

Document Status						
Rev No.	Author	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
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EXECUTIVE SUMMARY

Midwest Corporation Limited (Midwest) proposes to develop two areas where iron ore mines were abandoned in the 1970s. One of the areas is the old Koolanooka mine pit at Koolanooka Hills and the other is the Mungada iron ore pits and waste dumps at Blue Hills. Koolanooka Hills is located in the Shire of Morawa in the Wheatbelt Region and Blue Hills in the Shire of Perenjori in the southern Murchison Region in Western Australia; both project areas are on Banded Iron Formation (BIF) ranges.

Mining is proposed to resume at Tenement Numbers M70/1012, M70/1013 and M70/1014 at Koolanooka Hills (4.46 ha total area) and M59/0595 and M59/0596 at Blue Hills (52.5 ha of newly and previously disturbed land). As part of the mine feasibility studies, and to facilitate the environmental legal approvals processes, an assessment of the flora and vegetation of the proposed project areas was required. Midwest commissioned *ecologia* Environment Pty Ltd (*ecologia*) to carry out a vegetation and flora survey in two specific areas proposed for clearing to permit an extension of both the Koolanooka and Blue Hills mine sites. The results of this survey are to be included as part of a Public Environmental Review (PER) of these proposals – the level of assessment set by the Environmental Protection Agency (EPA) - and to support a Mining Proposal (MP) application to be submitted to the Department of Industry and Resources (DoIR).

The assessment of the flora and vegetation of the proposed mine sites is presented in this report, the purpose of which is to provide information on the flora and vegetation of the project areas as part of the Public Environmental Review (PER) process of the project.

Vegetation

Koolanooka Hills occurs in the Perenjori geographical region. These hills, within the Koolanooka Land System, form a range of rolling to very steep low hills.

The proposed Koolanooka Hills zone of impact was identified as having two types of vegetation, the first dominated by tall shrubland of *Allocasuarina acutivalvis* subsp. *prinsepiana* and *Acacia acuminata*, over open to moderately dense *Acacia exocarpoides* / *Melaleuca fulgens* subsp. *fulgens* / *Daviesia hakeoides* subsp. *hakeoides* and other shrubs, and the second by *Allocasuarina acutivalvis* subsp. *prinsepiana*, over *Calycopeplus paucifolius*, over open *Acacia sclerosperma* subsp. *sclerosperma*, over scattered *Dodonaea inaequifolia* shrubs.

The proposed Blue Hills zone of impact (of the Tallering land system) is larger and a number of different landform units occur in the area, including rocky hillcrests, gentle to moderate hillslopes and undulating plains. Sixteen vegetation types associated with six habitats were identified on these varied landforms.

On the undulating plains and footslopes of Blue Hills the vegetation varied and included:

- *Eucalyptus loxophleba* subsp. *supralaevis* open medium woodland, over *Acacia assimilis* subsp. *assimilis* (sometimes *Acacia obtecta*) and other shrubs such as chenopods, and
- *Acacia ramulosa* var. *ramulosa* sparse to open tall shrubland (sometimes with open *Acacia burkittii* and sparse *Melaleuca leiocarpa* / *Exocarpos aphyllus*), over scattered *Hakea recurva* subsp. *recurva* low to tall shrubs and other shrub species. These two vegetation types occur within the zone of impact for the Mungada West pit area.

The rocky hillslopes and hillcrest areas of both the Mungada East and Mungada West areas at Blue Hills tend to be dominated by vegetation such as: sparse to open low woodland to tall/medium shrubland of *Acacia ramulosa* var. *ramulosa* / *Acacia assimilis* subsp. *assimilis* / *Acacia acuminata* / *Acacia auacocarpa*, or moderately dense tall shrubland of *Melaleuca nematophylla* / *Dodonaea viscosa* subsp. *spatulata* or *Dodonaea inaequifolia*. *Micromyrtus trudgenii* occurs in these habitats.

The upper hillslope areas at Blue Hills also contain small patches of emergent *Acacia aneura* var. *argentea* low trees over the shrubland vegetation. The slope shrubland vegetation often contains the two superficially similar and mostly leafless shrub species, *Acacia exocarpoidea* and *Calycopeplus paucifolius*.

The hillcrest area at Mungada East pit is dominated by vegetation comprising *Allocasuarina acutivalvis* subsp. *prinsepiana* / *Melaleuca nematophylla* / *Calycopeplus paucifolius* moderately dense tall shrubland.

Threatened Ecological Communities (TECs)

The plant assemblages of the Koolanooka Hills System have been defined as a TEC (Vulnerable). The vegetation of these areas is dominated by sheoak and mixed shrubland of *Allocasuarina campestris* (hilltops) and *Acacia exocarpoidea* (on granite). The proposed zone of impact at Koolanooka Hills falls within the mapped areas for the TEC, and makes up a small portion of this area. According to DEC the plant assemblages of the TEC occur over two areas totalling 5419 ha. However, in the literature the Koolanooka Hills area is given as 3496 ha and the Perenjori Hills area 1948 ha which totals 5444 ha – 25 ha more than the DEC figure. As it is unclear whether the differences are from one or both occurrences, calculations on the percent of the TEC to be impacted are based on the areas given in the literature and not on the 5419 ha total stated by DEC. Therefore the 4.46 ha to be impacted at Koolanooka Hills constitutes 0.13% of the Koolanooka Hills TEC or 0.08% of the total TEC area of the Plant Assemblages of the Koolanooka System.

No TECs have been identified at the Blue Hills project area.

Other Reserves

While no TECs are listed as occurring at Blue Hills, between 2000 and 2004 Karara, Lochada and Warriedar pastoral leases were purchased by the DEC. These pastoral leases are now currently listed as conservation estate and are proposed conservation reserves. The pastoral lease area for Karara is 109,291 ha, and the additional leases purchased for

conservation purposes at Lochada and Warriedar Stations are 114,581 and 72,219 ha respectively; this gives a total of 296,091 ha in these proposed conservation reserves.

The Blue Hills project area comprises a small portion of land system 12 – Tallering, in land type 2 in the area. Land system 12, described as ‘hills with mixed shrublands’, is one of three in land type 2 that include ridges, ranges and hills of banded ironstone and greenstone. The hills and ridges of the Tallering land type are expressed on Lochada, Warriedar and Karara Stations which are in the conservation estate. The area of the Tallering land system is 329 km² and the area of this land system that is proposed for clearing at Mungada East and Mungada West is 52.5 ha, which equates to 0.16% of the Tallering land system. Of this area 11.7 ha has been cleared previously and the remainder (40.8 ha) is to be newly cleared. Therefore the proportion of the Tallering land system proposed to be newly cleared is 0.12%.

Flora of Conservation Significance

No DRF or Priority Flora species were recorded within the Koolanooka Hills zone of impact during the current survey. However, the taxon *Acacia sclerosperma* subsp. *sclerosperma* was recorded and this marks a range extension from previously known populations.

One DRF species, *Acacia woodmaniorum*, was recorded during the current surveys at Blue Hills, while three DEC listed Priority Flora, *Micromyrtus acutas*, (Priority 1), and, , *Micromyrtus trudgenii* and *Persoonia pentasticha* (both Priority 3), were recorded at both the Mungada East and Mungada West areas during the current survey. In addition, *Lepidosperma* sp. Blue Hills (a species of interest) was located at Mungada East.

Weeds

No Priority weeds were recorded at the Koolanooka Hills proposed impact area during the current survey. However two environmental weeds, Common Sowthistle (**Sonchus oleraceus*) and Ruby Dock (**Acetosa vesicaria*) were recorded.

One Priority weed, Patterson’s Curse (**Echium plantagineum* - Priority 1 weed), was found at the Mungada East area of Blue Hills on a disturbed lower slope near the old mine pit. In addition to this, three environmental weeds were also recorded at Mungada East; False Cleavers (**Galium spurium*) and False Hairgrass (both **Pentaschistis airoides* and **Pentaschistis airoides* subsp. *airoides*).

No Priority or environmental weeds were recorded during the current survey of the proposed impact area at Mungada West at Blue Hills.

Recommendations

Management of native flora and vegetation is addressed in the Public Environmental Review (PER) and the proposal’s Environmental Management Plan (EMP). In addition, the following actions should be implemented to mitigate impacts of the development on native flora and vegetation.

- To avoid the introduction and spread of weed species to and from the area (particularly the Priority 1 weed **Echium plantagineum*) strict hygiene measures should be implemented. All earthmoving machinery and other heavy vehicles involved are to be cleaned down before operations commence and remain within the

area until the work is completed. Vehicles are to be cleaned down when moving from areas where weeds are present to areas where no weeds are present and areas that contain flora of conservation significance. Regular monitoring of disturbed areas is to be undertaken to determine if weeds are spreading into cleared areas and, if necessary, spot spraying of emergent weeds may be required. As Paterson's Curse (*Echium plantagineum*) is a Priority 1 weed Midwest is required to remove and manage the weed and the appropriate management controls are outlined in this report. This noxious weed should be eradicated from the site prior to the mining process. This will require very good soil hygiene measures and long term follow up to identify and eradicate seedlings. Further information in regards to herbicide use for weed control can be found on the Department of Agriculture and Food website.

- Vegetation clearing is to be restricted to that which is absolutely necessary and should have as little impact as possible on areas where flora of conservation significance were recorded.
- Areas where native vegetation will be totally removed contain important genetic resources in the form of the soil seed bank, the canopy-stored seed bank, vegetative cuttings that can be propagated in a nursery, rhizomatous monocotyledon plants that can be divided and propagated. The organic material contained within the vegetation to be cleared can be used as mulch for disturbed sites in either chip or brush mulch form. All of the above resources can be used to rehabilitate degraded areas locally and to establish vegetated buffer zones around mine infrastructure.
- Topsoil is to be stockpiled for use in the rehabilitation of post-mining areas. This allows for a good growth medium for regenerating seedlings, and a source of existing local propagules (fruits, seeds, roots, rhizomes, bulbs, corms etc.) for returning local species to the vegetation.
- Cleared vegetation and coarse surface material such as logs and rocks are to be stockpiled for future use in rehabilitation as it provides useful fauna habitat and shelter locations for regenerating seedlings.
- Each area that is cleared for mining should be rehabilitated as soon as possible after mining. Special measures to counteract erosion may also be necessary in areas such as steep inclines.
- All earthmoving machinery is to be fitted with fire extinguishers to prevent the spread of any potential fire into nearby vegetation.
- No off-track driving is to be allowed at the Koolanooka or Blue Hills areas.

1.0 INTRODUCTION

Midwest Corporation Limited (Midwest) proposes to redevelop two iron ore mines abandoned in the 1970s. One mine is the old Koolanooka mine pit at Koolanooka Hills and the other is the Mungada iron ore pits at Blue Hills. Koolanooka Hills is located in the Shire of Morawa in the Wheatbelt Region (WALIS accessed 02/08/06) and Blue Hills in the Shire of Perenjori in the southern Murchison Region. Both areas are in Western Australia and are located on Banded Iron Formation (BIF) ranges.

Midwest wishes to resume mining at Tenement Numbers M70/1012, M70/1013 and M70/1014 at Koolanooka Hills and M59/0595 and M59/0596 at Blue Hills. As part of the mine feasibility studies, and to facilitate the environmental legal approvals processes, an assessment of the flora and vegetation of the proposed project areas was required. Midwest commissioned *ecologia* Environment (*ecologia*) to carry out a vegetation and flora survey of two specific areas proposed for clearing to permit an extension of both the Koolanooka and Blue Hills mine sites. The results of this survey are to be included as part of a Public Environmental Review (PER) of these proposals – the level of assessment set by the Environmental Protection Agency (EPA) - and to support a Mining Proposal (MP) application to be submitted to the Department of Industry and Resources (DoIR).

The assessment of the flora and vegetation of the proposed mine sites is presented in this report, the purpose of which is to provide information on the flora and vegetation of the project areas as part of the Public Environmental Review (PER) process of the project.

1.1 Legislative Framework

Federal and State legislation applicable to the conservation of native flora includes, but are not limited to, the *Environment Protection and Biodiversity Conservation Act 1999*, the *Wildlife Conservation Act 1950*, and the *Environmental Protection Act 1986*. Section 4a of the *Environmental Protection Act 1986* requires that developments take into account the following principles applicable to native flora:

- The Precautionary Principle

Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- The Principle of Intergenerational Equity

The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- The Principle of the Conservation of Biological Diversity and Ecological Integrity

Conservation of biological diversity and ecological integrity should be a fundamental consideration.

1.2 Location

Koolanooka Hills

The Koolanooka Hills project area is located approximately 165 km south-east of Geraldton and 10 km south-east of Morawa (WALIS accessed 02/08/06; Figure 1-1). The vegetation and flora survey covered 4.46 ha of land to be newly disturbed south-east of the old Koolanooka iron ore pit. This is located at the north-western end of Koolanooka Hills where the hills rise approximately 140 m above the surrounding undulating plain.

Blue Hills

The Blue Hills project area lies approximately 60 km north-east of Perenjori, 90 km south of Yalgoo (Bamford, 2004) and 60 km east of Koolanooka Hills (Figure 1-1). The vegetation and flora surveys undertaken at the Blue Hills project area covered approximately 52.5 ha. This comprised 18.8 ha of land to be newly cleared for the Mungada East proposed waste dump and 6.4 ha of predisturbed land for Mungada East pit, and 21.0 ha for the proposed waste dump, 5.3 ha for the pit as well as 1 ha for infrastructure at Mungada West. Mungada East and West are located in the Karara Station area that is also under exploration by Gindalbie Metals Ltd.



Figure 1-1: Regional Location Plan

2.0 REGIONAL SETTING

Koolanooka Hills

The Koolanooka mine site is located within the Shire of Morawa, approximately 165 km east-south-east of the Port of Geraldton. Surrounding lands covered by the Project mining leases are generally held freehold by local farmers and pastoralists.

The mine site is at the north-western end of Koolanooka Hills, which rise approximately 140 m above the surrounding undulating plain striking north north-west to south south-east for 13 km. These hills are composed of BIF, which is preferentially resistant to erosion.

The Koolanooka mine site was previously mined from 1966 to 1972 as part of the Geraldton Operations Joint Venture (GOJV) and a large proportion of the land north of Koolanooka Springs Road has been previously disturbed.

The plains surrounding Koolanooka Hills are generally used for agriculture, predominantly wheat and sheep farming.

Blue Hills

The Blue Hills mines are located on Karara Station within the Shire of Perenjori approximately 220 km east of Geraldton and 60 km east of Koolanooka. The Blue Hills range also consists of BIF and the name given to this ridge line is Windaning Ridge. Dips are generally steep and where the ironstones outcrop the topography is often rugged.

Exploration was conducted for iron ore deposits in the area in the 1960s and 1970s and two high grade iron ore deposits, Mungada East and Mungada West, were mined between 1970 and 1972. Records show that the Mungada West mine was still in high grade ore when mining ceased following the satisfaction of the supply contracts then in place.

The area surrounding Blue Hills was formerly a pastoral lease, but is now CALM (now DEC) Purchased Lease (CPL) 16 (Karara Station) vested with the Conservation Commission, and is under direct management by the Department of Environment and Conservation; a Conservation Park is proposed for the area.

2.1 Climate

The general area, within which both project areas lie, has an annual average minimum temperature range of 12-15°C and an annual average maximum temperature range of 21-24°C. The area experiences a low to moderate indexed rainfall variability, with an average of 300-400 mm of rain falling per annum (BoM accessed online 02/04/07).

Koolanooka Hills

The climate at Koolanooka Hills is considered semi-arid or warm Mediterranean (Beecham, 2001) with mild, wet winters and hot, dry summers. Winter rains are generally associated with frontal systems from the south-west, which weaken considerably when they reach the

Morawa district, while summer rains are associated with isolated thunderstorms (ATA, 2004b).

The mean annual rainfall (measured at Morawa) is 326.6 mm, and the average monthly rainfall ranges from 9 mm in December to 60 mm in June (Table 2.1). The mean monthly maximum daily temperatures range from 18°C in July to 37°C in January (BoM accessed online 02/04/07).

Table 2.1 Climatic Averages for Morawa Weather Station.

Lat: -29.21 S			Long: 116.01 E				Commenced: 1911		Last record: 17 Mar 2005			Elevation: 274 m	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
Mean daily max. temp (°C)													
36.7	36.2	33.0	28.2	22.9	19.3	18.1	19.4	23.0	26.7	30.8	34.5	27.4	
Mean daily min. temp (°C)													
19.0	19.5	17.4	13.8	9.8	7.4	6.2	6.4	7.7	10.3	13.7	16.6	12.3	
Mean 9am relative humidity (%)													
43	46	51	61	73	82	83	78	67	51	45	42	60	
Mean 3pm relative humidity (%)													
22	25	28	36	45	53	53	50	40	29	26	23	36	
Mean 9am wind speed (km/hr)													
14.1	14.8	13.0	11.0	8.3	7.6	7.2	8.3	10.1	13.1	13.6	13.5	11.2	
Mean 3pm wind speed (km/hr)													
12.3	12.3	12.1	11.8	12.0	13.0	12.9	13.6	13.6	13.5	13.9	13.3	12.9	
Mean Rainfall (mm)													
14.4	17.6	22.8	22.0	46.2	59.5	54.4	39.3	22.0	15.1	10.9	8.8	326.6	
Mean no. of rain days													
2.2	2.5	3.1	4.5	7.9	11.4	12.6	10.6	6.8	4.9	3.1	1.9	71.5	
Highest monthly rainfall (mm)													
93.2	109.7	219.7	107.1	191.5	179.3	155.2	111.6	66.6	86.4	101.4	61.4	580.4	
Mean daily evaporation (mm)													
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Source: Bureau of Meteorology, 2007.

Blue Hills

Blue Hills lies in the semi-desert Mediterranean bioclimatic region and experiences mild, wet winters and hot, dry summers. According to Bennett (2004) the nearest weather recording station is at Paynes Find. The mean annual rainfall at Paynes Find is 239.4 mm and the average monthly rainfall ranges from 10 mm in October to 43 mm in June (Table 2.2). The mean monthly maximum temperatures range from 18°C in July to 37°C in January (BoM accessed online 02/04/07).

Table 2.2 Climatic Averages for Paynes Find Weather Station.

Lat: -29.27 S			Long: 117.68 E				Commenced: 1919		Last record: March 2007			Elevation: 339 m	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
Mean daily max. temp (°C)													
37.1	36.2	32.8	28.3	23.1	19.2	18.4	19.7	23.6	27.5	31.5	35.0	27.7	
Mean daily min. temp (°C)													
20.7	20.9	18.0	14.3	9.7	6.5	5.3	5.8	7.9	11.0	15.2	18.3	12.8	
Mean 9am relative humidity (%)													
37	41	47	55	65	74	76	68	56	45	40	38	54	

Lat: -29.27 S	Long: 117.68 E					Commenced: 1919	Last record: March 2007					Elevation: 339 m	
Mean 3pm relative humidity (%)													
	21	25	28	34	42	48	50	43	34	25	22	21	21
Mean 9am wind speed (km/hr)													
	11.4	10.8	10.2	8.4	7.2	6.9	6.9	7.9	9.6	10.7	11.3	10.6	9.3
Mean 3pm wind speed (km/hr)													
	9.2	8.8	8.7	8.0	8.9	9.3	9.2	10.0	11.0	10.5	10.4	9.4	9.5
Mean Rainfall (mm)													
	18.5	20.9	27.1	26.5	39.9	42.8	33.5	27.6	14.4	9.8	10.3	12.0	239.4
Mean no. of rain days													
	2.4	2.3	3.1	3.7	6.4	8.2	7.4	6.6	4.6	2.9	2.4	2.1	52.1
Highest monthly rainfall (mm)													
	114.0	147.4	142.0	128.8	252.3	97.1	88.8	113.0	54.2	52.4	46.2	86.2	539.2
Mean daily evaporation (mm)													
	12.1	10.8	8.5	5.6	3.6	2.5	2.5	3.1	5.0	7.5	9.9	11.6	6.9

Source: Bureau of Meteorology, 2007.

2.2 Geology and Landforms

The geology of both the study areas is similar, being Archaean granites with infolded metamorphics of the Yilgarn Craton (Beard, 1976). The Yilgarn Craton is composed mainly of granites and gneisses, with minor infolded belts of metamorphic and sedimentary rocks. The metamorphic rocks are older than the granite and consist of a wide variety of rocks, including chemical sedimentary rocks of banded ironstone, and tend to form (mineralised) ranges of hills (Beard, 1976). The low ranges of hills are formed from outcrops of Archaean metamorphic rocks and include highly ferrous banded ironstone ridges tending SW-NE (Beard, 1976). Chains of salt lakes, reflecting an ancient drainage system, now only function in very wet years and occur on an ancient peneplain with low relief and have no connected drainage (Beecham, 2001).

Koolanooka Hills

The Koolanooka Hills occur in the Avon Wheatbelt subregion of the Southwest Botanical Province (Interim Biogeographic Regionalisation for Australia - IBRA) (FloraBase, 2006). The Avon Wheatbelt is an area of active drainage on residual lateritic uplands and derived sandplains in the Yilgarn Craton and this particular subregion is rich in endemics.

Three land systems are associated with the Koolanooka area;

- Koolanooka Land System (comprises the Koolanooka Hills)
- Noolagabbi Land System (associated with the level and gently inclined flats and lower slopes surrounding the Koolanooka Land System and is often associated with a saline drainage network); and
- Pindar Land System (associated with the gently undulating sandplain with long, gentle slopes to the southeast of the Koolanooka Hills) (ATA, 2004b)

The Koolanooka Hills occur in the Perenjori geographical region (Hocking *et al.*, 1982) and form a range of rolling to very steep low hills. The iron ore deposit occurs at the northern end of Koolanooka Hills that form a 13 km long zone of Archaean rocks with a sedimentary sequence overlain by, and interbedded with, various banded iron formations (BIF). The BIF

at Koolanooka is more than 200 m thick and the iron content is higher in the weathered surface zones than in the primary banded iron formation. The soils of Koolanooka Hills are generally rocky with gradational red, gravelly loams and are characterised by sand over gravel and shallow soils on granite or gneiss (ATA, 2004a). Prominent ridges such as the Koolanooka Hills reach up to 450 m AHD, about 100 m above plain level (Rockwater Pty Ltd, 2004).

Blue Hills

Blue Hills occur in the Yalgoo IBRA bioregion of the Eremaean Province (FloraBase, 2006). The Yalgoo bioregion is an interzone between the South-western Bioregions and the Murchison. This subregion, in the western Yilgarn Craton, typically has earth to red sandy earth plains and is particularly rich in ephemerals (Desmond & Chant, 2001) and falls within the Tallering Land System (Payne *et al.*, 1998). The Yalgoo bioregion has two subregions; the Edel subregion (YAL1) and the Tallering subregion (YAL2) within which Blue Hills lies (EPA, 2006).

The main Land Systems in close proximity to the Blue Hills mine sites are the Tallering, Yowie and Pindar Land Systems (Payne *et al.*, 1998).

The Yowie Land System is dominated by loamy plains and has soils of variable depth that include red clayey sands, hardpan loams and red earths on hardpan. Smaller areas of variable depth red clayey sands with ferruginous gravel over hardpan and deep red earths and juvenile alluvial deposits occur on the gravelly plains and narrow drainage tracts of the land system (Payne *et al.*, 1998).

The Pindar Land System is associated with loamy plains surrounded by sandplain. Soils of the loamy plains are deep and shallow red earths on hardpan and occasionally shallow red clayey sands on hardpan. The soils of the sand sheet areas are deep red clayey sands (Payne *et al.*, 1998).

The Tallering Land System is comprised predominantly of ridges and hills (generally linear) of Archaean BIF, dolerite and sedimentary rocks (including schist, mantles of platy cobbles and stones). These ridges and hills support Bowgada (*Acacia ramulosa*) [syn. *Acacia linophylla*] and other *Acacia* shrublands with undershrubs such as *Thryptomene* and *Eriostemon* species. The geographic relief of the system can be up to 200 m, but is generally much less (Payne *et al.*, 1998). In the central Tallering Land System, relief ranges from 30 m to 300 m. In this area the BIF and other meta-sedimentary rocks are associated with the Warriedar Fold Belt (Markey & Dillon, 2006). Prominent ridges occurring in the eastern sector (such as Blue Hills) have the highest elevations and exceed 500 m AHD (Rockwater Pty Ltd, 2004).

2.3 Hydrogeology

Groundwater recharge from rainfall may vary depending on rainfall conditions such as seasonal and annual variations in total rainfall and the intensity, duration and frequency of rainfall events. It is also affected by topography and drainage, soil cover, rock-types, land-use and other factors (Australian Natural Resources Atlas, [online](a)). Large groundwater supplies are not uncommon on the Yilgarn Craton. Small water supplies are provided from

bores and wells located to access groundwater from the Cainozoic sediments or weathered bedrock at hydrogeologically favourable sites (Rockwater Pty Ltd, 2006).

Drainage is mainly weak and low-gradient, predominantly to the palaeodrainage system which passes a few kilometres to the north of Koolanooka Hills, and includes the Yarra Yarra Lakes to the west of Carnamah. The major surface-water palaeodrainage would almost certainly have an associated palaeochannel sand aquifer (buried channel) containing hypersaline groundwater generally at depths of 50 to 100 m (Rockwater Pty Ltd, 2004).

Yarra Yarra Lakes (Figure 2-1 below), in an area of low relief land, cover the central west inland catchment, (Australian Natural Resources Atlas, n.d.(b)), in which Koolanooka Hills and Blue Hills both occur, fresh groundwater is uncommon, generally being associated with hilly areas. Groundwater salinity generally increases markedly towards the lower parts of the landscape and with depth in bores (Rockwater Pty Ltd, 2006). In times of flood, the palaeodrainage carries surface water southwards to Moora; in normal years the lakes are local surface-water and groundwater sinks (Rockwater Pty Ltd, 2004).

The Koolanooka Mine is located 50 km east of the Darling fault. Fresh groundwater is uncommon, and is generally associated with hilly areas. The Koolanooka pit is reported to have produced water (at an unknown rate) when it was operated by Western Mining Corporation (Rockwater Pty Ltd, 2004).

At Blue Hills negligible to small groundwater yields of fresh to marginal quality water were obtained from bores near Mungada west pit (Rockwater Pty Ltd (2006).

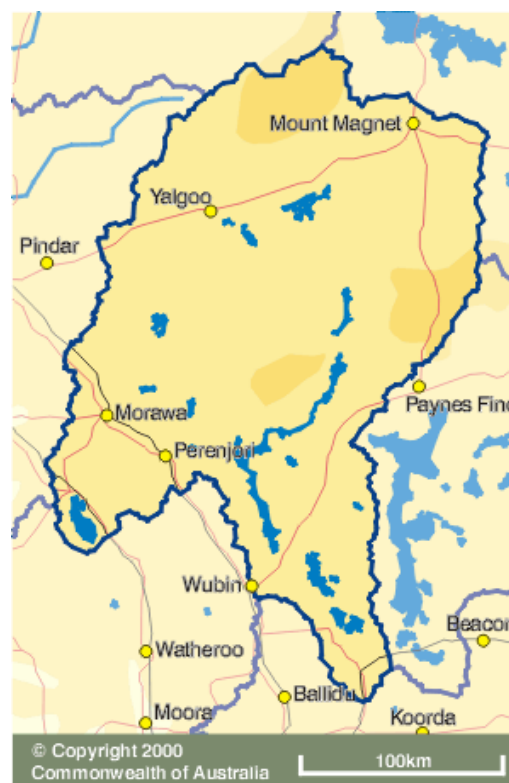


Figure 2-1. Yarra Yarra Lakes: Central west inland catchment (Sourced from: Australian Natural Resources Atlas n.d. (b))

2.3.1 Wetlands in the Vicinity of the Koolanooka Project Area

Wetlands within the vicinity of the proposed mine site include a system of salt lakes, in the central alignment of the rail easement, adjacent to the Koolanooka Hills formation. This wetland area was surveyed by ATA in May 2004 for the construction of a road and was found to have the DRF species *Halosarcia bulbosa* within its boundaries. The substrate of the lakes was described as saline clay on loamy clay and red sandy clay (ATA, 2004c).

The area was found to be generally uniform in structure but varied in species composition depending on the concentration of salt in the clay soils. In general, it was noted that the area was dominated by a Low Open Heath comprising Samphire (*Halosarcia doleiformis* and isolated stands of *Halosarcia bulbosa* (DRF), Saltbush (*Atriplex* sp.) and Bluebush (*Maireana* sp.) on bare ground (ATA, 2004c).

Koolanooka Spring is a site of green reed plants close to a small creek bed that passes between two granite hills and drains northwards. No surface water or flow occurs at the site in the dry months of the year. This wetland is more than 1 km north-east of the strata of the Koolanooka Hills. It is concluded that the spring is a near-surface, ephemeral feature that relies on recent rainfall (Rockwater Pty Ltd, 2004).

2.3.2 Wetlands in the Vicinity of the Blue Hills Project Area

A gilgai wetland system occurs to the west of Mungada Ridge, approximately 700 m south of the Mungada west pit. Previously this area was identified as a gilgai formation, rather than a classic wetland as it did not support the description of a wetland type environment due to the clayey ground conditions and vegetation types. The vegetation in this area is typical of heavy textured clay regimes, comprising tufted grasses typically located on the mounds with a low forest of scattered *Eucalyptus loxophleba* and dwarf scrub of *Muehlenbeckia* sp.

At least one other smaller gilgai formation was observed during the site visit further west in the same valley system. Gilgai formations are commonly found across the Gascoyne and Pilbara regions of Western Australia (excerpt from Mungada Ridge Hematite Project PER – Gindalbie -Provided by G. Johnson ENESAR).

