Level 2 Flora and Vegetation Survey - Mummaloo

Top Iron Pty Ltd

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Report Name: Level 2 Flora and Vegetation Survey Mummaloo	
Project Manager	Name: Laura Todd
Report Author	Name: Stephen Connell
Draftsperson/GIS Technician	Name: Stephen Connell

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Author Review	Name: Stephen Connell	Signature: 	Date: 23/08/2012
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EXECUTIVE SUMMARY

This report provides a review of the Flora and Vegetation within Top Iron's tenement at Mummaloo located near Mt Gibson, 75 km northeast of Wubin, Western Australia (WA). Following a desktop review and relevant database search, on-site floristic surveys were undertaken during Winter and Spring 2011 (16-19 July, 24-29 October) and Winter 2012 (12-19 August).

The surveys involved traversal of the study area during which plant specimens were collected for later identification. Ninety eight 100m^2 floristic quadrats were established. All plants species were identified in each quadrat and their percentage cover estimated. During traversal, special attention was given to determining the presence of Rare and Priority species and the status of any populations found. Mapping of structural and floristic plant communities was based on the ground survey, quadrat analysis and aerial photograph interpretation.

Two structural plant communities were mapped as a result of aerial photograph interpretation and the field study. A *Eucalyptus loxophleba var supralaevis - E. salmonophbloia* woodland community was found to occur on flat areas with surrounding hills covered by an open to dense, tall, multi-species shrubland dominated by Acacia and Melaleuca species.

Seven Floristic communities were identified by multivariate analysis of the quadrat data. Four of these communities occur within the multi-species shrublands while three were identified within the woodland structural community. No Threatened or Priority Ecological Communities (TEC's/PEC's) were located during the field survey.

The native vegetation varies in ecological condition. Most of the area is in good to very good ecological condition. Those areas subject to grazing by feral animals (camels, rabbits) are in degraded to very degraded condition. Physical disturbance associated with tracks, abandoned shacks, garbage dumps and historical drilling has caused severe localised damage.

176 native plant species were recorded within the study area. Seven exotic plant species (weeds) were recorded. These were mostly in association with disturbance (e.g. roadside disturbance and around abandoned shacks and mines).

Four Conservation Priority species were identified (*Allocasuarina tessellata* – Department of Environment and Conservation (DEC) Priority 1 as well as *Grevillea scabrida, G. subtiliflora* and *Persoonia pentasticha* – all three DEC Priority 3). The populations of all four species are healthy, widespread and abundant within the tenement. All four species occur mainly within the multi-species Shrublands.

There was no evidence of plant disease or significant weed incursion within the study area.

1 INTRODUCTION

Top Iron commissioned a Level 2 Flora Survey at its Mummaloo Project (Tenement E59/1694, Figures 1 and 2) to assess flora and vegetation values of the area, to assist with Environmental Impact Assessment of proposed mining activities in the future.. Following a desktop review, an on-site floristic survey of the tenement was undertaken in Winter and Spring 2011 (16-19 July, 24-29 October).

The objectives of the survey were to:

- Develop an inventory of the flora occurring within the survey area and determine the presence of any flora of conservation significance.
- Undertake an assessment of vegetation communities present, their condition and potential conservation significance.

1.1 STUDY LOCATION

Top Iron's exploration tenement at Mummaloo is located near Mt Gibson, 75 km northeast of Wubin, Western Australia (WA) – Figures 1 and 2. The Mount Gibson area lies within the Murchison Geological Province of the Yilgarn Craton. The Mount Gibson Range occurs in the southern part of the Yalgoo IBRA region. This area is an inter-zone, between southwest bioregions and the Murchison IBRA region (Environment Australia 2000). Broadscale mapping by Beard (1976) shows several vegetation associations.

The Mount Gibson Range was mapped as shrublands of *Acacia acuminata* (jam) and *Allocasuarina acutivalvis* on ironstone. Colluvial slopes were mapped as medium woodland of York gum (*Eucalyptus loxophleba*), Salmon gum (*Eucalyptus salmonophloia*) and gimlet (*Eucalyptus salubris*). Surrounding Mount Gibson, the vegetation was mapped as shrubland of bowgada (*Acacia ramulosa*) and *Acacia quadrimarginea* on stony ridges and shrublands of bowgada and jam scrub.

Mount Gibson is part of the Tallering Land System (Payne *et al*. 1998). These included several plant communities occurring on the landforms; 20% of the system is composed of ridges and hillswith shallow stony red earths with *A. ramulosa* and other acacias over *Thryptomene* and *Philotheca* species. Fifty eight percent of the land system consisted of hillslopes covered in scattered to moderately dense shrublands of *A. ramulosa* and other *Acacia* spp. over *Eremophila* spp., *Ptilotus obovatus*, *Thryptomene* spp. and *Philotheca* spp. The remaining part of the system covered the stony plains, drainage tracts and stripped surfaces.

2 METHODS

The potentially significant species and associations of flora expected to occur within the vicinity of the study area were identified and compiled by searching Department of Environment and Conservation (DEC) databases using a 15 km search buffer areas around the Mummaloo tenement. The centre point for the 15 km search buffer was 119°41' 29.99868' E, - 24°24'0" S. Databases searched included the following:

- The Threatened Flora Database.
- The WA Herbarium.
- The Declared Rare Flora and Priority Flora List.

A search of the DEC's Threatened Ecological Communities (TEC) Database used a 15 km buffer around the tenement. The north-west corner of the bounding box of the search area is 118° 33' 43.3044"E, -23° 25' 17.6484"S and the south-east corner is 120° 46' 46.4484"E, -25° 15' 32.6664"S. All maps and data are in GDA94 Zone 50 coordinates.

The flora and vegetation survey was designed to meet the criteria for a Level 2 survey as outlined within Environmental Protection Authority (EPA) Guideance Statement Number 51 (2004) *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.*

The on-site floristic surveys were undertaken during Winter and Spring 2011 (16-19 July, 24-29 October) and Winter 2012 (12-19 August). The surveys involved traversal of the study area during which plant specimens were collected for later identification. During traversal, particular attention was paid to determining the extent of Rare and Priority species and, if found, the status of any populations of these species. Plant specimens were identified and verified using the resources of the State Herbarium and on-line State Herbarium database 'Florabase'.

Plant Structural and Floristic Communities were mapped. Plant Structural Communities are based on the pattern of vegetation at a local scale as they reflect the underlying key determining factors of landforms, soils and hydrology. They are determined by the structure of the plant community and taxon dominance. Floristic community types are assemblages as defined by Gibson et al. (1994). The presence or absence of individual taxa in standard areas (quadrats) is used to define floristic groupings (or community types) based on shared species.

A total of ninety eight 100 m^2 floristic quadrats were established (Figure 3) within the tenement. Within each quadrat all plant species were identified and their cover determined. In addition a number of photographic locations were established to aid vegetation mapping. Mapping of structural plant communities was based on aerial photograph interpretation with the field studies providing details of community floristics and structure. Ecological condition was assessed according to Keighery (1994). The vegetation condition rating scale used is included as Appendix A. Evidence of threatening processes and indicators of plant population health, including dieback, canker and galling (if present) were also noted during field traversals. Plant community and structural formation definitions follow Muir (1977) as outlined in Appendix B.

The method used in the multivariate analysis of the quadrat data is illustrated below. A simple illustration is provided in Box 1. The data used for this analysis was species cover collected at the 98 floristic quadrats. These data were transformed into Braun-Blanquet Cover Classes (Table 1) to reduce bias in the classification due to high cover values (Jongman *et al.* 1987).

A two-way indicator species analysis (TWINSPAN, Hill *et al.* 1975) was used to classify plant quadrats on the basis of their species composition using WinTWINS Version 2.3 (Hill. & Šmilauer, 2005). TWINSPAN is a method of constructing a classification of sites, and using this site classification to obtain a classification of the species according to their ecological preferences. The two classifications are then used together to

obtain an ordered two-way table that expresses the species' and sites' ecological relationships as succinctly as possible.

Table 1: Cover Classes.

Cover Class	Percentage Cover
1	0 - 4%
2	5 - 25%
3	26 - 50%
4	51 - 75%
5	76 - 100%

Box 1. TWINSPAN Example

Table 2 shows a simple example of a TWINSPAN analysis. The rearrangement of both sites (columns) and species (rows) groups sites having similar species composition. Site groups are displayed in the bottom 2 rows of the table while species groups are displayed in the right 2 columns. Species composition data (the body of the Table) are Cover Classes (see Table 1).

The bottom rows show colour-coded groups of sites. The bottom row has 4 groups while the row above has only two groups. This latter row is the first step which segregated the sites into two groups with the next step separating these first groups into two each (bottom row). The species groups are colour-coded to match the site groups.

Sites 9, 15 and 11 comprise one of the final groups (red). This site group has similarities with the fourth group (sites 12, 13, and 14) but the first two groups of sites (blue and green) are less similar to it. The species group is typified by the presence of species C and R and they share many species but also have relatively few species which are associated with other site groups.

Table 2: An ordered two-way table derived from artificial data and analysed by TWINSPAN; the 0/1 numbering at the bottom and right specify classifications of the sites and species.

	Sites																Species Groups	
	16	10	8	5	6	1	2	3	4	7	9	15	11	12	13	14		
sps N	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
sps D	4	4	-	-	4	3	-	-	-	-	-	-	-	-	-	-	0	0
sps O	2	5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
sps F	2	-	-	-	2	2	1	3	-	-	-	-	-	-	-	-	0	0
sps P	-	1	-	2	2	-	-	3	2	2	-	-	-	-	-	-	0	0
sps U	1	-	-	-	2	-	-	4	-	3	-	-	-	-	-	-	0	0
sps L	2	-	3	3	5	5	-	-	-	-	-	-	-	-	-	-	0	0
sps G	-	-	-	-	5	4	-	-	-	-	-	2	-	-	-	-	0	0
sps T	-	1	-	-	4	-	4	4	4	4	1	-	-	-	-	-	0	0
sps I	-	1	3	2	2	3	4	5	3	5	2	-	-	-	-	-	0	0
sps A	-	1	4	3	2	3	4	4	5	4	-	-	2	-	-	-	0	0
sps M	-	-	5	5	3	3	-	5	2	2	2	2	-	2	2	–	0	1
sps K	-	-	-	-	3	4	2	4	2	5	-	-	-	-	-	2	0	1
sps Q	-	-	3	2	2	5	-	5	2	1	3	3	2	3	2	–	0	1
sps E	-	-	-	-	2	4	-	-	2	2	2	-	-	-	4	-	0	1
sps C	-	-	1	-	-	1	-	2	3	1	**3**	**4**	**5**	-	-	4	1	0
sps R	-	1	2	-	1	-	-	-	-	1	**3**	**4**	**2**	-	-	-	1	0
sps S	-	-	-	-	-	-	-	-	-	-	3	4	5	4	4	3	1	1
sps J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	1	1
sps B	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	4	1	1
sps H	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	3	1	1
Site	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1		
Groups	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1		

3 ASSESSMENT OF CONSERVATION SIGNIFICANCE

The conservation status of both flora and fauna species is assessed under Commonwealth and State legislation such as the Commonwealth *Environment Protection and Biodiversity Act* (EPBC Act) *1999* and the *West Australian Wildlife Conservation Act 1950.* The significance levels for species used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN, 2001). The *WA Wildlife Conservation Act 1950* uses a set of Schedules but also classifies species using IUCN categories.

In Western Australia, the Department of Environment and Conservation (DEC) has also produced a supplementary list of Priority Flora and Fauna, being species that are not considered threatened under the *WA Wildlife Conservation Act 1950* but for which there is cause for concern. Some priority species however are also assigned an IUCN Conservation category. The following levels of conservation significance are recognised in this report.

WA Wildlife Conservation Act (1950) Classification

Under the *Wildlife Conservation Act 1950*, specially protected species are listed under one of four schedules:

- Schedule 1 – Species that are rare or likely to become extinct. 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 Species listed under Schedule 1 are also referred to as Threatened Species for fauna or Declared Rare Flora (DRF) for flora.
- Schedule 2 – Species that are presumed to be extinct. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
- Schedule 3 – Birds protected under an international agreement.
- Schedule 4 – Other specially protected Fauna.

ICUN Classifications

The DEC in WA also classifies species into one of five IUCN categories:

- Extinct (EX) - also listed on Schedule 2 above
- Extinct in the wild (EW) - also listed on Schedule 1 above
- Critically endangered (CR) - also listed on Schedule 1 above
- Endangered (EN) - also listed on Schedule 1 above
- Vulnerable (VU) - also listed on Schedule 1 above

These categories are determined by the total distribution of the species, and not just their distribution within WA.

Priority Species

If a species does not meet the criteria for listing as Threatened Fauna or Declared Rare Flora (e.g. due to lack of information) and is poorly known and/or conservation dependent, it may then be classified as Priority species. Priority species are placed into one of five categories of priority and are managed by DEC accordingly.

- Priority One: Taxa with few, poorly known populations (generally <5) on threatened lands.
- Priority Two: Taxa with few, poorly known populations (generally <5) on conservation lands (at least some of which are not believed to be under immediate threat).
- Priority Three: Taxa with several, poorly known populations, some on conservation lands (at least

some of which are not believed to be under immediate threat).

- Priority Four: Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.
- Priority Five: Taxa that are conservation dependent (i.e. their conservation status is dependent on ongoing active management).

In summary the following categories (Table 3) and criteria are used to define the status of species at international, national and state levels and where relevant have been used within this report.

