempeana* over an Open Shrubland of *Grevillea eriostachya* over a Hummock Gtrassland *of Triodia basedowii* with *T. schinzii* over scattered *Androcalva loxophylla* on red loam flats.	

SITE	VEGETATION	
W53	Tall Open Shrubland of *Acacia pruinocarpa* over an Open Shrubland of *Eremophila forrestii* subsp. *forrestii* and *Aluta maisonneuvei* with patchy dominance by *Santalum lanceolatum* over a Hummock Grassland of *Triodia basedowii* and *T. schinzii* over an Open Herbland of *Bonamia erecta* and *Androcalva loxophylla* on loam flats adjacent to sand dunes.	

APPENDIX G
Species By Vegetation Association

SPECIES	ATOS/AhEhTG	ETMATS	Mulga	TsTHG	AmOH	ATOSTHG	GsTOS	AdLOW
Abutilon otocarpum	+							
Acacia ? aneura	+	+	+	+	+	+		+
Acacia ?aptaneura			+					
Acacia abrupta				+		+		
Acacia aneura	+	+	+		+	+		
Acacia aptaneura			+					
Acacia ?ayersiana	+		+					
Acacia helmsiana					+			
Acacia kempeana			+			+		
Acacia ligulata	+	+	+		+	+	+	
Acacia maitlandii		+			+	+		
Acacia melleodora		+		+	+	+		
Acacia minyura			+		+	+		
Acacia pachyacra	+		+	+		+		
Acacia pruinocarpa	+		+	+	+	+		
Acacia pteraneura	+		+		+	+		
Acacia sericophylla						+	+	
Acacia tetragonophylla	+	+	+			+		
Allocasuarina decaisneana					+	+		+
Aluta maisonneuvei		+			+	+	+	
Androcalva loxophylla			+	+	+	+		
Anthobolus leptomerioides					+	+		
Aristida contorta	+		+		+			
Aristida holathera var. *holathera*	+	+	+		+	+	+	
Aristida sp.	+							
Asteraceae sp.	+							
Boerhavia coccinea					+			
Bonamia erecta		+		+		+		
Brachychiton gregorii		+				+		
Calotis latiuscula (P3)	+							
Calytrix carinata						+		
Cenchrus ciliaris	+	+	+					
Cheilanthes sieberi subsp. *sieberi*			+					
Chrysocephalum apiculatum	+			+				
Chrysocephalum pterochaetum	+		+	+		+		
Chrysocephalum puteale				+			+	
Citrullus colocynthis	+							
Cleome viscosa	+							
Codonocarpus cotinifolius		+	+	+	+	+		
Corymbia chippendalei							+	
Corymbia opaca						+		
Corynotheca micrantha var. *divaricata*							+	
Crotalaria cunninghamii							+	
Crotalaria eremaea subsp. *strehlowii*	+							
Cymbopogon obtectus	+	+	+	+		+		
Dactyloctenium radulans			+		+			

SPECIES	ATOS/AhEhTG	ETMATS	Mulga	TsTHG	AmOH	ATOSTHG	GsTOS	AdLOW
Dampiera roycei						+		
Dicrastylis doranii						+	+	
Digitaria ammophila			+					
Digitaria brownii	+							
Dodonaea viscosa subsp. *angustissima*		+					+	
Enchylaena tomentosa	+							
Eragrostis eriopoda	+	+	+	+		+	+	
Eragrostis laniflora				+	+			
Eragrostis sp.			+					
Eremophila clarkei			+					
Eremophila duttonii			+					
Eremophila forrestii subsp. *forrestii*						+		
Eremophila gilesii subsp. *gilesii*			+					
Eremophila latrobei subsp. *latrobei*	+		+	+		+		
Eremophila longifolia		+	+		+			
Eremophila platythamnos subsp. *exotrachys*		+			+	+	+	
Eremophila sp.					+			
Eriachne aristidea						+		
Eriachne helmsii	+	+	+	+		+	+	
Eriachne sp.			+	+		+		
Eucalyptus gamophylla		+	+		+	+		
Eucalyptus mannensis subsp. *mannensis*		+						
Eucalyptus oxymitra		+						
Euphorbia drummondii	+	+	+	+	+	+		
Exocarpos sparteus						+		+
Glischrocaryon angustifolium						+		
Goodenia centralis				+		+		
Goodenia heterochila	+							
Goodenia mueckeana				+				
*Grevillea ? juncifoli*a subsp. *juncifolia*				+		+		
Grevillea eriostachya					+	+		
Grevillea stenobotrya		+			+	+	+	
Gyrostemon ramulosus				+	+			
Hakea chordophylla				+				
Hakea divaricata		+			+	+		
Halgania erecta						+		
Heliotropium moorei	+							
Hibiscus burtonii	+							
Hibiscus sturtii var. *truncatus*			+			+		
Indigofera georgei	+	+					+	
Kennedia prorepens						+		
Lepidium phlebopetalum	+							
Leptosema chambersii				+		+		
Maireana tomentosa	+		+					
Melaleuca interioris						+		
Micromyrtus flaviflora					+	+		

SPECIES	ATOS/AhEhTG	ETMATS	Mulga	TsTHG	AmOH	ATOSTHG	GsTOS	AdLOW
Newcastelia spodiotricha				+	+			
Paraneurachne muelleri					+	+		+
Portulaca oleracea	+							
Prostanthera sericea						+		
Ptilotus helipteroides			+					
Ptilotus macrocephalus			+					
Ptilotus obovatus					+	+		
Ptilotus schwartzii var. *schwartzii*						+		
Quoya loxocarpa							+	
Rhagodia eremaea			+					
Rostellularia adscendens var. *pogonanthera*	+							
Salsola australis		+	+					
Santalum lanceolatum			+		+	+	+	
Scaevola parviflora				+			+	
Olearia subspicata				+	+			
Scaevola spinescens						+		
Senna artemisioides subsp. *filifolia*	+		+				+	
Senna artemisioides subsp. *helmsii*	+				+			
Senna artemisioides subsp. *petiolaris*		+						
Senna artemisioides subsp. *x artemisioides*	+		+	+		+		
Senna pleurocarpa var. *pleurocarpa*	+	+				+		
Sida cardiophylla						+	+	
Sida sp.	+							
Sida sp. Excedentifolia (J.L. Egan 1925)					+			
Solanum centrale	+		+	+		+		
Solanum lasiophyllum	+					+		
Themeda triandra	+							
Tribulus sp.	+							
Triodia basedowii			+		+	+		
Triodia pungens		+			+	+		
Triodia schinzii		+	+	+	+	+	+	
Triodia sp.						+		+
Logania centralis						+		
Acacia ?aneura (hybrid)			+					