2.4 Biogeography

The bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

Koolanooka Hills

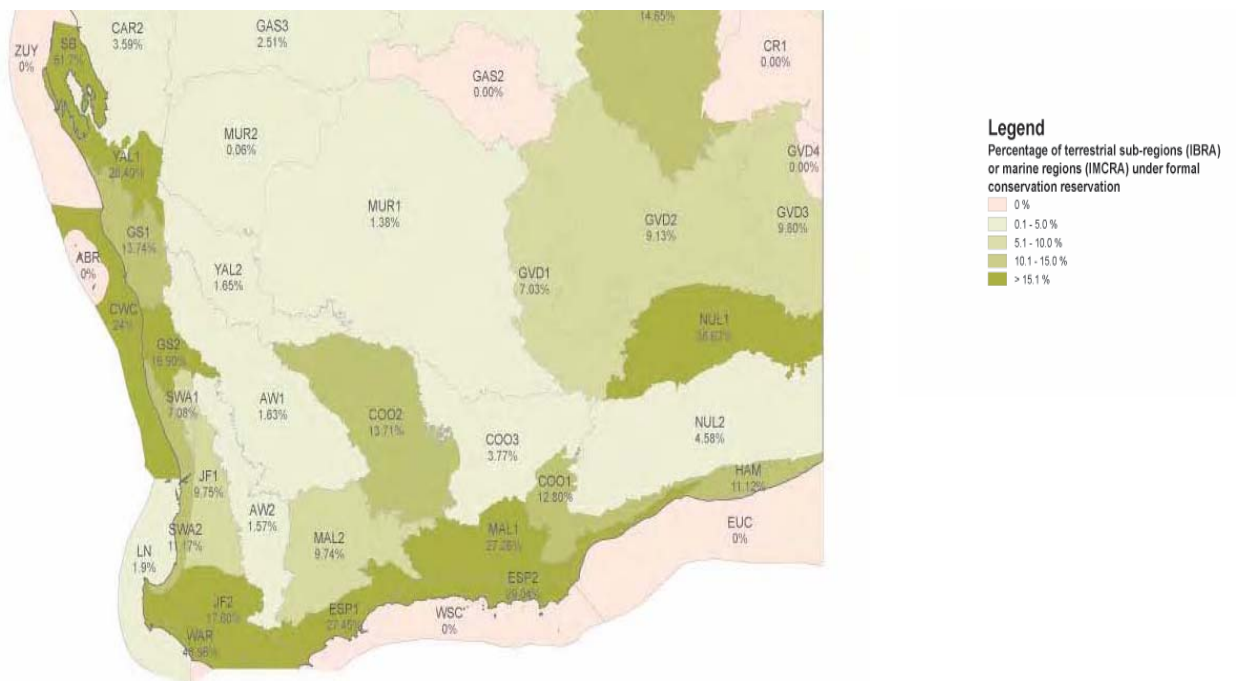
The Koolanooka Hills are located in the Avon Wheatbelt Bioregion (which has two subregions; Avon Wheatbelt 1 (AW1) of ancient drainage and Avon Wheatbelt 2 (AW2) of re-juvenated drainage) (Figure 2-2) occurring in the Southwest Botanical Province (FloraBase, 2006).

The Avon Wheatbelt 1 subregion, within which the Koolanooka Hills occur, is characterised by proteaceous shrub heaths on uplands and sandplains, mixed eucalypt, (*Allocasuarina huegeliana* and *Eucalyptus loxophleba*) woodlands on quaternary alluvials and eluvials (Beecham, 2001). This subregion is considered to be under high continental landscape stress, i.e. a high priority for the Comprehensive, Adequate and Representative (CAR) terrestrial reserve system. Two percent of this Interim Biogeographic Regionalisation of Australia (IBRA) subregion is protected (NRM Agencies, 2003), and 93% of native vegetation in the

Avon-Wheatbelt bioregion has already been cleared (DoE, 2004). The total area of the AW1 subregion is 6,566,022 ha and 1.63% of this subregion is under formal conservation reserve (EPA, 2006).

Blue Hills

Blue Hills occurs in the IBRA Yalgoo Bioregion (which more recently has been divided into two subregions; the Edel subregion (YAL1) and the Tallering subregion (YAL2) (Figure 2-2) occurring within the Eremaean Botanical Province (Environmental Protection Authority, 2006). The Yalgoo Botanical Province is characterised by low to open woodlands of *Eucalyptus*, *Acacia* and *Callitris* on red, sandy plains. This bioregion is considered to be under less continental stress (with respect to the CAR system) however, this lower rating is influenced by one large reserve in the extreme northern end (Toolanga Nature Reserve) and is not comprehensive or representative in terms of ecosystem representation. Tallering Peak (occurring at the northern end of the Tallering Land System) represents a rare range of ironstone and jaspilite that has unique vegetation complexes on it with low shrublands of *Thryptomene decussata* and *Eriostemon sericeus* which are classified as vulnerable (Desmond and Chant, 2001). Only 11.6% of the total Yalgoo Bioregion area is in the International Union for the Conservation of Nature (IUCN) conservation reserve (however the majority of this figure comes from the conservation reserve in the Edel subregion - YAL 2) and no vegetation complexes of the Tallering Peak ironstone range are held in reserve so are a high priority for ecosystem reservation (Desmond & Chant, 2001). The area of the Yalgoo Bioregion is 4,858,849 ha.



.Figure 2-2 The proportion of terrestrial and marine subregions in Western Australia’s formal conservation reserve system, June 2005.

Data source: Department of Conservation and Land Management in Environmental Protection Authority (2006).

2.5 Landuse History

The typical landuse in the Yarra Yarra Lakes inland catchment has been cattle grazing on pastoral leases and some cereal production. Much of the land is vacant crown land (Australian Natural Resources Atlas, n.d. (b)).

The DeGrey - Mullewa Stock Route was the early access way taken by men and stock in the 1870s. This trail, which is now the main road north for vehicular traffic, features original Government wells and natural rockholes. The stock route went as far south as Talling Peak, which is in the northern end of the Talling Land System (Heritage Council, 1988).

3.0 SURVEY METHODS

3.1 Guiding Principles

The survey methods adopted by *ecologia* were formulated on the basis of:

- The Western Australian Environmental Protection Authority's position paper with regard to terrestrial biological surveys as an element of biodiversity protection (EPA, 2002);
- The guidance statement with regard to terrestrial flora and vegetation surveys for environmental impact assessment (EPA, 2004); and
- Consultation with regional Department of Environment and Conservation (DEC) staff and other relevant government officers.

The project area occurs within two IBRA bioregions over two Botanical Provinces. The proposed extension of the mine site at Koolanooka Hills is in the Avon Wheatbelt 1 (AW1) bioregion within the Southwest Botanical Province and the proposed extensions of Mungada East and Mungada West pits (and corresponding waste dump areas) at Blue Hills are in the Yalgoo IBRA bioregion (Talling (YAL2) subregion) within the Eremaean Botanical Province (Environmental Protection Authority, 2006).

Based on the existing regional modification and loss of biodiversity, degree of threat and high sensitivity of these bioregions to further loss, background research, a reconnaissance survey, followed by further survey work was required (EPA, 2004). After preliminary results were obtained it was necessary to extend the scope of work to include some aspects of a comprehensive survey (see below) as it was apparent that more detailed assessment was required to assess the significance of the vegetation in the footprint areas in a regional context. The types of study required for this project and the purpose of each are listed below.

- Background research. To gather background information on the footprint or target area (i.e. search of literature, data and map based information).
- Reconnaissance. To verify the accuracy of the background information, further delineate and characterise the flora and range of vegetation units present in the footprint and to identify potential impacts.

- Detailed Survey. To enhance the level of knowledge of the flora and vegetation at the local scale and its local context or significance (if the context at a broader scale was well known).
- Comprehensive Survey. To enhance the knowledge of the context or significance of the flora and vegetation found in the footprint areas at the Subregional scale.

The survey required two visits to the Koolanooka footprint area and five visits to the Blue Hills footprint area, as the areas of the footprints changed after initial surveys. Plots were surveyed in each vegetation unit to thoroughly sample the flora and all the vegetation units and to document vegetation condition in the target area. As regional information had been gathered during earlier surveys, these later surveys were limited to the proposed impact areas indicated by Midwest.

3.2 Specific Objectives

The *ecologia* survey and previous surveys aimed to provide the following:

1. A desktop review of the flora, vegetation and ecological communities of conservation significance that were known to occur in the vicinity of the footprint areas;
2. A comprehensive inventory of the vascular flora found by field survey of the footprint areas (including flora of conservation significance, other native flora, naturalised alien flora and declared weeds);
3. A description and classification of the small-scale vegetation units found in the field survey within the footprint areas;
4. Maps detailing the locations of all flora of conservation significance found in the footprints;
5. A review of the conservation significance (in the local, regional and state level contexts) of the flora and vegetation units and related ecological values in the footprints; and
6. Broad recommendations regarding the conservation of the significant values identified above.

3.3 Field Methods

The vegetation and flora of the proposed mine site footprints were surveyed in July, September and October 2006, and in February, June and August 2007. A total of 20.75 person days was invested in the survey work (Table 3.1). An assessment of the regional context of the vegetation and targeted searches for selected Priority Flora found within the footprint were undertaken from July 2006 to February 2007 to supplement information available from previous studies.

Table 3.1 Summary of Survey Timing and Duration.

SURVEY AREA	SURVEY DATE	# PERSON DAYS
Koolanooka Hills	25th July 2006	1
	26 September 2006	2
Mungada East	25 July 2006	1
	26 September 2006	1
	28 February 2007	0.5
	16, 17 & 18 June 2007	6
	09 August 2007	0.25
Mungada West	26 September 2006	0.5
	26 October 2006	1
	Quadrats 14 & 15 June 2007	4
	10 August 2007	2.5
Local survey-Blue Hills	19 June 2007	1
TOTAL		20.75

The field survey combined the following basic methods:

1. Site-based floristic sampling and vegetation description;
2. Linked traverse surveys targeting rare and priority flora and weeds.

3.3.1 Vegetation Description

Structural information describing the vegetation unit including the height, cover, form and dominant species were recorded within each layer using a vegetation structure classification system adapted from Muir (1977) (Table 3.2). The Muir vegetation structure classification system is difficult to visualise, so whilst the site data are presented as recorded in the field using the Muir system the written vegetation descriptions have been simplified to exclude the alphabetic delineations.

Table 3.2 Vegetation Structure Classification (adapted from Muir, 1977).

LIFE FORM / HEIGHT CLASS	CANOPY COVER			
	DENSE 70% - 100%	MID DENSE 30% - 70%	SPARSE 10% - 30%	VERY SPARSE 2% - 10%
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee	Dense Mallee	Mallee	Open Mallee	Very Open Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 - 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 - 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D

LIFE FORM / HEIGHT CLASS	CANOPY COVER			
	DENSE 70% - 100%	MID DENSE 30% - 70%	SPARSE 10% - 30%	VERY SPARSE 2% - 10%
Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass > 0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges

* In agreement with current usage by *Eucalyptus* specialists (Brooker *et al.*, 2002), “mallee” in this study is defined as *Eucalyptus* spp. that are multi-stemmed from the ground level and usually less than 10 m in height, whilst “tree” is defined as being single-stemmed although possibly branching a short distance above ground level.

3.4 Flora Survey

Vegetation and flora surveys were undertaken over six periods from the 25th to 26th of July, 26th to 27th of September, 25th to 26th of October 2006 and the 28th February, 13th to 20th June and 9th and 10th of August 2007. The surveys targeted proposed disturbance areas specified by Midwest.

The Koolanooka Hills flora survey comprised a foot traverse survey of a 4.46 ha area identified by Midwest (Figure 3-1). Flora quadrat survey sites of 20 m x 20 m were used in each vegetation type to assess the flora and vegetation present (however, the vegetation in this area has been disturbed in the past and it was difficult to find an intact area in which to site the 20 x 20 m quadrats). At each flora site the following was recorded: coordinates using a global positioning system (GPS), digital photo, landform type, rock type, soil type, leaf litter and wood litter status, vegetation condition, disturbance level and fire history. In addition to the quadrats, two transects were walked (with the botanists spaced approximately 50 m apart) in a v shape through the centre of the vegetation; the boundary of the area to be surveyed was also traversed in the same way. The combination of quadrats and boundary and centre traverses ensured that the whole area was traversed – especially as large areas had been previously disturbed.

The same survey methods were used at Blue Hills. Flora quadrat survey sites of 20 m x 20 m were used to assess the flora and vegetation present at Mungada East and West (Figure 3-2). In addition, linked field traverses were employed to ensure that all of the proposed impact areas at both Mungada East and West were searched for Priority Flora taxa. To carry out these linked traverses the botanists spaced themselves 10 m apart and surveyed each of the proposed impact areas in a grid fashion. The linked traverses were employed to search for conservation significant flora taxa and weeds.

Voucher collections were made of Declared Rare and Priority Flora species, and all species not readily identifiable in the field were collected and identified subsequently using current taxonomic keys and the resources of the Western Australian Herbarium. For each species recorded, the following information was documented:

- Height;
- Density/Coverage; and
- Location.

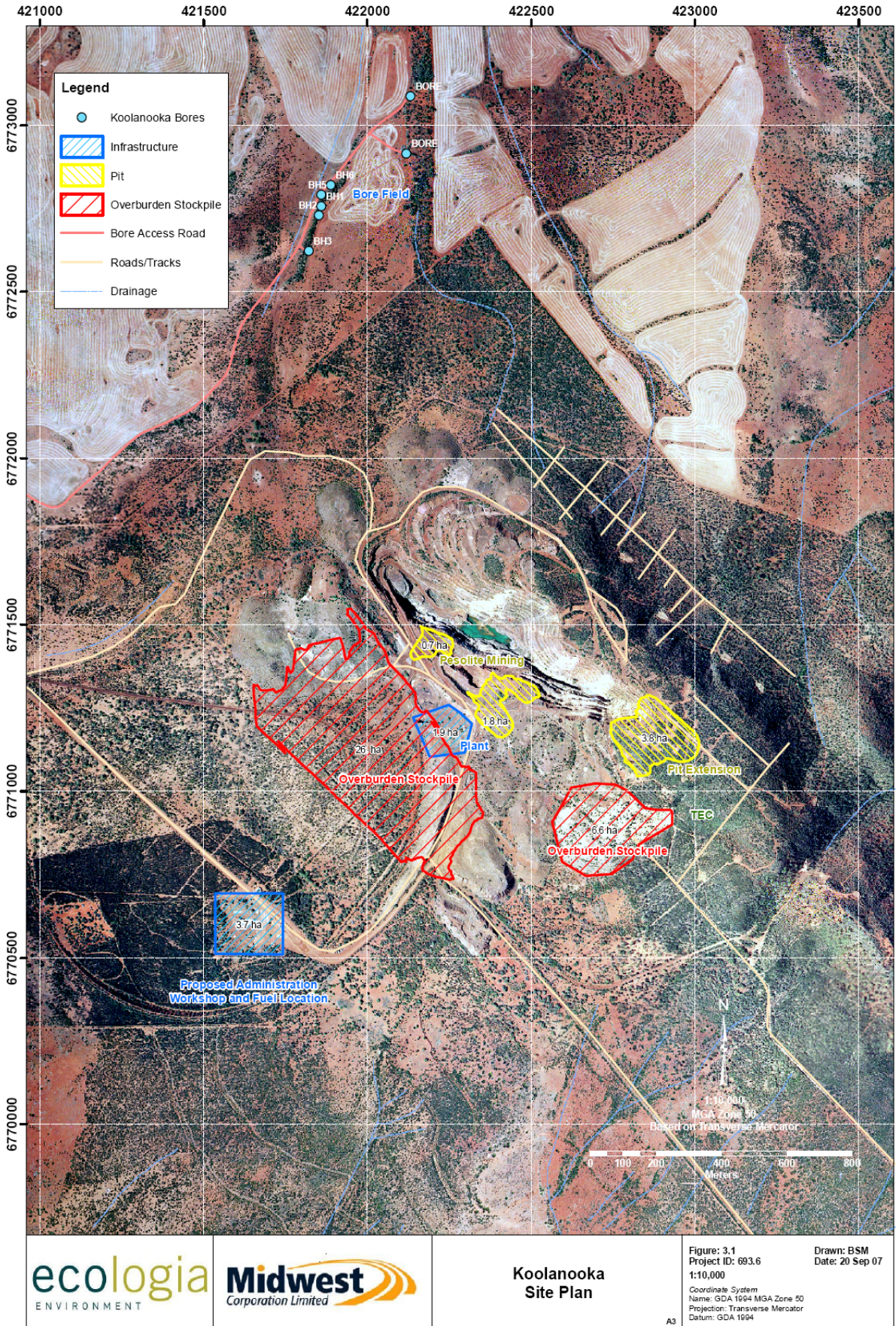


Figure 3-1 Area Surveyed at Koolanooka Hills (3.8 ha yellow area).

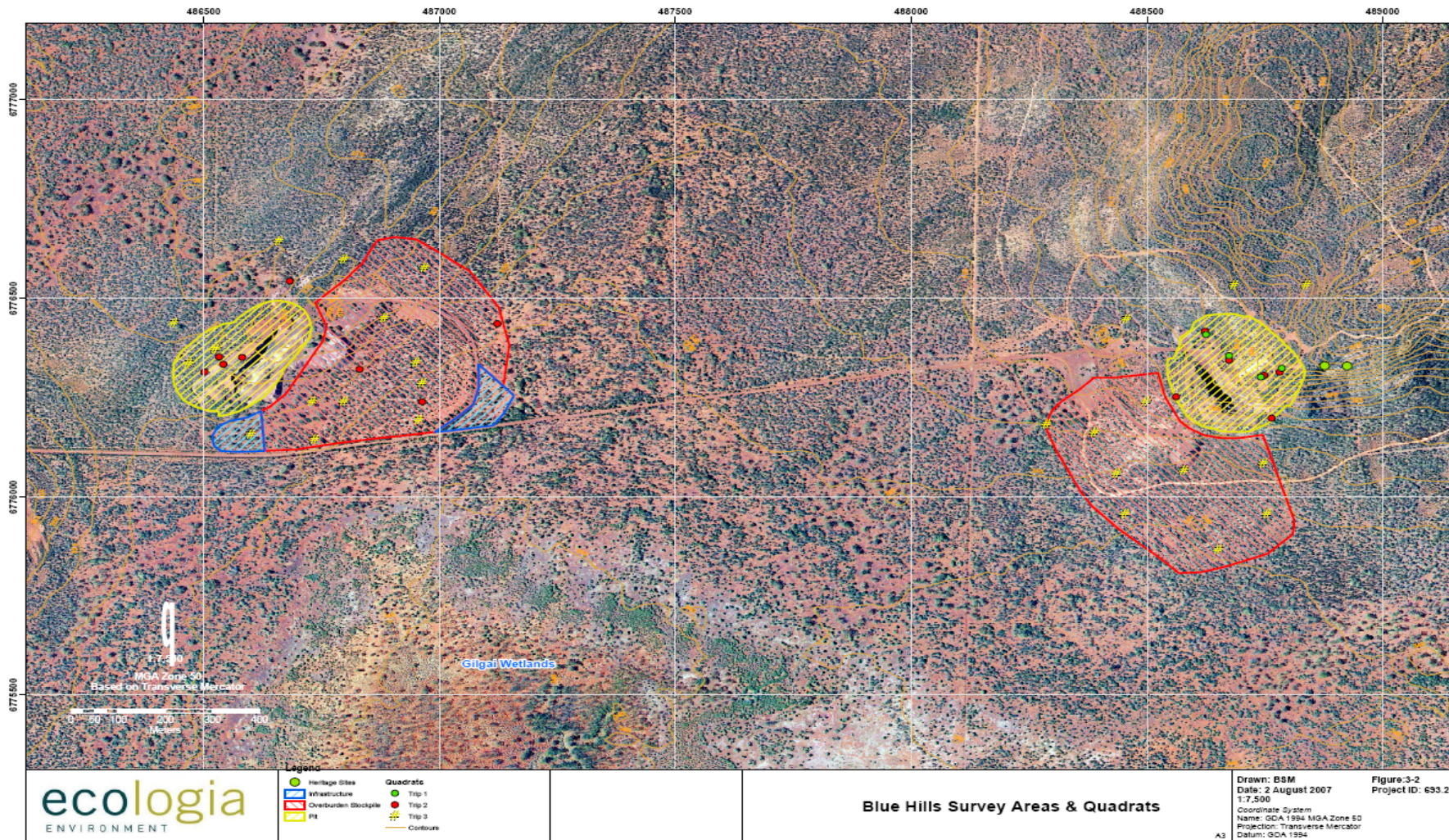


Figure 3-2: Areas Surveyed at Blue Hills (Mungada West and Mungada East)

3.5 Baseline Flora and Vegetation Surveys

Prior to the field survey, a search of the WA Herbarium using FloraBase was undertaken to determine the Priority Flora previously recorded near the proposed development. Information from previous surveys by other consultants was also used including searches of the Department of Environment and Conservation (DEC) Threatened Flora Databases. This provided information on Rare and Priority Flora previously recorded near the proposed development. As per requirements (EPA, 2004), nomenclature of all flora species encountered in the survey was aligned with that currently adopted by the Western Australian Herbarium (FloraBase, 2007).

Previous surveys undertaken at both Koolanooka Hills and Blue Hills were carried out in accordance with *EPA Guidance Statement No. 51: Guidance for the Assessment of Environmental Factors: Terrestrial flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004), and the survey methods produced quadrat-based quantitative data.

3.6 Survey Limitations and Constraints

The long term average monthly rainfall at Paynes Find weather recording station was lower in 2006 than in 2005; annual rainfall was also lower than the long term average. For example total rainfall at Paynes Find in 2006 was 252.5 mm compared with the total long term average of 392.4 mm. This trend was the same for Perenjori recording station (Woodman, 2006b).

Due to the dry year experienced in parts of the southern Murchison Region, lower species richness would be expected to be recorded in surveys undertaken in 2006 and 2007. Although, survey work undertaken in 2007 added to the species list, as higher than the monthly long term average rain was received in January and July. *ecologia* is not aware of any other surveys having been undertaken in the area at the same time as the *ecologia* surveys. However, the DEC survey of the central Tallering land system produced a species list that included approximately 50% annuals; rainfalls were good in the months preceding this survey (Markey and Dillon, 2006). An average species number for all DEC plots (103) surveyed was 49. Average species numbers for the *ecologia* surveys at Mungada East and Mungada West were both 12 and the proportion of annual taxa from these counts (quadrat data) was 10% at Mungada East and 6% at Mungada West. When the opportunistic collections are included and the complete species list is considered the proportion of annual taxa is 18% at Mungada East and 2% at Mungada West. The low diversity compared with the DEC survey cannot only be explained by rainfall and the reduction in the number of annual taxa recorded, but also by the number of quadrats surveyed. Because of the relatively small proposed impact areas, at Mungada East 18 quadrats were assessed by *ecologia* and 24 quadrats at Mungada West. During the DEC survey at Koolanooka and Perenjori 235 taxa were recorded from 50 plots; of this total annual species accounted for approximately 41%. Average biodiversity for the 41 Koolanooka quadrats assessed by DEC was 35, while that from the two quadrats assessed by *ecologia* was 24. Of the 46 taxa recorded by *ecologia* from quadrats and opportunistic records, approximately 24% were annuals. The lower biodiversity in the *ecologia* quadrats can be explained by the drier weather experienced in 2006, but also by the fact that it was difficult to find places to site quadrats or transects in the

4.46 ha surveyed by *ecologia* at Koolanooka, as much of the area had been previously disturbed.

Vegetation types were determined by comparison of dominant species similarity rather than via multivariate statistical analysis. There was not sufficient individual quadrat data for this sort of analysis; however the various vegetation types have been documented by drawing on unpublished data and by conducting additional field work.

The EPA Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004), has identified the main factors that can limit and constrain flora and vegetation surveys and the current project was evaluated against these factors (Table 3-3).

Table 3-3 Flora and Vegetation Survey Constraints.

Aspect	Constraint	Comment
Scope	No	The survey scope was prepared in consultation with DEC and other stakeholders and was designed to comply with EPA requirements.
Proportion of flora identified, recorded and/or collected	Negligible	At Koolanooka 46 taxa were recorded and only three of these were not identified to species level (6.5%). At Mungada East 94 taxa were recorded and only three of these were not identified to species level (3.2%). At Mungada west 84 taxa were recorded and eight of these were not identified to species level (8.3%). Low rainfall precluded collection of annual species during earlier surveys. Species accumulation curves were not carried out, as the recommended quadrat size of 20 m x 20 m for the Murchison Region was used.
Availability of contextual information (pre-existing background versus new material)	Negligible	A few recent and systematic flora surveys and mapping studies of the vegetation have been carried out in the Blue Hills and Koolanooka Hills areas. Information and some data from recent surveys which encompassed larger areas than those surveyed by <i>ecologia</i> were made available, including from some relevant government and privately-commissioned studies.
Completeness and further work which might be needed	Moderate	A rare flora search for Priority Flora within the footprint was conducted but could be continued after a better rainfall season for inclusion of annual species.
Timing/weather/season/cycle	Moderate	The survey was commenced in Winter 2006 before flowering and annual growth had commenced. It continued into spring (September & October 2006), late summer (end February 2007) and winter (June and August 2007). Due to the dry years currently being experienced, some annuals may not have been present.
Disturbances which affected results of survey	Negligible	Some of the vegetation within the assessment area on the mine sites had been previously disturbed by earlier exploration and drilling works, however this did not affect the survey methods.
Intensity (in retrospect, was the intensity adequate?)	No	The intensity of the flora and vegetation survey of the footprint was adequate given that information from previous surveys was accessible.
Resources	No	Resources were adequate for the botanical survey with investment in fieldwork totalling almost 21 person days.
Remoteness and/or access problems	No	Access to the footprint areas was very good, no areas were inaccessible.
Competency/experience of the consultant carrying out the survey	No	All botanists involved had previous field experience. Ms. Sharnya Thompson who identified most specimens collected at Blue Hills and Koolanooka Hills, has over six years' experience in botanical taxonomy. Ms. Cate Tauss, who helped with some specimens, has 12 years' experience and considerable taxonomic expertise.

4.0 VEGETATION

4.1 Regional Vegetation

Koolanooka Vegetation

Beard's (1976) vegetation classification of Western Australia is commonly used to assist with the description of regional vegetation. The Koolanooka System is in Beard's Greenough Region within the Irwin Botanical District and this botanical district is in the southern Murchison Region of the Southwestern Botanical Province (Beard, 1976).

The vegetation associated with the Koolanooka System is described as consisting of several vegetation types (Beard, 1976). Vegetation Type 1 comprises open woodland of sheoak (referred to by Beard, 1976, by the synonym *Casuarina huegeliana* [*Allocasuarina huegeliana*], however this is treated as cf. (interpreted as) *Allocasuarina acutivalvis* in a recent report by Meissner and Caruso (2006), as there are no WA Herbarium records of *A. huegeliana* for Koolanooka Hills). Vegetation Type 2 comprises the mallee *Eucalyptus ebbanoensis*, *Acacia acuminata* and *Dodonaea inaequifolia* interspaced with thickets of *Allocasuarina campestris* (referred to by Beard, 1976, by the synonym *Casuarina campestris*). Vegetation Type 3 comprises *Acacia acuminata* thicket with *Grevillea stenostachya*, *Melaleuca cordata*, *M. nematophylla* and *M. radula* and Vegetation Type 4 comprises *Eucalyptus loxophleba* (York Gum) woodland interspaced with the same thicket, which forms the vegetation pattern on the footslopes of Koolanooka Hills, while the granite outcrops support mixed *Acacia* spp. (*A. tetragonophylla*, *A. quadrimarginea* and *A. ramulosa*) (Beard, 1976).

Five plant assemblages of the Koolanooka System are now listed as Threatened Ecological Communities (TECs) by the Department of Environment and Conservation (DEC). Beecham (2001) lists the TECs as: *Allocasuarina campestris* shrub over red loam on hill slopes; shrubs (such as *Acacia* spp.) and emergent mallees on shallow red loam over massive ironstone on steep rocky slopes; *Eucalyptus ebbanoensis* subsp. *ebbanoensis* mallee and *Acacia* spp. scrub with scattered *Allocasuarina huegeliana* (c.f. *Allocasuarina acutivalvis*, see above) over red loam and ironstone on the upper slopes and summits; *Eucalyptus loxophleba* woodland over scrub on the footslopes; and, mixed *Acacia* spp. scrub on granite.

The Koolanooka Hills TEC occurs over two areas totalling 5419 ha (M. Morley, DEC, pers.comm. 18th Dec 2006), which is 25 ha less than the 5444 ha stated in the Koolanooka Interim Recovery Plan (Hamilton-Brown, 2000). As it is unclear whether the differences are from one or both occurrences, calculations on the percent of the TEC to be impacted are based on the areas given in the literature and not on the 5419 ha total stated by DEC.

The plant assemblages of the Koolanooka System TEC are split into two occurrences, one at Perenjori Hills and the other at Koolanooka Hills. The area at Koolanooka Hills that will be impacted by the project is 4.46 ha and this constitutes 0.13% of the Koolanooka Hills TEC (Table 3-1) or 0.08% of the total TEC area of the Plant Assemblages of the Koolanooka System (using the areas quoted in Hamilton-Brown and not the DEC stated area, as it is not known where exactly the area reduction has occurred). An iron ore mine was located in the northern portion of Koolanooka Hills on a mining lease covering 1665 ha of the Koolanooka

Hills TEC occurrence and it is estimated that of this original TEC area, 20% remains untouched (i.e. 333 ha). The remaining untouched occurrence is on Crown land (2783 ha) while 380 ha is freehold land none of which is fenced to prevent grazing (Hamilton-Brown, 2000). Eighty nine percent of the plant assemblages of the Koolanooka System remain, and this percentage includes the TEC at Perenjori Hills (Hamilton-Brown, 2000).