Table 3: Categories Used to Define the Conservation Status of Species.

Level	Governing Body, Legislation (if relevant)	Conservation Categories
International	International Union for Conservation of Nature and natural resources (IUCN)	Extinct (EX) Extinct in the Wild (EW) Critically Endangered (CR) Endangered (EN) Vulnerable (VU) Near Threatened (NT) Least Concern (LC) Data Deficient (DD) Not Evaluated (NE)
National	Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC), EPBC Act 1999	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent
State of WA	Department of Environment and Conservation (DEC), Wildlife Conservation Act 1950	Threatened Fauna/Declared Rare Flora (Schedule 1) Extinct in the Wild Critically Endangered Endangered Vulnerable Extinct (Schedule 2) Schedule 3 (Fauna) Birds protected under an international agreement Schedule 4 (Fauna)
State of WA	Department of Environment and Conservation (DEC) supplementary priority list (not listed under legislation)	Priority species: • Priority One • Priority Two • Priority Three • Priority Four • Priority Five

4 RESULTS

4.1 PRE-EUROPEAN VEGETATION

Regional vegetation mapping was undertaken by Beard (1976, 1981). Beeston *et al*. (2001) converted the existing paper maps to digital GIS format. They analysed the information with respect to vegetation loss and reported on the current conservation status of community types. According to this assessment, the study area covers two vegetation types (Mi-05m and Sc-09c) with another type in close proximity (Table 4, Figure 3). These Vegetation Units are broadly circumscribed and include a range of vegetation communities. Beeston *et al.* (2001) consider that none of the Vegetation Units are currently threatened (> 30% of their original areas remain, Table 4).

Table 4: Pre-European Vegetation.

Beard Code	Vegetation Association	Description	Pre-European extent (ha)	Current extent (ha)	Remaining (%)
Mi-05m	141	Medium woodland; York gum, salmon gum & gimlet	676,791	250,256	37.0
Sc-02m	437	Shrublands; Mixed acacia thicket on sandplain	415,944	346,177	83.2
Sc-09c	552	Shrublands ; *Casuarina acutivalvus* & *Calothamnus* (also *Melaleuca*) thicket on greenstone hills	40,252	36,688	91.1

4.2 STRUCTURAL PLANT COMMUNITY MAPPING

Two structural plant community types were mapped in this study as a result of aerial photograph interpretation (Figure 2) and the field survey. The communities are broadly consistent with the vegetation units of Beard (1976). Figure 4 show the distribution of the structural plant communities across the study area. In addition Figure 4 shows the location of significant flora species identified as discussed in Section 4.9.

The 2 vegetation types identified during this study are described below.

4.2.1 COMMUNITY 1: EUCALYPTUS LOXOPHLEBA VAR SUPRALAEVIS – E. SALMONOPHLOIA OPEN WOODLAND

Area: 233 ha
Landscape: Flats, occasionally on gentle slopes and crests
Substrate: red/brown rocky loams and hard pans, quartz rubble
Structure: Open Scrub to Open Woodland
Plant Cover: 22% (range 15%-45%)
Composition:

- Overstorey: (10%) *Eucalyptus loxophleba var supralaevis, E. salmonophloia*,
- Understorey: (10%) *Eremophila oldfieldii subsp. angustifolia, Eremophila oppositifolia var angustifolia, Dodonaea inaequifolia, Exocarpos aphyllus, Santalum lanceolatum, Eremophila deserti, Scaevola spinescens*
- Ground Layer: (2%) *Olearia muelleri, Zygophyllum aurantiacum subsp. aurantiacum, Maireana georgei, Acacia kochii.*

Number of Species (per 100m^2): 18.6 (range 11-34)

Illustration: Plate 1
Description: Open scrub to open woodland (5 to 20m tall) of *Eucalyptus loxophleba var supralaevis* and *E. salmonophloia* emergent above shrubs/small trees of *Acacia* sps., *Eremophila sps.* and species of *Santalaceae*. The understorey is open and consists of mostly *Acacia sps.* and *Eremophila sps.* A low ground layer may be present and is dominated by chenopods (e.g. *Maireana georgei*) and daisies (Family Asteraceae). The community occurs on red loamy earths, hard pans and gravelly loams in essentially flat areas, sometimes on crests and is in very good ecological condition. This community occupies 233 hectares.

Plate 1: *Eucalyptus loxophleba var supralaevis – E. salmonophloia* open woodland.

4.2.2 COMMUNITY 2: MIXED SPECIES OPEN-DENSE SHRUBLANDS

Area: 660 ha
Landscape: Flats, slopes and crests, drainage lines
Substrate: red/brown rocky loams, outcrops, quartz rubble
Structure: Open low to dense tall shrublands, thickets
Plant Cover: 34% (range 18%-42%)
Composition:

- Overstorey: (16%) *Allocasuarina acutivalvis subsp. prinsepiana, Melaleuca stereophloia*, *Casuarina obesa, Acacia acuminata*
- Understorey: (10%) *Allocasuarina tessellata, Eremophila oppositifolia var angustifolia, Grevillea scabrida, Melaleuca uncinata, Calothamnus gilesii, Pimelea microcephala subsp. Microcephala, Hemigenia dielsii*
- Ground Layer: (8%) *Borya sphaerocephala*, *Olearia muelleri, Zygophyllum aurantiacum subsp. aurantiacum, Maireana georgei.*

Number of Species (per 100m^2): 19.5 (range 13-33)

Illustration: Plate 2

Description: Open low to dense tall mixed species shrublands and thickets (to 4m) of tall *Acacia acuminata Melaleuca stereophloia*, *Casuarina obesa* over medium to tall shrubs *of Allocasuarina tessellata, Eremophila oppositifolia var angustifolia, Grevillea scabrida, Melaleuca uncinata* and others. A low ground layer is often present and is dominated by *Borya sphaerocephala,* chenopods (species of Maireana) and daisies (e.g. *Olearia muelleri,* species of *Brachyscome*). Geophytes are common (Orchids, *Drosera macrantha, Wurmbea tenella*). The community occurs on red loamy earths, shallow loams over rock, drainage lines and hill crests. It is in very good ecological condition. This community occupies 660 hectares.

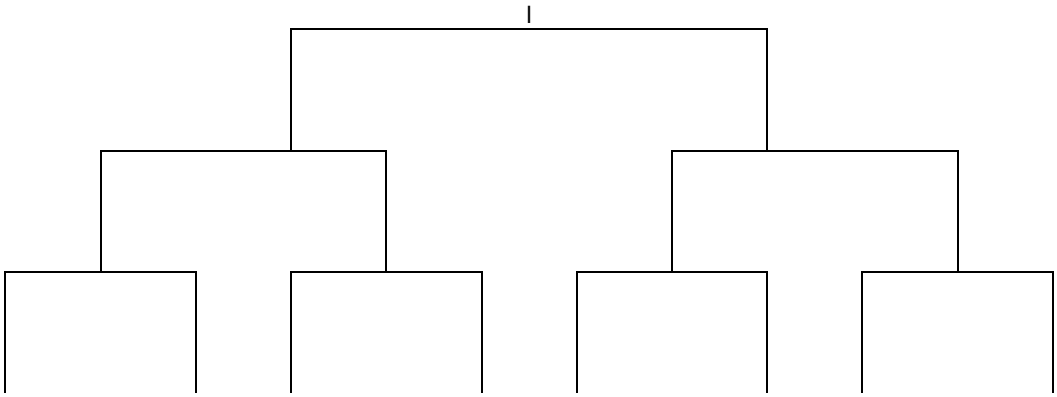
Plate 2: Mixed Species Open-Dense Shrublands.

4.3 FLORISTIC PLANT COMMUNITY MAPPNG

Seven plant community types were identified and mapped as a result of the TWINSPAN analysis. Table 5 shows a summary of the results. Values within this Table are the percentage occurrence of each species within the individual communities. Eight communities are produced by TWINSPAN at the third stage. However community 8, which consisted of three quadrats, is an amorphous collection of disturbed sites and is not further described.

Figure 5 shows the distribution of the recognised plant community types across the plant quadrats. Aerial photograph interpretation was used to help derive general distribution maps for the identified community types (Figure 6). The communities form a mosaic across the landscape as can be seen in the aerial photography (Figure 2).

Table 5: Summary Results of the TWINSPAN Analysis. Values for species are percentage occurrence within each community.



Community ID	1	2	3	4	5	6	7	8
Allocasuarina acutivalvis subsp. prinsepiana	9	0	50	57	14	0	0	0
Grevillea paradoxa	0	0	83	29	14	0	0	0
Micromyrtus racemosa	0	11	17	14	0	0	0	0
Melaleuca radula	28	0	0	0	0	0	3	0
Calothamnus gilesii	22	0	0	0	0	0	0	0
Borya sphaerocephala	50	33	17	29	0	0	0	0
Aristida contorta	19	11	0	0	0	0	3	0
Allocasuarina tessellata	78	56	0	14	0	0	0	0
Melaleuca stereophloia	38	56	17	29	0	0	3	0
Grevillea subtiliflora	38	44	0	14	0	0	0	0
Goodenia havilandii	72	11	33	14	14	0	3	33
Tricoryne elatior	13	0	0	0	0	0	0	0
Podolepis gracilis	3	22	0	0	0	0	0	0
Arthropodium dyeri	41	0	0	0	0	0	0	0
Melaleuca uncinata	34	44	83	14	14	0	3	0
Cheilanthes austrotenuifolia	59	44	83	86	14	0	0	0
Lobelia winfridae	91	67	100	86	43	0	3	0
Waitzia acuminata	78	78	83	71	86	80	7	33
Casuarina obesa	53	33	0	29	0	20	14	0
Acacia kochii	44	22	0	14	0	20	10	0
Grevillea scabrida	69	67	50	86	14	20	17	0
Podolepis lessonii	81	78	50	57	14	20	7	67
Pentaschistis airoides subsp. airoides	19	22	0	29	0	20	7	0
Ptilotus gaudichaudii var. gaudichaudii	25	0	0	14	0	0	7	33
Phlegmatospermum drummondii	22	22	17	14	14	0	7	0
Leptosema aphyllum	6	0	0	0	0	0	3	0
Cephalipterum drummondi	50	33	0	29	14	60	17	33
Acacia acuminata	75	78	50	57	57	60	28	100
Lawrencella rosea	3	11	0	0	0	20	0	0
Hemigenia dielsii	38	44	0	71	0	0	7	67
Calandrinia eremaea	6	44	17	43	0	20	3	0
Thysanotus	22	0	33	43	14	0	3	0

manglesianus								
Gnephosis angianthoides	16	0	67	43	0	0	7	0
Dichopogon tyleri	3	22	33	0	0	0	3	0
Cheiranthera simplicifolia	22	0	67	57	57	0	0	0
Eremophila latrobei subsp latrobei	0	0	17	57	14	0	0	0
Hakea recurva	3	0	33	71	14	0	3	0
Prostanthera eckersleyana	0	0	50	0	14	0	0	0
Acacia assimilis subsp. assimilis	0	0	50	14	14	0	3	0
Callitris columellaris	3	11	0	14	14	20	0	0
Acacia tetragonophylla	38	67	67	86	71	80	34	33
Persoonia pentasticha	9	22	0	29	29	20	3	0
Erodium cicutarium	6	0	0	14	29	0	0	0
Pimelea microcephala subsp. microcephala	13	0	67	29	57	20	17	0
Philotheca brucei	6	0	50	57	43	0	7	0
Olearia pimelioides	0	0	50	29	43	0	7	0
Lawrencia densiflora	9	11	17	57	43	0	7	0
Blennospora drummondii	3	0	0	14	0	0	0	33
Sida calyxhymenia	6	0	17	43	14	0	24	0
Sclerolaena densiflora	9	78	50	14	29	20	59	0
Dodonaea inaequifolia	25	22	17	57	43	60	34	67
Austrostipa elegantissima	59	44	67	43	86	80	79	33
Angianthus preissianus	16	0	0	14	43	0	7	67
Comesperma integerrimum	9	0	17	0	43	40	3	0
Sisymbrium erysimoides	3	33	0	0	29	20	14	0
Maireana carnosa	6	44	0	0	14	40	24	0
Daucus glochidiatus	3	0	0	0	0	0	3	33
Calocephalus multiflorus	3	0	0	0	0	0	3	33
Acacia acanthoclada subsp glaucescens	0	33	0	14	14	60	14	0
Solanum nummularium	6	0	0	29	14	80	17	0
Ptilotus obovatus	22	33	0	57	86	100	45	67
Angianthus tomentosus	0	0	17	0	14	0	3	0
Lepidium oxytrichum	0	0	0	29	43	20	7	33
Millotia myosotidifolia	0	11	0	0	14	20	7	0
Acacia andrewsii	6	22	0	86	100	80	21	0
yello daisy	16	33	17	0	71	40	52	0
Enchylaena tomentosa	3	0	17	0	0	0	17	0
Senna artemisioides var filifolia	16	33	0	29	43	100	90	100
Scaevola spinescens	3	11	0	14	57	0	31	0
Zygophyllum aurantiacum subsp. aurantiacum	9	33	33	29	57	100	72	100
Acacia anthochaera	3	33	0	14	43	0	45	33
Sclerolaena diacantha	0	0	0	29	0	20	10	0
Eucalyptus loxophleba	0	0	0	29	29	80	38	33

subsp supralaevis								
Exocarpos aphyllus	0	0	0	29	14	60	48	33
Eremophila oldfieldii subsp. angustifolia	0	0	17	29	100	80	48	67
Eremophila oppositifolia var angustifolia	0	0	0	29	86	20	48	0
Senna glaucifolia	0	0	0	14	14	40	28	67
Gunniopsis rodwayi	0	0	0	0	14	20	14	33
Maireana trichoptera	0	0	33	0	57	40	41	0
Calotis multicaulis	0	0	0	0	14	20	10	0
Sclerolaena densiflora	0	0	17	0	14	60	7	0
Alyxia buxifolia	0	11	0	14	29	0	31	0
Olearia muelleri	0	11	0	29	43	20	62	33
Maireana georgei	0	0	17	0	43	0	34	67
Santalum lanceolatum	0	0	0	0	14	20	21	0
Santalum acuminatum	0	11	0	0	14	0	21	0
Eucalyptus salmonophloia	0	0	0	0	29	0	72	33
Acacia erinacea	0	0	0	0	0	0	45	33
Eremophila deserti	0	0	0	0	0	0	14	0
Maireana carnosa	0	0	0	14	0	20	28	0
Ptilotus divaricatus	0	0	0	0	0	0	10	0
Acacia duriuscula	0	0	0	0	0	0	17	0
Ptilotus exaltatus var exaltatus	9	0	0	0	0	20	72	67
Ptilotus spathulatus var. spathulatus	3	0	0	0	0	0	34	0
Chenopodium gaudichaudianum	6	22	0	14	0	40	86	33
Sonchus oleraceus	3	0	0	0	0	0	3	67
Number of quadrats	**32**	**9**	**6**	**7**	**7**	**5**	**29**	**3**
Average Number of species	**17.1**	**16.4**	**20.3**	**24.0**	**22.7**	**19.4**	**18.5**	**16.3**
Minimum species number	**10**	**13**	**16**	**18**	**17**	**16**	**11**	**14**
Maximum species number	**23**	**25**	**27**	**33**	**26**	**23**	**34**	**19**