Table 4-1 Threatened Ecological Communities Impact Table

Restricted Communities Impact Table					
TEC – Koolanooka System	Land Status	Condition	# total known Koolanooka System TEC occurrences	Estimated Area (ha)	Proposed impact (%)
Koolanooka Hills	Private land, Leasehold and Shire Reserve	Slightly modified	1	3496.3	0.13%
Perenjori Hills	Private land	Moderately modified	1	1947.7	0%

(Areas given are from Hamilton-Brown, 2000).

Blue Hills Vegetation

Blue Hills is close to the Irwin Botanical District and the Austin Botanical District Boundary, therefore it lies in the South-western Interzone, a marginal area in the southern Murchison Region, which is particularly rich in ephemerals. (Beard, 1976).

In Beard's (1976) vegetation classification, Blue Hills occurs in the Yalgoo Subregion of the Austin Botanical District within the Eremaean Botanical Province. The Yalgoo Subregion is a transitional area from the Eremaean Province where the vegetation is mostly Eremaean in character but with a slight shift due to an increase in rainfall. The major vegetation types of the Yalgoo Subregion include heath on granite outcrops (*Borya*, *Thryptomene*, *Baeckea* and *Calycopeplus*), *Acacia* scrub (*Acacia acuminata*, *A. ramulosa* and *A. quadrimarginea*), *Acacia-Melaleuca* thicket (*Acacia ramulosa*, *A. acuminata*, *Melaleuca uncinata* with variations including *M. nematophylla*), scrub with scattered trees (*Acacia ramulosa*, *A. acuminata*, *Hakea preissii*, *Eucalyptus loxophleba*, *E. oleosa*, *Callitris columellaris*, *Bursaria spinosa* and *A. aneura*) and salt flats (surrounded by samphire e.g. *Halosarcia* spp., teatree e.g. *Melaleuca / Leptospermum*, and *Acacia-Eremophila* scrub).

The vegetation of the Yalgoo Subregion becomes lower and denser towards the South-western Botanical Province as *Acacia aneura* (mulga - adapted to intermittent rainfall) starts to disappear and is replaced by other *Acacia* species. In the inland part of the Yalgoo Subregion the vegetation is mixed *Acacia* scrub with scattered *A. aneura* on the plains, scrub of *A. ramulosa / A. acuminata* on the hills and of *A. ramulosa / A. murrayana* on the sand-plains at higher levels, and scrub of *A. sclerosperma / A. eremaea* with *Atriplex* and *Maireana* on lower-lying flats. On stony hills *Acacia ramulosa* and *A. acuminata* become dominant and are joined by *A. quadrimarginea* and *A. stereophylla*. The understorey

vegetation includes *Allocasuarina campestris*, *Melaleuca uncinata* and *Thryptomene australis*.

Adjacent to Rothsay in the south of the Yalgoo Subregion, steep ridges of Archaean metamorphic banded ironstone rocks occur. These formations are covered with shrublands of *Acacia quadrimarginea* and *A. acuminata* that are in general dominated by *A. ramulosa*, *Casuarina* sp. and *Melaleuca uncinata* sometimes with scattered trees of *Eucalyptus loxophleba* and *Allocasuarina dielsiana* (syn. *Casuarina dielsiana* referred to by Beard, 1976). The valleys in this part of the Yalgoo Subregion (adjacent to Rothsay where steep ridges trend SW-NE) have *Acacia* scrub with scattered trees, whereas in the south-west of the region the valleys are mapped as eucalypt woodland. Various prominent hills and ranges remain to be described but the vegetation of Talling Peak (a massif of banded ironstone and jaspilite) in the northwest of the subregion has been described as sparse and including shrubs of *Acacia quadrimarginea*, *A. ?coolgardiensis*, *Eremophila leucophylla*, *Thryptomene johnsonii*, a smaller *Baeckea* or *Thryptomene* sp. and *Ptilotus obovatus* (Beard, 1976). However at Beard's scale of 1:100 000 little difference was noted between communities on granitoids and metamorphic sedimentary rocks (Markey & Dillon, 2006).

More broadly, the Austin Botanical District is characterised by mulga (*Acacia aneura*) low woodland on the plains, shrubs on the hills, and *Eucalyptus* species and *Triodia basedowii* on the sand plains (ATA, 2004a).

No Threatened Ecological Communities (TECs) occur within the IBRA Yalgoo bioregion (which corresponds to Beard's Yalgoo Subregion), however vegetation surveys undertaken to date have been limited with no regolith mapping available (Desmond and Chant, 2001).

4.2 Koolanooka Hills Project Area - Vegetation

4.2.1 Vegetation Previously Described for the Koolanooka Hills Project area

In 2003 a vegetation and flora survey of Midwest's lease area in the Koolanooka Hills was undertaken by ATA. A total of 220 taxa, belonging to 117 genera and 43 families, was recorded from the Koolanooka Hills study area. This total included 207 native and 13 introduced or non-endemic species. The dominant plant families recorded were Asteraceae (26 taxa), Mimosaceae (21 taxa), Myrtaceae (21 taxa) and Poaceae (19 taxa) (ATA, 2004b).

The vegetation of the project area for the current section surveyed by *ecologia*, was described in ATA's report as closed tall shrubs dominated by *Acacia assimilis* subsp. *assimilis*, *Allocasuarina campestris* and *Melaleuca filifolia* over herbland of mixed species and bare rock (ATA, 2004).

A 2005 flora survey by DEC of the Koolanooka & Perenjori Hills recorded a total of 238 taxa, of which 217 were native and 21 were weed species (Meissner and Caruso, 2006). The dominant families were Asteraceae (39 species, three weeds), Myrtaceae (21), Poaceae (21 species, 11 weeds), Mimosaceae (19) and Chenopodiaceae (11). Eight priority species, five undescribed species and five taxa of interest were found during this survey. Five endemic species were identified, three of which were collected for the first time in this area (Meissner & Caruso, 2006). Five community types (one with two sub-types) were identified with differences attributed to changes of landform type and soil fertility.

While the indicator species for each community type were tabulated in this report, the different vegetation community types were not described.

4.2.2 Vegetation of the Current Koolanooka Hills Survey Area

Vegetation recorded during *ecologia's* survey of the proposed impact area at Koolanooka Hills comprised the following types:

Vegetation type 1: Moderate upper hill slope to hill ridge.

Allocasuarina acutivalvis subsp. *prinsepiana* / *Acacia acuminata* open to moderately dense tall shrubland, over open to moderately dense *Acacia exocarpoides* / *Melaleuca fulgens* subsp. *fulgens* / *Daviesia hakeoides* subsp. *hakeoides* (sometimes *Acacia tetragonophylla* / *Comesperma volubile* / *Melaleuca radula*) open medium shrubs (Plate 4-1). (This vegetation type includes Koolanooka flora site 02.)

Vegetation type 2: Steep to moderate hill slope

Allocasuarina acutivalvis subsp. *prinsepiana* / *Calycopeplus paucifolius* scattered to sparse tall shrubs, over *Acacia sclerosperma* subsp. *sclerosperma* / *Dodonaea inaequifolia* open to scattered medium to low shrubs (Plate 4-2). (This vegetation type includes Koolanooka flora site 01.)

Neither of these vegetation types matched exactly those described in the ATA report (2004).

Statistical analysis of the vegetation recorded at the Koolanooka project area using PATN and comparison to DEC data showed that the vegetation was most closely linked to the DEC's vegetation community 3. This community type occurs on midslopes and crests of Koolanooka and Perenjori Hills, and can be described as open woodlands, shrublands, and open shrublands of *Allocasuarina* spp., *Melaleuca nematophylla*, and *Calycopeplus paucifolius*, over a mixed shrubland of *Dodonaea inaequifolia* and *Philotheca brucei* subsp. *brucei*. Indicator species for this community are *Acacia exocarpoides*, *Calycopeplus paucifolius*, *Dodonaea inaequifolia* and *Philotheca brucei* subsp. *brucei*.



Plate 4-1: Koolanooka Hills Vegetation Type 1

Plate 4-2: Koolanooka Hills Vegetation Type 2

4.3 Blue Hills Project Area - Vegetation

4.3.1 Vegetation Previously Described for the Blue Hills Project area

In 2004 a vegetation survey was undertaken by Bennett Environmental Consulting for ATA. Fifty-three vascular families, 126 genera and 212 taxa were recorded during the survey. This included 205 native and seven introduced or non-endemic taxa. The dominant families were Asteraceae, Mimosaceae, Poaceae, Chenopodiaceae and Myrtaceae (Bennett Environmental Consulting, 2004). A vegetation map of the area was produced and the location of the project impact areas has been superimposed on this map (Figure 4-1).

The vegetation of the immediate project impact area was mapped as comprising the following communities:

- Tall shrubland of *Acacia* species typically dominated by *Acacia ramulosa* subsp. *ramulosa* over a low open shrubland dominated by *Philotheca sericea* over an open herbland of annual daisies and/or bare ground (**Arr**);
- Tall open scrub of mixed species typically *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Calycopeplus pauciflorus*, *Melaleuca nematophylla* and *Acacia* species over a very open herbland/grassland or BIF rocks (**ApCp**);
- Open shrub mallee of *Eucalyptus ewartiana* over a tall open scrub of *Acacia ramulosa* subsp. *ramulosa* over an open herbland of annual daisies and/or bare ground (**Ew**);
- Low woodland to low open forest of *Eucalyptus loxophleba* subsp. *loxophleba* over a low shrubland often dominated by Chenopodiaceae over a very open herbland and bare ground (**B**);
- Tall open scrubland of mixed species typically *Acacia assimilis* var. *assimilis* and *Melaleuca nematophylla* over a low open shrubland to open low heath of *Ptilotus obovatus* var. *obovatus* over a herbland of annual daisies (**AaPo**);
- Tall shrubland of *Acacia ramulosa*, *Acacia burkittii*, *Melaleuca leiocarpa* and *Melaleuca uncinata* over a herbland of annual daisies and/or bare ground (**Mu**); and
- Degraded areas, mined previously (**Deg**).

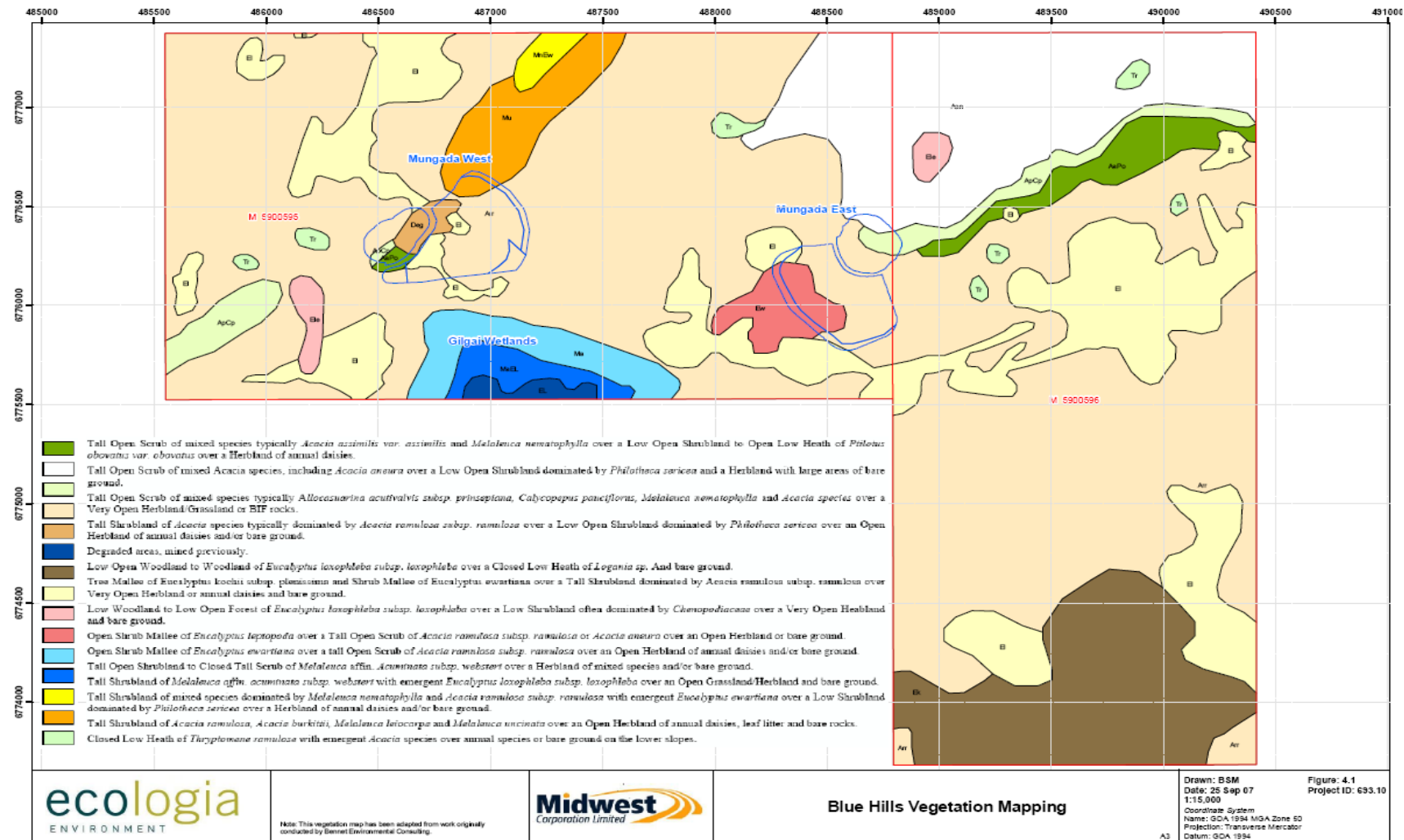


Figure 4-1 Blue Hills Project Area superimposed on Bennett's vegetation map

The vegetation of Blue Hills was described briefly by Bamford (2004) while undertaking a fauna survey in 2004. The Banded Iron Formation (BIF) and some granite landforms were found to support a shrubland and low woodland of *Acacia*, *Allocasuarina* and Myrtaceae plants growing in generally shallow, rocky-loam soils. The foothills, rocky-loam slopes and rocky outcrops support a tall shrubland of Narrow-leaf Mulga, *Acacia ramulosa* var. *linophylla* [syn. *Acacia linophylla*]. In this shrubland, emergent eucalypts also occur close to the foothills and in other low-lying areas where water may concentrate.

In 2005 the DEC undertook a vegetation survey of the central Talling Land System specifically targeting hills and ridges of BIF between Mt. Gibson and Talling Peak. Surveyed areas included Mt. Karara, Jasper Hill, Windaning Hill and its associated ridge (Windaning Ridge) and Talling Peak. Nearly all of this area is covered by mining and exploration tenements. During this survey 414 taxa were recorded from 69 families, four of which were hybrids and 26 were introduced species. Twelve of these taxa were of conservation significance and four were newly recorded taxa for the Yalgoo bioregion. Several significant range extensions were reported, including a new population of a Priority 1 species *Millotia dimorpha*. Nine unnamed taxa were collected, several of which are being considered for priority listing (Markey & Dillon, 2006).

Eight community types were recorded by Markey and Dillon (2006) and three of these were further divided into distinctive sub-types. Community types near or at the Windaning Ridge area, comprise community type 1a, distributed from Mt. Karara to Mingar Hill and east of Warriadar Hill, which is distinguished from 1b (widespread occurrence on hillslopes and isolated hills and ridges) by its relatively species poor status. Indicator species for community type 1a include *Acacia* aff. *coolgardiensis* (A. Markey & S. Dillon 3313) and *Acacia sibiana* in the dominant stratum, over shorter shrubs; *Aluta aspera* subsp. *hesperia*, *Eremophila forrestii* subsp. *forrestii*, *Philotheca desertii* subsp. *desertii* and *Hemigenia* sp. Cue. *Cheilanthes adianthoides* is a characteristic rockfern groundcover species. Indicator species for community type 1b include *Eremophila latrobei* subsp. *latrobei*, *Philotheca serica*, *Prostranthera magnifica* and *Cheilanthes adianthoides*. Community type 2 is most relevant as it occurs on the western slopes of Windaning Ridge, near the old Mungada mine site. This community type is described as consisting of a range of shrublands and thickets over an understorey rich in shrubs and is said to be species rich (Markey & Dillon, 2006) with an average of 60 taxa per quadrat, where annuals contributed about half this number. Significant indicator species of this community type include *Allocasuarina acutivalvis*, *Melaleuca nematophylla*, *Grevillea paradoxa* and *Acacia sibiana* over low shrubs of *Aluta aspera* subsp. *aspera*, *Eremophila latrobei*, *Eremophila forrestii* and *Xanthosia bungei*. Taxa in two groups (of eight from the larger survey area) were restricted to Mt. Karara and Windaning Ridge and included the new species *Acacia karina* (formerly sp. Karara (C. Godden 14)) (P2) found on Windaning Ridge (Markey & Dillon, 2006).

The DEC's community type 3 also occurs within the area, on the plateau at the top of Windaning Ridge as well as at Badja Station. This community consists of sparse shrublands on the crests and moderately steep slopes of BIF, siltstones and chert. It is a moderately rich community with an average of 22 taxa per quadrat. Indicator species include two Priority Flora, *Micromyrtus trudgenii* (P3) and *Calytrix uncinata* Craven (P3). Also within the Windaning Ridge locality is the DEC's community type 4a, which is found on the east facing steep cliffs of Windaning Ridge as well as at Mt. Karara and Pinyalling Hill. It is noted to be

a very species rich community with an average of 55 taxa per quadrat, again comprising mostly annual species. Indicator species include *Calycopeplus pauciflorus*, *Dodonea petiolaris*, *D. viscosa* and *Cheilanthes* spp. The DEC considers the depauperate patches described from previous surveys of the lower Windaning slopes to be a subset of the surrounding vegetation but still harbouring species of conservation significance e.g. *Micromyrtus acuta* (formerly *Micromyrtus cuensis* J.W.Green ms) (P1) (Markey & Dillon, 2006).

From statistical analysis performed using PATN, four sites, QE03, E02, E04, and E05 were part of vegetation community type 2 identified during the DEC survey. Three sites, QE08, W05, and E03 were considered to be part of the DEC's vegetation type 4a, while the remaining sites did not show any close relationship to sites surveyed by the DEC.

Between June and September 2006 Woodman Environmental Consulting surveyed the vegetation of and linking between Mt. Karara and Mungada Ridge. They reported 508 plant taxa occurring in the project area from 72 families and 202 genera (Woodman 2006b). However, this total was a combination of the results of previous surveys with those of the DEC's survey of the area.

Woodman's statistical analysis resulted in three vegetation super groups which were divided into 13 groups and further divided into 17 sub-groupings and 21 floristic community types (FCT); Super Group 1 comprised *Eucalyptus* woodlands and *Acacia* shrublands on flat outwash and valley areas with no exposed rock, while Super Group 2 comprised woodlands and shrublands on rocky BIF or other substrates from lowerslopes to crests, and Super Group 3 comprised *Acacia* shrublands with emergent *Eucalyptus* spp. on midslopes with lateritic gravels (Woodman Environmental Consulting, 2006b).

Of Woodman's 21 mapped FCTs the following occur around the Mungada east and west pit:

- FCT 1a) Open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* with open shrubland dominated by *Acacia tetragonophylla* and *A. obtecta* over chenopod species including *Sclerolaena diacantha* and *Rhagodia drummondii* on flats and drainage depressions (FCT 1a occurs in a mosaic with FCT 2).
- FCT 2) Open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and/or *E. striatocalyx* subsp. *striatocalyx* over shrubland of mixed species including *Acacia erinacea*, *Eremophila pantonii* and *Senna stowardii* over mixed species including *Sclerolaena fusiformis* and *Scaevola spinescens* on flats and rocky lowerslopes with ironstone gravels.
- FCT 4) Scrubland dominated by *Acacia ramulosa* var. *ramulosa* over sparse mixed species on flats and slopes. An indicator species for FCT4 is *Monachather paradoxus* and recorded within this community type are *Acacia acanthoclada* subsp. *glaucescens*, and *Persoonia pentasticha* (P3) and the new taxa *Calotis* aff. *cuneifolia* (A. Markey & S. Dillon 3447) and *Drummondita fulva* (previously aff. *microphylla* (R. Cranfield 8586 A)) (P3).
- FCT 17) Shrubland of *Acacia* species dominated by *A. sibina* and *A. aff. coolgardiensis* (A. Markey & S. Dillon 3447) with *Melaleuca hamata* and/or *M. leiocarpa* with emergent *Eucalyptus ewartiana* on flats. *Persoonia pentasticha* (P3), *Acacia* aff.

coolgardiensis (A. Markey & S. Dillon 3313) and *Drummondita fulva* (previously aff. *microphylla* (R. Cranfield 8586 A)) (P3) were also recorded within this community type (FCT 17 occurs in a mosaic with FCT 4).

- FCT 12) Shrubland of *Acacia* species including *Acacia assimilis* subsp. *assimilis*, *A. ramulosa* var. *ramulosa*, *A. exocarpoides* and *A. sibina* over mixed species including *Hibbertia arcuata*, *Calycopeplus paucifolius*, *Grevillea obliquistigma* subsp. *obliquistigma* on flats to mid-upperslopes with ironstone gravel. Other species recorded in FCT 12 include *Acacia woodmaniorum* (DRF), *Micromyrtus cuensis* J.W.Green ms (P1), *Micromyrtus trudgenii* (P3), *Rhodanthe collina* (P1) and new taxa *Acacia* aff. *coolgardiensis* (A. Markey & S. Dillon 3313), *Acacia karina* (P2), *Calotis* aff. *cuneifolia* (A. Markey & S. Dillon 3447) *Drummondita fulva* (P3) and *Lepidosperma* sp. Karara BIF (A. Markey & S. Dillon 3468).
- FCT 13) Dense shrubland of *Allocasuarina acutivalvis* subsp. *prinsepiana* with *Melaleuca nematophylla* over *Grevillea paradoxa*, *Xanthosia bungei* and *Lepidosperma* sp. Karara BIF (A. Markey & S. Dillon 3468) on mid-upperslopes on BIF. Along with *Acacia woodmaniorum* (DRF), *Millotia dimorpha* (P1), *Rhodanthe collina* (P1), and *Micromyrtus trudgenii* (P3), and new taxa *Acacia karina* (formerly sp. Karara (C. Godden 14)) (P2), *Drummondita fulva* (P3) and *Lepidosperma* sp. Karara (H.Pringle 3865).

A detailed statistical analysis of similarity of the *ecologia* survey vegetation quadrats with those of Woodman dataset was unable to be performed due to lack of access to the required data. Access to this data was requested on several occasions during the first half of 2008 however Gindablie declined to make it available.

4.3.2 Vegetation of the Current Blue Hills Survey Area

Vegetation recorded during *ecologia's* survey of the proposed impact areas at Blue Hills comprised the following types:

SITE	VEGETATION & HABITAT
Gentle to moderate hill slope	
E02, E06.	<i>Melaleuca nematophylla</i> / <i>Acacia ramulosa</i> var. <i>ramulosa</i> (sometimes <i>Acacia aulacophylla</i>) open low woodland to medium shrubland, over <i>Acacia exocarpoides</i> / <i>Dodonaea viscosa</i> subsp. <i>spatula</i> / <i>Micromyrtus trudgenii</i> (P3) open medium shrubs (Plate 4-3) (This vegetation type occurs within Woodman's FCT 12.)
Moderate hill slope	
W03, W05, E03, QW13, QW03, QW04, QE02.	<i>Acacia ramulosa</i> var. <i>ramulosa</i> (sometimes with scattered to open <i>A. aneura</i> var. <i>argentea</i> / <i>A. aneura</i> var. <i>major</i>) scattered low trees, over <i>Calycopeplus paucifolius</i> / <i>Micromyrtus trudgenii</i> (P3) tall shrubland, over sparse to open <i>Melaleuca nematophylla</i> , over open <i>Philotheca ?sericea</i> open low shrubs (also sometimes <i>P. brucei</i> subsp. <i>brucei</i> / <i>Acacia ?coolgardiensis</i> subsp. <i>coolgardiensis</i> / <i>Drummondita microphylla</i>) over sparse <i>Eremophila latrobei</i> subsp. <i>latrobei</i> dwarf shrubs (Plate 4-5) (This vegetation type occurs within Woodman's FCT4.).
E01	<i>Melaleuca nematophylla</i> / <i>Dodonaea viscosa</i> subsp. <i>spatulata</i> and <i>Micromyrtus trudgenii</i> moderately dense tall shrubland, over <i>Acacia woodmaniorum</i> ms (P2) / <i>Drummondita microphylla</i> shrubs over herbs, ferns, mosses and lichens (Plate 4-7) (This vegetation type occurs within Woodman's FCT 13 but without the dominant <i>Allocasuarina acutivalvis</i> subsp. <i>prinsepiana</i> .)
E05, QE08, QE09	<i>Acacia ramulosa</i> var. <i>ramulosa</i> or <i>Calycopeplus paucifolius</i> / <i>Dodonaea petiolaris</i> open to moderately dense medium tall shrubland, over mixed shrubs (Plate 4-9) (This vegetation type occurs in Woodman's FCT 4; at one of these sites, <i>Persoonia pentasticha</i> (P3) was recorded along with <i>Micromyrtus trudgenii</i> .)
QE01, QE06, QE12, QW08, QW11.	Moderately dense <i>Acacia ramulosa</i> var. <i>ramulosa</i> or <i>Acacia ramulosa</i> var. <i>linophylla</i> low trees, sometimes over moderately dense <i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i> high shrubs, over sparse mixed low shrubs, dominated by <i>Ptilotus obovatus</i> var. <i>obovatus</i> .
QW05, QE03	Open <i>Acacia ramulosa</i> var. <i>ramulosa</i> / <i>Acacia ramulosa</i> var. <i>linophylla</i> / <i>Acacia aneura</i> var. <i>argentea</i> low trees, over sparse mixed medium shrubs, over moderately dense to dense <i>Aluta aspera</i> subsp. <i>hesperia</i> medium and low shrubs.
QE07	Moderately dense <i>Acacia aulacocarpa</i> tall shrubs, over moderately dense mixed medium shrubs dominated by <i>Philotheca brucei</i> subsp. <i>brucei</i> , over open mixed low shrubs dominated by <i>Philotheca brucei</i> subsp. <i>brucei</i> / <i>Philotheca sericea</i> .

SITE	VEGETATION & HABITAT
QE05	Sparse <i>Acacia ramulosa</i> var. <i>linophylla</i> low trees, over open <i>Acacia ramulosa</i> var. <i>linophylla</i> tall shrubs, over open <i>Philotheca sericea</i> low to medium shrubs.
QW06	Scattered outcropping <i>Melaleuca hamata</i> low trees, over moderately dense <i>Acacia ramulosa</i> var. <i>ramulosa</i> tall shrubs, over sparse <i>Philotheca deserti</i> subsp. <i>deserti</i> low shrubs.
Hillcrest to moderate upper hill slope	
W06	<i>Melaleuca nematophylla</i> / <i>Acacia assimilis</i> subsp. <i>assimilis</i> moderately dense tall shrubland over other mixed shrubs (Plate 4-11). (This vegetation type occurs loosely within Woodman's FCT 12, but with <i>Melaleuca nematophylla</i> , and Bennett's AaPo.)
Steep hill crest to rocky outcrop	
W04, QW14.	<i>Acacia ramulosa</i> var. <i>ramulosa</i> / <i>Acacia assimilis</i> subsp. <i>assimilis</i> / <i>Acacia acuminata</i> open medium shrubland, over <i>Philotheca ?sericea</i> and other open low shrubs (Plate 4-10). (This vegetation type occurs loosely within Woodman's FCT 12, but with <i>Acacia acuminata</i> .)
Moderate to gentle rocky ridge crest/hill crest	
E04	<i>Allocasuarina acutivalvis</i> subsp. <i>prinsepiana</i> / <i>Melaleuca nematophylla</i> / <i>Calycopeplus paucifolius</i> moderately dense tall shrubland (Plate 4-8). (This vegetation type occurs loosely within Woodman's FCT 13.)
Undulating plain/footslope	
W02, W08, QE04, QW12, QW01, QW09.	<i>Eucalyptus loxophleba</i> subsp. <i>supralaevis</i> open medium woodland, over <i>Acacia assimilis</i> subsp. <i>assimilis</i> (sometimes <i>Acacia obtecta</i> or <i>Acacia ramulosa</i> var. <i>ramulosa</i>) over <i>Ptilotus obovatus</i> var. <i>obovatus</i> / <i>Dodonaea inaequifolia</i> (or sometimes mixed chenopods) dwarf shrubs (Plate 4-4). (This vegetation type occurs loosely within Woodman's FCT 1a and FCT 2.)
W01, W07, QW07, QW 10, MH(01), SH.	<i>Acacia ramulosa</i> var. <i>ramulosa</i> (sometimes with open <i>Acacia burkittii</i> and sparse <i>Melaleuca leiocarpa</i> / <i>Exocarpos aphyllus</i>) sparse to open tall shrubland, over scattered <i>Hakea recurva</i> subsp. <i>recurva</i> low to tall shrubs, over sparse <i>Hibbertia arcuata</i> / <i>Philotheca brucei</i> subsp. <i>brucei</i> / <i>Philotheca sericea</i> / <i>Dodonaea inaequifolia</i> / dwarf shrubs (sometimes ? <i>Waitzia</i> sp. and <i>Ptilotus obovatus</i> var. <i>obovatus</i> herbs and shrubs) (Plate 4-6). (This vegetation type occurs loosely within Woodman's FCT 4.)

SITE	VEGETATION & HABITAT
QE10	Sparse <i>Eucalyptus ewartiana</i> medium mallee trees, with open <i>Acacia ramulosa</i> var. <i>ramulosa</i> / <i>Acacia ramulosa</i> var. <i>linophylla</i> high shrubs, over scattered <i>Ptilotus obovatus</i> var. <i>obovatus</i> low shrubs.
QE11	Scattered <i>Acacia aneura</i> var. <i>?argentea</i> medium trees, over open <i>Acacia ramulosa</i> var. <i>linophylla</i> / <i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i> low trees, over sparse <i>Calycopeplus paucifolius</i> high shrubs, over open <i>Aluta aspera</i> subsp. <i>hesperia</i> medium shrubs.
QW02	Dense <i>Acacia coolgardiensis</i> subsp. <i>effusa</i> medium tall trees over moderately dense <i>Eremophila clarkei</i> and <i>Drummondita microphylla</i> medium shrubs.



Plate 4-3: Blue Hills – Gentle to moderate hill slope



Plate 4-4: Blue Hills – undulating plain



Plate 4-5: Blue Hills – moderate hill slope



Plate 4-6: Blue Hills – undulating plain



Plate 4-7: Blue Hills – moderate hill slope



Plate 4-8: Blue Hills – moderate to gentle rocky ridge crest/hill crest



Plate 4-9: Blue Hills – moderate hill slope



Plate 4-10: Blue Hills – steep hill crest to rocky outcrop



Plate 4-11: Blue Hills – hill crest to moderate upper hill slope

Based on the mapping previously carried out by Bennett (ATA, 2004), these vegetation types are represented outside of the project impact area.

5.0 FLORA OF THE KOOLANOOKA – BLUE HILLS PROJECT AREAS

5.1 Sampling Adequacy

5.1.1 Koolanooka Sampling Adequacy

The flora and vegetation survey was conducted using *EPA Guidance Statement No. 51: Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004) as a guide, and the survey methods produced quadrat-based quantitative data.

Two 20 m x 20 m quadrats (chosen to be representative of the vegetation present) were intensively surveyed for all vascular flora species present. Any plant species not present in the quadrats but observed while traversing the area were collected opportunistically. The boundary of the area was walked by the botanists (spaced approximately 50 m apart) and the centre of the area also.

The quadrat size used is that recommended for the area. The area to be surveyed at the Koolanooka mine site was relatively small, only 4.46 ha, and given the small area few vegetation types were encountered. The mine site survey area was revisited a second time and sampling adequacy is therefore considered to be adequate.

5.1.2 Blue Hills Sampling Adequacy

Mungada East and West were surveyed using the same methods mentioned above; these areas were surveyed four or five times. Seventeen quadrats were assessed at Mungada East and 24 at Mungada West. In addition, the whole of the proposed impact areas at both sites were surveyed by traversing the area and searching for Priority Flora.

Data from previous consultants' surveys and DEC surveys was accessible and used to further describe vegetation types in the area surveyed by *ecologia*.

5.2 Previous Survey Results for the Project Area

Koolanooka Hills

ATA recorded 220 taxa during its survey of Koolanooka Hills and of the road and rail areas within the Midwest mining leases. This number included 117 genera from 43 families, 13 of which were weed species (ATA, 2004b).

DEC, during its survey of the Koolanooka and Perenjori Hills, recorded 237 taxa from 53 families, of which 21 were weeds (Meissner & Caruso, 2006).

Blue Hills

Bennett recorded 212 taxa, during a survey of Blue Hills and the surrounding Karara Station. This included 126 genera from 53 families, seven of which were weed species (Bennett, 2004).

Two hundred and six vascular plant taxa, including seven introduced taxa, were recorded during flora surveys of the Mt Karara / Mungada Haul Road undertaken in 2004 and 2005 (Woodman Environmental Consulting, 2006a).

During the 2004 DEC survey of the Central Tallering Land System, which includes Blue Hills, a total of 414 vascular flora taxa, from 69 families, was recorded, and this total included four hybrids and 26 introduced species (Markey & Dillon, 2006).

Woodman's 2006 survey results were combined with previous Woodman surveys as well as those from DEC's survey of the central Tallering Region (Markey & Dillon, 2006) to give a total of 72 families, 202 genera and 508 taxa of which 25 were weed (introduced) species (Woodman, 2006b).

5.3 Current Survey Results for the Project Area

Koolanooka Hills

Forty-five taxa from 25 families and 35 genera were recorded during *ecologia's* Koolanooka survey (Appendix C). Of these taxa, one was identified to family level only, one to a query genus level and one to a query species within a known genus; two weed species were recorded during the survey.

Blue Hills

Ninety-four taxa from 34 families and 52 genera were recorded during *ecologia's* survey at Mungada East (Appendix C). Of these taxa, one was identified to family level only and two were confirmed to genus level only; four alien (weed) species were recorded during the survey.

Eighty-three taxa from 29 families and 43 genera were recorded during *ecologia's* survey of Mungada West (Appendix C), and of these taxa, one was identified to family level only, and seven were confirmed to genus level; no alien (weed) species were recorded during the survey.

5.4 Flora of Conservation Significance

5.4.1 Environment Protection and Biodiversity Conservation Act 1999

At a National level, flora is protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). The Act lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct or Extinct in the Wild (for definitions of categories, see Appendix A Table A-1).

Four species of nationally threatened flora are known from the vicinity of the Koolanooka Hills project area (Table B1, Appendix B) (Dept of the Environment and Water Resources, 2007); *Eremophila viscida* (Endangered), *Halosarcia bulbosa* (Vulnerable), *Eucalyptus synandra* (Vulnerable) and *Eremophila nivea* (Endangered). The first two taxa were recorded by ATA in an earlier survey of the area (2004b).

One species of nationally threatened flora is known from the vicinity of the Blue Hills project area (Table B2, Appendix B) (Dept of the Environment, Water, Heritage and the Arts, 2007);

Eucalyptus synandra (Vulnerable) is known from along Emu Fence Road on Karara Station (Woodman, 2006b).

None of these EPBC listed flora species were collected during the current Koolanooka and Blue Hills surveys.

Threatened Ecological Communities

Threatened Ecological Communities are defined as:

‘naturally occurring biological assemblages that occur in a particular type of habitat the sum of species within ecosystems and, as a whole, provide many of the processes that support specific ecosystems and provide ‘ecological services.’ (DEC, 2006).

Changes to the landscape and native habitat as a result of human activity have placed many endemic species and unique habitats at risk. The Australian Government mechanism for national environment protection and biodiversity conservation is the EPBC Act (1999).

The EPBC Act 1999 provides for:

- Identification and listing of threatened species and Threatened Ecological Communities.
- Development of Recovery Plans for listed species and ecological communities.
- Recognition of Key Threatening Processes; and, where appropriate,
- Reduction of these processes through Threat Abatement Plans.

No nationally-listed TECs have been recorded within the project area.

5.4.2 Wildlife Conservation Act, 1950 (Western Australia)

Declared Rare Flora (DRF) is also protected under the Western Australian Wildlife Conservation (Rare Flora) Notice 2005 of the *Wildlife conservation Act 1950*. The notice lists flora taxa that are extant and considered likely to become extinct or rare. These taxa are legally protected and removal or impact to their surroundings cannot be conducted without ministerial approval obtained specifically on each occasion for each population.

Six species of state threatened flora are known from the vicinity of the Koolanooka Hills project area (Table B1, Appendix B) (Wildlife Conservation (Rare Flora) Notice 2006(2)). *Acacia woodmaniorum* (Rare) has been recorded by both the DEC and by Woodman at Mungada and Blue Hills, *Eremophila viscida* (Rare) and *Halosarcia bulbosa* (Rare) were recorded by ATA (2004b), *Eucalyptus synandra* (Rare) and *Eremophila nivea* (Rare) have been recorded near Morawa (FloraBase, 2007), and *Eremophila rostrata* has been recorded at Perenjori (ATA, 2006b; FloraBase, 2006). One of these taxa, *Acacia woodmaniorum*, was recorded during the current survey at Blue Hills.

The Western Australian Department of Environment and Conservation (DEC) also maintains a list of taxa which are considered to be poorly known, uncommon, or under threat, but for which there is insufficient justification on the basis of known distribution and population

sizes for inclusion on the DRF schedule. These are classified as Priority Flora. The Declared Rare Flora and the four ranks of Priority Flora are defined by specific criteria (Table A2, Appendix A).

One state-listed TEC has been recorded within the survey areas – the Koolanooka Hills System TEC, which is listed as Vulnerable (Beecham, 2001).

5.4.3 Priority Flora recorded previously within or near the survey area

DEC listed Rare and Priority Flora have been recorded during previous surveys undertaken at both Koolanooka Hills and Blue Hills.

Koolanooka Hills

One hundred and sixty two Rare and Priority taxa are known to occur in the Avon-Wheatbelt 1 Sub-bioregion (NRM Agencies, 2003) and 30 Declared Rare (DRF) and Priority Flora species have been recorded previously in the vicinity of Koolanooka Hills, (Table B-1, Appendix B).

A survey of Koolanooka Hills and of the road and rail areas within the Midwest mining leases (ATA, 2004a) found two DRF taxa, *Eremophila viscida* and *Halosarcia bulbosa*, and five Priority Flora taxa; *Baeckea* sp. Three Springs (M.E. Trudgen 5368) (P2), *Acacia acanthoclada* subsp. *glaucescens* (P3)*, *Frankenia glomerata* (P3), *Grevillea stenostachya* (P3) and *Persoonia pentasticha* (P3). This previous survey encompassed a much larger area including the plains to which *Eremophila viscida* and *Halosarcia bulbosa* (DRF) are restricted.

The following eight Priority Flora were recorded during the DEC's survey of Koolanooka and Perenjori Hills; *Melaleuca barlowii* (P1), *Millotia dimorpha* (P1), *Rhodanthe collina* (P1), *Baeckea* sp. Perenjori (J.W. Green 1516) (P2), *Stenanthemum poicilum* (P2), *Acacia acanthoclada* subsp. *glaucescens* (P3)*, *Gunniopsis rubra* (P3) and *Persoonia pentasticha* (P3) (Meissner and Caruso, 2006).

* Priority rankings listed above are those indicated in the reports cited and they have not been changed to reflect the current listings. However the following changes apply under the current listing.

- *Acacia acanthoclada* subsp. *glaucescens* (P3) is no longer a priority taxa

Blue Hills

One hundred and six Rare and Priority taxa are known to occur in the Yalgoo bioregion (FloraBase, 2006) and 31 Declared Rare (DRF) and Priority Flora species have previously been recorded in the vicinity of Blue Hills (Table B-2, Appendix B).

Blue Hills, as well as the surrounding Karara Station, was surveyed by Bennett (Bennett Environmental Consulting, 2004). Two Priority Flora taxa were recorded on hill slopes in particular on BIF rocks, and these were; *Cryptandra imbricata* (P3)* and *Persoonia pentasticha* (P3). (It is probable that *Stenanthemum poicilum* (P2) was also recorded but the specimen had no reproductive material necessary for full taxonomic confirmation.)

During the DEC's 2005 survey of the central Tallering Land System the following six Priority Flora were found; *Austrostipa blackii* (C.E. Hubb.) S.W.L. Jacobs & J. Everett (P3), *Calytrix uncinata* Craven (P3), *Gunniopsis rubra* Chinnock (P3), *Micromyrtus cuensis* J.W. Green ms (P1)*, *Millotia dimorpha* P.S. Short (P1) and *Polianthion collinum* Rye [syn. *Genus* sp. Yalgoo (J.M. Ward s.n. 11/7/1999)] (P1)*. Current Priority Flora lists (Atkins, Dec 2006) also include *Acacia woodmaniorum* (DRF) - listed as *Acacia* sp. Blue Hill Range RJ Cranfield 8582 in Atkins 2006(2)) and *Acacia karina* (formerly *Acacia* sp. Karara (C. Godden 14)) (P2), which were collected during DEC's 2005 survey but have only recently been listed.

A number of surveys have been conducted in the vicinity of Blue Hills which included Midwest leases across Blue Hills (including Mungada Ridge) but also south, west and north-west of Mt. Karara (Woodman, 2004, Woodman, 2006b). At Mungada Ridge the following Priority Flora were identified; *Chamelaucium* sp. Yalgoo (Y Chadwick 1816) (P1), *Grevillea subtiliflora* (P1), *Gunniopsis divisa* (P1), *Hydrocotyle* sp. Warriedar (PG Wilson 12267) (P1), *Melaleuca barlowii* (P1), *Micromyrtus cuensis* ms (P1)*, *Micromyrtus* sp. Warriedar (S Patrick 1879A) (P1)*, *Millotia dimorpha* (P1), *Rhodanthe collina* (P1), *Acacia* sp. Karara (C. Godden 14) (P2)*, *Acacia woodmaniorum* (P2; under consideration for listing as a DRF)*, *Stenanthemum poecilum* (P2), *Acacia acanthoclada* subsp. *glaucescens* (P3)*, *Austrostipa blackii* (P3), *Cryptandra imbricata* ms (P3)*, *Grevillea globosa* (P3), *Grevillea scabrada* (P3), *Persoonia pentasticha* (P3), *Polianthion collinum* [syn. *Genus* sp. Yalgoo (JM Ward s.n. 11/7/1999)] (P3) and the new taxa *Acacia* aff. *coolgardiensis*, *Calotis* aff. *cuneifolia* (A. Markey & S. Dillon 3447) (recommended for Priority listing), *Drummondita* aff. *microphylla* (recommended for Priority listing) and *Lepidosperma* sp. Karara BIF (A. Markey & S. Dillon 3468).

*Priority rankings listed above are those indicated in the reports cited and they have not been changed to reflect the current listings. However the following changes apply under the current listing.

- *Cryptandra imbricata* (P3) is no longer a priority taxa.
- *Micromyrtus cuensis* J.W. Green ms (P1) = *Micromyrtus acuta*.
- *Polianthion collinum* Rye [syn. *Genus* sp. Yalgoo (J.M. Ward s.n. 11/7/1999)] (P1) is now P3
- *Micromyrtus* sp. Warriedar (S Patrick 1879A) = *Micromyrtus trudgenii* Rye (P1)
- *Acacia* sp. Karara (C. Godden 14) = *Acacia karina* (P2)
- *Acacia woodmaniorum* now a Declared Rare Flora
- *Acacia acanthoclada* subsp. *glaucescens* is no longer a priority taxa

The distributions of the conservation significant taxa found within the project footprint during *ecologia*'s survey and some of their biological characteristics are discussed below.

5.4.4 Priority flora recorded within the current survey areas

Koolanooka Hills

No Priority Flora taxa were recorded during the survey of the proposed impact area at Koolanooka Hills.

Blue Hills

Four Priority Flora taxa were recorded during *ecologia*'s surveys of the proposed mining disturbance areas at Blue Hills and these taxa are described below:

Acacia woodmaniorum (**DRF**) (Mimosaceae) is a species that appears to be restricted to the Blue Hills area. This species is described below by an adapted version of that provided by Bruce Maslin (*Acacia* specialist) for the Holotype specimen (PERTH 07414897) at the Western Australian Herbarium.

Acacia woodmaniorum (**DRF**) is an intricately branched prickly harsh shrub 1-1.5 (-2) m tall. The bark is grey and slightly rough. The new shoots are red when first initiated. The branchlets are light green or yellow at extremities, the decurrent phyllodes are glaucous and more or less lightly pruinose. The marginal nerve of phyllodes is red (young), ageing to yellow. Three spines occur on angles of the free portion of the phyllodes, and are pale red when young, aging to brown. The dead decurrent phyllodes are grey and persist on branches below living crown. The peduncles are often ringed red and the wattle flowers are yellow.

The individuals of *A. woodmaniorum* that were recorded by *ecologia* fit the above descriptions (Plates 5-1& 5-2).



Plate 5-1: *Acacia woodmaniorum* (DRF)



Plate 5-2: *Acacia woodmaniorum* (DRF)

Micromyrtus acuta Rye (**P1**) (Myrtaceae) (formerly *Micromyrtus* sp. Murchison M. E. Trudgen 2229)

Micromyrtus acuta is a rounded shrub growing to 0.5 – 2.5 m high (Plates 5-3). The leaves are tiny (up to 3 mm long and 1 mm wide) and shaped like a tear drop (wide at one end and narrow at the other). It produces small white flowers from around July to September and occurs on a number of different substrates, including ironstone.



Plate 5-3: *Micromyrtus acuta* Rye (P1)



Plate 5-1: *Micromyrtus placoides* Rye (P1)

Micromyrtus placoides Rye (P1) (Myrtaceae) is a rounded shrub growing 0.5 – 2 m tall. This species is widely spreading with several stems or branches from the base. The shrub produces white flowers, which have been noted in July and September. The shrub occurs on a number of different substrates including red-orange sandy clay and ironstone. The shrub typically occurs on gently undulating plains, dry creek beds, hillcrests and ridges (Plate 5-1).

Micromyrtus trudgenii (formerly *Micromyrtus* sp. Warriedar (S. Patrick 1879A), P1) (P3) (Myrtaceae) is an erect, open and straggly weeping shrub growing to 0.5 – 2 m tall. This species has small, linear-oblong leaves that tend to grow in dense clusters and then fall as they begin to age. The shrub produces yellow flowers, which have been noted in July and September. The flowers are small and tubular with five lobes and are cream to yellow in colour (Plates 5-4 & 5-5).



Plate 5-4: *Micromyrtus trudgenii* (P3)



Plate 5-5: *Micromyrtus trudgenii* (P3)

Persoonia pentasticha (P3) (Proteaceae) is an erect, spreading shrub growing to between 0.4 to 1.8 m in height. The flowers are yellow and are produced from August to November. It grows on sandy loam at the base of granite outcrops (Plates 5-6 & 5-7).



Plate 5-6: *Persoonia pentasticha* (P3)



Plate 5-7: *Persoonia pentasticha* (P3)

[Descriptions by the Western Australian Herbarium, Department of Environment and Conservation. Text used with the permission of DEC FloraBase website: (<http://florabase.calm.wa.gov.au/help/copyright>). Accessed on Thursday, 05 December 2006].

5.4.5 Flora having potential conservation significance

Koolanooka Hills

One taxon of potential conservation significance was recorded during *ecologia's* surveys at Koolanooka Hills.

Two specimens of *Acacia sclerosperma* subsp. *sclerosperma* were collected and these records mark a southerly range extension within the Avon Wheatbelt Region. The taxon is also found in the Pilbara, Gascoyne, Carnarvon, Murchison, Geraldton Sandplains and Yalgoo IBRA Regions as well as in the north of the Avon Wheatbelt.

During the DEC's 2005 survey of the Koolanooka and Perenjori Hills, five new and undescribed species were recorded; *Acacia* sp. Koolanooka Hills falcate (R. Meissner and Y. Caruso 84), *Caesia* sp. Koolanooka Hills (R. Meissner and Y. Caruso 78), *Dodonaea* sp. Koolanooka Hills (R. Meissner and Y. Caruso 17), *Drummondita* sp. Koolanooka Hills (R. Meissner and Y. Caruso 69) and *Lepidosperma* sp. Koolanooka (K. Newbey 9336). Five taxa of interest were also found during this survey which included; *Acacia* aff. *declinata*, *Hibbertia* aff. *exasperata*, *Eucalyptus ebbanoensis* subsp. *glaucciramula*, *Labichea lanceolata* subsp. *brevifolia* and *Tetralia* aff. *capillaris*.

Blue Hills

Lepidosperma sp. Blue Hills, a species of potential conservation significance, was recorded during *ecologia's* survey at Blue Hills – at Mungada East.

Nine new taxa were recorded during DEC's 2005 survey of the area: *Acacia* aff. *coolgardiensis*, *Acacia woodmaniorum* (DRF), *Acacia karina* (formerly sp. Karara (C. Godden 14)) (recently listed as a P2 taxon), *Calotis* aff. *cuneifolia*, *Drummondita fulva* (previously aff. *microphylla* (R. Cranfield 8586 A)) (P3), *Eremophila* cf. *platycalyx* (A. Markey & S. Dillon 3337), *Eremophila* sp. (A. Markey & S. Dillon 3338), *Lepidosperma* sp. Karara (H. Pringle 3865)(now *Lepidosperma* sp. Blue Hills), *Prostanthera* aff. *campbellii* and the new hybrids, *Cheilanthes* cf. *lasiophyllum* x *sieberi* (first hybridisation of this genus in WA) and *Senna glutinosa* subsp. *chatelainiana* x *charlesiana* (A. Markey & S. Dillon 3413) (Markey & Dillon, 2006). Woodman (2006b) recorded a possibly undescribed species of *Prostanthera* sp. as well as the possible new taxa, *Acacia* aff. *subsessilis* and *Grevillea* aff. *zygoloba*.

5.5 Introduced Flora

Priority weeds that are, or have the potential to become, pests to agriculture can be declared formally under the *Agriculture and Related Resources Protection Act 1976*. Weeds listed under the Act are listed with a coded definition of the requirements for control. Five Priority groupings are used, and more than one Priority may be placed on a weed species (see Appendix A, Table A-3 for definitions of codes).

5.5.1 Introduced Flora Previously Recorded Within the Current Survey Area

Koolanooka Hills

During the ATA survey (2004b) the following 13 weed species were found on Midwest leases; **Avena barbarta*, **Bromus diandrus*, **Bromus hordeaceus*, **Chenopodium murale*, **Echium plantagineum* (a Priority 1 weed was found around the mine site), **Ehrharta calycina*, **Eragrostis curvula*, **Erodium botrys*, **Hypochaeris glabra*, **Pennisetum setaceum*, **Pentaschistis airoides*, **Rumex vesicarius* and **Sonchus oleraceus* (ATA, 2004b).

DEC recorded 22 weed taxa during the survey of Koolanooka and Perenjori Hills and the following 19 weed taxa were found at Koolanooka Hills; **Acetosa vesicaria*, **Arctotheca calendula*, **Avena fatua*, **Brassica tournefortii*, **Bromus madritensis*, **Bromus rubens*, **Ehrharta longiflora*, **Cuscuta epithimum*, **Hypochaeris glabra*, **Lamarckia aurea*, **Mesembryanthemum nodiflorum*, **Pentaschistis airoides* subsp. *airoides*, **Petrohragia dubia*, **Rostraria pumila*, **Silene nocturna*, **Sisymbrium erysimoides*, **Sonchus oleraceus*, **Vulpia bromoides* and **Vulpia muralis* (Meissner & Caruso, 2006).

Blue Hills

During the Bennett (2004) survey of Blue Hills the following 10 weed species were recorded in the surrounding area: **Bromus hordeaceus*, **Bromus rubens*, **Erodium botrys*, **Hypochaeris glabra*, **Malva parviflora*, **Medicago minima* var. *minima*, **Mesembryanthemum nodiflorum*, **Sonchus oleraceus*, **Stellaria media* and **Rostraria pumilio*.

Woodman (2006b) recorded 25 weed plant taxa from 'the project area' however most of these taxa were recorded by Markey and Dillon (2006) after a good rainfall season in 2005. The taxa recorded were **Anagallis arvensis*, **Arctotheca calendula*, **Brassica tournefortii*, **Bromus rubens*, **Cleretum papulosum* subsp. *papulosum*, **Corchorus* sp., **Cuscuta epithimum*, **Echium plantagineum* (Priority 1 weed), **Ehrharta longiflora*, **Erodium cicutarium*, **Galium aparine* (Priority 1/Priority 2 weed for entire state), **Hypochaeris glabra*, **Lamarckia aurea*, *?Malva parviflora*, **Medicago minima*, **Mesembryanthemum nodiflorum*, **Pentaschistis airoides*, **Rostraria pumila*, **Silene nocturna*, **Sonchus oleraceus*, **Spargula pentandra*, **Urospermum picroides*, **Ursinia anthemoides*, **Vulpia muralis* and *Vulpia myuros* var. *myuros*.

More specifically the DEC survey of the central Tallering Land System recorded the following 14 weed taxa at Windanning Ridge; **Arctotheca calendula*, **Brassica tournefortii*, **Cleretum papulosum* subsp. *papulosum*, **Cuscuta epithimum*, **Ehrharta longiflora*, **Galium aparine* (Priority 1/Priority 2 weed for entire state), **Hypochaeris glabra*, **Lamarckia aurea*, **Pentaschistis airoides*, **Silene nocturna*, **Sonchus oleraceus*, **Urospermum picroides*, **Ursinia anthemoides*, **Vulpia muralis* and *Vulpia myuros* var. *myuros*.

5.5.2 Introduced Flora Recorded Within the Current Survey Area

Koolanooka Hills

No Priority weeds were recorded within the Koolanooka Hills proposed impact area surveyed by *ecologia*. However, two environmental weeds, Common Sowthistle (**Sonchus oleraceus*) and Ruby Dock (**Acetosa vesicaria*) were recorded.

Blue Hills

One Priority weed **Echium plantagineum* (Priority 1 weed) (Hussey *et al.*, 1997) was found at the Mungada East area of Blue Hills on disturbed areas on lower slopes near the old mining pit. In addition to this, three environmental weeds were recorded in the area: False Cleavers (**Galium spurium*) and False Hairgrass (both **Pentaschistis airoides* subsp. *airoides* and **Pentaschistis airoides*).

**Echium plantagineum* (Patterson's Curse; Plate 5.11), the Priority 1 weed at Mungada East, is described as an erect annual or biennial herb growing from 0.1 m to 1 m high. The plants flower from September to January and the flowers can range in colour from blue or purple to pink or white. The plant is a weed of roadsides, vacant lands and disturbed grounds (FloraBase, 2006).

[Descriptions by the Western Australian Herbarium, Department of Environment and Conservation. Text used with the permission of DEC FloraBase website: (<http://florabase.calm.wa.gov.au/help/copyright>). Accessed on Thursday, 16 November 2006].

As **Echium plantagineum* is a Priority 1 weed, Midwest is required to remove and manage the weed and the appropriate management controls are outlined in Table A-3, Appendix A.

Further information in regards to herbicide use for weed control can be found on the Department of Agriculture and Food website.

No Priority or environmental weeds were recorded during the current survey of the proposed impact area at the Mungada West area of Blue Hills.



Plate 5-11: *Echium plantagineum* (Priority 1 weed) (FloraBase, 2006).

Photography by R.Knox & J. Dodds. Image used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (<http://florabase.calm.wa.gov.au/help/copyright>). Accessed on Thursday, 16 November 2006.

6.0 DISCUSSION

6.1 Conservation Significance

6.1.1 Declared Rare Flora

Koolanooka Hills

Eremophila rostrata, *Eremophila viscida* (EPBC Endangered list) and *Halosarcia bulbosa*, all listed as Rare in the WA Rare Flora Notice, 2006, have been recorded previously in the vicinity of Koolanooka Hills (ATA, 2004b).

No Declared Rare Flora taxa, protected under the *Environment Protection and Biodiversity Act 1999* or the *WA Wildlife Conservation Act 1950*, were recorded during the current survey of the proposed zones of impact at Koolanooka Hills.

Blue Hills

Jingamia Mallee (*Eucalyptus synandra*, DRF) is known to occur within the vicinity of Blue Hills, along Emu Fence Road on Karara Station (Woodman, 2006a); it has also been recorded near Morawa and Mt. Gibson (FloraBase, 2007).

This Declared Rare Flora taxon, protected under the *WA Wildlife Conservation Act 1950*, was not recorded during the current survey of the proposed zones of impact at Blue Hills.

6.1.2 Priority Flora

The regional conservation significance and the likely impact (as a percentage) to known populations of the DRF, Priority Flora and flora of interest at and in the vicinity of the proposed mine areas are considered below (Table 6.1).

Koolanooka Hills

No Priority Flora taxa were recorded from within the current survey area at Koolanooka Hills. However, the record of the taxon *Acacia sclerosperma* subsp. *sclerosperma* is of interest, as this represents a southerly range extension from its previously known distribution, in the Pilbara, Gascoyne, Carnarvon, Murchison, Geraldton Sandplains and Yalgoo and northern Avon Wheatbelt IBRA bioregions.

Blue Hills

One Declared Rare Flora species and three Priority Flora species were recorded at both the Mungada East and Mungada West survey areas at Blue Hills. These taxa are *Acacia woodmaniorum* (DRF), *Micromyrtus acutas* Rye (P1), and *Micromyrtus trudgenii* and *Persoonia pentasticha* (both P3).

The locations of these Priority Flora taxa have not been plotted in the local area as the numbers of plants recorded for some of the species are large and discrete populations could not be identified (see Table 6.1). However the distributions of recorded regional populations have been already mapped for most of these taxa by Gindalbie (Woodman, 2006b) and these are included as Appendix E.

6.1.3 Threatened Ecological Communities

The plant assemblages of the Koolanooka Hills System have been defined as a TEC (Vulnerable). The vegetation of these areas is dominated by sheoak and mixed shrubland of *Allocasuarina campestris* (hilltops) and *Acacia exocarpoides* (on granite). The zone of impact at Koolanooka Hills falls within the mapped areas for the TEC, and makes up a small proportion of this. The plant assemblages of the Koolanooka Hills TEC occur over two areas totalling 5419 ha (M. Morley DEC pers. comm.). Hamilton-Brown (2000) states that the Koolanooka Hills area is 3496 ha and the Perenjori Hills area 1948 ha; using these areas to calculate proposed impact percentages, 0.13% of the Koolanooka Hills TEC or 0.08% of the total TEC area of the Plant Assemblages of the Koolanooka System will be impacted (as the area at Koolanooka Hills proposed for clearance is 4.46 ha). Eighty-seven percent of the plant assemblages of the Koolanooka System (Koolanooka hills and Perenjori Hills) remain and much of the earlier loss is from the footslopes of the Koolanooka Hills and southern Perenjori Hills (Hamilton-Brown, 2000).

6.1.4 Reserves in the Area

No TECs are listed as occurring at Blue Hills. While pastoral activity has taken place on the lands within the Yalgoo bioregion since the latter half of the 19th Century, Karara, Lochada and Warriedar pastoral leases were purchased by the DEC between 2000 and 2004 (Markey and Dillon, 2006). These pastoral leases are currently listed as conservation estate under the proposed Karara Conservation Reserve. The pastoral lease area for Karara is 109,291 ha, and the additional leases purchased for conservation purposes at Lochada and Warriedar Stations are 114,581 and 72,219 ha respectively; this gives a total of 296,091 ha in the proposed Karara Conservation Reserve.