4.3.1 COMMUNITY 1 - MIXED SPECIES SHRUBLAND 1

Area: 481 ha
Number of quadrats: 32
Landscape. western slopes and crests, flat areas
Substrate: Rock – shallow red loams over ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Casuarina obesa	*Allocasuarina tessellata* *Acacia acuminata*	*Grevillea scabrida* *Acacia kochii* *Grevillea subtiliflora* *Acacia tetragonophylla*	*Lobelia winfridae* *Podolepis lessonii* *Waitzia acuminata* *Goodenia havilandii* *Cheilanthes austrotenuifolia* *Austrostipa elegantissima*

Trees	Tall Shrubs	Shrubs	Ground Layer
			Borya sphaerocephala *Cephalipterum drummondi*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
	Melaleuca stereophloia *Melaleuca uncinata*	*Melaleuca radula* *Calothamnus gilesii* *Hemigenia dielsii* *Dodonaea inaequifolia* *Cheiranthera simplicifolia*	*Arthropodium dyeri* *Ptilotus gaudichaudii var. gaudichaudii* *Phlegmatospermum drummondii* *Thysanotus manglesianus* *Ptilotus obovatus*

Mean species richness: 17.1 (range 10-23)
Plant Cover: 28% (range 20%- 50%)
Mean weed frequency: 13%
Mean vegetation condition: good
Structure: Open to dense Scrub - Shrub/Tree Mallee
Structural units:

- dense heath
- open woodland
- dense scrub
- open scrub

Description:
Open to dense tall shrubland (to 4m) of *Allocasuarina tessellata* (P1) and *Acacia acuminata* with occasional emergent *Casuarina obesa* (to 8m) over medium shrubs of *Grevillea subtiliflora* (P3), *Acacia tetragonophylla, Melaleuca radula* and *Calothamnus gilesii* over low shrubs of *Grevillea scabrida* (P3), *Acacia kochii* and *Hemigenia dielsii* over a dense annual groundlayer of *Lobelia winfridae, Podolepis lessonii, Waitzia acuminata, Goodenia havilandii, Cheilanthes austrotenuifolia, Austrostipa elegantissima, Borya sphaerocephala* and Cephalipterum drummondi.

Treatened and Priority Species Present:
Allocasuarina tessellata (P1)
Grevillea scabrida (P3)
Grevillea subtiliflora (P3)
Persoonia pentasticha (P3)

4.3.2 COMMUNITY 2 - MIXED SPECIES SHRUBLAND 2

Area: 25 ha
Number of quadrats: 9
Landscape: western slopes and crests
Substrate: Rock – shallow loams over ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Casuarina obesa	*Acacia acuminata* *Allocasuarina tessellata* *Melaleuca stereophloia*	*Acacia tetragonophylla* *Grevillea subtiliflora* *Grevillea scabrida* *Hemigenia dielsii*	*Podolepis lessonii* *Waitzia acuminata* *Sclerolaena densiflora* *Lobelia winfridae* *Cheilanthes austrotenuifolia* *Austrostipa elegantissima*

Trees	Tall Shrubs	Shrubs	Ground Layer
			Calandrinia eremaea *Maireana carnosa*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
	Melaleuca uncinata *Acacia anthochaera*	*Senna artemisioides var filifolia* *Acacia acanthoclada subsp glaucescens* *Acacia kochii* *Dodonaea inaequifolia* *Persoonia pentasticha* *Acacia andrewsii* *Chenopodium gaudichaudianum*	*Borya sphaerocephala* *Cephalipterum drummondi* *Ptilotus obovatus* *yello daisy* *Zygophyllum aurantiacum subsp. aurantiacum* *Sisymbrium erysimoides* *Phlegmatospermum drummondii* *Pentaschistis airoides subsp. airoides* *Podolepis gracilis*

Mean species richness: 16.4 (range 13-25)
Plant Cover: 32% (range 20%- 60%)
Mean weed frequency: 0
Mean vegetation condition: good
Structure: Open Scrub to Open Shrub/Tree Mallee
Structural units:

Open tall shrubland
dense tall shrubland
Dense low woodland
dense scrub

Description:
Open to closed tall mixed species shrubland (to 4m) of *Acacia acuminata, Allocasuarina tessellata* (P1) and *Melaleuca stereophloia* with occasional *Casuarina obesa* emergent to 8m, over medium height shrubs of *Acacia tetragonophylla* and *Grevillea subtiliflora* (P3), over low shrubs of *Grevillea scabrida* (P3) and *Hemigenia dielsii* over an annual groundlayer of Podolepis *lessonii, Waitzia acuminata, Sclerolaena densiflora* and *Lobelia winfridae.*

Treatened and Priority Species Present:
Allocasuarina tessellata (P1)
Grevillea scabrida (P3)
Grevillea subtiliflora (P3)
Persoonia pentasticha (P3)

4.3.3 COMMUNITY 3 - MIXED SPECIES SHRUBLAND 3

Area: 37 ha
Number of quadrats: 6
Landscape: eastern slopes and flat areas
Substrate: Rock – shallow loams over ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
	Melaleuca uncinata *Acacia acuminata* *Allocasuarina acutivalvis subsp. prinsepiana*	*Grevillea paradoxa* *Acacia tetragonophylla*	*Lobelia winfridae* *Waitzia acuminata* *Cheilanthes austrotenuifolia*

Trees	Tall Shrubs	Shrubs	Ground Layer
	Acacia assimilis subsp. assimilis		*Austrostipa elegantissima* *Gnephosis angianthoides* *Podolepis lessonii* *Sclerolaena densiflora* *Olearia pimelioides*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
		Hakea recurva *Cheiranthera simplicifolia* *Pimelea microcephala subsp. microcephala* *Grevillea scabrida* *Philotheca brucei* *Prostanthera eckersleyana*	*Zygophyllum aurantiacum subsp. aurantiacum* *Dichopogon tyleri* *Goodenia havilandii* *Thysanotus manglesianus* *Maireana trichoptera*

Mean species richness: 20.3 (range 16-27)
Plant Cover: 32% (range 25%- 60%)
Mean weed frequency: 0
Mean vegetation condition: good
Structure: Open Scrub to Open Shrub/Tree Mallee
Structural units:

Open tall shrubland
dense tall shrubland
Dense low woodland
dense scrub

Description:

Open to closed tall mixed species shrubland (to 3 m) of *Melaleuca uncinata, Acacia acuminata, Allocasuarina acutivalvis subsp. prinsepiana* and *Acacia assimilis subsp. assimilis* over medium shrubs of *Grevillea paradoxa* and *Acacia tetragonophylla* over low shrubs of *Cheiranthera simplicifolia, Pimelea microcephala subsp. microcephala, Grevillea scabrida* (P3), *Philotheca brucei* and *Prostanthera eckersleyana* over an annual groundlayer of *Lobelia winfridae, Waitzia acuminata, Cheilanthes austrotenuifolia, Austrostipa elegantissima, Gnephosis angianthoides, Podolepis lessonii, Sclerolaena densiflora* and *Olearia pimelioides.*

Treatened and Priority Species Present:
Grevillea scabrida (P3)

4.3.4 COMMUNITY 4 - MIXED SPECIES SHRUBLAND 4

Area: 76 ha
Number of quadrats: 7
Landscape: eastern slopes and flat areas
Substrate: Rock – shallow loams over ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
	Acacia acuminata *Allocasuarina acutivalvis subsp. prinsepiana*	*Acacia tetragonophylla* *Hakea recurva* *Grevillea scabrida*	*Lobelia winfridae* *Cheilanthes austrotenuifolia*

Trees	Tall Shrubs	Shrubs	Ground Layer
		Acacia andrewsii *Hemigenia dielsii* *Cheiranthera simplicifolia* *Philotheca brucei* *Dodonaea inaequifolia* *Eremophila latrobei subsp latrobei*	*Waitzia acuminata* *Podolepis lessonii* *Lawrencia densiflora* *Ptilotus obovatus*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Casuarina obesa *Eucalyptus loxophleba subsp supralaevis*	*Melaleuca stereophloia* *Eremophila oldfieldii subsp. angustifolia*	*Grevillea paradoxa* *Exocarpos aphyllus* *Eremophila oppositifolia var angustifolia* *Pimelea microcephala subsp. microcephala* *Senna artemisioides var filifolia* *Persoonia pentasticha* *Olearia muelleri* *Solanum nummularium*	*Austrostipa elegantissima* *Gnephosis angianthoides* *Thysanotus manglesianus* *Calandrinia eremaea* *Sida calyxhymenia* *Olearia pimelioides* *Zygophyllum aurantiacum subsp. aurantiacum* *Borya sphaerocephala* *Cephalipterum drummondi* *Pentaschistis airoides subsp. airoides* *Lepidium oxytrichum* *Sclerolaena diacantha*

Mean species richness: 24 (range 18-33)
Plant Cover: 28% (range 20%- 55%)
Mean weed frequency: 0
Mean vegetation condition: good
Structure: Open Scrub to Open Shrub/Tree Mallee
Structural units:

Open tall shrubland
dense tall shrubland
Dense low woodland
dense scrub

Description:
Open to closed tall mixed species shrubland (to 4 m) of *Acacia acuminata* and *Allocasuarina acutivalvis subsp. prinsepiana* with occasional emergent *Casuarina obesa* and *Eucalyptus loxophleba subsp supralaevis* (to 10m) over medium height shrubs of *Acacia tetragonophylla and Hakea recurva* over low shrubs of *Grevillea scabrida* (P3), *Acacia andrewsii, Hemigenia dielsii, Cheiranthera simplicifolia, Philotheca brucei, Dodonaea inaequifolia and Eremophila latrobei subsp latrobei* over an annual groundlayer of *Lobelia winfridae, Cheilanthes austrotenuifolia, Waitzia acuminata, Podolepis lessonii, Lawrencia densiflora* and *Ptilotus obovatus*

Treatened and Priority Species Present:
Allocasuarina tessellata (P1)
Grevillea scabrida (P3)
Grevillea subtiliflora (P3)
Persoonia pentasticha (P3)

4.3.5 COMMUNITY 5 – OPEN WOODLAND 1

Area: 38 ha
Number of quadrats: 7
Landscape: eastern slopes and flat areas
Substrate: Rock – shallow red loams over ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Eucalyptus loxophleba subsp supralaevis *Eucalyptus salmonophloia*	*Eremophila oldfieldii subsp. angustifolia* *Acacia acuminata*	*Eremophila oppositifolia var angustifolia* *Acacia andrewsii* *Cheiranthera simplicifolia* *Pimelea microcephala subsp. microcephala* *Scaevola spinescens*	*Waitzia acuminata* *Ptilotus obovatus* *Austrostipa elegantissima* *Zygophyllum aurantiacum subsp. aurantiacum* *Maireana trichoptera*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
	Acacia anthochaera	*Acacia tetragonophylla* *Philotheca brucei* *Dodonaea inaequifolia* *Senna artemisioides var filifolia* *Olearia muelleri* *Persoonia pentasticha* *Alyxia buxifolia*	*Lobelia winfridae* *Lawrencia densiflora* *Olearia pimelioides* *Lepidium oxytrichum* *Angianthus preissianus* *Comesperma integerrimum* *Maireana georgei* *Sclerolaena densiflora* *Erodium cicutarium* *Sisymbrium erysimoides*

Mean species richness: 22.7 (range 17-26)
Plant Cover: 24% (range 20%- 40%)
Mean weed frequency: 0
Mean vegetation condition: good
Structure: Open Scrub/Mallee/woodland
Structural units:

Open low- medium woodland
Mallee

Description:
A low to medium height (to 10m) open woodland of *Eucalyptus loxophleba subsp supralaevis* and *Eucalyptus salmonophloia* over sparse tall shrubs of *Eremophila oldfieldii subsp. angustifolia* and *Acacia acuminata* over medium height shrubs of *Eremophila oppositifolia var angustifolia* and *Acacia tetragonophylla* over low shrubs of *Acacia andrewsii, Cheiranthera simplicifolia, Pimelea microcephala subsp. microcephala* and *Scaevola spinescens* over an annual ground flora of *Waitzia acuminata, Ptilotus obovatus, Austrostipa elegantissima, Zygophyllum aurantiacum subsp. aurantiacum* and *Maireana trichoptera*

Treatened and Priority Species Present:
Grevillea scabrida (P3)
Persoonia pentasticha (P3)

4.3.6 COMMUNITY 6 – OPEN WOODLAND 2

Area: 20 ha
Number of quadrats: 5
Landscape: flats, eastern slopes
Substrate: Rock – shallow loams over shale and ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Eucalyptus loxophleba subsp supralaevis	*Eremophila oldfieldii subsp. angustifolia* *Acacia acuminata*	*Acacia tetragonophylla* *Exocarpos aphyllus* *Senna artemisioides var filifolia* *Acacia andrewsii* *Solanum nummularium* *Dodonaea inaequifolia* *Acacia acanthoclada subsp glaucescens*	*Ptilotus obovatus* *Zygophyllum aurantiacum subsp. aurantiacum* *Waitzia acuminata* *Austrostipa elegantissima* *Cephalipterum drummondi* *Sclerolaena densiflora*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Casuarina obesa	*Callitris columellaris*	*Senna glaucifolia* *Eremophila oppositifolia var angustifolia* *Santalum lanceolatum* *Chenopodium gaudichaudianum* *Pimelea microcephala subsp. microcephala* *Olearia muelleri* *Persoonia pentasticha* *Grevillea scabrida* *Acacia kochii* *Ptilotus exaltatus var exaltatus*	*Maireana trichoptera* *Comesperma integerrimum* *Maireana carnosa* *Lepidium oxytrichum* *Sclerolaena densiflora* *Sisymbrium erysimoides* *Podolepis lessonii* *Millotia myosotidifolia* *Gunniopsis rodwayi* *Calotis multicaulis* *Calandrinia eremaea* *Pentaschistis airoides subsp. airoides* *Sclerolaena diacantha* *Maireana carnosa* *Lawrencella rosea*

Mean species richness: 19.4 (range 16-23)
Plant Cover: 25% (range 15%-40%)
Mean weed frequency: 0
Mean vegetation condition: good
Structure: Open Scrub/Mallee/woodland
Structural units:

Open low- medium woodland
Mallee

Description:
A low to medium height (to 10m) open woodland of *Eucalyptus loxophleba subsp supralaevis* and *Casuarina obesa* over sparse tall shrubs *of Eremophila oldfieldii subsp. angustifolia* and *Acacia acuminata* over medium shrubs of *Acacia tetragonophylla* and *Exocarpos aphyllus* over low shrubs of *Senna artemisioides var filifolia, Acacia andrewsii, Solanum nummularium, Dodonaea inaequifolia* and *Acacia acanthoclada subsp glaucescens* over an annual groundlayer of *Ptilotus obovatus, Zygophyllum aurantiacum subsp.*

aurantiacum, Waitzia acuminata, Austrostipa elegantissima, Cephalipterum drummondi and *Sclerolaena densiflora.*

Treatened and Priority Species Present:
Grevillea scabrida (P3)
Persoonia pentasticha (P3)

4.3.7 COMMUNITY 7 – OPEN WOODLAND 3

Area: 214 ha
Number of quadrats: 29
Landscape: flats, eastern slopes
Substrate: Rock – shallow loams over shale and ironstone, rocky/gravelly

Typical Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Eucalyptus salmonophloia	*Eremophila oldfieldii subsp. angustifolia* *Acacia anthochaera*	*Exocarpos aphyllus* *Eremophila oppositifolia var angustifolia* *Senna artemisioides var filifolia* *Chenopodium gaudichaudianum* *Ptilotus exaltatus var exaltatus* *Olearia muelleri*	*Austrostipa elegantissima* *Zygophyllum aurantiacum subsp. aurantiacum* *Sclerolaena densiflora*

Other Common Species:

Trees	Tall Shrubs	Shrubs	Ground Layer
Eucalyptus loxophleba subsp supralaevis	*Acacia acuminata*	*Acacia tetragonophylla* *Senna glaucifolia* *Santalum lanceolatum* *Santalum acuminatum* *Acacia erinacea* *Dodonaea inaequifolia* *Scaevola spinescens* *Alyxia buxifolia* *Acacia andrewsii*	*Ptilotus obovatus* *Maireana trichoptera* *Maireana georgei* *Ptilotus spathulatus var. spathulatus* *Maireana carnosa* *Maireana carnosa* *Sida calyxhymenia*

Mean species richness: 18.5 (range 11-34)
Plant Cover: 20% (range 15%-40%)
Mean weed frequency: 10%
Mean vegetation condition: good
Structure: Open Scrub/Mallee/woodland
Structural units:
Open low- medium woodland
Mallee
Description:
A low to medium height (to 10m) open woodland of *Eucalyptus salmonophloia* and *Eucalyptus loxophleba subsp supralaevis* over sparse tall shrubs of *Eremophila oldfieldii* subsp. angustifolia and *Acacia anthochaera* over sparse medium shrubs of *Exocarpos aphyllus, Eremophila oppositifolia var angustifolia* and *Acacia tetragonophylla* over low shrubs of *Senna artemisioides var filifolia, Chenopodium*

gaudichaudianum, Ptilotus exaltatus var exaltatus and *Olearia muelleri* over an annual ground flora of *Austrostipa elegantissima, Zygophyllum aurantiacum subsp. aurantiacum* and *Sclerolaena densiflora.*

Treatened and Priority Species Present:
Grevillea scabrida (P3)
Grevillea subtiliflora (P3)
Persoonia pentasticha (P3)

4.4 VEGETATION CONDITION

The vegetation covering much of the tenement varies in ecological condition from good to very good, , with an average vegetation rating of good according to the condition rating scale outlined in Keighery (1994) – Appendix A, see Figure 7 for condition mapping. Historically, grazing has been a severe disturbance, however vegetation is recovering with pastoral de-stocking. The shrublands all have intact understories and while the woodlands are more sparsely/patchily vegetated this is consistent with other open *Eucalyuptus salmonophloia – E. loxophleba woodland communities* (e.g. see Armstrong and Associates 2004). All communities possess a range of herb and shrub species with healthy populations. The species richness of the floristic quadrats indicates generally good condition. With destocking, ecological condition is improving with degraded areas being mostly localised (e.g. around rabbit warrens, human activity, creeklines). The main disturbances are grazing by feral species (e.g. rabbits) and the development of mining exploration tracks. It is understood that the area was explored historically prior to Top Iron exploration activities. Top Iron is in the process of rehabilitating its approved exploration areas and aims to re-use old tracks rather than clear new tracks where ever possible.

4.5 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

A Threatened Ecological Community (TEC) is one that has been endorsed by Western Australia's Environment Minister as being subject to processes that threaten to destroy or significantly modify it across much of its range. It must also fit into one of the categories 'presumed totally destroyed', 'critically endangered', 'endangered' or 'vulnerable'. Possible TECs that do not meet survey criteria are added to the DEC's Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. TECs are indirectly protected under WA legislation through the *Environmental Protection Act 1986* and *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.*

A search using the DEC TEC/PEC database for a 15 km buffer indicated that there are 8 TEC/PECs in the search area, however none inside the study area. Table 6 lists the TECs found within 15 kms of the study area.

No TEC's or PEC's were located within the survey area during the field survey.

Table 6: Threatened and Priority Ecological Communities with 15 km Buffer of Study Area.

Community ID	Community Name	Conservation Status
Granite pool invertebrate assemblages	Granite outcrop pools with endemic aquatic fauna	Priority 2
Koolanooka System	Plant assemblages of the Koolanooka System	Vulnerable
Maranalgo Calcrete	Maranalgo west calcrete assemblage type on Moore palaeodrainage on Maranalgo Station	Priority 1
Minjar/Gnows Nest	Minjar/Gnows Nest vegetation complexes (banded ironstone formation)	Priority 1
Mount Gibson	Mount Gibson Range vegetation complexes (banded	Priority 1

Community ID	Community Name	Conservation Status
	ironstone formation)	
Mount Karara/Mungada Ridge/Blue Hills	Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation)	Priority 1
Ninghan Calcrete	Ninghan calcrete groundwater assemblage type on Moore palaeodrainage on Ninghan Station	Priority 1
Warriedar Hill/Pinyalling	Warriedar Hill/Pinyalling vegetation complexes (banded ironstone formation)	Priority 1

4.6 FLORA

176 native plant species representing 104 genera and 49 families were recorded within the study area (Table 7). The most common plant families included Scrophulariaceae, Myrtaceae, Fabaceae and Proteaceae. The tree layers are dominated by species of *Eucalyptus, Acacia acuminata, Acacia anthochaera* and *Casuarina obesa*. Species of *Melaleuca* and *Acacia* dominate the taller shrub flora while *Eremophila, Grevillea* and *Acacia* are frequent within the lower shrubs. The ground flora is species rich with daisies (Family Asteraceae) and saltbushes (Family Chenopodiaceae) being common. A species-rich seasonal geophytic flora is present.

Table 7: Native Plant Species.

Species	Author	Family
Acacia acanthoclada subsp glaucescens	Maslin	Fabaceae
Acacia acuaria	W.Fitzg.	Fabaceae
Acacia acuminata	Benth	Fabaceae
Acacia andrewsii	W.Fitzg.	Fabaceae
Acacia anthochaera	Maslin	Fabaceae
Acacia assimilis var assimilis	S. Moore	Fabaceae
Acacia duriuscula	W.Fitz.	Fabaceae
Acacia erinacea	Benth.	Fabaceae
Acacia inceana var conformis	Domin	Fabaceae
Acacia kochii	Ewart & Jean White	Fabaceae
Acacia murrayana	F.Muell ex Benth.	Fabaceae
Acacia tetragonophylla	F.Muell.	Fabaceae
Allocasuarina acutivalvis subsp. prinsepiana	(C.R.P.Andrews) L.A.S.Johnson	Casuarinaceae
Allocasuarina tessellata	(C.A.Gardner) L.A.S.Johnson	Casuarinaceae
Alyxia buxifolia	R.Br.	Apocynaceae
Amyema miquelii	(Lehm. ex Miq.) Tieghem	Loranthaceae
Amyema preissii	(Miq.)Tiegham	Loranthaceae
Angianthus preissianus	(Steetz) Benth.	Asteraceae
Angianthus tomentosus	J.C.Wendl.	Asteraceae
Aristida contorta	F.Muell.	Poaceae
Arthropodium dyeri	Idomin)Brittan	Asparagaceae
Asteridea athrixioides	(Sond. & F.Muell.) Kroner	Asteraceae
Astroloma serratifolium	(DC) Druce	Ericaceae
Atriplex bunburyana	F.Muell.	Chenopodiaceae
Atriplex codonocarpa	P.G.Wilson	Chenopodiaceae
Austrodanthonia caespitosa	(Gaudich.)H.P.Linder	Poaceae
Austrostipa elegantissima	(Labill.) Jacobs & Everett	Poaceae
Austrostipa nitida	(Summerh. & C.E.Hubb.) S.W.L.Jacobs & J.Everett	Poaceae
Blennospora drummondii	A.Gray	Asteraceae