The Blue Hills project area comprises two component land systems: 12 – Tallering (prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks) and 58 – Yowie (extensive nearly level plains with sandy surfaces) (Payne *et al.* 1998). Mungada East and Mungada West comprise both of these land systems. The hills and ridges of the Tallering land system are arranged, more or less, linearly, often with less than 5 km separating the different mapped areas of this land type. The arrangement reflects a distinct geomorphological history in the formation of these rocky hills and ridges. Both the Tallering and Yowie land systems are expressed on Lochada, Warriedar and Karara Stations which are in the conservation estate. The areas of the Tallering and Yowie Land Systems are 329 km² and 9,189 km² respectively (Payne *et al.*, 1998) and the area of land proposed for clearing at Mungada East and Mungada West is 52.5 ha. As only a small portion of the land to be cleared occurs in the larger, Yowie Land System impact calculations will be presented based on the Tallering Land System only, and 52.5 ha of 329 km² equates to 0.16% of the Tallering land system. Of this area 11.7 ha has been cleared previously and the remainder (40.8 ha) is to be newly cleared. Therefore the proportion of the Tallering land system proposed to be newly cleared is 0.12%. However, as noted above, as the Yowie Land System component has not been included in these calculations the actual impact on the vegetation of the Tallering Land System will be lower than this 0.16%.

6.1.5 Conservation Significant Taxa Recorded at Both Areas from a Number of Surveys and Potential Project Impacts on these Taxa

A summary of taxa of conservation significance, as defined under the federal *EPBC Act 1999* and the WA state *Wildlife Conservation Act 1950*, identified at the survey sites (Koolanooka

Hills, Mungada East and Mungada West footprints) is presented in Table 6.1. The numbers of plants known outside the footprint (within 5 km), and the approximate percentage of known plants to be impacted by the project are also presented in Table 6.1. The exact number of individual plants per population is not indicated in all records on FloraBase and average numbers of plants have been used based on numbers of plants in populations that are included on FloraBase.

No Priority Flora taxa were recorded at the Koolanooka area surveyed.

The greatest impact at Blue Hills will be to *Micromyrtus* sp. Warriedar at an estimated combined impact of 31.21%; all other estimated impacts fall below 10% of the local populations. *Micromyrtus* sp. Warriedar occurs in very high numbers along the BIF ridges in this general area and large populations have been counted on Midwest's mineral exploration tenements at Blue Hills. These populations have not been included in these calculations, as the DEC indicated that they should not be. However, if these populations were included the impact to this taxon would be much less. Based on the numbers of plants found in a relatively small area, it is anticipated that further searching in the local area would result in more populations of most of these taxa being found, and this would reduce these estimated impacts considerably.

Table 6-1 The populations of flora of conservation significance recorded at the Midwest Corporation Ltd project areas surveyed at Koolanooka and Blue Hills and the likely impact on these taxa due to proposed clearing of those areas.

Species	Cons. code	Number of plants counted by ecologia outside impact area	Number of plants in vicinity (within 5 km) but outside impact area – from FloraBase, Woodman, DEC and Bennett reports	Total number known plants outside impact area	Number of plants in impact area	Total number of known plants	Percentage of known plants to be Impacted
Koolanooka							
No Priority Flora taxa recorded							0.00%
Blue Hills							
Mungada West							
<i>Micromyrtus acuta</i> Rye ms	P1	60	270++	330	10	340	2.94%
<i>Micromyrtus turdgenii</i>	P3	379	6055	6434	1121	7555	14.84%
<i>Acacia woodmaniorum</i> ms	DRF	171	11829	12000	83	12083	0.69%
<i>Persoonia pentasticha</i>	P3	8	278	286	6	292	2.05%
Mungada East							
<i>Micromyrtus acuta</i> Rye ms	P1	60	270++	330	4	334	1.19%
<i>Micromyrtus turdgenii</i>	P3	379	6055	6434	1798	8232	21.84%
<i>Acacia woodmaniorum</i> ms	DRF	171	11829	12000	728	12728	5.72%

Species	Cons. code	Number of plants counted by ecologia outside impact area	Number of plants in vicinity (within 5 km) but outside impact area – from FloraBase, Woodman, DEC and Bennett reports	Total number known plants outside impact area	Number of plants in impact area	Total number of known plants	Percentage of known plants to be Impacted
<i>Persoonia pentasticha</i>	P3	8	278	286	25	311	8.04%
<i>Lepidosperma</i> sp. Blue Hills	New species	130	Not available	130 (at least)	2	132	1.52% (at most)
Blue Hills combined impacts							
<i>Micromyrtus acuta</i> Rye ms	P1	60	270++	330	14	344	4.07%
<i>Micromyrtus trudgenii</i>	P3	379	6055	6434	2919	9353	31.21%
<i>Acacia woodmaniorum</i> ms	DRF	171	11829	12000	811	12811	6.33%
<i>Persoonia pentasticha</i>	P3	8	278	286	31	317	9.78%
<i>Lepidosperma</i> sp. Blue Hills	New species	130	Not available	130 (at least)	2	132	1.52% (at most)

Note: The number of plants in recorded populations is not always provided on FloraBase, therefore an average number of plants has been calculated based on those populations where plant numbers and cover are given; this average has then been multiplied by the number of populations recorded

6.2 Legislative Conformance

This assessment has been undertaken in accordance with the EPA's Position Statement No. 3 and Guidance Statement No. 51. As outlined in Section 3.6, and in Table 3.3, the surveys carried out in both areas have contributed local data on the flora and vegetation present within the proposed disturbance footprint and the survey is considered to be largely complete.

Three principles apply to native flora assessments under the *Environmental Protection Act 1986*. Their application to the flora and vegetation of the Koolanooka and Blue Hills project areas is as follows:

1) The Precautionary Principle

The precautionary principle states that where threats of serious or irreversible environmental damage exist, lack of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation. Therefore lack of absolute quantification of the areas of vegetation involved should not preclude measures that aim to offset the environmental deficits that will result from the clearing of this vegetation.

a. Vegetation units of the project footprint areas

Data was available from quantitative flora and vegetation surveys recently and previously undertaken in the region.

b. Flora of the project footprint areas

Information has been provided in this report about the Priority Flora that will be impacted by the project. The effect of the removal of the populations of these species found in the footprint on their long term survival is largely unknown, however, populations of the species to be impacted occur outside the project footprint area.

Lack of scientific certainty about the impact of the project on these species should not preclude measures that aim to address the recovery or conservation of these species, or those to offset the environmental deficits that will result from the clearing of the locations where the species are currently present, or the habitat areas from which their germplasm can be recovered.

2) The Principles of Intergenerational Equity

Construction of the mine sites and waste dumps will result in the clearing of about 3.8 ha of native vegetation at Koolanooka and 56.3 ha (44.6 ha to be newly cleared and 11.7 ha pre-disturbed) at Blue Hills. This will lead to local biodiversity loss (primarily in the reduction of the gene pools of flora species involved and the reduction of flora habitat) and contribute to regional ecosystem decline. These factors, in turn, will contribute to deficits in the natural heritage to be left to future generations of this region. If Principles of Intergenerational Equity are to be upheld, an investigation and evaluation of the local vegetation (to determine meaningful offsets against these losses) will need to be implemented.

3) The Principle of Conservation of Biological Diversity and Ecological Integrity

The implementation of the project will result in local biodiversity loss (primarily in the reduction of the gene pools of flora species and the reduction of flora habitat) and could contribute to regional ecosystem decline. If the Principle of Conservation of Biological

Diversity and Ecological Integrity is to be upheld, a thorough investigation and evaluation to determine meaningful offsets against these losses will need to be implemented. The Environmental Management Plan for this project will provide guidance to minimise and prevent further biodiversity loss and ecological decline beyond the footprint areas (weed proliferation and fire).

7.0 CONCLUSIONS

The conservation significance of the flora and vegetation of the project areas can be viewed in the context of other regional data available.

Koolanooka Hills

The Avon Wheatbelt 1 Subregion in which the Koolanooka Hills occur is considered to be under high continental landscape stress. Two percent of the vegetation of this Subregion is protected. Five plant assemblages of Beard's Koolanooka System are now listed as TECs by DEC; the area to be impacted is 4.46 ha, which constitutes 0.13% of the Koolanooka Hills System TEC or 0.08% of the total TEC area of the plant assemblages of the Koolanooka System (which includes the Perenjori Hills). The development of the mine site will impact slightly on the conservation of regional biodiversity. Appropriate offsets against the loss of biodiversity on the mine site should be investigated.

No flora of conservation significance were recorded in the area surveyed at Koolanooka, therefore there will be no impact to the flora other than the loss of local biodiversity resulting from vegetation clearing.

Blue Hills

Blue Hills is situated in the Yalgoo botanical province and the bioregion is considered to be under less continental stress than the Avon Wheatbelt 1 Subregion. A total of 52.5 ha (40.8 ha newly and 11.7 ha previously) is proposed for clearance at Blue Hills. This total area amounts to 0.16% (0.12% newly and 0.04% previously cleared) of the Tallering Land System occurring in the region (however this impact is actually lower because some of the Yowie Land System will be impacted, but because it is such a small area the calculations have been based on the effects on the smaller Tallering Land System. Karara, Lochada and Warriadar pastoral leases are now owned by the state and are proposed to become conservation parks in 2015; the Tallering land system occurs on these stations and large areas of it will be part of the future conservation estate. No TECs are known to be present in the area.

In addition to the loss of local biodiversity arising from vegetation clearing, one DRF, *Acacia woodmaniorum*, and three Priority Flora taxa will be impacted by the clearing at Blue Hills: *Micromyrtus placoides*, *Micromyrtus trudgenii*, and *Persoonia pentasticha*. *Lepidosperma* sp. Blue Hills, a taxon of interest, will be impacted also and its current regional distribution is indicated in Appendix E.

The distribution of *Acacia woodmaniorum* appears to be restricted to Blue Hills (14 records on FloraBase and all from the Mungada/Windaning area; see Appendix E). The priority flora taxa have been recorded elsewhere:

Micromyrtus acuta – 17 records including from Weld Range, Tallerang, Mt Narryer, Tallering Peak and Cue;

Micromyrtus trudgenii – 29 records including from Gossan, Windaning, Jasper, Extension and Arsenic Hills (see Appendix E);

Persoonia pentasticha – 33 records including from close to Mullewa, Pedan Rocks, Wubin-Paynes Find Rd, including on West Perenjori and East Yuna Reserves (see Appendix E).

8.0 RECOMMENDATIONS

Management of native flora and vegetation is addressed in the Public Environmental Review (PER) and the proposal's Environmental Management Plan (EMP). In addition, the following actions should be implemented to mitigate impacts of the development on native flora and vegetation.

- To avoid the introduction and spread of weed species to and from the area (particularly the Priority 1 weed *Echium plantagineum*) strict hygiene measures should be implemented. All earthmoving machinery and other heavy vehicles involved are to be cleaned down before operations commence and remain within the area until the work is completed. Vehicles are to be cleaned down when moving from areas where weeds are present to areas where no weeds are present and areas that contain flora of conservation significance. Regular monitoring of disturbed areas is to be undertaken to determine if weeds are spreading into cleared areas and, if necessary, spot spraying of emergent weeds may be required. As Paterson's Curse (*Echium plantagineum*) is a Priority 1 weed Midwest is required to remove and manage the weed and the appropriate management controls are outlined in this report. This noxious weed should be eradicated from the site prior to the mining process. This will require very good soil hygiene measures and long term follow up to identify and eradicate seedlings. Further information in regards to herbicide use for weed control can be found on the Department of Agriculture and Food website.
- Vegetation clearing is to be restricted to that which is absolutely necessary and should have as little impact as possible on areas where flora of conservation significance were recorded.
- Areas where native vegetation will be totally removed contain important genetic resources in the form of the soil seed bank, the canopy-stored seed bank, vegetative cuttings that can be propagated in a nursery, rhizomatous monocotyledon plants that can be divided and propagated. The organic material contained within the vegetation to be cleared can be used as mulch for disturbed sites in either chip or brush mulch form. All of the above resources can be used to rehabilitate degraded areas locally and to establish vegetated buffer zones around mine infrastructure.
- Topsoil is to be stockpiled for use in the rehabilitation of post-mining areas. This allows for a good growth medium for regenerating seedlings, and a source of existing local propagules (fruits, seeds, roots, rhizomes, bulbs, corms etc.) for returning local species to the vegetation.
- Cleared vegetation and coarse surface material such as logs and rocks are to be stockpiled for future use in rehabilitation as it provides useful fauna habitat and shelter locations for regenerating seedlings.
- Each area that is cleared for mining should be rehabilitated as soon as possible after mining. Special measures to counteract erosion may also be necessary in areas such as steep inclines.
- All earthmoving machinery is to be fitted with fire extinguishers to prevent the spread of any potential fire into nearby vegetation.
- No off-track driving should be allowed at the Koolanooka or Blue Hills areas.

9.0 STUDY TEAM

The Koolanooka Hills and Blue Hills Rare Flora Survey described in this document was planned, coordinated and executed by:



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Scott Hitchcock	BSc (Env Mgmt)	Botanist	

Licences

Licences - "Licence to take flora for scientific purposes"		
The Koolanooka Hills and Blue Hills flora surveys were conducted under the authorisation of the following licences issued by the Department of Environment and Conservation:		
	Permit Number	Valid Until
"Licence to take flora for scientific purposes"		
Caroline M ^c Cormick	SL007817	30 th April 2008
Conrad Slee	SL007733	15 th January 2008
Melissa Hay	SL007712	21 st December 2007
Scott Hitchcock	SL007816	30 th April 2008

ACKNOWLEDGEMENTS

Sharnya Thomson and Cate Tauss identified plant specimens collected during these surveys.

10.0 REFERENCES

- ATA Environmental (2004a). Notice Of Intent, Direct Shipping Ore (DSO) Project Koolanooka Iron Ore Mine. Unpublished Report for MidWest Corporation.
- ATA Environmental (2004b). Vegetation and Flora Assessment Koolanooka. Report No. 2004/23. Prepared for Midwest Corporation.
- ATA Environmental (2004c) Vegetation Assessment and Targeted Flora Survey Koolanooka Iron Ore Project -Rail Easement. Prepared for Midwest Corporation.
- Atkins, K.J. (2008). Declared Rare and Priority Flora List, Department of Conservation and Land Management.
- Australian Natural Resources Atlas n.d.(a), Water. Australian Government. Available from: http://audit.ea.gov.au/anra/water/docs/state_overview/WA_ovpage.html#GWHyd [23 March 2007].
- Australian Natural Resources Atlas n.d.(b), Water resources - an overview - Yarra Yarra Lakes, Australian Government. Available from: http://audit.ea.gov.au/anra/water/water_frame.cfm?region_type=WA®ion_code=618&info=resources [23 March 2007].
- Bamford Consulting Ecologists (2004). Blue Hills Fauna Assessment, prepared for ATA Environmental.
- Beard, J. S. (1976). Vegetation Survey of Western Australia, Murchison 1:1,000,000 Vegetation Series Explanatory Notes to Sheet 6, The Vegetation of the Murchison Region. University of Western Australia Press, Nedlands.
- Beecham, B. (2001). Avon Wheatbelt (AW1 – Ancient Drainage subregion) Department of Conservation and Land Management, Western Australia.
- Bennett Environmental Consulting (2004). Flora and Vegetation Blue Hills. Prepared for ATA Environmental, on behalf of Midwest Corporation.
- Bureau of Meteorology (2006). Available: www.bom.gov.au [accessed 02/08/06], [27/03/07] & [03/04/07]
- Department of Agriculture and Food (2006). Declared Plants in Western Australia. Available: <http://www.agric.wa.gov.au/> [accessed 13/12/06]
- Department of Environment (2004). Protecting Native Vegetation – New Laws for Western Australia.
- Department of the Environment and Water Resources (2007). EPBC Act List of Threatened Flora. Australian Government. Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora> [02 April 2007]

- Desmond, A. & Chant, A. (2001). Yalgoo (Yal) Department of Conservation and Land Management, Western Australia.
- Environmental Protection Authority (2006). *The State of the Environment report Western Australia draft*. Government of Western Australia Available: <http://portal.environment.wa.gov.au/> [22 March 2007]
- Hamilton- Brown, S. (2000). Plant Assemblages of the Koolanooka System - Interim Recovery Plan 2000-2003. Department of Conservation and Land Management.
- Heritage Council, 1988, Heritage Trail, De Grey – Mullewa Stock Route. Available from: http://trails.heritage.wa.gov.au/ht_pdf/DeGreyMullewa.pdf [28 March 2007]
- Hocking, R. M., Van De Graaff, W. J. E., Blockley, J. G. & Butcher, B. P. (1982). 1:250,000 Geographical Series - Explanatory Notes on the Ajana Geological Sheet, Western Australia. Department of Mines, Western Australia.
- Hussey, B. M. J., Keighery, G. J., Cousens, R. D., Dodd, J. and Lloyd, S. G. (1997). Western Weeds. The Plant Protection Society of Western Australia and Agriculture Western Australia. Kensington, W.A.
- Meissner, R. & Caruso, Y (2006). Flora and vegetation of banded ironstone formations of the Yilgarn Craton: Koolanooka and Perenjori Hills. Department of Environment and Conservation, Western Australia.
- Markey A. S. and Dillon, S. J. (2006). Flora and vegetation of the Banded Ironstone Formations of the Yilgarn Craton: the central Tallering Land System, Department of Environment and Conservation.
- Payne, A. L., Van Vreeswyk, A. M. E., Pringle, H. J. R, Leighton, K. A. & Henning, P. (1988). An inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area, Western Australia – Technical Bulletin No. 90. Government of Western Australia.
- Rockwater Pty Ltd (2004). *Assessment of Groundwater Supplies for proposed Mining of Iron Ore at Koolanooka*. Unpublished report prepared for Midwest Corporation Ltd.
- Rockwater Pty Ltd (2006). *Results of groundwater exploration drilling at Koolanooka and Blue Hills* . Unpublished report prepared for Midwest Corporation Ltd.
- State NRM agencies: Department of Agriculture, Department of Conservation and Land Management, Department of Environment & Department of Fisheries (2003). Preliminary Agency Statement of Natural resource Management Priorities in Western Australia Available: <http://portal.environment.wa.gov.au/portal/page>
- West Australian Land Information System (2006). WALIS Website [online] available: <http://atlas.walis.wa.gov.au/atlaswa/> accessed 02/08/06
- Western Australian Herbarium (2006). Florabase Website [online] available: <http://florabase.calm.wa.gov.au/> accessed 03/08/06

- Wildlife Conservation (Rare Flora) Notice (2008) Western Australian Government Gazette, p. 5311.
- Woodman Environmental Consulting (2004). EPBC Referral form for Blue Hills, Gindalbie Metals [online] Available:
http://www.deh.gov.au/cgibin/epbc/epbc_ap.pl?name=show_document&document_id=21949&proposal_id=2797 accessed 12 December 2006.
- Woodman Environmental Consulting (2006a). Gindalbie Gold N.L. and Midwest Corporation: Mt. Karara/Mungada Haul Road Flora Survey and Plant Community Mapping Draft.
- Woodman Environmental Consulting (2006b). Gindalbie Metals Ltd.: Flora and Vegetation of the Karara - Mungada Project Survey Area.

Appendix A: Explanation of Conservation Codes

Explanation of Conservation Codes

Table A-1 Definition of categories described under the EPBC Act.

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

Table A-2 Definition of Declared Rare and Priority categories.

Code	Definition
DRF	Declared Rare Flora-Extant Taxa. Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
P1: Priority One	Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2: Priority Two	Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P3: Priority Three	Poorly Known Taxa. Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
P4: Priority Four	Rare Taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

(From Atkins, 2008, Declared Rare and Priority Flora List 2008, DEC)

Table A-3 Explanation of codes for Declared Weeds in Western Australia.

Priority	Requirements
P1 Prohibits movement	The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce, including livestock and fodder.
P2 Aim is to eradicate infestation	Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3 Aims to control infestation by reducing area and/or density of infestation	<p>The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property, on or in livestock, fodder, grain, vehicles and/or machinery.</p> <p>Treat to destroy and prevent seed set for all plants:</p> <ul style="list-style-type: none"> • within 100 metres inside of the boundaries of the infestation. • within 50 metres of roads and high-water marks on waterways. • within 50 metres of sheds, stock yards and houses. <p>Treatment must be done prior to seed set each year.</p> <p>Of the remaining infested area:</p> <ul style="list-style-type: none"> • Where plant density is 1-10 per hectare, treat 100% of infestation. • Where plant density is 11-100 per hectare, treat 50% of infestation. • Where plant density is 101-1000 per hectare, treat 10% of infestation. <p>Properties with less than two hectares of infestation must treat the entire infestation.</p> <p>Additional areas may be ordered to be treated.</p>
P4 Aims to prevent infestation spreading beyond existing boundaries of infestation	<p>The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property, on or in livestock, fodder, grain, vehicles and/or machinery.</p> <p>Treat to destroy and prevent seed set for all plants:</p> <ul style="list-style-type: none"> • within 100 metres inside of the boundaries of the infested property. • within 50 metres of roads and high-water marks on waterways. • within 50 metres of sheds, stock yards and houses. • Treatment must be done prior to seed set each year. Properties with less than two hectares of infestation must treat the entire infestation. <p>Additional areas may be ordered to be treated.</p> <p>Special considerations:</p> <p>In the case of P4 infestations where they continue across property boundaries, there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.</p>
P5	Infestations on public lands must be controlled.

(Department of Agriculture and Food, 2006).

**Appendix B: Rare and Priority Flora Potentially Occurring within the
Koolanooka Hills and Blue Hills Project Areas**

Table B-1 Rare and Priority Flora and flora of conservation significance having potential to occur within the Koolanooka Hills survey area.

Family	Species	Status
Chenopodiaceae	<i>Halosarcia bulbosa</i> Paul G.Wilson	Rare
Myoporaceae	<i>Eremophila nivea</i>	Rare
Myoporaceae	<i>Eremophila rostrata</i> ms	Rare
Myoporaceae	<i>Eremophila viscida</i> Endl.	Rare
Myrtaceae	<i>Eucalyptus synandra</i> Crisp	Rare
Anthericaceae	<i>Tricoryne</i> sp. Morawa (G.J. Keighery & N. Gibson 6759)	P1
Asteraceae	<i>Gnephosis setifera</i> P. S. Short	P1
Asteraceae	<i>Millotia dimorpha</i> P.S.Short	P1
Asteraceae	<i>Rhodanthe collina</i>	P1
Myrtaceae	<i>Leptospermum exsertum</i>	P1
Myrtaceae	<i>Melaleuca barlowii</i> Craven	P1
Asteraceae	<i>Fitzwillia axilliflora</i> (Ewart & Jean White) P.S.Short	P2
Myrtaceae	<i>Baeckea</i> sp. Perenjori (J.W. Green 1516)	P2
Myrtaceae	<i>Baeckea</i> sp. Three Springs (M.E. Trudgen 5368)	P2
Rhamnaceae	<i>Stenanthemum poicilum</i> Rye	P2
Aizoaceae	<i>Gunniopsis rubra</i>	P3
Asteraceae	<i>Angianthus micropodioides</i>	P3
Asteraceae	<i>Epitriche demissus</i>	P3
Asteraceae	<i>Podotheca unisetata</i> P. S. Short	P3
Frankeniaceae	<i>Frankenia glomerata</i> Turcz.	P3
Goodeniaceae	<i>Lechenaultia galactites</i> L.W.Sage ms	P3
Mimosaceae	<i>Acacia acanthoclada</i> subsp. <i>glaucescens</i> Maslin	P3
Mimosaceae	<i>Acacia formidabilis</i>	P3
Mimosaceae	<i>Acacia isoneura</i> subsp. <i>Isonaura</i>	P3
Myrtaceae	<i>Enekbatus longistylus</i> Trudgen & Rye ms	P3
Myrtaceae	<i>Verticordia venusta</i> A.S.George	P3
Papilionaceae	<i>Urodon capitatus</i> Turcz.	P3
Poaceae	<i>Austrostipa blackii</i> (C.E.Hubb.) S.W.L.Jacobs & J.Everett	P3
Proteaceae	<i>Grevillea asparagoides</i>	P3
Proteaceae	<i>Grevillea stenostachya</i> C.A.Gardner	P3
Proteaceae	<i>Persoonia pentasticha</i> P.H.Weston	P3
Stylidiaceae	<i>Levenhookia octomaculata</i> F.L.Erickson & J.H.Willis	P3
New Species (DEC survey, 2005)		
Mimosaceae	<i>Acacia</i> sp. Koolanooka falcate (R. Meissner and Y. Caruso 84)	
Anthericaceae	<i>Caesia</i> sp. Koolanooka Hills (R. Meissner and Y. Caruso 78)	
Sapindaceae	<i>Dodonaea</i> sp. Koolanooka Hills (R. Meissner and Y. Caruso 17)	
Rutaceae	<i>Drummondita</i> sp. Koolanooka Hills (R. Meissner and Y. Caruso 69)	
Chenopodiaceae	<i>Lepidosperma</i> sp. Koolanooka (K. Newbey 9336)	
Taxa of Interest (DEC survey, 2005)		
Mimosaceae	<i>Acacia</i> aff. <i>declinata</i>	
Dilleniaceae	<i>Hibbertia</i> aff. <i>exasperata</i>	
Myrtaceae	<i>Eucalyptus ebbanoensis</i> subsp. <i>glauciramula</i>	
Caesalpiniaceae	<i>Labichea lanceolata</i> subsp. <i>brevifolia</i>	
Cyperaceae	<i>Tetaria</i> aff. <i>capillaris</i>	

(Summarised from: FloraBase, 2008; a DEC database Rare Flora search, 2004; Atkins 2008 and previous surveys).

Table B-2 Rare and Priority Flora and flora of conservation significance having potential to occur within the Blue Hills survey area.

Family	Species	Status
Mimosaceae	<i>Acacia woodmaniorum</i> Maslin & Buscumb ms	DRF
Myrtaceae	<i>Eucalyptus synandra</i> Crisp	Rare
Aizoaceae	<i>Gunniopsis divisa</i> Chinnock	P1
Apiaceae	<i>Hydrocotyle</i> sp. Warriedar (P.G. Wilson 12267)	P1
Asteraceae	<i>Millotia dimorpha</i> P.S.Short	P1
Asteraceae	<i>Rhodanthe collina</i> Paul G.Wilson	P1
Myrtaceae	<i>Chamelaucium</i> sp. Yalgoo (Y. Chadwick 1816)	P1
Myrtaceae	<i>Leptospermum exsertum</i> Joy Thomps.	P1
Myrtaceae	<i>Micromyrtus cuensis</i> J.W.Green ms	P1
Myrtaceae	<i>Melaleuca barlowii</i> Craven	P1
Proteaceae	<i>Grevillea subtiliflora</i> McGill.	P1
Proteaceae	<i>Persoonia kararae</i>	P1
Rhamnaceae	<i>Polianthion collinum</i> Rye [syn. <i>Genus</i> sp. Yalgoo (J.M. Ward s.n. 11/7/1999)]	P1
Apiaceae	<i>Hydrocotyle coorowensis</i> H.Eichler ms	P2
Papilionaceae	<i>Isotropis canescens</i> F.Muell.	P2
Rhamnaceae	<i>Stenanthemum poicilum</i> Rye	P2
Aizoaceae	<i>Gunniopsis rubra</i> Chinnock	P3
Goodeniaceae	<i>Lechenaultia</i> sp. Kokardine (B.H. Smith 177)	P3
Myrtaceae	<i>Micromyrtus trudgenii</i>	P3
Lamiaceae	<i>Spartothamnella</i> sp. Helena & Aurora Range (P.G. Armstrong 155-109)	P3
Mimosaceae	<i>Acacia formidabilis</i>	P3
Mimosaceae	<i>Acacia speckii</i> R.S. Cowan & Maslin	P3
Mimosaceae	<i>Acacia acanthoclada</i> subsp. <i>glaucescens</i> Maslin	P3
Myrtaceae	<i>Calytrix uncinata</i> Craven	P3
Poaceae	<i>Austrostipa blackii</i> (C.E.Hubb.) S.W.L. Jacobs & J.Everett	P3
Proteaceae	<i>Grevillea globosa</i> C.A.Gardner	P3
Proteaceae	<i>Grevillea scabrida</i> C.A.Gardner	P3
Proteaceae	<i>Persoonia pentasticha</i> P.H.Weston	P3
Stylidiaceae	<i>Levenhookia octomaculata</i> F.L.Erickson & J.H.Willis	P3
	New Species (DEC survey, 2005)	
Mimosaceae	<i>Acacia karina</i> (formerly sp. Karara (C. Godden 14))	P2
Asteraceae	<i>Calotis</i> aff. <i>cuneifolia</i> (A. Markey & S. Dillon 3447)	
Chenopodiaceae	<i>Lepidosperma</i> sp. Karara (H.Pringle 3865)	
Lamiaceae	<i>Prostanthera</i> aff. <i>campbellii</i>	
Mimosaceae	<i>Acacia</i> aff. <i>coolgardiensis</i>	
Myoporaceae	<i>Eremophila</i> cf. <i>platycalyx</i> A. Markey & S. Dillon 3337)	
Myoporaceae	<i>Eremophila</i> sp. (A. Markey & S. Dillon 3338)	
Rutaceae	<i>Drummondita fulva</i> (formerly aff. <i>microphylla</i>)	P3

Taxa of Interest (DEC survey, 2005)		
Adiantaceae	<i>Cheilanthes cf. lasiophyllum x sieberi</i>	New hybrid
Caesalpiniaceae	<i>Senna glutinosa</i> spp. <i>chatelainiana x charlesiana</i> (A. Markey & S. Dillon 3413)	New hybrid
Chenopodiaceae	<i>Maireana planifolia x villosa</i>	New hybrid
Taxa of Interest (Woodman survey, 2006b)		
Mimosaceae	<i>Acacia</i> aff. <i>subsessilis</i>	Poss. new taxon
Lamiaceae	<i>Prostanthera</i> sp.	Possibly undescribed

Summarised from: FloraBase, 2008; DEC database search, 2008; ATA, 2004; Woodman Environmental Consultants, 2004, 2006a & 2006b; Markey & Dillon, 2006).

Appendix C: Complete Species Lists for Koolanooka Hills and Blue Hills Areas Surveyed

Table C-1 List of flora species collected during the current Koolanooka Hills flora surveys.

Family	Species
Adiantaceae	<i>Cheilanthes adiantoides</i>
Amaranthaceae	<i>Ptilotus obovatus</i> <i>Ptilotus polystachyus</i> var. <i>polystachyus</i>
Anthericaceae	<i>Thysanotus manglesianus</i> <i>Thysanotus patersonii</i>
Apiaceae	<i>Trachymene cyanopetala</i>
Asclepiadaceae	<i>Rhyncharrhena linearis</i>
Asteraceae	Asteraceae sp. ?Senecio sp. <i>Lawrencella rosea</i> <i>Myriocephalus guerinae</i> <i>Rhodanthe battii</i> * <i>Sonchus oleraceus</i> <i>Waitzia acuminata</i> var. <i>acuminata</i>
Casuarinaceae	<i>Allocasuarina acutivalvis</i> subsp. <i>prinsepiana</i>
Chenopodiaceae	<i>Maireana carnosae</i> <i>Rhagodia drummondii</i>
Dioscoreaceae	<i>Dioscorea hastifolia</i>
Epacridaceae	<i>Astroloma serratifolium</i>
Euphorbiaceae	<i>Calycopeplus paucifolius</i>
Goodeniaceae	<i>Goodenia ?berardiana</i> <i>Velleia hispida</i>
Isoetaceae	<i>Isoetes inflata</i>
Malvaceae	<i>Sida atrovirens</i>
Mimosaceae	<i>Acacia acuminata</i> <i>Acacia assimilis</i> subsp. <i>assimilis</i> <i>Acacia exocarpoides</i> <i>Acacia nigripilosa</i> subsp. <i>nigripilosa</i> ☞ <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> <i>Acacia tetragonophylla</i>
Myoporaceae	<i>Eremophila oldfieldii</i> subsp. <i>oldfieldii</i>
Myrtaceae	<i>Melaleuca fulgens</i> subsp. <i>fulgens</i> <i>Melaleuca nematophylla</i> <i>Melaleuca radula</i>
Papilionaceae	<i>Daviesia hakeoides</i> subsp. <i>hakeoides</i>
Poaceae	<i>Aristida contorta</i> <i>Austrostipa elegantissima</i>
Polygalaceae	<i>Comesperma volubile</i>
Polygonaceae	* <i>Acetosa vesicaria</i>
Proteaceae	<i>Grevillea levis</i> <i>Grevillea paradoxa</i>
Sapindaceae	<i>Dodonaea inaequifolia</i>
Solanaceae	<i>Anthocercis anisantha</i> subsp. <i>anisantha</i>

Family	Species
	<i>Solanum ellipticum</i>
Sterculiaceae	<i>Rulingia luteiflora</i>

Classification and nomenclature according to the Western Australian Herbarium (FloraBase, 2007),

Key: * = introduced species

☞ = flora of interest

Table C-2 List of flora species collected during the current Blue Hills (Mungada East) flora surveys.

Family	Species
Adiantaceae	<i>Cheilanthes adiantoides</i> <i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>
Amaranthaceae	<i>Ptilotus obovatus</i> <i>Ptilotus obovatus</i> var. <i>obovatus</i> <i>Ptilotus schwartzii</i>
Anthericaceae	<i>Arthropodium dyeri</i>
Apiaceae	<i>Xanthosia bungei</i>
Apocynaceae	<i>Alyxia buxifolia</i>
Asclepiadaceae	<i>Rhyncharrhena linearis</i>
Asteraceae	<i>Calocephalus multiflorus</i> <i>Calotis hispidula</i> <i>Calotis</i> sp. <i>Lawrencella rosea</i> <i>Myriocephalus guerinae</i> <i>Rhodanthe battii</i> <i>Waitzia acuminata</i> var. <i>acuminata</i>
Boraginaceae	* <i>Echium plantagineum</i> (P1 weed) <i>Trichodesma zeylanicum</i>
Boryaceae	<i>Borya sphaerocephala</i>
Caesalpiniaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>
Casuarinaceae	<i>Allocasuarina acutivalvis</i> subsp. <i>prinsepiana</i>
Crassulaceae	<i>Crassula colorata</i> var. <i>acuminata</i> <i>Crassula extrorsa</i>
Cyperaceae	<i>Lepidosperma costale</i> ☞ <i>Lepidosperma</i> sp. Blue Hills
Dilleniaceae	<i>Hibbertia arcuata</i>
Droseraceae	<i>Drosera macrantha</i> subsp. <i>macrantha</i>
Epacridaceae	<i>Astroloma serratifolium</i>
Euphorbiaceae	<i>Calycopeplus paucifolius</i>
Goodeniaceae	<i>Goodenia ?berardiana</i> <i>Goodenia berardiana</i> <i>Scaevola spinescens</i>
Lamiaceae	<i>Hemigenia</i> sp. Cue (K.F. Kenneally 47A) <i>Hemigenia</i> sp. Pindar (H. Demarz 7428) <i>Hemigenia</i> sp. Yuna (A.C. Burns 95) <i>Microcorys obovata</i> <i>Prostanthera patens</i>
Malvaceae	<i>Sida atrovirens</i> <i>Sida calyxhymenia</i> <i>Sida excedentifolia</i> MALVACEAE sp.
Mimosaceae	<i>Acacia acuminata</i> <i>Acacia aneura</i> var. <i>aneura</i> <i>Acacia aneura</i> var. ? <i>argentea</i> <i>Acacia aneura</i> var. <i>argentea</i> <i>Acacia aneura</i> var. <i>microcarpa</i> <i>Acacia anthochaera</i> <i>Acacia assimilis</i> subsp. <i>assimilis</i> <i>Acacia aulacocarpa</i> <i>Acacia aulacophylla</i> <i>Acacia ayersiana</i> <i>Acacia coolgardiensis</i> subsp. <i>effusa</i>

Family	Species
Myoporaceae	<i>Acacia exocarpoides</i>
	<i>Acacia murrayana</i>
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>
	☞ <i>Acacia woodmaniorum</i> (DRF)
	<i>Acacia tetragonophylla</i>
	<i>Eremophila clarkei</i>
	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>
Myrtaceae	<i>Eremophila oldfieldii</i> subsp. <i>oldfieldii</i>
	<i>Eremophila</i> sp.
	<i>Aluta aspera</i> subsp. <i>hesperia</i>
	<i>Eucalyptus ewartiana</i>
	<i>Eucalyptus loxophleba</i> subsp. <i>supralaevis</i>
	<i>Melaleuca nematophylla</i>
	<i>Micromyrtus obovata</i>
Papilionaceae	☞ <i>Micromyrtus placoides</i> (P1)
	☞ <i>Micromyrtus trudgenii</i> (P3)
Phormiaceae	<i>Thryptomene decussata</i>
	<i>Gastrolobium laytonii</i>
Plantaginaceae	<i>Mirbelia bursarioides</i>
	<i>Dianella revoluta</i> var. <i>divaricata</i>
Poaceae	<i>Plantago debilis</i>
	<i>Austrodanthonia caespitosa</i>
Proteaceae	* <i>Pentaschistis airoides</i>
	* <i>Pentaschistis airoides</i> subsp. <i>airoides</i>
	<i>Grevillea extorris</i>
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>
	<i>Hakea invaginata</i>
	<i>Hakea recurva</i> subsp. <i>recurva</i>
	☞ <i>Persoonia pentasticha</i> (P3)
Rhamnaceae	<i>Cryptandra imbricata</i>
Rubiaceae	* <i>Galium spurium</i>
Rutaceae	<i>Drummondita microphylla</i>
	<i>Philotheca brucei</i> subsp. <i>brucei</i>
	<i>Philotheca deserti</i> subsp. <i>deserti</i>
	<i>Philotheca sericea</i>
Santalaceae	<i>Exocarpos aphyllus</i>
Sapindaceae	<i>Dodonaea inaequifolia</i>
	<i>Dodonaea pachyneura</i>
	<i>Dodonaea petiolaris</i>
	<i>Dodonaea viscosa</i> subsp. <i>spatulata</i>
Solanaceae	<i>Solanum ellipticum</i>
	<i>Solanum lasiophyllum</i>

Classification and nomenclature according to the Western Australian Herbarium (FloraBase, 2007),

Key: * = introduced species

☞ = flora of interest

Table C-3 List of flora species collected during the current Blue Hills (Mungada West) flora surveys.

Family	Species
Adiantaceae	<i>Cheilanthes adiantoides</i>
Amaranthaceae	<i>Ptilotus exaltatus</i> <i>Ptilotus obovatus</i> var. <i>obovatus</i>
Anthericaceae	<i>Thysanotus manglesianus</i>
Asteraceae	? <i>Waitzia</i> sp. <i>Olearia pimeleoides</i> <i>Rhodanthe</i> sp.
Caesalpiniaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i> <i>Senna artemisioides</i> subsp. x <i>artemisioides</i>
Chenopodiaceae	<i>Maireana tomentosa</i> subsp. <i>tomentosa</i> <i>Maireana trichoptera</i> <i>Maireana villosa</i> <i>Rhagodia ?drummondii</i> <i>Rhagodia</i> sp. <i>Sclerolaena fusiformis</i> <i>Sclerolaena uniflora</i>
Cupressaceae	<i>Callitris columellaris</i>
Dilleniaceae	<i>Hibbertia arcuata</i>
Droseraceae	<i>Drosera macrantha</i> subsp. <i>macrantha</i>
Euphorbiaceae	<i>Calycopeplus paucifolius</i>
Goodeniaceae	<i>Scaevola spinescens</i>
Lamiaceae	<i>Prostanthera magnifica</i> <i>Prostanthera patens</i>
Loranthaceae	<i>Amyema gibberula</i> <i>Amyema gibberula</i> var. <i>tatei</i> <i>Lysiana casuarinae</i>
Malvaceae	<i>Sida arenicola</i> <i>Sida atrovirens</i>
Mimosaceae	<i>Acacia ?coolgardiensis</i> subsp. <i>coolgardiensis</i> <i>Acacia acuminata</i> <i>Acacia aneura</i> var. <i>argentea</i> <i>Acacia aneura</i> var. <i>major</i> <i>Acacia anthochaera</i> <i>Acacia assimilis</i> subsp. <i>assimilis</i> <i>Acacia aulacophylla</i> <i>Acacia burkittii</i> <i>Acacia coolgardiensis</i> subsp. <i>effusa</i> <i>Acacia exocarpoides</i> <i>Acacia obtecta</i> <i>Acacia ramulosa</i> var. <i>linophylla</i> <i>Acacia ramulosa</i> var. <i>ramulosa</i> <i>Acacia sclerosperma</i> <i>Acacia tetragonophylla</i> ☞ <i>Acacia woodmaniorum</i> (DRF)
Myoporaceae	? <i>Eremophila ?decipiens</i> subsp. <i>decipiens</i> <i>Eremophila clarkei</i> <i>Eremophila exilifolia</i> <i>Eremophila georgei</i> <i>Eremophila latrobei</i> subsp. <i>latrobei</i>
Myrtaceae	<i>Aluta aspera</i> subsp. <i>hesperia</i> <i>Eucalyptus loxophleba</i> subsp. <i>supralaevis</i> <i>Melaleuca hamata</i>

Family	Species
	<i>Melaleuca leiocarpa</i>
	<i>Melaleuca nematophylla</i>
	☞ <i>Micromyrtus placoides</i> (P1)
	☞ <i>Micromyrtustrudgenii</i> (P3)
	<i>Thryptomene costata</i>
Orchidaceae	<i>Cyanicula amplexans</i>
Papilionaceae	<i>Mirbelia bursarioides</i>
Phormiaceae	<i>Dianella revoluta</i> var. <i>divaricata</i>
Pittosporaceae	<i>Pittosporum angustifolium</i>
Poaceae	<i>Austrostipa scabra</i>
	<i>Monachather paradoxus</i>
	POACEAE sp.
Polygalaceae	<i>Comesperma integerrimum</i>
Proteaceae	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>
	<i>Hakea recurva</i> subsp. <i>recurva</i>
	☞ <i>Persoonia pentasticha</i> (P3)
Rhamnaceae	<i>Cryptandra imbricata</i>
Rutaceae	<i>Drummondita microphylla</i>
	<i>Philotheca brucei</i> subsp. <i>brucei</i>
	<i>Philotheca deserti</i> subsp. <i>deserti</i>
	<i>Philotheca ?sericea</i>
	<i>Philotheca sericea</i>
Santalaceae	<i>Exocarpos aphyllus</i>
	<i>Santalum acuminatum</i>
	<i>Santalum lanceolatum</i>
Sapindaceae	<i>Dodonaea inaequifolia</i>
	<i>Dodonaea petiolaris</i>
Solanaceae	<i>Solanum ellipticum</i>
	<i>Solanum ?lasiophyllum</i>
	<i>Solanum lasiophyllum</i>
	<i>Solanum nummularium</i>

Classification and nomenclature according to the Western Australian Herbarium (FloraBase, 2007),

Key: * = introduced species

☞ = flora of interest

**Appendix D: Site Sheets Data for Koolanooka Hills and Blue Hills
Areas Surveyed**

Koolanooka Hills

693.00 Midwest Site 00 Koolanooka

Described CCS **Date** 25/07/2006 **Type:** Opportunistic collections

Location SE of old Koolanooka minesite near iron ore pit.

MGA Zone 50 422886 mE 6771141 mN

Habitat Ridge/Hilltop

Soil Red brown clayey loam

Rock Type mostly ferrous - laterite, some chert

Vegetation Allocasuarina acutivalvis subsp. prinsepiana / Acacia acuminata moderately dense tall shrubland over moderately dense medium shrubland including Acacia exocarpoides / Melaleuca fulgens subsp. fulgens / Daviesia hakeoides subsp. hakeoides and other shrubs over scattered herbs.

Vegetation Condition patchy, good condition

Fire None evident

Notes sparse leaf litter, plentiful wood litter widespread
Disturbance is moderately widespread - old drill pads and drill tracks

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	20 %	3 - 3.5
	Acacia assimilis subsp. assimilis	1 %	2 - 2.8
	Acacia exocarpoides	10 %	0.8 - 1.9
	Acacia nigripilosa subsp. nigripilosa	1 %	0.5 - 1.4
	Acacia sclerosperma subsp. sclerosperma	2 trees, 0.5 %	2.4 - 2.8
	Acacia tetragonophylla	1 %	1.4
	Allocasuarina acutivalvis subsp. prinsepiana	25 %	2 - 4.5
	Anthocercis anisantha subsp. anisantha	5 plants 0.5 %	0.4
	Asteraceae sp.	10 %	0.3 - 0.4
	Astroloma serratifolium	2	0.3 - 0.4
	Austrostipa elegantissima	3 plants 0.5 %	0.3
	Cheilanthes adiantoides	0.5 %	0.05
	Daviesia hakeoides subsp. hakeoides	5 %	0.9 - 1.4
	Dioscorea hastifolia	0.5 %	climber
	Dodonaea inaequifolia	1 %	1.8 - 2
	Eremophila oldfieldii subsp. oldfieldii	1 %	1.9 - 2.8
	Grevillea paradoxa	1 %	1.8 - 2.1
	Isoetes inflata	2 plants, 0.5 %	0.05
	Melaleuca fulgens subsp. fulgens	5 %	1.7 - 2.2
	Melaleuca nematophylla	5 %	2.1 - 2.7
	Ptilotus obovatus	4 plants, 0.5 %	0.3 - 0.4
	Rulingia luteiflora	1 plant	0.6
	Solanum ellipticum	0.5 %	0.1
	Solanum ellipticum	0.5 %	0.1
	Thysanotus patersonii	0.5 %	climber

739.00 Midwest Site 01 Koolanooka 2

Described CMC **Date** 26/09/2006 **Type:** Q 20m*20m

Location Ridge site above Koolanooka mine site.

MGA Zone 50 422833 **mE** 6771178 **mN**

Habitat Steep to moderate hill slope, moderate leaf litter, mainly under shrubs, sparse wood litter.

Soil Red-orange, sandy clay

Rock Type Ferrous

Vegetation Scattered *Allocasuarina acutivalvis* subsp. *prinsepiana*, over sparse *Calycopeplus paucifolius*, over open *Acacia sclerosperma* subsp. *sclerosperma*, over scattered *Dodonaea inaequifolia* shrubs.

Vegetation Condition Excellent

Fire none evident

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia acuminata</i>	N	1-2m
	<i>Acacia assimilis</i> subsp. <i>assimilis</i>	N	< 2m
	<i>Acacia exocarpoides</i>	N	1m
	<i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i>	3	<2m
	<i>Allocasuarina acutivalvis</i> subsp. <i>prinsepiana</i>	N	>2m
	<i>Aristida contorta</i>	N	0.2m
	<i>Astroloma serratifolium</i>	N	0.9m
	<i>Austrostipa elegantissima</i>	N	0.1 - 0.4m
	<i>Calycopeplus paucifolius</i>	2	<2m
	<i>Cheilanthes adiantoides</i>	N	0.1m
	<i>Dodonaea inaequifolia</i>	N	1-2m
	<i>Grevillea paradoxa</i>	1	1-2m
	<i>Maireana carnos</i>	N	0.1m
	<i>Melaleuca nematophylla</i>	N	<2m
	<i>Myriocephalus guerinae</i>	N	<0.1m
	<i>Rhagodia drummondii</i>	N	0.2m
	<i>Rhyncharrhena linearis</i>	N	creeper
	<i>Solanum ellipticum</i>	N	0.1m
	<i>Velleia hispida</i>	N	0.1m
	<i>Waitzia acuminata</i> var. <i>acuminata</i>	N	0.1m

739.00 Midwest Site 02 Koolanooka 2

Described CCS **Date** 26/09/2006 **Type:** Q 20m * 20m

Location ~ 50m south of old Koolanooka Iron Ore Mine Pit

MGA Zone 50 422889 **mE** 6771198 **mN**

Habitat Moderate upper hill slope to hill ridge. Moderate leaf litter, mainly under shrubs and moderate wood litter.

Soil Red-brown, fine sandy loam.

Rock Type Ferrous, laterite.

Vegetation Allocasuarina acutivalvis subsp. prinsepiana / Acacia acuminata open to moderately dense tall shrubland, over open to moderately dense Acacia tetragonophylla / Comesperma volubile / Melaleuca radula open medium shrubs.

Vegetation Condition Good - Old drill pad track near by, with some Vegetation pushed in.

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	? Senecio sp.	t	0.15
	Acacia acuminata	3	>2
	Acacia exocarpoides	1	1-2
	Acacia sclerosperma subsp. sclerosperma	2	0.5-1
	Acacia tetragonophylla	2	1-2
	Acetosa vesicaria	n	0.1
	Allocasuarina acutivalvis subsp. prinsepiana	3	>2
	Aristida contorta	n	0.2
	Astroloma serratifolium	1	<0.5
	Austrostipa elegantissima	n	0.4
	Cheilanthes adiantoides	n	0.1
	Comesperma volubile	2	1-2
	Dioscorea hastifolia	n	climber
	Dodonaea inaequifolia	2	0.5-1
	Goodenia ?berardiana	n	0.1
	Grevillea levis	1	<0.5
	Lawrencella rosea	n	0.1
	Maireana carnososa	n	<0.5
	Melaleuca radula	2	1-2
	Myriocephalus guerinae	n	0.1
	Ptilotus polystachyus var. polystachyus	n	0.1
	Rhodanthe battii	n	0.1
	Rulingia luteiflora	1	<0.5
	Sida atrovirens	1	<0.5
	Sonchus oleraceus	n	0.3
	Thysanotus manglesianus	n	climber
	Trachymene cyanopetala	n	0.05m
	Waitzia acuminata var. acuminata	n	0.1
	Dioscorea hastifolia	n	climber

Blue Hills

BLHL Mungada East Site Opportunistic Observations

Described CCS/CMC **Date** 26/07/2006 **Type:** O

Location Opportunistic collections. ~80m NE of entrance to old Blue hills iron ore pit

MGA Zone 50 488626 mE 6776397 mN

Habitat Rocky moderate hillslope with outcrops.

Soil Brown/red clayey loam

Rock Type ferrous, BIF

Vegetation Site 1 WP062-084: Melaleuca nematophylla / Dodonaea viscosa subsp. spatulata moderately dense tall shrubland, over Acacia woodmaniorum / Drummondita microphylla over herbs, ferns, mosses and lichens.

Site 2 pic 5596 WP004-009: Acacia ramulosa var. ramulosa open low woodland, over Acacia exocarpoides / Dodonaea viscosa subsp. spatulata / Micromyrtus sp. Warriedar (S. Patrick 1879A)=(P1) open medium shrubs.

Site 3 Breakaway slope pic 5601, WP016: Acacia aneura var. argentea open tall shrubland, over Acacia exocarpoides/Dodonaea viscosa subsp. spatulata/Micromyrtus sp. Warriedar (S. Patrick 1879A)=(P1) shrubs.

Site 4 pic 5602, Rocky ridge top/hill top WP017: Allocasuarina acutivalvis subsp. prinsepiana/Melaleuca nematophylla moderately dense tall shrubland, over Acacia exocarpoides / Drummondita microphylla open medium shrubs.

Veg Condition Pristine in patches, disturbed in other areas by clearing for tracks

Fire

Notes WP062-084 = GPS#3
WP001-018 = GPS#10

Species List:

Quad	Name	Cover	Height
	Acacia aneura var. aneura	0.5 %	3.5m
	Acacia assimilis subsp. assimilis	1 plant, 0.5 %	0.7
	Acacia ayersiana	30 %	1.1 - 2.7
	Acacia exocarpoides	5 %	1.2 - 1.7
	Acacia ramulosa var. ramulosa	20 %	2.5 - 3
	Acacia woodmaniorum	2 (5 %)	0.7-1m
	Allocasuarina acutivalvis subsp. prinsepiana	25 %	0.8 - 2.9
	Aluta aspera subsp. hesperia	1 %	1.6 - 1.9
	Calocephalus multiflorus	0.5 %	0.1
	Calotis sp.	1 %	0.05
	Calycopeplus paucifolius	2 %	2.5 - 3.5 tree
	Cheilanthes adiantoides	1 %	0.05
	Crassula extrorsa	0.5 %	0.2
	Dodonaea inaequifolia	1 %	1.2 - 1.6
	Dodonaea viscosa subsp. spatulata	15 %	2 - 2.5
	Dodonaea viscosa subsp. spatulata	10 %	0.4 - 1.8
	Drummondita microphylla	2 %	1.1 - 1.4
	Eremophila latrobei subsp. latrobei	1%	0.3
	Eremophila latrobei subsp. latrobei	1 %	1.5 - 1.8
	Eremophila oldfieldii subsp. oldfieldii	5	0.4 - 0.7
	Eucalyptus loxophleba subsp. supralaevis	1 %	3 - 6
	Hakea recurva subsp. recurva	1 plant	0.9
	Melaleuca nematophylla	15 %	1.5 - 2.6
	Melaleuca nematophylla	50 %	1.8 - 4.5
	Micromyrtus obovata	3 plants/0.5 %	1.9 - 2.4
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	5 %	1.5 - 2.4
	Mirbelia bursarioides	0.5 %	0.3 - 1.1
	Mirbelia bursarioides	1 %	1.6 - 1.8

Mirbelia bursarioides	1 plant	1.3
Pentaschistis airoides	0.5 %	0.1
Philotheca brucei subsp. brucei	2 %	1.8 - 2.1
Philotheca sericea	~3 plants/0.5 %	1.4 - 1.5
Philotheca sericea	5 %	0.8 - 1.2
Ptilotus obovatus	1 plant/0.5 %	0.3
Sida atrovirens	13 plants	0.1 - 0.3
Solanum ellipticum	0.5 %	0.1
Solanum lasiophyllum	0.5 %	0.3
Trichodesma zeylanicum	10 plants/0.5 %	0.1
Waitzia acuminata var. acuminata	5 %	0.3 - 0.4

BLHL Mungada East Site 01

Described CCS/CMC **Date** 26/07/2006 **Type:** Releve

Location ~80m NE of entrance to old Blue hills iron ore pit, adjacent to old Blue Hills Iron Ore Pit, ~60 km SE of Morowa

MGA Zone 50 488626 **mE** 6776397 **mN**

Habitat Rocky moderate hillslope with outcrops

Soil brownly red loamy clay

Rock Type Ferrous rock

Vegetation Site 1 WP062-084: Melaleuca nematophylla / Dodonaea viscosa subsp. spatulata moderately dense tall shrubland, over Acacia woodmaniorum / Drummondita microphylla over herbs, ferns, mosses and lichens.

Veg Condition Pristine in patches, disturbed in other areas by clearing for tracks

Fire No fire evident

Notes Photos on Conrad's Pentax (NOTE Drummondita aff. microphylla -new species ID was changed to Drummondita microphylla by CT 2006)

WP062-084 = GPS#3

WP001-018 = GPS#10

Species List:

Quad	Name	Cover	Height
	Acacia aneura var. microcarpa	1 (0.5%)	3.5m
	Acacia assimilis subsp. assimilis		
	Acacia woodmaniorum	2 (5 %)	0.7-1m
	Aluta aspera subsp. hesperia		
	Calocephalus multiflorus		
	Calycopeplus paucifolius		
	Cheilanthes adiantoides		
	Crassula extrorsa		
	Dodonaea viscosa subsp. spatulata		
	Drummondita microphylla	2%	1.1-1.4m
	Eremophila latrobei subsp. latrobei		
	Eremophila latrobei subsp. latrobei		
	Eremophila oldfieldii subsp. oldfieldii		
	Eucalyptus loxophleba		
	Hakea recurva subsp. recurva		
	Melaleuca nematophylla		
	Microcorys obovata		
	Mirbelia bursarioides		
	Philotheca brucei subsp. brucei		
	Philotheca sericea	0.5%	1.4-1.5
	Ptilotus obovatus		
	Sida calyxhymentia		
	Solanum ellipticum		
	Solanum lasiophyllum		
	Trichodesma zeylanicum		
	Waitzia acuminata var. acuminata		

BLHL Mungada East Site 02

Described CCS **Date** 26/07/2006 **Type:** Releve

Location Blue Hills near old Mungada East Iron Ore Pit, WP004-009

MGA Zone 50 488675 **mE** 6776344 **mN**

Habitat Stoney Hillslope

Soil

Rock Type

Vegetation Acacia ramulosa var. ramulosa open low woodland, over Acacia exocarpoides / Dodonaea viscosa subsp. spatulata / Micromyrtus sp. Warriedar (S. Patrick 1879A)=(P1) open medium shrubs.

Veg Condition

Fire

Notes WP003 - WP009

NOTE Drummondita aff. microphylla -new species ID was changed to Drummondita microphylla by CT 2006)

Species List:

Quad	Name	Cover	Height
	Acacia exocarpoides	2(5%)	1-2(1.2-1.7m)
	Acacia ramulosa var. ramulosa	3(20%)	2.5-3m
	Dodonaea viscosa subsp. spatulata	3(10%)	1-2(0.4-1.8m)
	Drummondita microphylla	2(2%)	<0.5m(0.2-0.25m)
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	(2)5%	>2m(1.5-2.4m)
	Mirbelia bursarioides	1(1%)	1-2(1.21.8m)
	Unknown (SIC Calotis hispidula)	1(1%)	herb0.05m

BLHL Mungada East Site 03

Described CCS **Date** 26/07/2006 **Type:** Revele

Location Blue Hills Mungada East mine pit

MGA Zone 50 488742 **mE** 6776290 **mN**

Habitat Breakaway Slope

Soil

Rock Type

Vegetation WP016: Acacia ayersiana open tall shrubland, over Acacia exocarpoides / Dodonaea viscosa subsp. spatulata / Micromyrtus sp. Warriedar (S. Patrick 1879A)=(P1)shrubs.

Veg Condition

Fire

Notes WP016

Species List:

Quad	Name	Cover	Height
	Acacia ayersiana	3(30%)	>2m(1.1-2.7m)
	Acacia exocarpoides	2(5%)	1-2(1.2-1.7m)
	Dodonaea viscosa subsp. spatulata	3(10%)	1-2(0.4-1.8m)
	Drummondita microphylla	2(2%)	<0.5m(0.2-0.25m)
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2 (5%)	>2m(1.5-2.4m)
	Mirbelia bursarioides	1(1%)	1-2(1.21.8m)

BLHL Mungada East Site 04

Described CCS **Date** 26/07/2006 **Type:** Releve

Location Old Blue Hills (Mungada East) Mine Pit

MGA Zone 50 488787 mE 6776312 mN

Habitat Rocky Ridge top/hilltop

Soil

Rock Type

Vegetation Site 4 pic 5602, Rocky ridge top/hill top WP017: Allocasuarina acutivalvis subsp. prinsepiana / Melaleuca nematophylla moderately dense tall shrubland, over Acacia exocarpoides (but patchy) / Drummondita microphylla open medium shrubs.