Species	Author	Family
Borya sphaerocephala	R.Br.	Boryaceae
Bossiaea walkeri	F.Muell.	Fabaceae
Brachyscome ciliaris	(Labill.)Less	Asteraceae
Brachyscome iberidifolia	Benth.	Asteraceae
Brachyscome pusilla	Steetz	Asteraceae
Caladenia hirta subsp. rosea	Hopper & A.P.Br.	Orchidaceae
Caladenia incensa	Hopper & A.P.Br.	Orchidaceae
Calandrinia eremaea	Ewart.	Portulacaceae
Callitris columellaris	F.Muell.	Cupressaceae
Calocephalus multiflorus	(Turz.)Benth.	Asteraceae
Calothamnus gilesii	F.Muell.	Myrtaceae
Calotis multicaulis	(Turz.)Druce	Asteraceae
Calytrix leschenaultii	(Schauer)Benth.	Myrtaceae
Cassytha aurea	Weber	Lauraceae
Casuarina obesa	Miq.	Casuarinaceae
Cephalipterum drummondi	A.Gray	Asteraceae
Cheilanthes austrotenuifolia	H. Quirk & T.C. Chambers	Pteridaceae
Cheiranthera simplicifolia	(E.M.Benn.) L.Cayzer & Crisp	Pittosporaceae
Chenopodium gaudichaudianum	(Moq.) Paul G.Wilson	Chenopodiaceae
Chthonocephalus pseudevax	Steetz	Asteraceae
Comesperma integerrimum	Endl.	Polygalaceae
Cyanicula amplexans	(A.S.George) Hopper & A.P.Br.	Orchidaceae
Daucus glochidiatus	(Labill.)Fisch,Mey,Ave-Lall	Apiaceae
Daviesia benthamii subsp. acanthoclona	(F.Muell.) Crisp	Fabaceae
Dianella divaricata	R.Br.	Hemerocallidaceae
Dichopogon tyleri	Brittan	Asparagaceae
Dodonaea inaequifolia	Turz.	Sapindaceae
Dodonaea rigida	J.G.West	Sapindaceae
Drosera macrantha	Endl.	Droseraceae
Enchylaena tomentosa	R.Br.	Chenopodiaceae
Eremophila clarkei	Oldfield & F.Muell.	Scrophulariaceae
Eremophila deserti	(Benth.) Chinnock	Scrophulariaceae
Eremophila eriocalyx	F.Muell.	Scrophulariaceae
Eremophila glutinosa	Chinnock	Scrophulariaceae
Eremophila latrobei subsp latrobei	F.Muell.	Scrophulariaceae
Eremophila oldfieldii subsp. angustifolia	(S.Moore) Chinnock	Scrophulariaceae
Eremophila oppositifolia var angustifolia	(S.Moore)Chinnock	Scrophulariaceae
Eriachne pulchella subsp. pulchella	Domin	Poaceae
Erodium cygnorum	Nees	Geraniaceae
Eucalyptus ewartiana	Maiden	Myrtaceae
Eucalyptus loxophleba subsp. supralaevis	L.A.S.Johnson & K.D.Hill	Myrtaceae
Eucalyptus salmonophloia	F.Muell.	Myrtaceae
Euphorbia tannensis subsp. eremophila	(A.Cunn.) Hassall	Euphorbiaceae
Exocarpos aphyllus	R.Br.	Santalaceae
Frankenia pauciflora	DC.	Frankeniaceae
Gnephosis angianthoides	(Steetz)Anderb.	Asteraceae
Goodenia havilandii	Maiden & Betche	Goodeniaceae
Grevillea hakeoides	Meisn.	Proteaceae
Grevillea paradoxa	F.Muell.	Proteaceae
Grevillea pityophylla	F.Muell.	Proteaceae
Grevillea scabrida	C.A.Gardner	Proteaceae

Species	Author	Family
Grevillea subtiliflora	McGill.	Proteaceae
Gunniopsis rodwayi	(Ewart) C.A.Gardner	Aizoaceae
Hakea francisiana	F.Muell.	Proteaceae
Hakea invaginata	B.L.Burtt	Proteaceae
Hakea recurva	Meisn.	Proteaceae
Halgania integerrima	Endl.	Boraginaceae
Haloragis trigonocarpa	F.Muell.	Haloragaceae
Hemigenia dielsii	(Hemsl.)C.A.Gardner	Lamiaceae
Hibbertia exasperata	(Steud.)Briq.	Dilleniaceae
Hibbertia glomerata	Benth.	Dilleniaceae
Hibbertia pungens	Benth.	Dilleniaceae
Hybanthus floribundus subsp. floribundus	(Lindl.) F.Muell.	Violaceae
Isoetopsis graminifolia	Turcz.	Asteraceae
Jacksonia arenicola	Chappill	Fabaceae
Lawrencella rosea	Lindl.	Asteraceae
Lawrencia densiflora	(Baker f.) Melville	Malvaceae
Lepidium oxytrichum	Sprague	Brassicaceae
Leptosema aphyllum	R.Br.	Fabaceae
Leucopogon sp. Clyde Hill (M.A. Burgman 1207)		Ericaceae
Lobelia winfridae	Diels	Campanulaceae
Lysiana exocarpii	(Behr) Tiegh.	Loranthaceae
Maireana carnosa	(Moq.)P.G.Wilson	Chenopodiaceae
Maireana georgei	(Diels) Paul G.Wilson	Chenopodiaceae
Maireana trichoptera	(J.M.Black) Paul G.Wilson	Chenopodiaceae
Malleostemon roseus	(E.Pritz.) J.W.Green	Myrtaceae
Melaleuca cordata	Turcz.	Myrtaceae
Melaleuca lateriflora	Benth.	Myrtaceae
Melaleuca nematophylla	Craven	Myrtaceae
Melaleuca radula	A.Dietr	Myrtaceae
Melaleuca stereophloia	Craven	Myrtaceae
Melaleuca uncinata	R.Br.	Myrtaceae
Micromyrtus clavata	J.W.Green	Myrtaceae
Micromyrtus racemosa	Benth.	Myrtaceae
Millotia myosotidifolia	(Benth.)Steetz	Asteraceae
Mirbelia bursarioides	A.M.Monro & Crisp ms	Fabaceae
Olearia muelleri	(Sond.)Benth.	Asteraceae
Olearia pimeleoides	(DC.) Benth.	Asteraceae
Persoonia manotricha	A.S.Markey & R.Butcher	Proteaceae
Persoonia pentasticha	P.H.Weston	Proteaceae
Philotheca brucei	(F.Muell.)Wilson	Rutaceae
Phlegmatospermum drummondii	(Benth.) O.E.Schulz	Brassicaceae
Pimelea microcephala subsp. microcephala	R.Br.	Thymeleaceae
Pimelia avonensis	Rye	Thymeleaceae
Pleurosorus rutifolius	(R.Br.) Fee	Aspleniaceae
Podolepis gracilis	(Lehm.)R.A.Graham	Asteraceae
Podolepis lessonii	(Cass.)Benth.	Asteraceae
Poranthera microphylla	Brongn	Phyllanthaceae
Prostanthera althoferi subsp. althoferi	B.J.Conn	Lamiaceae
Prostanthera eckersleyana	F.Muell.	Lamiaceae
Pterostylis pyramidalis	Lindl.	Orchidaceae

Species	Author	Family
Ptilotus divaricatus	(Gaudich.) F.Muell	Amaranthaceae
Ptilotus exaltatus var exaltatus	Nees	Amaranthaceae
Ptilotus gaudichaudii var. gaudichaudii	(Steud.)J.M.Black	Amaranthaceae
Ptilotus obovatus	(Gaudich.) F.Muell.	Amaranthaceae
Ptilotus polystachyus	(Gaudich.) Muell.	Amaranthaceae
Ptilotus schwartzii var. schwartzii	Tate	Amaranthaceae
Ptilotus spathulatus var. spathulatus	(R.Br.)Steud.	Amaranthaceae
Rhodanthe citrina	(Benth.)Wilson	Asteraceae
Rhodanthe rubella	(A.Gray) Paul G.Wilson	Asteraceae
Rhyncharrhena linearis	(Decne.) K.L.Wilson	Apocynaceae
Salsola tragus	L.	Chenopodiaceae
Santalum acuminatum	(R.Br.)A.DC	Santalaceae
Santalum lanceolatum	R.Br.	Santalaceae
Scaevola spinescens	R.Br.	Goodeniaceae
Schoenia cassiniana	(Gaudich.)Steetz	Asteraceae
Sclerolaena densiflora	(W.Fitzg.) A.J.Scott	Chenopodiaceae
Sclerolaena diacantha	(Nees)Benth.	Chenopodiaceae
Sclerolaena drummondii	(Benth.) Domin	Chenopodiaceae
Sclerolaena eurotioidies	(F.Muell.)A.J.Scott	Chenopodiaceae
Sclerolaena fusiformis	Paul G.Wilson	Chenopodiaceae
Senna artemisioides subsp. petiolaris	Randell	Fabaceae
Senna artemisioides var filifolia	Randell	Fabaceae
Senna charlesiana	(Symon) Randell	Fabaceae
Senna glaucifolia	(Randell)Randell	Fabaceae
Senna glutinosa subsp. chatelainiana	(Gaudich.) Randell	Fabaceae
Senna pleurocarpa var. pleurocarpa	(F.Muell.)Randell	Fabaceae
Sida calyxhymenia	DC	Malvaceae
Solanum lasiophyllum	Poir	Solanaceae
Solanum nummularium	S. Moore	Solanaceae
Stenopetalum anfractum	E.A.Shaw	Brassicaceae
Tecticornia halocnemoides	(Willd.) K.A.Sheph. & Paul G.Wilson	Chenopodiaceae
Thryptomene cuspidata	(Turcz.)J.W.Green	Myrtaceae
Thryptomene mucronulata	Turz	Myrtaceae
Thysanotus manglesianus	Kunth	Asparagaceae
Trachymene ornata	(Endl.)Druce	Araliaceae
Trachymene pilosa	Smith	Araliaceae
Trichanthodium exile	(W.Fitzg.) P.S.Short	Asteraceae
Tricoryne elatior	R.Br.	Hemerocallidaceae
Tripterococcus brunonis	Endl.	Celastraceae
Velleia rosea	S.Moore	Goodeniaceae
Wahlenbergia tumidifructa	P.J.Sim	Campanulaceae
Waitzia acuminata	Steetz	Asteraceae
Wurmbea sp. Paynes Find (C.J. French 1237)		Colchicaceae
Wurmbea tenella	(Endl.)Benth.	Colchicaceae
Zygophyllum aurantiacum subsp. aurantiacum	(Lindl.) F.Muell.	Zygophyllaceae
Zygophyllum kochii	Tate	Zygophyllaceae

4.7 WEEDS

Seven weed species were recorded (Table 8). None are serious environmental weeds. Most were associated with disturbance – e.g. roadside, around rabbit warrens, mines and shacks.

Table 8: Exotic Plant Species

Species	Author	Family
Arctotheca calendula	(L.) Levyns	Asteraceae
Centaurea melitensis	L.	Asteraceae
Erodium cicutarium	(L.)L'Her	Geraniaceae
Pentaschistis airoides subsp. airoides	(Nees)Stapf	Poaceae
Plantago coronopus	L.	Plantaginaceae
Sisymbrium erysimoides	Desf.	Brassicaceae
Sonchus oleraceus	L.	Asteraceae

4.8 PLANT PESTS AND DISEASES

There was no evidence of plant disease within the study area.

4.9 CONSERVATION SIGNIFICANT FLORA

A significant flora search requested from the DEC for a 15 km buffer of the Mummaloo Tenement found 24 species. All significant flora species from the DEC search are listed in Table 9, along with their conservation significance. Conservation significance ratings are described in detail in Section 3.

Four priority species were located during field studies; *Allocasuarina tessellata* (Priority 1), *Grevillea scabrida* (Priority 3), *Grevillea subtiliflora* (Priority 3) and *Persoonia pentasticha* (Priority 3). Further details on these species are presented below and their locations in the study area are shown in Figure 4.

It is considered unlikely that the species from the DEC 15 km buffer search which were not located during field surveys occur during the study area on the basis of habitat preferences and given the comprehensive quadrat based survey which covered these species flowering times.

Table 9: Significant Flora from DEC Search of 15 km buffer of Tenement

Species Name	Conservation Status
Acacia ampliata	P1
Acacia cerastes	P1
Acacia imitans	R
Acacia synoria	P2
*Allocasuarina tessellata**	P1
Austrostipa blackii	P3
Baeckea sp. Perenjori (J.W. Green 1516)	P2
Chamelaucium sp. Yalgoo (Y. Chadwick 1816)	P1
Darwinia masonii	R
Dodonaea amplisemina	P3
Eucalyptus synandra	R

Species Name	Conservation Status
Euryomyrtus recurva	P3
Goodenia perryi	P3
*Grevillea scabrida**	P3
*Grevillea subtiliflora**	P3
Hybanthus cymulosus	R
Lepidosperma gibsonii	R
*Persoonia pentasticha**	P3
Philotheca nutans	P1
Podotheca uniseta	P3
Pseudactinia sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)	P3
Rhodanthe collina	P1
Spartothamnella puberula	P2
Verticordia venusta	P3

Table Notes: * Located during field surveys

***Allocasuarina tessellata* (Plate 3) – DEC Priority 1**

Description: A broom-like shrub or small tree to 5m tall (Plate 3). The leaves are reduced. The thin young stems are the most obvious feature of the canopy and are often mistaken for leaves. Plants are either male or female with only females producing woody fruit (Wilson & Johnson 1989).

Flowering Period: Spring

Distribution and Habitat: Endemic to Western Australia. It is known only from the Mt Gibson area with one eastern outlying population north of Southern Cross. The species grows on loam, sand above greenstone and dolerite boulders. It is locally common.

Mummaloo Occurrence: (Figure 6, Plate 4). *Allocasuarina tessellata was* found throughout the study area. It is a typical component of the mixed species shrublands. It is estimated that the population numbers in excess of 1000 plants. The population and plants are healthy with active fruit and seed set noted. The species is not currently threatened within the study area.

Plate 3: *Allocasuarina tessellata* (Florabase July 2011).

Plate 4: *Allocasuarina tessellata* Habitat Photograph at Mumaloo.

***Grevillea scabrida* (Plate 5) – DEC Priority 3**

Description: A densely & irregularly branched shrub to 2m tall (Plate 5). The leaves are curved and rough to the touch. Flowers are green-white and occur as small clusters along the stems (Olde & Marriot 1995).

Flowering Period: Winter-Spring

Distribution and Habitat: Endemic to Western Australia. The species is known only from the Mt Gibson area. It grows on red clay and stony loams and is locally common.

Mummaloo Occurrence: (Figure 6) Found extensively in the study area. It is estimated that the total population of *G. scabrida* within the study area approaches 1,000 plants. The populations are healthy and plants were in flower at the time of the field visit. It is common within the mixed species shrublands and more infrequently occurs in the *Eucalyptus* woodlands. Plants do not appear to be grazed and the populations are not currently threatened within the study area.

Plate 5: *Grevillea scabrida* (Florabase July 2011).