Veg Condition

Fire

Notes WP017, WP018

NOTE Drummondita aff. microphylla -new species ID was changed to Drummondita microphylla by CT 2006

Species List:

Quad	Name	Cover	Height
	Acacia exocarpoides	2(2%)	1-2m
	Allocasuarina acutivalvis subsp. prinsepiana	3(25%)	>2m
	Dodonaea inaequifolia	1(1%)	1-2m
	Drummondita microphylla	2%	1.1-1.4m
	Melaleuca nematophylla	3(15%)	>2m
	Mirbelia bursarioides	1(0.5%)	0.5-1m
	Philothea sericea	0.5%	1.4-1.5m
	Philothea sericea	2(5%)	0.5-1m

BLHL2 Mungada East Site Opportunistic Observations

Described CCS/CMC **Date** 27/09/2006 **Type:** O

Location Blue Hills Range, Mungada East

MGA Zone mE mN

Habitat

Soil

Rock Type

Vegetation

Vegetation Condition

Fire none evident

Notes

Species List:

Quad	Name	Cover	Height
	Echium plantagineum	3	0.2 m herb
	Hibbertia arcuata	1	< 0.5 m
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	3	1 - 2 m shrub
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	3 m shrub
	Persoonia pentasticha	n	0.5 m

BLHL2 Mungada East Site 01

Described CMC **Date** 27/09/2006 **Type: Q** 20m x 20m

Location Blue Hills Range, approx. 80m NE of entrance to old Blue Hills Iron Ore Pit and around 60km SE of Morawa.

MGA Zone 50 488623 mE 6776416 mN

Habitat Moderate hill slope, Sparse leaf litter, mainly under shrubs and sparse wood litter.

Soil Brown sandy clay

Rock Type Ferrous and BIF

Vegetation Melaleuca nematophylla / Dodonaea viscosa subsp. spatulata moderately dense tall shrubland, over Acacia woodmaniorum / Drummondita microphylla over herbs, ferns, mosses and lichens.

Vegetation Condition Excellent - Tracks outside quadrat, drill pads.

Fire None evident

Notes Acacia woodmaniorum =P2

Species List:

Quad	Name	Cover	Height
	Acacia assimilis subsp. assimilis	1	1 -2 m shrub
	Acacia woodmaniorum	2 (5%)	0.7-1m
	Arthropodium dyeri	N	0.3 m herb
	Austrodanthonia caespitosa	N	0.3m
	Crassula colorata var. acuminata	T	0.1 m herb
	Dodonaea viscosa subsp. spatulata	3	2-2.5m
	Drummondita microphylla	3	< 1 m
	Galium spurium	N	prostrate
	Goodenia ? berardiana	N	0.1 m herb
	Hakea recurva subsp. recurva	1	1 - 2 m tree
	Lawrencella rosea	N	0.1 m herb
	Melaleuca nematophylla	4	1.8-4.5m
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	3	1-2m, shrub
	Myriocephalus guerinae	N	0.1 m herb
	Pentaschistis airoides	T	0.2 m grass
	Philothea brucei subsp. brucei	N	1.1 m shrub
	Rhodanthe battii	N	< 0.5 m herb
	Sida atrovirens	N	0.1 m herb
	Waitzia acuminata var. acuminata	N	0.1 m herb
	Xanthosia bungei	2	0.15 m shrub
	Xanthosia bungei	N	0.25m shrub

BLHL2 Mungada East Site 02

Described CCS **Date** 27/09/2006 **Type: Q** 20m x 20m

Location Blue Hills Range. Hill slope South of Blue Hills Mungada Iron Ore Pit.

MGA Zone 50 488675 **mE** 6776343 **mN**

Habitat Moderate Hill slope, Moderate leaf litter, mainly under shrubs, moderate wood litter.

Soil Light brown fine sandy clay.

Rock Type Ferrous and BIF

Vegetation Melaleuca nematophylla / Acacia ramulosa var. ramulosa open low woodland, over Acacia exocarpoides / Dodonaea viscosa subsp. spatula / Micromyrtus sp. Warriedar (S. Patrick 1879A) (P1) open medium shrubs.

Vegetation Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia exocarpoides		
	Acacia ramulosa var. ramulosa	3	> 2 m tree
	Acacia tetragonophylla	1	0.5 - 1 m shrub
	Calotis hispidula	N	0.1 m herb
	Cheilanthes sieberi subsp. sieberi	n	< 0.1 m herb
	Eremophila latrobei subsp. latrobei	1	0.5 - 1 m shrub
	Goodenia ? berardiana	n	0.1m herb
	Goodenia berardiana	N	0.1m herb
	Hemigenia sp. Pindar (H. Demarz 7428)	n	< 0.3 m
	Melaleuca nematophylla	1	3 m shrub
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	1 - 2 m shrubs
	Mirbelia bursarioides	1	0.5-1 m
	Pentaschistis airoides subsp airoides	T	< 0.3 m grass
	Philothea sericea	1	0.5 - 1 m herb
	Plantago debilis	1	0.1 m herb
	Ptilotus obovatus var. obovatus	1	< 0.5 m
	Sida excedentifolia	n	0.3 m shrub
	Solanum ellipticum	2	0.1 m shrub
	Solanum lasiophyllum	1	0.3 m shrub
	Thryptomene decussata	2	1 - 2 m shrub
	Waitzia acuminata var. acuminata	n	0.1 m herb

BLHL2 Mungada East Site 03

Described CMC **Date** 27/09/2006 **Type: Q** 20m x 20 m

Location Blue Hills Range - Mungada. Breakaway slope, just short of Hill Crest.

MGA Zone 50 488749 **mE** 6776305 **mN**

Habitat Gentle top of Hill, elevation 446m. Moderate leaf litter, mainly under shrubs. Moderate wood

Soil Red-brown fine sandy clay

Rock Type Ferrous and BIF

Vegetation Acacia aneura var. argentea open tall shrubland, over Calycopeplus paucifolius / Micromyrtus sp. Warriedar (S. Patrick 1879A), over Philotheca sericea shrubs.

Vegetation Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia aneura var. argentea	3	< 5 m tree
	Acacia coolgardiensis subsp. effusa	n	< 5 m tree
	Acacia exocarpoides	n	< 1 m
	Allocasuarina acutivalvis subsp. prinsepiana	3	< 5 m tree
	Calycopeplus paucifolius	3	< 3 m shrub
	Crassula colorata var. acuminata	1	0.1 m herb
	Dodonaea petiolaris	n	< 0.5 m
	Eremophila latrobei subsp. latrobei	2	0.5 -1 m shrub
	Hakea invaginata	N	1.8m
	Hakea recurva subsp. recurva	n	2 m tree
	Hemigenia sp. Pindar (H. Demarz 7428)	n	< 0.5 m
	Melaleuca nematophylla	n	3 m shrub
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	1.7 m shrub
	Mirbelia bursarioides	n	< 0.5 m
	Philotheca brucei subsp. brucei	n	1.3 m shrub
	Philotheca sericea	3	< 0.5 m
	Ptilotus schwartzii	n	0.3 m
	Sida atrovirens	n	0.1 m
	Sida atrovirens	n	0.4 m shrub
	Solanum lasiophyllum	n	< 0.5 m

BLHL2 Mungada East Site 04

Described CCS **Date** 27/09/2006 **Type:** Q 20 m x 20 m
Season E

Location Blue Hills. Approx. 50 m east of the deepest part of old Mungada / Blue Hills Iron Ore Pit.

MGA Zone 50 488782 **mE** 6776313 **mN**

Habitat Moderate to gentle rocky ridge crest/hill crest.

Soil Brown, fine sandy loam, with a surface layer of humus, stones/boulders/rock outcrop

Rock Type Ferrous - Banded Iron Formation (BIF)

Vegetation Allocasuarina acutivalvis subsp. prinsepiana / Melaleuca nematophylla / Calycopeplus paucifolius moderately dense tall shrubland.

Vegetation Condition Good - Pristine in patches, some disturbance from dissection by cleared tracks.

Fire No fire history evident

Notes Moderate leaf litter, mainly under shrubs. Moderate wood litter

Species List:

Quad	Name	Cover	Height
	Acacia woodmaniorum	1	0.5 -1 m shrub
	Allocasuarina acutivalvis subsp. prinsepiana	3	>2m (3m)
	Calycopeplus paucifolius	2	>2m (2.5 m)
	Drummondita microphylla	1	0.5-1m shrub
	Eremophila latrobei subsp. latrobei	1	< 0.5 m shrub
	Gastrolobium laytonii	1	1 - 2 m tree
	Melaleuca nematophylla	3	>2m (3m)
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	2.5m Shrub
	Philotheca brucei subsp. brucei		< 0.5 m shrub
	Philotheca sericea	2	1 - 2 m shrub
	Rhyncharhena linearis	1	climber
	Xanthosia bungei	2	0.3m shrub

BLHL2 Mungada East Site 05

Described CCS & CMC **Date** 27/09/2006 **Type:** Vegetation description

Location Blue Hills Range. Rocky outcrop, south side of Mungada East pit.

MGA Zone 50 488765 **mE** 6776197 **mN**

Habitat Moderate hill slope.

Soil Brown clay.

Rock Type Ferrous laterite, Banded Iron Formation (BIF)

Vegetation Acacia ramulosa var. ramulosa / Calycopeplus paucifolius/ Dodonaea petiolaris open to moderately dense medium tall shrubland, over mixed shrubs.

Vegetation Condition Excellent - Nearby disturbance from drill pads.

Fire None evident

Notes Sparse leaf litter, mainly under shrubs. Sparse wood litter.

Species List:

Quad	Name	Cover	Height
	Acacia ramulosa var. ramulosa	3	<5m (3m)
	Acacia woodmaniorum	1	0.5-1m
	Calycopeplus paucifolius	3	>2m
	Dodonaea inaequifolia	2	1-2m
	Dodonaea petiolaris	3	>2m
	Eremophila sp.	2	1-2m
	Hemigenia sp. Pindar (H. Demarz 7428)	1	<0.5m
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	>2m(2m)
	Persoonia pentasticha	N	0.5m
	Ptilotus obovatus var. obovatus	2	<0.5m
	Solanum lasiophyllum	1	<0.5m

BLHL2 Mungada East Site 06

Described CCS & CMC **Date** 27/09/2006 **Type: Q** 20 m x 20 m

Location Blue Hills, Mungada East. West of Mungada pit, Blue Hills. Approx 60 km east of Morawa

MGA Zone 50 488562 **mE** 6776251 **mN**

Habitat Gentle hill slope. Sparse leaf litter, mainly under shrubs. Negligible wood litter.

Soil Brown, clay loam

Rock Type Ferrous & BIF

Vegetation Acacia ramulosa var. ramulosa / Acacia aulacophylla / Melaleuca nematophylla open medium shrubland, over Acacia exocarpoides.

Vegetation Condition Pristine - Tracks to mine site to the North

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia aulacophylla	3	1 - 2 m tree
	Acacia exocarpoides		
	Acacia ramulosa var. ramulosa		
	Dodonaea viscosa subsp. spatulata	1	Shrub
	Hemigenia sp. Yuna (A.C. Burns 95)	1	< 0.5 m
	Melaleuca nematophylla		
	Rhyncharrhena linearis	n	Climber
	Solanum lasiophyllum	n	< 0.5 m

BLHL2 Mungada East Site MEWD

Described CCS & CMC **Date** 28/02/2007 **Type:** Opportunistic Observations 14.5 ha

Location Mungada east proposed waste dump, Blue Hills

MGA Zone mE mN

Habitat

Soil

Rock Type

Vegetation Eucalyptus loxophleba woodland, over open mixed shrubs (MEWD03 WP0120 #19)

Vegetation Condition

Fire

Notes Mallee fowl gravel mound WP117 GPS#11 set2 Pentax 1207-1208
WPs of transect search WP104-WP123 GPS#11 set 2

Species List:

Quad	Name	Cover	Height
	Acacia anthochaera	N	>2m sh
	Astroloma serratifolium	N	0.2m sh
	Borya sphaerocephala	N	< 0.5m herb
	Eucalyptus ewartiana	N	
	Micromyrtus sp. Warriedar (S. Patrick 1879A)		>2m sh
	Persoonia pentasticha	N	0.6m sh
	Persoonia pentasticha	N	0.6m sh
	?Rhamnaceae	N	1-2m sh

BHW Mungada West Site 00

Described CCS/CMC **Date** 26/10/2006 **Type:** Opportunistic Observations

Location Opportunistic collections, various areas surrounding Mungada old iron ore pit, ~ 70 km East of Morowa and ~30 km south of Yalgoo.

MGA Zone mE mN

Habitat

Soil

Rock Type

Vegetation

Vegetation Condition

Fire none evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia anthochaera	1	1-2m
	Callitris columellaris	3	<5m(2m)

BHW Mungada West Site 01

Described CMC **Date** 26/10/2006 **Type: Q** 20m x 20m

Location About 100m SE of old waste rock dumps of the Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 486964 mE 6776238 mN

Habitat Gentle undulating plain

Soil Red-orange clay, with a common surface layer of fine gravel.

Rock Type Non-banded ferrous rock/gravel

Vegetation Acacia ramulosa var. ramulosa / Melaleuca leiocarpa / Exocarpos aphyllus sparse tall shrubland, over Hakea recurva subsp. recurva scattered low shrubs, over sparse ?Waitzia sp. and Ptilotus obovatus var. obovatus shrubs/herbs.

Vegetation Condition Excellent (minimal disturbance)

Fire No fire history evident

Notes Sparse leaf litter, mainly under shrubs. Moderate wood litter.

Species List:

Quad	Name	Cover	Height
	Acacia ? coolgardiensis subsp. coolgardiensis	N	>2m
	Acacia ramulosa var. ramulosa	2	>2m
	Acacia tetragonophylla	N	>2m
	Dianella revoluta var. divaricata	N	herb/lily
	Exocarpos aphyllus	N	>2m
	Hakea recurva subsp. recurva	2	<5m(0.5m)
	Melaleuca leiocarpa	N	>2m
	Monachather paradoxus	N	grass0.5m
	Persoonia pentasticha	N	<0.5 m
	Poaceae sp.	N	grass0.2m
	Ptilotus obovatus var. obovatus	N	<0.5m,herb
	Sida atrovirens	N	<0.5m, herb
	?Waitzia sp.	1	herb

BHW Mungada West Site 02

Described CCS **Date** 26/10/2006 **Type: Q** 20m x 20m

Location Just below SE edge of waste rock dumps from Mungada West (Blue Hills) Iron Ore mine pit, Lease M59/595. ~70 km East of Morowa

MGA Zone 50 486831 **mE** 6776320 **mN**

Habitat Gentle undulating plain

Soil Red-orange clay-loam with a surface layer of loose Soil and surface crust, with few patches of coarse gravel/pebble.

Rock Type Nil Bedrock, Banded Iron Formation (BIF) gravel only

Vegetation Eucalyptus loxophleba subsp. supralaevis open medium woodland, over Acacia obtecta sparse tall shrubs, over Ptilotus obovatus var. obovatus dwarf shrubs.

Vegetation Condition Good (limited disturbance by water and sediment runoff from waste rock dumps)

Fire No fire history evident

Notes Moderate leaf litter, mainly under shrubs and trees. Moderate wood litter.

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	1	1-2m
	Acacia exocarpoides	2	1-2m
	Acacia obtecta	2	>2m (2.5m)
	Acacia tetragonophylla	1	0.5-1m
	Austrostipa ?elegantissima	N	grass 0.3m
	?Eremophila ?decipiens subsp. decipiens	1	0.5-1m
	Eucalyptus loxophleba subsp. supralaevis	3	5-15m
	Exocarpos aphyllus	1	1-2m
	Maireana tomentosa subsp. tomentosa	1	<0.5m
	Pittosporum angustifolium	1	0.5-1m
	Ptilotus obovatus var. obovatus	2	<0.5m
	Scaevola spinescens	1	0.5-1m
	Sclerolaena uniflora	1	<0.5m
	Senna artemisioides subsp. filifolia	2	<0.5m

BHW Mungada West Site 03

Described CMC **Date** 27/10/2006 **Type: Q** 20m x 20m

Location About 50m W of top of the old Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 486533 **mE** 6776351 **mN**

Habitat Moderate hill slope, with rocky outcropping

Soil Red-orange clay loam with a continuous surface layer of stones/boulders and surface level plates (outcrop) and boulders.

Rock Type Non-Banded Ferrous

Vegetation Scattered *Acacia ramulosa* var. *ramulosa* and open *Micromyrtus* sp. *Warriedar* (S. Patrick 1879A) tall shrubland, over sparse *Melaleuca nematophylla*, over open *Philotheca brucei* subsp. *brucei* / *Philotheca* ?*sericea*, over sparse *Eremophila latrobei* subsp. *latrobei* dwarf shrubs.

Vegetation Condition Excellent (minimal disturbance from nearby tracks)

Fire No fire history evident

Notes Sparse leaf litter, mainly under shrubs. Sparse wood litter.

Species List:

Quad	Name	Cover	Height
	<i>Acacia assimilis</i> subsp. <i>assimilis</i>	N	>2m (3m)
	<i>Acacia exocarpoides</i>	N	<0.5m
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>	1	>2m
	<i>Dodonaea inaequifolia</i>	N	<0.5m
	<i>Eremophila clarkei</i>	N	0.5-1m
	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	2	<0.5m
	<i>Melaleuca nematophylla</i>	2	1-2m
	<i>Micromyrtus</i> sp. <i>Warriedar</i> (S. Patrick 1879A)	3	>2m
	<i>Philotheca</i> ? <i>sericea</i>	2	0.5-1m
	<i>Philotheca brucei</i> subsp. <i>brucei</i>	2	0.5-1m
	<i>Ptilotus obovatus</i> var. <i>obovatus</i>	N	<0.5m
	<i>Sida atrovirens</i>	N	<0.5m (0.3m)

BHW Mungada West Site 04

Described CCS **Date** 27/10/2006 **Type: Q** 20m x 20m

Location At SW edge of top of the old Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 486582 mE 6776350 mN

Habitat Steep hill crest to rocky outcrop

Soil Red orange clay-loam, with a continuous surface layer of stones/boulders and coarse gravel pebbles.

Rock Type Banded Iron Formation (BIF)

Vegetation Acacia ramulosa var. ramulosa /Acacia aulacophylla / Acacia acuminata open medium shrubland, over Philotheca ?sericea and other open low shrubs.

Vegetation Condition Good (limited disturbance by nearby tracks, and grazing by hard hoofed animals-goats)

Fire No fire history evident

Notes Sparse leaf litter mainly under shrubs. Moderate wood litter.

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	2	1-2m
	Acacia aulacophylla	2	1-2m
	Acacia exocarpoides	1	1-2m
	Acacia ramulosa var. ramulosa	2	1-2m
	Acacia tetragonophylla	2	1-2m
	Austrostipa ?elegantissima	1	grass0.5m
	Dodonaea inaequifolia	1	0.5-1m
	Eremophila latrobei subsp. latrobei	2	<0.5-1m
	Hakea recurva subsp. recurva	1	1-2m
	Maireana tomentosa subsp. tomentosa	2	<0.5m (0.3m)
	Maireana trichoptera	1	<0.5m (0.15m)
	Melaleuca nematophylla	1	1-2m
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	1-2m
	Olearia pimeleoides	1	0.5-1m
	Philotheca ?sericea	3	0.5-1m
	Philotheca brucei subsp. brucei	1	0.5-1m
	Prostanthera patens	1	<0.5 (0.25m)
	Ptilotus obovatus var. obovatus	1	<0.5m
	Rhagodia ?drummondii	1	<0.5 (0.35m)
	Santalum acuminatum	1	<5m (2.5m)
	Scaevola spinescens	1	0.5-1m
	Sclerolaena fusiformis	1	<0.5m (0.05m)
	Sida atrovirens	1	<0.5m (0.4m)
	Solanum ?lasiophyllum	1	<0.5m
	Solanum nummularium	1	<0.5m

BHW Mungada West Site 05

Described CMC **Date** 27/10/2006 **Type: Q** 20m x 20m

Location About 80m W of top of the old Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 486502 **mE** 6776313 **mN**

Habitat Moderate hill slope

Soil Red-orange clay loam, with a surface layer of humus, and continuous coarse gravel/pebbles and stones/boulders.

Rock Type Non-banded ferrous (should be Banded Iron Formation - BIF [CS])

Vegetation Scattered *Acacia aneura* var. *major* / *Acacia ramulosa* var. *ramulosa* tall shrubs, over open *Melaleuca nematophylla* / *Acacia ramulosa* var. *ramulosa* medium shrubland, over *Philotheca ?sericea* / *Acacia ?coolgardiensis* subsp. *coolgardiensis* open low shrubs and sparse *Philotheca brucei* subsp. *brucei* dwarf shrubs.

Vegetation Condition Excellent (minimal disturbance by goat grazing)

Fire No fire history evident

Notes Moderate leaf litter, mainly under shrubs. Moderate wood litter.

Species List:

Quad	Name	Cover	Height
	<i>Acacia ? coolgardiensis</i> subsp. <i>coolgardiensis</i>	1	>2m (3m)
	<i>Acacia aneura</i> var. <i>major</i>	N	<5m
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>	2	>2m
	<i>Dodonaea inaequifolia</i>	N	0.5-1m
	<i>Hibbertia arcuata</i>	N	<0.5m
	<i>Melaleuca nematophylla</i>	2	>2m
	<i>Micromyrtus</i> sp. <i>Warriedar</i> (S. Patrick 1879A)	N	1-2m
	<i>Philotheca ? sericea</i>	3	1-2m
	<i>Philotheca brucei</i> subsp. <i>brucei</i>	2	0.5-1m
	<i>Solanum ellipticum</i>	N	<0.5m (0.2m)

BHW Mungada West Site 06

Described CCS **Date** 27/10/2006 **Type: Q** 20m x 20m

Location About 30m S of top of the old Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 486542 **mE** 6776333 **mN**

Habitat Hillcrest, to moderate upper hill slope

Soil Pale orange to grey clay laom, with a continuous layer of stones/boulders, coarse gravel/pebbles and some outcropping rock.

Rock Type Banded Iron Formation (BIF) and mudstone/shale

Vegetation Melaleuca nematophylla /Acacia assimilis subsp. assimilis moderately dense tall shrubland, over other mixed shrubs.

Vegetation Condition Good (limited disturbance by some nearby vehicle tracks and grazing by hard hoofed animals - goats).

Fire No fire history evident

Notes Moderate leaf litter, mainly under shrubs. Moderate wood litter.

Species List:

Quad	Name	Cover	Height
	Acacia assimilis subsp. assimilis	2	>2m
	Acacia exocarpoides	1	0.5-1m
	Acacia ramulosa var. ramulosa	1	1-2m
	Dodonaea inaequifolia	2	1-2m
	Eremophila clarkei	1	1-2m
	Eremophila latrobei subsp. latrobei	2	1-2m
	Hibbertia arcuata	1	0.5-
	Melaleuca nematophylla	3	>2m
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	1-2m
	Philotheca ? sericea	2	0.5-1m
	Philotheca brucei subsp. brucei	2	1-2m
	Solanum nummularium	1	0.5-1m

BHW Mungada West Site 07

Described CMC **Date** 27/10/2006 **Type: Q** 20m x 20m

Location About 80m NW of the old Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 486683 mE 6776542 mN

Habitat Gentle undulating plain

Soil Red-orange clay loam with a continuous surface layer of stones and surface level plates (outcropping rock)

Rock Type Banded Iron Formation (BIF) and some non-banded ferrous rock

Vegetation Open Acacia ramulosa var. ramulosa / Acacia burkittii and scattered Hakea recurva subsp. recurva tall shrubland, over scattered Melaleuca nematophylla / Acacia tetragonophylla medium shrubs, over sparse Hibbertia arcuata / Philotheca brucei subsp. brucei / Dodonaea inaequifolia dwarf shrubs.

Vegetation Condition Good (limited disturbance by grazing from hard hoofed animals (goats).

Fire No fire history evident

Notes Negligible leaf litter, mainly under shrubs. Plentiful wood litter. Boundary Waypoints WP022, 23, 24, 25

Species List:

Quad	Name	Cover	Height
	?Waitzia sp.	T	Herb
	Acacia burkittii	2	>2m
	Acacia ramulosa var. ramulosa	3	>2m
	Acacia tetragonophylla	N	1-2m
	Amyema gibberula	N	hemi parasite
	Calycopeplus paucifolius	1	1-2m (1.6m)
	Dianella revoluta var. divaricata	N	<0.5m flax lily
	Dodonaea inaequifolia	2	<0.5m
	Eremophila latrobei subsp. latrobei	N	0.5-1m
	Eucalyptus loxophleba subsp. supralaevis	N	5-15m (10m)
	Exocarpos aphyllus	1	1-2m
	Hakea recurva subsp. recurva	N	>2m
	Hibbertia arcuata	2	1-2m
	Melaleuca nematophylla	N	1-2m
	Mirbelia bursarioides	2	1-2m (1.5m)
	Philotheca ?sericea	2	0.5-1m
	Philotheca brucei subsp. brucei	N	<0.5m
	Poaceae sp.	N	grass 0.2m

BHW Mungada West Site 08

Described CCS **Date** 27/10/2006 **Type: Q** 20m x 20m

Location About 300m ENE of the old Mungada West (Blue Hills) Iron Ore Mine Pit. Lease M59/595. ~70km east of Morowa.

MGA Zone 50 487123 **mE** 6776435 **mN**

Habitat Gentle plain/flat to undulating plain

Soil Red-orange loamy clay, with a surface layer of few patches of fine gravel, with more surface crust and loose Soil.

Rock Type Nil Bedrock, Ferrous gravel.

Vegetation Eucalyptus loxophleba subsp. supralaevis open medium woodland, over Acacia assimilis subsp. assimilis and other Acacia spp. sparse tall shrubs, over Ptilotus obovatus var. obovatus and Maireana spp. sparse dwarf shrubs.

Vegetation Condition Excellent (minimal disturbance by some old vehicle tracks).

Fire No fire history evident

Notes Moderate leaf litter, mainly under shrubs and trees. Moderate wood litter.

Species List:

Quad	Name	Cover	Height
	Acacia assimilis subsp. assimilis	2	>2m
	Acacia ramulosa var. ramulosa	2	>2m
	Acacia tetragonophylla	1	1-2m
	Austrostipa scabra	1	grass 0.3m
	Eucalyptus loxophleba subsp. supralaevis	3	5-15m
	Exocarpos aphyllus	1	1-2m
	Hakea recurva subsp. recurva	1	<0.5m
	Maireana tomentosa subsp. tomentosa	1	<0.5m
	Maireana trichoptera	1	<0.5m (0.25m)
	Olearia pimeleoides	1	<0.5m (0.45m)
	Ptilotus exaltatus	N	herb 0.5m
	Ptilotus obovatus var. obovatus	2	<0.5m
	Rhagodia ?drummondii	1	<0.5m (0.35m)
	Sclerolaena fusiformis	2	<0.5m (0.15m)
	Senna artemisioides subsp. filifolia	1	<0.5m

BHW Mungada West Site MWWD

Described CCS/CMC **Date** 28/02/2007 **Type:** Opportunistic Observations 8.3 ha

Location Mungada west proposed waste dump - full notes see site sheets

MGA Zone mE mN

Habitat

Soil

Rock Type

Vegetation for MWWD01: *Persoonia pentasticha* (P3) veg = *Acacia ramulosa*/*Melaleuca nematophylla*
open tall shrubland (Pentax 1191)

Vegetation Condition

Fire none evident

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia obtecta</i>	N	2.5m shrub
	<i>Amyema gibberula</i> var. <i>tatei</i>	N	aerial parasite
	Micromyrtus sp. Warriedar (S. Patrick 1879A)		>2m shrub
	Micromyrtus sp. Warriedar (S. Patrick 1879A)		
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	N	
	Persoonia pentasticha	N	< 0.5m shrub
	Persoonia pentasticha	N	< 0.5m shrub

MUNG East & West

Site Opp Coll

Described CMC/MH

Date June 2007

Type: Opportunistic Observations

Location Blue Hills

MGA Zone

mE

mN

Habitat

Soil

Rock Type

Vegetation

Veg Condition

Fire

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	2	> 2.0 m SH
	Acacia obtecta	n	1.0 - 2.0 m SH
	Acacia woodmaniorum		3 plants
	Alyxia buxifolia	n	1.0 - 2.0 m SH
	Callitris columellaris		
	Calycopeplus paucifolius		
	Cryptandra imbricata	n	1.5 m SH
	Cryptandra imbricata	n	1.0 - 2.0 m SH
	Dianella revoluta var. divaricata		se
	Dodonaea inaequifolia		
	Dodonaea petiolaris	n	0.5 - 1.0 m SH
	Drosera macrantha subsp. macrantha	n	herb
	Exocarpos aphyllus	n	< 5.0 m T
	Grevillea extorris	n	1.0 - 2.0 m SH
	Hibbertia arcuata	n	1-2m
	Lepidosperma costale	2	< 0.5 m SE
	Lysiana casuarinae		
	MALVACEAE sp.	n	0.1 m H
	Melaleuca leiocharpa	2	> 2.0 m SH
	Micromyrtus placoides	n	< 0.5 m SH
	Micromyrtus placoides	n	0.5 - 1.0 m SH
	Micromyrtus placoides	5	
	Mirbelia bursarioides	2	1.0 - 2.0 m SH
	Persoonia pentasticha	n	< 0.5 m SH
	Persoonia pentasticha	n	< 0.5 m SH
	Philothea deserti subsp. deserti		
	Philothea deserti subsp. deserti		
	Scaevola spicigera	n	0.5 - 1.0 m SH
	Senna charlesiana	n	2m SH
	Thryptomene costata	2	0.5 - 1.0 m SH

MUNG East **Site** **QE01**

Described **MH** **Date** 16/06/2007 **Type: Q** 20m x 20m

Location Mungada East

MGA Zone 50 488445 **mE** 6776446 **mN**

Habitat Midslope

Soil Red-orange sandy-clay

Rock Type Many BIF and ferrous rocks

Vegetation MD Acacia ramulosa var. ramulosa low trees, over MD Grevillea obliquistigma subsp. obliquistigma high shrubs, over sparse mixed low shrubs, dominated by Ptilotus obovatus var. obovatus.