***Grevillea subtiliflora* (Plates 6 & 7) – DEC Priority 3**

Description: An open irregularly branched shrub to 2.5m tall (Plate 6). The leaves are dissected and softly pungent. Flowers are white and occur as small clusters at the tips of the stems (Olde & Marriot 1995).

Flowering Period: Winter-Spring

Distribution and Habitat: Endemic to Western Australia. The species is known only from the Mt Gibson area. It grows on red clay and stony loams and is locally common.

Mummaloo Occurrence: (Figure 6, Plate 7) Found extensively on hill crests and western slopes in the study area. It is estimated that the total population of *G. subtiliflora* within the study area approaches 1,000 plants. The populations are healthy and plants were in flower at the time of the field visit. It is common within the

mixed species shrublands and more infrequently occurs in the *Eucalyptus* woodlands. Plants do not appear to be grazed and the populations are not currently threatened.

Plate 6: *Grevillea subtiliflora* (Florabase July 2011).

Plate 7: *Grevillea subtiliflora* Habitat Photograph at Mumaloo.

***Persoonia pentasticha* (Plate 8) – DEC Priority 3**

Description: Persoonia pentasticha is a small yellow flowering shrub growing 0.3 to 1.8 m tall with a similar spread to 1 m diameter.

Flowering Period: Spring

Distribution and Habitat: Endemic to Western Australia. It occurs from Mingenew,Mullewa, Perenjori to Yuna and Oudabunna Station. The species grows on loam, sand above greenstone and dolerite boulders. It is never locally common.

Mummaloo Occurrence: (Figure 6, Plate 9). Found sporadically in the study area. It is estimated that the total population of *P. pentasticha* within the study area approaches 500 plants. The population is healthy and plants were in flower at the time of the Spring field visit. It is common within the mixed species shrublands and more infrequently occurs in the *Eucalyptus* woodlands. Plants do not appear to be grazed and the populations are not currently threatened within the study area.

Plate 8: *Persoonia pentasticha* (Florabase July 2011).

Plate 9: *Persoonia pentasticha* Habitat Photograph at Mumaloo.

5 LIMITATIONS

There are a number of limitations that may arise during flora and vegetation surveying. These survey limitations are addressed in Table 11 below.

Table 10: Consideration of Study Limitations

Limitation	Comment
Survey Intensity (In retrospect, was the intensity adequate?)	Survey intensity (desktop research followed by seasonal field surveys) follows EPA (2004) recommendations.
Competency/experience of the consultant(s) carrying out the survey.	The author has had significant experience in flora and vegetation surveys including desktop reviews, site inspections and report writing.
Scope. (life forms sampled etc)	All flora species observed during the site visits were identified, with a focus on searching for any significant species or TEC's during the survey
Proportion of flora collected and identified (based on sampling, timing and intensity)	Only species which were not identifiable in the field were collected for further identification. This was deemed suitable for the type of survey undertaken.
Timing/weather/season/cycle.	The survey timing (Autumn and Spring) is considered appropriate for the region.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No disturbances affected the survey.

Limitation	Comment
Completeness (e.g. was relevant area fully surveyed) and further work which might be needed.	Desktop study covered proposed clearing area. Site inspection covered all areas of proposed disturbance. No further work is currently deemed necessary.
Resources (e.g. degree of expertise available in flora identification to taxon level).	All specimens identified to species level.
Mapping reliability.	All mapping completed is deemed reliable. Hand held GPS used to record coordinates and mapping done using professional GIS system.
Access problems.	No access problems encountered.
Sources of information and availability of contextual information (i.e. pre- existing background versus new material).	Extensive regional and local information was available and was consulted. DEC Threatened Flora and TEC Databases were searched and the author had conducted several previous studies in the region.

6 REFERENCES

Armstrong, P., and Associates (2004) Vegetation Assessment and Rare Flora Search between Perenjori and Mt. Gibson. Unpublished report for Mt Gibson Iron Limited.

Department of the Environment, Water, Heritage and the Arts. (2010) Australian Natural Resources Atlas. [Online] 2010. [Cited: July 21, 2010.] http://www.anra.gov.au/.

Beard JS (1976) Vegetation Survey of Western Australia. Murchison 1:1000000 Vegetation Series. Explanatory Notes to Sheet 6. Vegetation of the Murchison Region. University of Western Australia Press, Perth.

Beard J.S. (1981) Vegetation Surveys of Western Australia, University of Western Australia Press

Beecham, B. (2001) Avon-Wheatbelt 1 (AW1 – Ancient Drainage subregion) A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Environment and Conservation, Perth Western Australia.

Beeston, G.R., A.J.M. Hopkins & D.P. Shepherd (2001) Land-use and Vegetation in Western Australia. National Land and Water Resources Audit. W.A. Dept. Agr. Food

CALM. (2002) A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Western Australia.

Department of Environment and Conservation (2011) Definitions, Categories and Criteria for Threatened and Priority Ecological Communities www.dec.wa.gov.au

Department of Environment and Conservation Declared Rare and Priority Flora List (2011) www.dec.wa.gov.au

Department of Environment and Conservation Threatened (Declared Rare) Flora database (2011) www.dec.wa.gov.au

Desmond, A., Chant, A. (2001) Yalgoo (YAL –Yalgoo subregion) A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Environment and Conservation, Perth Western Australia.

Environment Australia (2000) Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1. – Summary Report. Department of Environment and Heritage, Canberra.

EPA (2000) Environmental Protection of Native Vegetation in Western Australia: Clearing of native vegetation with particular reference to the agricultural area, Environmental Protection Authority Position Statement No. 2. Environmental Protection Authority, Government of Western Australia, 2000.

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

Gibson, N., B. Keighery, G. Keighery, A. Burbidge, M. Lyons, (1994) A Floristic Survey of the southern Swan Coastal Plain. Australian Heritage Commission, Canberra.

Hill, M.O., Bunce, R.G.H. & Shaw, M.W. (1975) Indicator species analysis, a divisive polythetic method of classification, and its application to a survey of native pinewoods in Scotland. Journal of Ecology, 63, 597-613.

Hill, M.O. & Šmilauer, P. (2005) TWINSPAN for Windows version 2.3. Centre for Ecology and Hydrology & University of South Bohemia, Huntingdon & Ceske Budejovice
Jongman, R.H.G., C.J.F ter Braak, O.F.R. van Tongeren (1987) Data Analysis in Community and Landscape Ecology. Pudoc, Wageningen.

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

McKenzie, N.L, J.E. May and S. McKenna (2002) Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. DEC/

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

Olde, P. and N. Marriot (1995) The Grevillea Book, Volume 3. Kangaroo Press, Kenthurst.

Payne AL Van Vreeswyk AME, Pringle HJR, Leighton KA, Henning P (1998) An inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area, Western Australia. Agriculture Western Australia, Technical Bulletin No. 90, South Perth.

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

Western Australian Herbarium Specimen database (2009) www.dec.wa.gov.au

Western Australian Herbarium (2011) *Florabase.* Department of Environment and Conservation. http://florabase.calm.wa.gov.au

Wilson, K.L. and L.A.S. Johnson. (1989) Casuarinaceae. Flora of Australia Volume 3, AGPS, Canberra.

7 FIGURES

Figure 1: Location of Top Iron Exploration Tenement E59/1694.

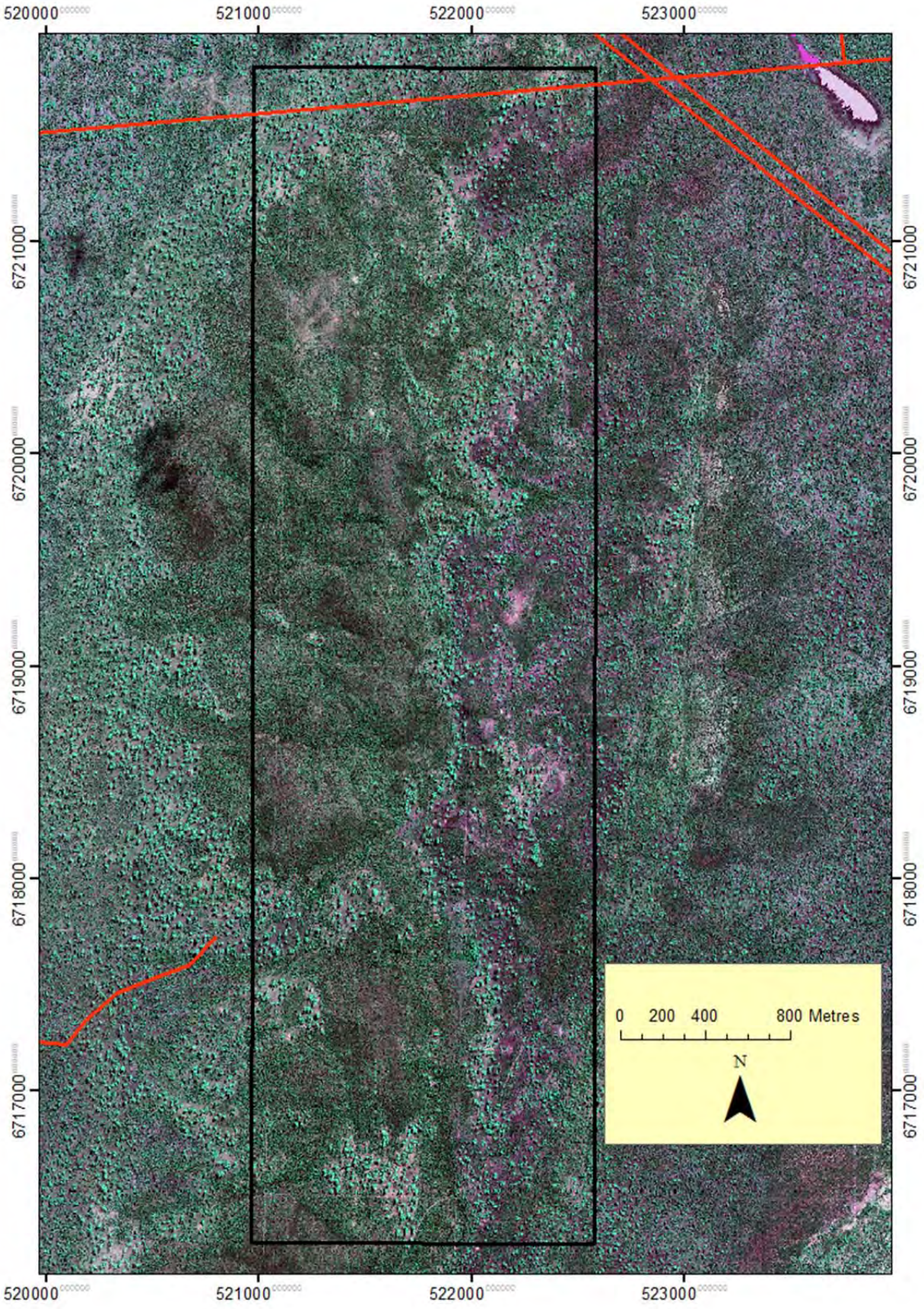


Figure 2: Tenement Location and Local Aerial Photography

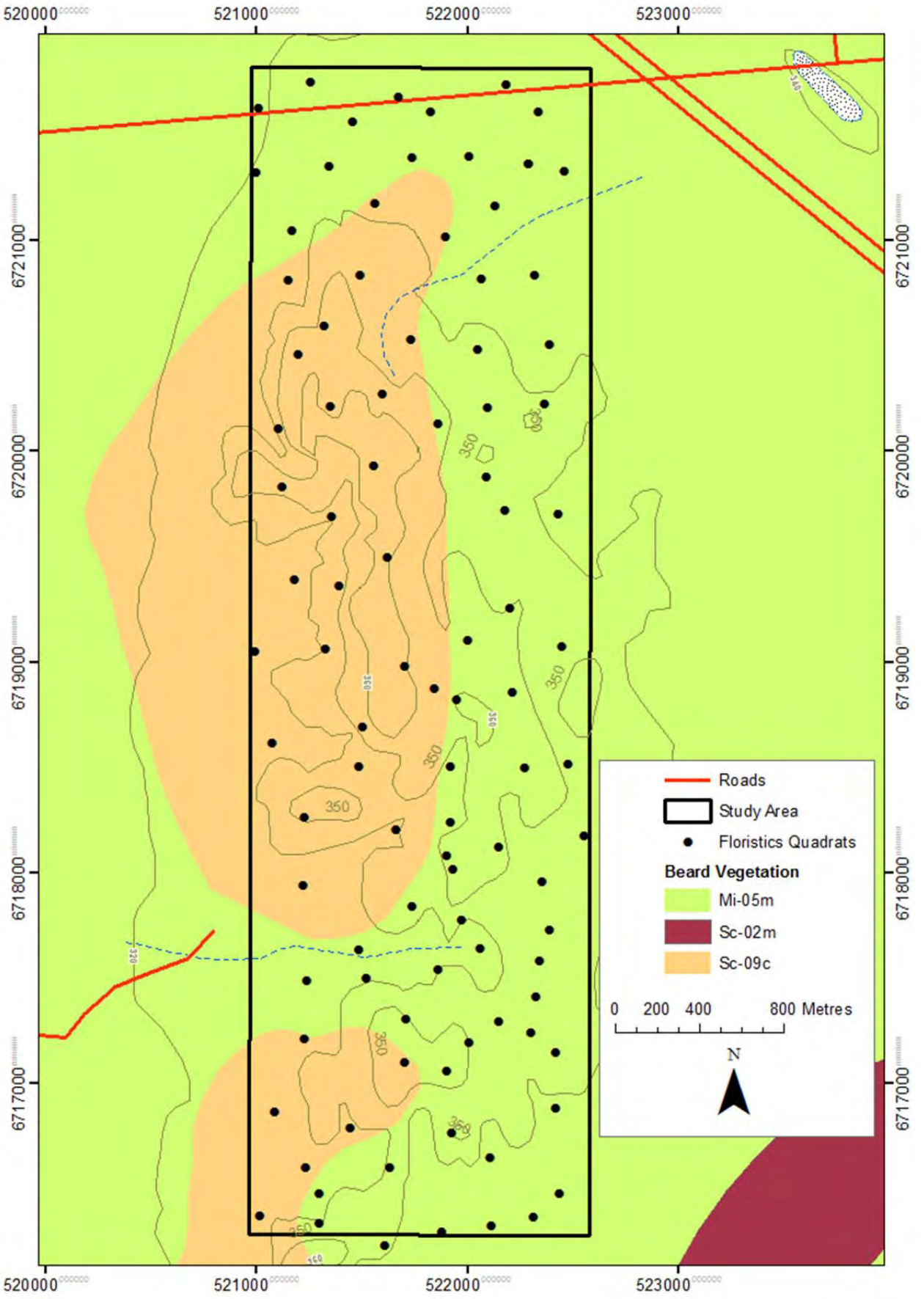


Figure 3: Pre-European Vegetation and floristic quadrats.

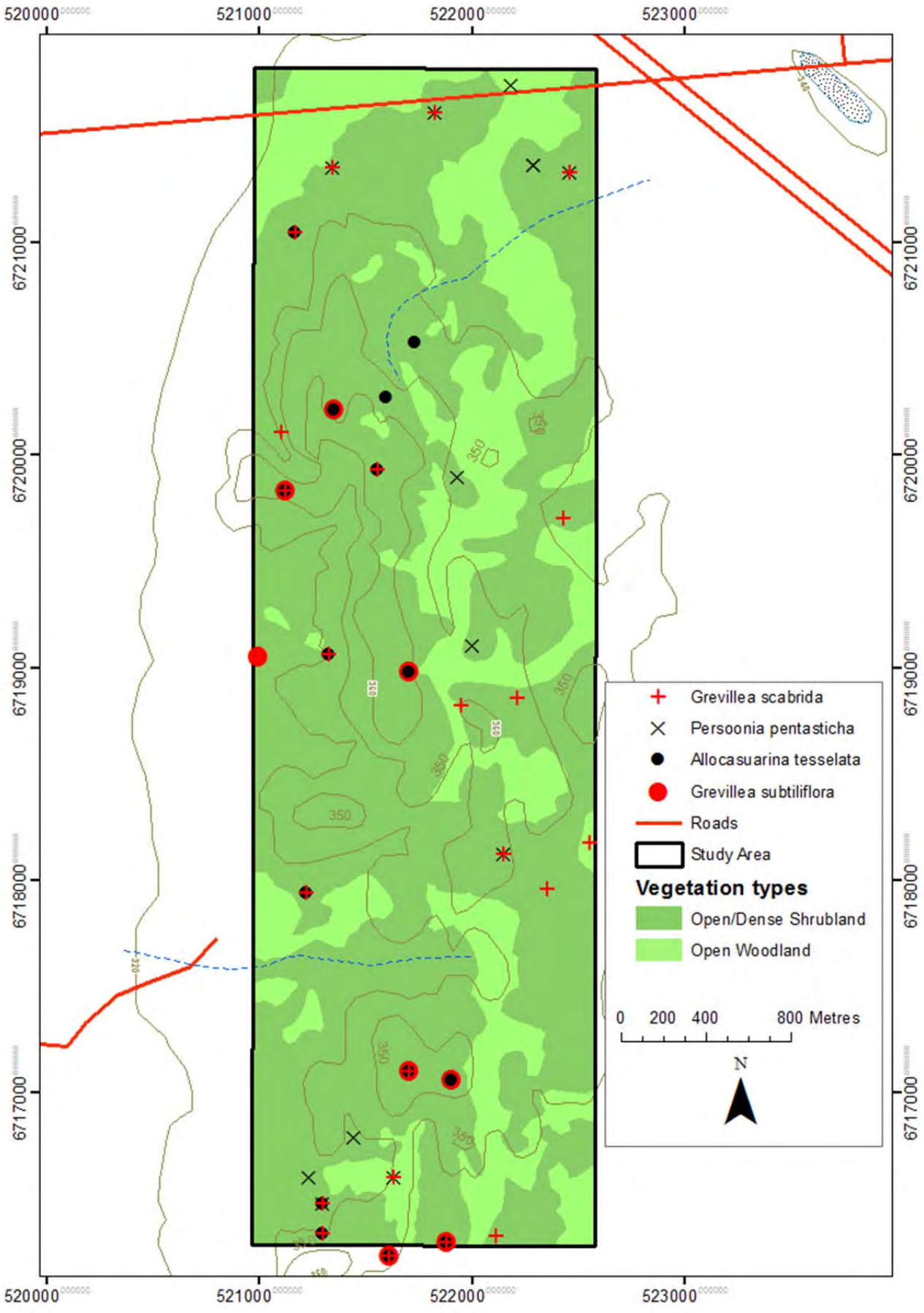


Figure 4: Structral Vegetation Mapping and Locations of Significant Flora

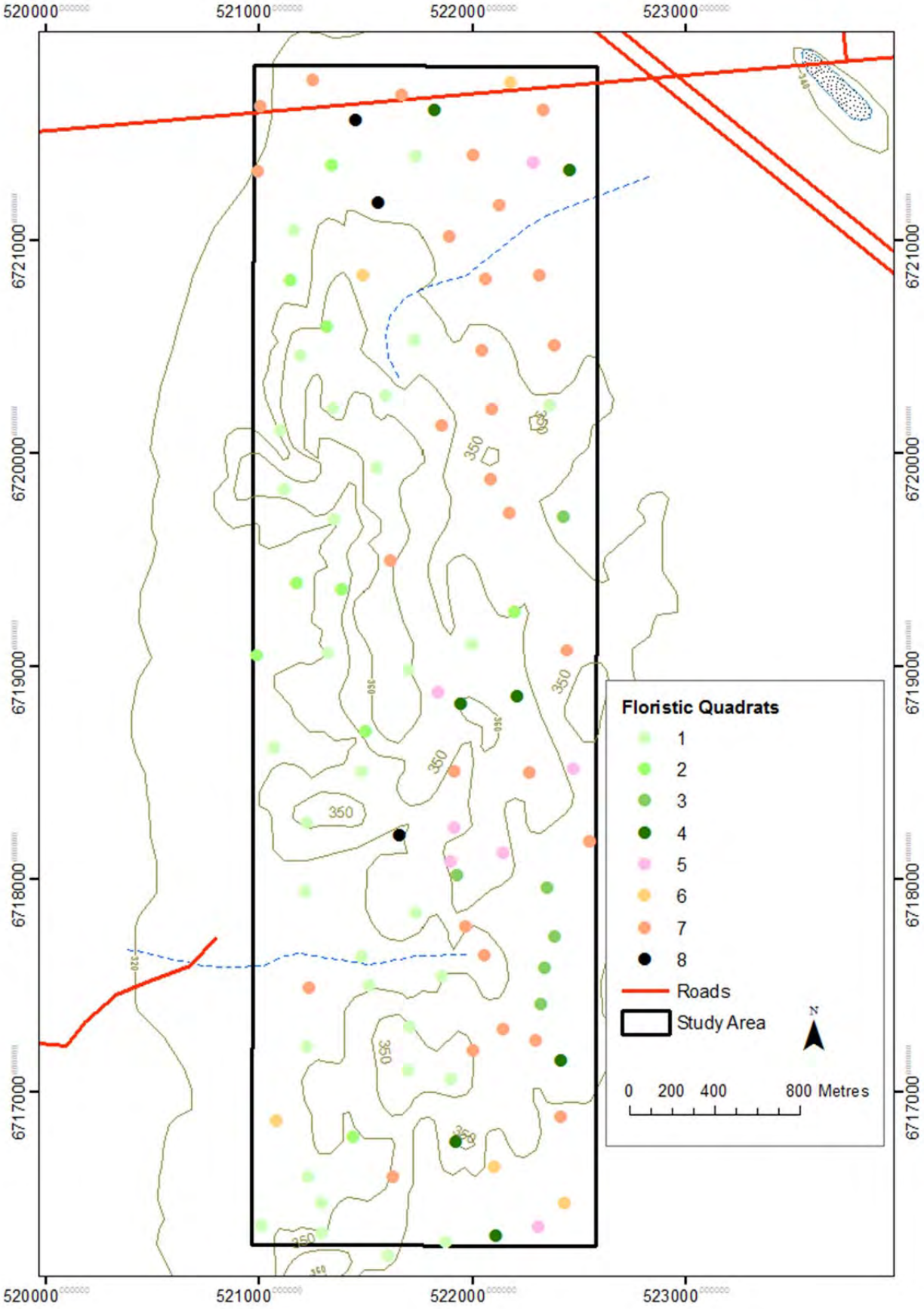


Figure 5: Floristic Classification of Quadrats

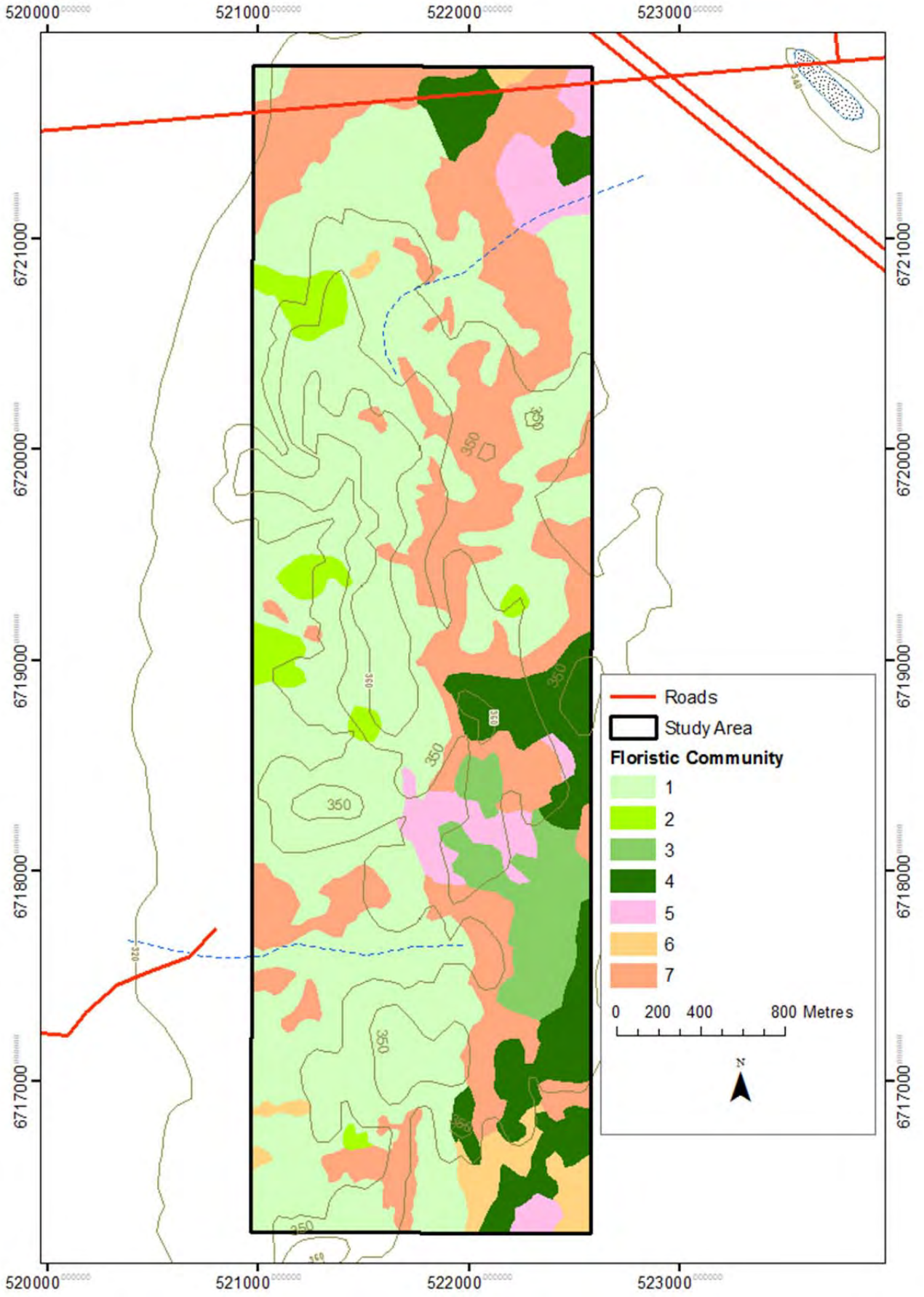


Figure 6: Floristic Communities

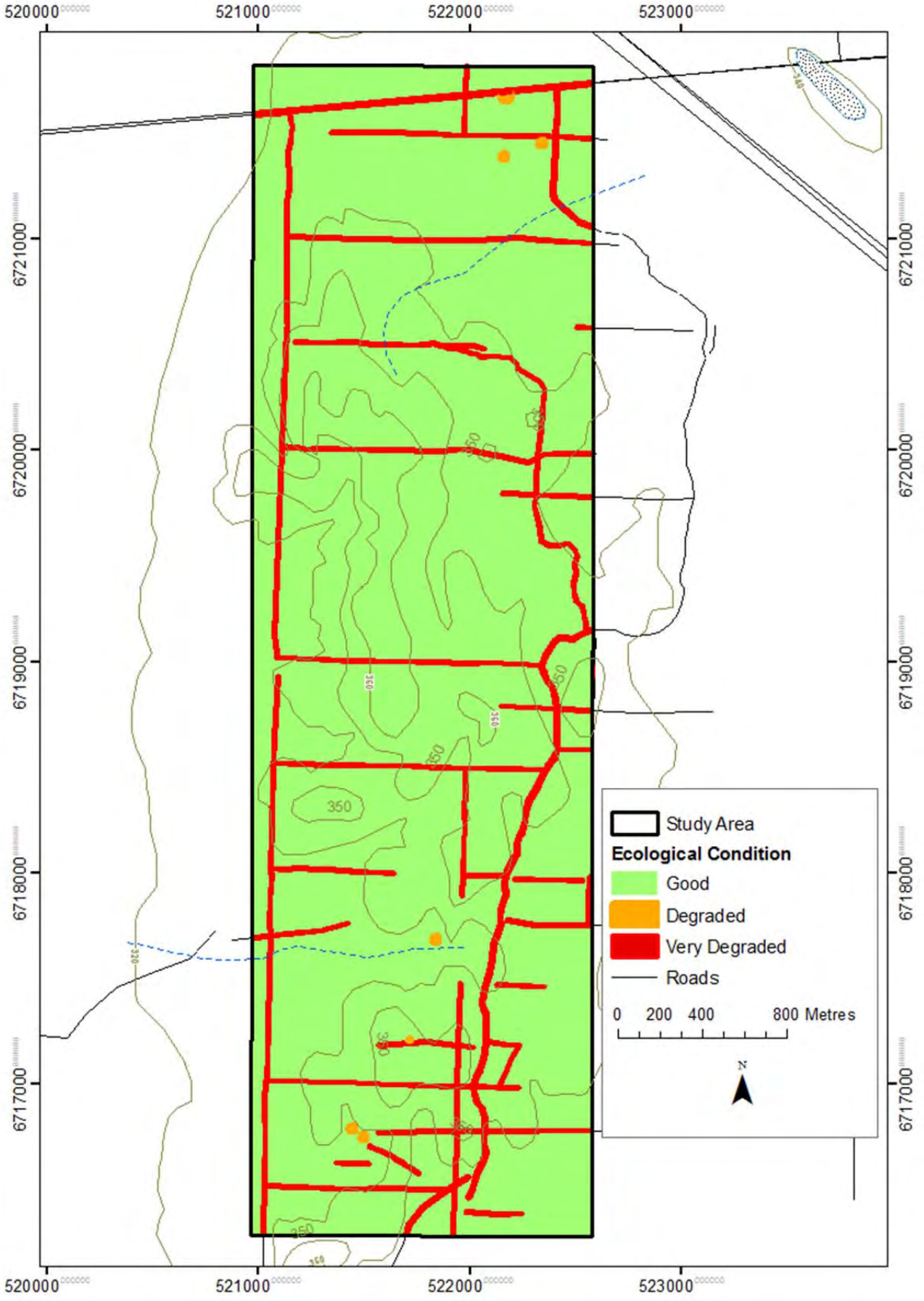


Figure 7: Ecological Condition Mapping

APPENDIX A. CRITERIA USED FOR THE ASSESSMENT OF REMNANT VEGETATION CONDITION (KEIGHERY, 1994)

Rating	Criteria
4. Very Good	Evidence of localised low level damage to otherwise healthy bush. Recruitment should be apparent. Weed and grazing damage is confined (<20% of area). Some modification to vegetation structure due to changes in fire regimes may be apparent. Little evidence of logging or fire wood collection.
3. Good	Evidence of localised high level damage to otherwise low-level damaged bush. Recruitment is localised and the populations of some species may be senescent. Weed and grazing damage is apparent in <50% of the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Gall and mistletoe damage may be apparent. Evidence of logging or fire wood collection.
2. Degraded	Widespread high level damage. Recruitment is disrupted and most woody species appear senescent. Weed and grazing damage may be apparent throughout the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Locally some strata are absent. Gall and mistletoe damage may be apparent. Evidence of logging or fire wood collection.
1. Very Degraded	Widespread high level damage. Recruitment is disrupted and most woody species appear senescent. Weed and grazing damage may be apparent throughout the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Widespread loss of vertical strata. Gall and mistletoe damage may be apparent. Evidence of logging or firewood collection.
Damage type	**Description**
High Level	Grazing (domestic and feral), logging, clearing and excavation, die-back, salinisation or other water table modification, road works, flower picking, major structures (eg. managed or fenced areas), mowing, car bodies.
Low Level	Dumping (household, garden etc.), minor structures (eg. sheds), fire wood collection, weed infestation, modified fire regime.

APPENDIX B. PLANT COMMUNITY STRUCTURAL FORMATION AND HEIGHT CLASSES (MUIR, 1977)

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

APPENDIX C. GPS LOCATIONS

Threatened and Priority Flora

Allocasuarina tessellata

Easting	Northing
521611	6716228
521299	6716338
521297	6716478
521879	6716295
521705	6718982
521326	6719064
521222	6717943
521733	6720530
521596	6720272
521348	6720216
521122	6719832
521555	6719934
521900	6717057
521703	6717101
521167	6721049

Grevillea scabrida

Easting	Northing
522461	6721332
521611	6716228
521299	6716338
521297	6716478
521630	6716598
521879	6716295
522111	6716324
522146	6718123
521948	6718822
521326	6719064
522214	6718859
521222	6717943
522354	6717960
522556	6718175
521824	6721615
521103	6720106
521122	6719832
521555	6719934
522428	6719701
521703	6717101
521346	6721353
521167	6721049

Grevillea subtiliflora

Easting	Northing
521611	6716228
521879	6716295
521705	6718982
520992	6719052
521348	6720216
521122	6719832
521900	6717057
521703	6717101

Persoonia pentasticha

Easting	Northing
522293	6721365
522293	6721365
522461	6721332
521297	6716478
521630	6716598
522186	6721741
521934	6719895
522146	6718123
521824	6721615
521346	6721353
522001	6719101
521443	6716789
521233	6716599

APPENDIX D. PLANT SPECIES LIST

Family	Species
Aizoaceae	*Gunniopsis rodwayi*
Amaranthaceae	*Ptilotus divaricatus*
	Ptilotus exaltatus var exaltatus
	Ptilotus gaudichaudii var. gaudichaudii
	Ptilotus obovatus
	Ptilotus polystachyus
	Ptilotus schwartzii var. schwartzii
	Ptilotus spathulatus var. spathulatus
Apiaceae	*Daucus glochidiatus*
Apocynaceae	*Alyxia buxifolia*
	Rhyncharrhena linearis
Araliaceae	*Trachymene ornata*
	Trachymene pilosa
Asparagaceae	*Thysanotus manglesianus*
	Dichopogon tyleri
	Arthropodium dyeri
Aspleniaceae	*Pleurosorus rutifolius*
Asteraceae	*Arctotheca calendula**
	*Centaurea melitensis**
	*Sonchus oleraceus**
	Angianthus preissianus
	Angianthus tomentosus
	Asteridea athrixioides
	Blennospora drummondii
	Brachyscome ciliaris
	Brachyscome iberidifolia
	Brachyscome pusilla
	Calocephalus multiflorus
	Calotis multicaulis
	Cephalipterum drummondi
	Chthonocephalus pseudevax
	Gnephosis angianthoides
	Isoetopsis graminifolia
	Lawrencella rosea
	Millotia myosotidifolia
	Olearia muelleri
	Olearia pimeleoides
	Podolepis gracilis
	Podolepis lessonii
	Rhodanthe citrina
	Rhodanthe rubella
	Schoenia cassiniana
	Trichanthodium exile
	Waitzia acuminata

Boraginaceae	*Halgania integerrima*
Boryaceae	*Borya sphaerocephala*
Brassicaceae	*Sisymbrium erysimoides**
	Lepidium oxytrichum
	Phlegmatospermum drummondii
	Stenopetalum anfractum
Campanulaceae	*Wahlenbergia tumidifructa*
	Lobelia winfridae
Casuarinaceae	*Allocasuarina acutivalvis subsp. prinsepiana*
	Allocasuarina tessellata
	Casuarina obesa
Celastraceae	*Tripterococcus brunonis*
Chenopodiaceae	*Atriplex bunburyana*
	Atriplex codonocarpa
	Chenopodium gaudichaudianum
	Enchylaena tomentosa
	Maireana carnosa
	Maireana georgei
	Maireana trichoptera
	Salsola tragus
	Sclerolaena densiflora
	Sclerolaena diacantha
	Sclerolaena drummondii
	Sclerolaena eurotioidies
	Sclerolaena fusiformis
	Tecticornia halocnemoides
Colchicaceae	*Wurmbea sp. Paynes Find (C.J. French 1237)*
	Wurmbea tenella
Cupressaceae	*Callitris columellaris*
Dilleniaceae	*Hibbertia exasperata*
	Hibbertia glomerata
	Hibbertia pungens
Droseraceae	*Drosera macrantha*
Ericaceae	*Astroloma serratifolium*
	Leucopogon sp. Clyde Hill (M.A. Burgman 1207)
Euphorbiaceae	*Euphorbia tannensis subsp. eremophila*
Fabaceae	*Acacia acanthoclada subsp glaucescens*
	Acacia acuaria
	Acacia acuminata
	Acacia andrewsii
	Acacia anthochaera
	Acacia assimilis var assimilis
	Acacia duriuscula
	Acacia erinacea
	Acacia inceana var conformis
	Acacia kochii
	Acacia murrayana
	Acacia tetragonophylla

	Bossiaea walkeri
	Daviesia benthamii subsp. acanthoclona
	Jacksonia arenicola
	Leptosema aphyllum
	Mirbelia bursarioides
	Senna artemisioides subsp. petiolaris
	Senna artemisioides var filifolia
	Senna charlesiana
	Senna glaucifolia
	Senna glutinosa subsp. chatelainiana
	Senna pleurocarpa var. pleurocarpa
Frankeniaceae	*Frankenia pauciflora*
Geraniaceae	*Erodium cicutarium**
	Erodium cygnorum
Goodeniaceae	*Goodenia havilandii*
	Scaevola spinescens
	Velleia rosea
Haloragaceae	*Haloragis trigonocarpa*
Hemerocallidaceae	*Tricoryne elatior*
	Dianella divaricata
Lamiaceae	*Hemigenia dielsii*
	Prostanthera althoferi subsp. althoferi
	Prostanthera eckersleyana
Lauraceae	*Cassytha aurea*
Loranthaceae	*Amyema miquelii*
	Amyema preissii
	Lysiana exocarpii
Malvaceae	*Lawrencia densiflora*
	Sida calyxhymenia
Myrtaceae	*Calothamnus gilesii*
	Calytrix leschenaultii
	Eucalyptus ewartiana
	Eucalyptus loxophleba subsp. supralaevis
	Eucalyptus salmonophloia
	Malleostemon roseus
	Melaleuca cordata
	Melaleuca lateriflora
	Melaleuca nematophylla
	Melaleuca radula
	Melaleuca stereophloia
	Melaleuca uncinata
	Micromyrtus clavata
	Micromyrtus racemosa
	Thryptomene cuspidata
	Thryptomene mucronulata
Orchidaceae	*Caladenia hirta subsp. rosea*
	Caladenia incensa
	Cyanicula amplexans

	Pterostylis pyramidalis
Phyllanthaceae	*Poranthera microphylla*
Pittosporaceae	*Cheiranthera simplicifolia*
Plantaginaceae	*Plantago coronopus**
Poaceae	*Pentaschistis airoides subsp. airoides**
	Aristida contorta
	Austrodanthonia caespitosa
	Austrostipa elegantissima
	Austrostipa nitida
	Eriachne pulchella subsp. pulchella
Polygalaceae	*Comesperma integerrimum*
Portulacaceae	*Calandrinia eremaea*
Proteaceae	*Grevillea hakeoides*
	Grevillea paradoxa
	Grevillea pityophylla
	Grevillea scabrida
	Grevillea subtiliflora
	Hakea francisiana
	Hakea invaginata
	Hakea recurva
	Persoonia manotricha
	Persoonia pentasticha
Pteridaceae	*Cheilanthes austrotenuifolia*
Rutaceae	*Philotheca brucei*
Santalaceae	*Exocarpos aphyllus*
	Santalum acuminatum
	Santalum lanceolatum
Sapindaceae	*Dodonaea inaequifolia*
	Dodonaea rigida
Scrophulariaceae	*Eremophila clarkei*
	Eremophila deserti
	Eremophila eriocalyx
	Eremophila glutinosa
	Eremophila latrobei subsp latrobei
	Eremophila oldfieldii subsp. angustifolia
	Eremophila oppositifolia var angustifolia
Solanaceae	*Solanum lasiophyllum*
	Solanum nummularium
Thymeleaceae	*Pimelea microcephala subsp. microcephala*
	Pimelia avonensis
Violaceae	*Hybanthus floribundus subsp. floribundus*
Zygophyllaceae	*Zygophyllum aurantiacum subsp. aurantiacum*
	Zygophyllum kochii