Veg Condition Poor - old waste dump area, lots of dead plants

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia exocarpoides	n	1.0 - 2.0 m SH
	Acacia murrayana	n	1.0 - 2.0 m SH
	Acacia ramulosa var. ramulosa	4	< 5.0 m T
	Acacia tetragonophylla	n	> 2.0 m SH
	Eucalyptus loxophleba subsp. supralaevis	n	< 5.0 m T
	Grevillea obliquistigma subsp. obliquistigma	n	> 2.0 m SH
	Grevillea obliquistigma subsp. obliquistigma	4	> 2.0 m SH
	Melaleuca leiocarpa	n	> 2.0 m SH
	Philotheca brucei subsp. brucei	n	0.5 - 1.0 m SH
	Ptilotus obovatus var. obovatus	2	< 0.5 m SH
	Solanum lasiophyllum	n	0.5 - 1.0 m SH

MUNG East Site QE02

Described CMC **Date** 16/06/2007 **Type: Q** 20m x 20m

Location

MGA Zone 50 488683 **mE** 6776532 **mN**

Habitat Ridgetop

Soil Fine light-brown, sandy-clay

Rock Type Continuous BIFrocks

Vegetation Open Acacia aneura var. argentea / Melaleuca nematophylla low trees, over open mixed high shrubs of Micromyrtus sp. Warriedar (S. Patrick 1879A) / Eremophila latrobei subsp. latrobei / Calycopeplus paucifolius, over open Drummondita microphylla medium shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia aneura var. argentea	n	< 5.0 m T
	Acacia aneura var. argentea	2	> 5.0 m T
	Acacia assimilis subsp. assimilis	n	< 5.0 m T
	Acacia ramulosa var. linophylla	n	< 5.0 m T
	Allocastrum acutivalvis subsp. prinsepiana	n	< 5.0 m T
	Calycopeplus paucifolius	2	> 2.0 m SH
	Drummondita microphylla	3	0.5 - 1.0 m SH
	Eremophila clarkei	n	0.5 - 1.0 m SH
	Eremophila clarkei	n	1.0 - 2.0 m SH
	Eremophila latrobei subsp. latrobei	2	> 2.0 m SH
	Hakea invaginata	n	< 5.0 m T
	Hakea recurva subsp. recurva	n	> 2.0 m SH
	Hemigenia sp. Cue (K.F. Kenneally 47A)	2	< 0.5 m SH
	Hibbertia arcuata	n	0.5 - 1.0 m SH
	Melaleuca nematophylla	n	< 5.0 m T
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	> 2.0 m SH
	Mirbelia bursarioides	n	0.5 - 1.0 m SH
	Xanthosia bungei	n	< 0.5 m SH

MUNG East **Site** **QE03**

Described **MH** **Date** 16/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488837 **mE** 6776532 **mN**

Habitat Midslope, close to the ridgetop

Soil Red-orange, sandy-clay

Rock Type Continuous BIF and ferrous rocks

Vegetation Scattered outcropping *Acacia ramulosa* var. *linophylla* / *Acacia aneura* var. *argentea* low trees, over dense *Aluta aspera* subsp. *hesperia* medium shrubs, over MD *Hemigenia* sp. Cue (K.F. Kenneally 47A) low shrubs.

Veg Condition Good

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia aneura</i> var. <i>argentea</i>	2	< 5.0 m T
	<i>Acacia aulacocarpa</i>	1	< 2.0 m SH
	<i>Acacia ramulosa</i> var. <i>linophylla</i>	2	< 5.0 m T
	<i>Aluta aspera</i> subsp. <i>hesperia</i>	5	0.5 - 1.0 m SH
	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	n	1.0 - 2.0 m SH
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>	n	< 2.0 m SH
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>	n	< 2.0 m SH
	<i>Hemigenia</i> sp. Cue (K.F. Kenneally 47A)	4	< 0.5 m SH
	<i>Micromyrtus</i> sp. Warriedar (S. Patrick 1879A)	n	1.0 - 2.0 m SH
	<i>Philotheca sericea</i>	3	0.5 - 1.0 m

MUNG East **Site** QE04

Described MH **Date** 16/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488287 **mE** 6776180 **mN**

Habitat Footslope

Soil Red-orange, sandy-clay

Rock Type Many ferrous and granite

Vegetation MD Eucalyptus loxophleba subsp. supralaevis medium trees, over open Acacia ramulosa var. ramulosa high shrubs, over MD Dodonaea inaequifolia medium shrubs, over open mixed low shrubs, dominated by Dodonaea inaequifolia.

Veg Condition Poor - tracks and drain into site

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	1	> 2.0 m SH
	Acacia exocarpoides	n	0.5 - 1.0 m SH
	Acacia murrayana	n	0.5 - 1.0 m SH
	Acacia ramulosa var. ramulosa	3	< 5.0 m T
	Acacia tetragonophylla	n	> 2.0 m SH
	Dodonaea inaequifolia	4	0.5 - 1.0 m SH
	Dodonaea pachyneura	n	0.5 - 1.0 m SH
	Eucalyptus loxophleba subsp. supralaevis	4	5 - 15 m T
	Grevillea obliquistigma subsp. obliquistigma	1	> 2.0 m SH
	Grevillea obliquistigma subsp. obliquistigma	1	> 2.0 m SH
	Philotheca brucei subsp. brucei	n	0.5 - 1.0 m SH
	Ptilotus obovatus var. obovatus	n	< 0.5 m SH
	Scaevola spinescens	n	0.5 - 1.0 m SH
	Senna artemisioides subsp. x artemisioides	n	> 2.0 m SH
	Solanum ellipticum	n	< 0.5 m SH
	Solanum lasiophyllum	n	< 0.5 m SH

MUNG East Site QE05

Described MH **Date** 16/06/2007 **Type:** Q 20m x 20m

Location

MGA Zone 50 488387 mE 6776159 mN

Habitat Midslope

Soil Red-orange, sandy-clay

Rock Type Continuous granite and ferrous

Vegetation Sparse Acacia ramulosa var. linophylla low trees, over open Acacia ramulosa var. linophylla high shrubs, over open Philotheca sericea low to medium shrubs.

Veg Condition Good - near track, lots of dust

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia ramulosa var. linophylla	2	< 5.0 m T
	Acacia ramulosa var. ramulosa	3	> 2.0 m SH
	Dodonaea pachyneura	n	0.5 - 1.0 m SH
	Eremophila clarkei	n	1.0 - 2.0 m SH
	Eremophila latrobei subsp. latrobei	2	0.5 - 1.0 m SH
	Eucalyptus ewartiana	n	< 5.0 m T
	Grevillea obliquistigma subsp. obliquistigma	1	> 2.0 m SH
	Hibbertia arcuata	n	1.0 - 2.0 m SH
	Melaleuca nematophylla	n	> 2.0 m SH
	Mirbelia bursarioides	n	0.5 - 1.0 m SH
	Philotheca brucei subsp. brucei	n	1.0 - 2.0 m SH
	Philotheca sericea	3	1.0 - 2.0 m SH
	Prostanthera patens	n	< 0.5 m SH

MUNG East **Site** **QE06**

Described **MH** **Date** 26/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488498 **mE** 6776237 **mN**

Habitat Midslope

Soil Red-orange, sandy-clay

Rock Type Continuous BIF and ferrous rocks

Vegetation MD mixed medium shrubs dominated by *Acacia ramulosa* var. *ramulosa* / *Grevillea obliquistigma* subsp. *obliquistigma*, over sparse *Aluta aspera* subsp. *hesperia* low shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia acuminata</i>	2	1.0 - 2.0 m SH
	<i>Acacia aulacocarpa</i>	2	1.0 - 2.0 m SH
	<i>Acacia murrayana</i>	n	> 2.0 m SH
	<i>Acacia ramulosa</i> var. <i>linophylla</i>	2	1.0 - 2.0 m SH
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>	4	1.0 - 2.0 m SH
	<i>Aluta aspera</i> subsp. <i>hesperia</i>	2	0.5 - 1.0 m SH
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>	2	1.0 - 2.0 m SH
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>	4	1.0 - 2.0 m SH

MUNG East **Site** **QE07**

Described **MH** **Date** 16/06/200 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488436 **mE** 6776056 **mN**

Habitat Midslope

Soil Red-orange, sandy-clay

Rock Type Continuous BIF and ferrous rocks

Vegetation MD Acacia aulacocarpa tall shrubs, over MD mixed medium shrubs dominated by *Philotheca brucei* subsp. *brucei*, over open mixed low shrubs dominated by *Philotheca brucei* subsp. *brucei* / *Philotheca sericea*.

Veg Condition

Fire

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia aulacocarpa</i>	4	> 2.0 m SH
	<i>Acacia tetragonophylla</i>	2	1.0 - 2.0 m SH
	<i>Astroloma serratifolium</i>	n	< 0.5 m SH
	<i>Dodonaea inaequifolia</i>	2	1.0 - 2.0 m SH
	<i>Eremophila clarkei</i>	2	1.0 - 2.0 m SH
	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	1	0.5 - 1.0 m SH
	<i>Hakea recurva</i> subsp. <i>recurva</i>	n	1.0 - 2.0 m SH
	<i>Persoonia pentasticha</i>	n	< 0.5 m SH
	<i>Philotheca brucei</i> subsp. <i>brucei</i>	4	1.0 - 2.0 m SH
	<i>Philotheca sericea</i>	3	0.5 - 1.0 m SH
	<i>Ptilotus obovatus</i> var. <i>obovatus</i>	n	< 0.5 m SH

MUNG East **Site** **QE08**

Described CMC **Date** 16/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488577 **mE** 6776065 **mN**

Habitat Footslope

Soil Orange-brown, sandy-clay

Rock Type Many ferrous rocks

Vegetation Open Acacia ramulosa var. linophylla / Calycopeplus paucifolius low trees, to high shrubs, over sparse Drummondita microphylla medium shrubs, over sparse herbs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia assimilis subsp. assimilis	n	> 2.0 m SH
	Acacia ramulosa var. linophylla	3	< 5.0 m T
	Acacia ramulosa var. ramulosa	n	< 5.0 m T
	Calycopeplus paucifolius	3	< 5.0 m T
	Drummondita microphylla	2	1.0 - 2.0 m SH
	Eremophila clarkei	n	1.0 - 2.0 m SH

MUNG East **Site** **QE09**

Described **CMC** **Date** 16/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488745 **mE** 6776081 **mN**

Habitat Midslope

Soil Orange-brown, sandy-clay

Rock Type Continuous BIF and ferrous

Vegetation Sparse Acacia ramulosa var. linophylla / Acacia ramulosa var. ramulosa low trees, over MD
Calycopeplus paucifolius high shrubs, over sparse herbs.

Veg Condition Excellent

Fire none evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia ramulosa var. linophylla	2	< 5.0 m T
	Acacia ramulosa var. ramulosa	2	< 5.0 m T
	Calycopeplus paucifolius	4	> 2.0 m SH
	Dodonaea inaequifolia	n	> 2.0 m SH
	Drummondita microphylla	2	> 2.0 m SH
	Mirbelia bursarioides	n	1.0 - 2.0 m SH
	Philotheca brucei subsp. brucei	n	1.0 - 2.0 m SH

MUNG East **Site** QE10

Described CMC **Date** 16/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488452 **mE** 6775954 **mN**

Habitat Footslope

Soil Orange-brown, sandy-clay

Rock Type Common BIF

Vegetation Sparse Eucalyptus ewartiana low mallee trees, with open Acacia ramulosa var. ramulosa/
Acacia ramulosa var. linophylla high shrubs, over scattered Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia ramulosa var. linophylla	3	< 5.0 m T
	Acacia ramulosa var. ramulosa	3	< 5.0 m T
	Eucalyptus ewartiana	3	3-5m mallee
	Philotheca brucei subsp. brucei	n	1.0 - 2.0 m SH
	Ptilotus obovatus var. obovatus	n	< 0.5 m SH
	Solanum lasiophyllum	n	0.5 - 1.0 m SH

MUNG East Site QE11

Described CMC **Date** 16/06/2007 **Type:** Q 20m x 20m
Seaso

Location

MGA Zone 50 488651 **mE** 6775864 **mN**

Habitat Undulating plain

Soil Orange-brown, sandy-clay

Rock Type Continuous ferrous

Vegetation Scattered *Acacia aneura* var. ?*argentea* medium trees, over open *Acacia ramulosa* var. *linophylla* / *Grevillea obliquistigma* subsp. *obliquistigma* low trees, over sparse *Calycopeplus paucifolius* high shrubs, over open *Aluta aspera* subsp. *hesperia* medium shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia aneura</i> var. ? <i>argentea</i>	n	> 5.0 m T
	<i>Acacia ramulosa</i> var. <i>linophylla</i>	n	> 2.0 m SH
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>	3	< 5.0 m T
	<i>Aluta aspera</i> subsp. <i>hesperia</i>	3	1.0 - 2.0 m SH
	<i>Calycopeplus paucifolius</i>	2	> 2.0 m SH
	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	n	1.0 - 2.0 m SH
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>	2	< 5.0 m T
	<i>Hibbertia arcuata</i>	2	0.5 - 1.0 m SH
	<i>Philotheca brucei</i> subsp. <i>brucei</i>	2	0.5 - 1.0 m SH

MUNG East **Site** **QE12**

Described **CMC** **Date** 16/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 488755 **mE** 6775954 **mN**

Habitat Footslope

Soil Orange-brown, sandy-clay

Rock Type Some BIF and ferrous

Vegetation Moderately dense *Acacia ramulosa* var. *linophylla* / *Grevillea obliquistigma* subsp. *obliquistigma* low trees, over sparse *Calycopheplus paucifolius* high shrubs, over sparse herbs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	<i>Acacia assimilis</i> subsp. <i>assimilis</i>	n	< 5.0 m T
	<i>Acacia ramulosa</i> var. <i>linophylla</i>	4	< 5.0 m T
	<i>Calycopheplus paucifolius</i>	2	> 2.0 m SH
	<i>Drummondita microphylla</i>	n	1.0 - 2.0 m SH
	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	n	1.0 - 2.0 m SH
	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>	3	< 5.0 m T
	<i>Hibbertia arcuata</i>	n	1.0 - 2.0 m SH
	<i>Philotheca brucei</i> subsp. <i>brucei</i>	n	1.0 - 2.0 m SH

MUNG West **Site** QW01

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486437 **mE** 6776436 **mN**

Habitat Plain

Soil Orange-brown, sandy-clay

Rock Type Many ferrous

Vegetation Scattered Eucalyptus loxophleba subsp. supralaevis medium trees, over open Acacia ramulosa var. linophylla low trees, over sparse Acacia tetragonophylla medium shrubs, over sparse Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia exocarpoides	n	1.0 - 2.0 m SH
	Acacia ramulosa var. linophylla	n	> 2.0 m SH
	Acacia ramulosa var. ramulosa	3	< 5.0 m T
	Acacia tetragonophylla	2	1.0 - 2.0 m SH
	Eremophila clarkei	n	< 0.5 m SH
	Eucalyptus loxophleba subsp. supralaevis	n	5 - 15 m T
	Philotheca brucei subsp. brucei	n	< 0.5 m SH
	Ptilotus obovatus var. obovatus	3	< 0.5 m SH

MUNG West **Site** QW02

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486659 **mE** 6776642 **mN**

Habitat Footslope

Soil Orange-brown, sandy-clay

Rock Type many ferrous rocks

Vegetation MD Acacia coolgardiensis subsp. effusa / Hakea recurva subsp. recurva low trees, over sparse Eremophila clarkei high shrubs, over sparse Drummondita microphylla / Philotheca brucei subsp. brucei mixed medium shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia coolgardiensis subsp. effusa	4	< 5.0 m T
	Acacia ramulosa var. ramulosa	n	1.0 - 2.0 m SH
	Dianella revoluta var. divaricata	n	SE
	Drummondita microphylla	2	1.0 - 2.0 m SH
	Eremophila clarkei	2	> 2.0 m SH
	Eremophila exilifolia	n	0.5 - 1.0 m SH
	Eremophila latrobei subsp. latrobei	n	0.5 - 1.0 m SH
	Hakea recurva subsp. recurva	n	< 5.0 m SH
	Hibbertia arcuata	n	0.5 - 1.0 m SH
	Mirbelia bursarioides	n	1.0 - 2.0 m SH
	Philotheca brucei subsp. brucei	n	0.5 - 1.0 m SH
	Scaevola spinescens	n	> 2.0 m SH

MUNG West **Site** QW03

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486797 **mE** 6776595 **mN**

Habitat Midslope

Soil Very fine, orange-brown sandy-clay

Rock Type Continuous ferrous rocks

Vegetation Sparse Acacia aneura var. argentea / Melaleuca nematophylla low trees, over open Eremophila latrobei subsp. latrobei / Mirbelia bursarioides high shrubs, over open Drummondita microphylla medium shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia aneura var. argentea	n	< 5.0 m T
	Acacia assimilis subsp. assimilis	n	1.0 - 2.0 m SH
	Acacia ramulosa var. ramulosa	n	1.0 - 2.0 m SH
	Drummondita microphylla	3	1.0 - 2.0 SH
	Eremophila latrobei subsp. latrobei	3	> 2.0 m SH
	Melaleuca nematophylla	2	< 5.0 m T
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	n	1.0 - 2.0 m SH
	Mirbelia bursarioides	2	> 2.0 m SH
	Philothea brucei subsp. brucei	n	1.0 - 2.0 m SH
	Sida atrovirens	n	< 0.5 m SH

MUNG West **Site** QW04

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486968 **mE** 6776574 **mN**

Habitat Midslope

Soil Orange-brown, sandy-clay

Rock Type Many ferrous rocks

Vegetation Open Melaleuca nematophylla low trees, over open Acacia ramulosa var. ramulosa high shrubs, over open Drummondita microphylla medium to high shrubs, over sparse Hibbertia arcuata medium shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia assimilis subsp. assimilis	n	1.0 - 2.0 m SH
	Acacia assimilis subsp. assimilis	n	1.0 - 2.0 m SH
	Acacia ramulosa var. linophylla	n	< 5.0 m T
	Acacia ramulosa var. ramulosa	3	> 2.0 m SH
	Aluta aspera subsp. hesperia	n	0.5 - 1.0 m SH
	Aluta aspera subsp. hesperia	n	0.5 - 1.0 m SH
	Calycopeplus paucifolius	2	> 2.0 m SH
	Drummondita microphylla	3	1.0 - 2.0 m SH
	Eremophila clarkei	n	1.0 - 2.0 m SH
	Eremophila clarkei	n	1.0 - 2.0 m SH
	Hibbertia arcuata	2	0.5 - 1.0 m SH
	Melaleuca leiocarpa	2	< 5.0 m T
	Melaleuca leiocarpa	n	< 5.0 m T
	Melaleuca nematophylla	3	< 5.0 m T
	Philotheca brucei subsp. brucei	n	0.5 - 1.0 m SH

MUNG West **Site** QW05
Described MH **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486882 **mE** 6776447 **mN**

Habitat Midslope

Soil Red-orange, sandy-clay

Rock Type Many ferrous and BIF

Vegetation Open Acacia ramulosa var. ramulosa low trees, over sparse mixed medium shrubs, over MD Aluta aspera subsp. hesperia medium and low shrubs.

Veg Condition Good

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	2	> 2.0 m SH
	Acacia exocarpoides	2	> 2.0 m SH
	Acacia ramulosa var. ramulosa	3	< 5.0 m T
	Aluta aspera subsp. hesperia	4	1.0 - 2.0 m SH
	Calycopeplus paucifolius	2	1.0 - 2.0 m SH
	Drummondita microphylla	1	0.5 - 1.0 m SH
	Eremophila latrobei subsp. latrobei	2	1.0 - 2.0 m SH
	Grevillea obliquistigma subsp. obliquistigma	2	> 2.0 m SH
	Hibbertia arcuata	2	1.0 - 2.0 m SH
	Melaleuca hamata	2	1.0 - 2.0 m SH
	Philotheca brucei subsp. brucei	1	1.0 - 2.0 m SH

MUNG West **Site** QW06

Described MH **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486949 **mE** 6776335 **mN**

Habitat Footslope

Soil Red-orange, sandy-clay

Rock Type Many ferrous rocks

Vegetation Scattered outcropping Melaleuca hamata low trees, over MD Acacia ramulosa var. ramulosa high shrubs, over sparse Philotheca deserti subsp. deserti low shrubs.

Veg Condition Poor

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia ramulosa var. linophylla	n	> 2.0 m SH
	Acacia ramulosa var. ramulosa	4	> 2.0 m SH
	Aluta aspera subsp. hesperia	n	< 0.5 m SH
	Grevillea obliquistigma subsp. obliquistigma	2	> 2.0 m SH
	Melaleuca hamata	1	< 5.0 m T
	Melaleuca leiocarpa	n	> 2.0 m SH
	Philotheca deserti subsp. deserti	2	0.5 - 1.0 m SH
	Prostanthera magnifica	n	1.0 - 2.0 m SH

MUNG West **Site** QW07
Described MH **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486962 **mE** 6776283 **mN**

Habitat Footslope

Soil Red-orange, sandy-clay

Rock Type Many ferrous rocks

Vegetation MD Acacia ramulosa var. ramulosa high shrubs, over openixed medium shrubs of Melaleuca leiocarpa / Hakea recurva subsp. recurva / Acacia ramulosa var. ramulosa, over sparse Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Poor - Significant number of dead plants

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia ramulosa var. linophylla	n	> 2.0 m SH
	Acacia ramulosa var. ramulosa	4	> 2.0 m SH
	Hakea recurva subsp. recurva	3	1.0 - 2.0 m SH
	Melaleuca leiocarpa	3	1.0 - 2.0 m SH
	Philothea deserti subsp. deserti	n	0.5 - 1.0 m SH
	Ptilotus obovatus var. obovatus	3	< 0.5 m SH
	Santalum lanceolatum	n	< 5.0 m T

MUNG West **Site** QW08

Described MH **Date** 14/06/2007 **Type:** Q 20m x 20m

Location

MGA Zone 50 486797 mE 6776237 mN

Habitat Footslope - midslope

Soil Red-orange, sandy-clay

Rock Type Common ferrous rocks

Vegetation MD Acacia ramulosa var. ramulosa high shrubs, over MD Acacia ramulosa var. ramulosa medium shrubs, over open Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Good - close to mine pit

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia ramulosa var. ramulosa	1	> 2.0 m SH
	Acacia ramulosa var. ramulosa	4	> 2.0 m SH
	Acacia tetragonophylla	n	> 2.0 m SH
	Eremophila clarkei	n	0.5 - 1.0 m SH
	Hakea recurva subsp. recurva	2	0.5 - 1.0 m SH
	Lysiana casuarinae	n	0.5 - 1.0 m SH
	Ptilotus obovatus var. obovatus	3	< 0.5 m SH

MUNG West **Site** QW09

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486730 **mE** 6776239 **mN**

Habitat Footslope

Soil Orange-brown sandy-clay

Rock Type Few ferrous rocks

Vegetation Open Eucalyptus loxophleba subsp. supralaevis high shrubs, over scattered Acacia ramulosa var. ramulosa medium to high shrubs, over sparse Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Poor - wash out from waste pit, dead shrubs

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia exocarpoides	n	1.0 - 2.0 m SH
	Acacia ramulosa var. ramulosa	n	1.0 - 2.0 m SH
	Acacia tetragonophylla	n	< 0.5 m SH
	Eucalyptus loxophleba subsp. supralaevis	3	5 - 15 m T
	Ptilotus obovatus var. obovatus	2	< 0.5 m SH
	Sclerolaena uniflora	n	< 0.5 m SH

MUNG West **Site** QW10

Described MH **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486956 **mE** 6776192 **mN**

Habitat Flat / plain

Soil Red-orange, sandy-clay

Rock Type Few ferrous rocks

Vegetation MD Acacia acuminata high shrubs, over sparse Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Good - dust from nearby track

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	4	> 2.0 m SH
	Acacia anthochaera	n	> 2.0 m SH
	Acacia exocarpoides	n	1.0 - 2.0 m SH
	Acacia obtecta	n	1.0 - 2.0 m SH
	Acacia tetragonophylla	n	1.0 - 2.0 m SH
	Comesperma integerrimum	n	climber
	Hakea recurva subsp. recurva	n	1.0 - 2.0 m SH
	Ptilotus obovatus var. obovatus	2	< 0.5 m SH
	Senna artemisioides subsp. x artemisioides	n	1.0 - 2.0 m SH

MUNG West **Site** QW11

Described MH **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486734 **mE** 6776142 **mN**

Habitat Footslope / midslope

Soil Red-orange, sandy-clay

Rock Type Common ferrous

Vegetation MD Acacia ramulosa var. ramulosa high shrubs, over MD Acacia ramulosa var. ramulosa medium shrubs, over open Ptilotus obovatus var. obovatus low shrubs.

Veg Condition Poor - close track (dust), water wash out

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia obtecta	n	> 2.0 m SH
	Acacia ramulosa var. ramulosa	1	> 2.0 m SH
	Acacia ramulosa var. ramulosa	4	>2 m SH
	Acacia ramulosa var. ramulosa	n	> 2.0 m SH
	Acacia tetragonophylla	n	1.0 - 2.0 m SH
	Hakea recurva subsp. recurva	1	1.0 - 2.0 m SH
	Maireana villosa	n	< 0.5 m SH
	Ptilotus obovatus var. obovatus	3	< 0.5 m SH
	Solanum ellipticum	n	< 0.5 m SH

MUNG West **Site** QW12

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486598 **mE** 6776155 **mN**

Habitat Footslope

Soil Orange-brown, sandy-clay

Rock Type Common ferrous rocks

Vegetation Open Eucalyptus loxophleba subsp. supralaevis medium trees, over sparse Ptilotus obovatus var. obovatus low trees.

Veg Condition Degraded - wash out from waste pit.

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	n	1.0 - 2.0 m SH
	Acacia exocarpoides	n	1.0 - 2.0 m SH
	Acacia tetragonophylla	n	1.0 - 2.0 m SH
	Eucalyptus loxophleba subsp. supralaevis	3	5 - 15 m T
	Philotheca brucei subsp. brucei	n	< 0.5 m SH
	Ptilotus obovatus var. obovatus	2	< 0.5 m SH
	Sclerolaena uniflora	n	< 0.5 m SH

MUNG West **Site** QW13

Described CMC **Date** 14/06/2007 **Type:** **Q** 20m x 20m

Location

MGA Zone 50 486468 **mE** 6776334 **mN**

Habitat Midslope

Soil Orange-brown, sandy-clay

Rock Type Many ferrous

Vegetation Open Acacia ramulosa var. ramulosa / Melaleuca nematophylla low trees, over open Acacia assimilis subsp. assimilis / Micromyrtus sp. Warriedar (S. Patrick 1879A) tall shrubs, over open Philotheca brucei subsp. brucei / Drummondita microphylla medium shrubs.

Veg Condition Excellent

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia assimilis subsp. assimilis	3	> 2.0 m SH
	Acacia exocarpoides	n	1.0 - 2.0 m Sh
	Acacia ramulosa var. linophylla	n	> 2.0 m SH
	Acacia ramulosa var. ramulosa	3	< 5.0 m T
	Acacia tetragonophylla	n	1.0 - 2.0 m Sh
	Drummondita microphylla	3	1.0 - 2.0 m SH
	Eremophila clarkei	n	0.5 - 1.0 m SH
	Eremophila clarkei	2	1.0 - 2.0 m Sh
	Hibbertia arcuata	2	1.0 - 2.0 m Sh
	Melaleuca nematophylla	3	< 5.0 m T
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	3	> 2.0 m SH
	Philotheca brucei subsp. brucei	3	1.0 - 2.0 m SH
	Ptilotus obovatus var. obovatus	n	< 0.5 m SH
	Sida atrovirens	n	0.5 - 1.0 m SH

MUNG West **Site** QW14

Described MH **Date** 14/06/2007 **Type:** **Q** 20m x 20m
Seaso

Location

MGA Zone 50 486525 **mE** 6776369 **mN**

Habitat Tor

Soil Red-orange, sandy-clay

Rock Type Continuous BIF and ferrous

Vegetation MD Acacia acuminata, over open mixed medium shrubs, dominated by Acacia ramulosa var. ramulosa, over open mixed low shrubs dominated by Philotheca sericea.

Veg Condition Good

Fire None evident

Notes

Species List:

Quad	Name	Cover	Height
	Acacia acuminata	4	> 2.0 m SH
	Acacia aneura var. argentea	n	> 2.0 m SH
	Acacia exocarpoides	1	> 2.0 m SH
	Acacia ramulosa var. ramulosa	3	1.0 - 2.0 m SH
	Acacia tetragonophylla	n	> 2.0 m SH
	Dodonaea inaequifolia	n	1.0 - 2.0 m SH
	Eremophila clarkei	n	0.5 - 1.0 m SH
	Eremophila latrobei subsp. latrobei	2	1.0 - 2.0 m SH
	Hakea recurva subsp. recurva	2	> 2.0 m SH
	Micromyrtus sp. Warriedar (S. Patrick 1879A)	2	> 2.0 m SH
	Mirbelia bursarioides	n	0.5 - 1.0 m SH
	Philotheca brucei subsp. brucei	2	1.0 - 2.0 m SH
	Philotheca sericea	2	0.5 - 1.0 m SH
	Solanum lasiophyllum	n	< 0.5 m SH

BHPC West Site 01

Described MH **Date** 10/08/2007 **Type: Q** 20m x 20m

Location Blue Hills Mungada West

MGA Zone 50 486922 mE 6776628 mN

Habitat

Soil Red-orange sandy clay with a surface crust

Rock Type Continuous ferrous stones and pebbles.

Vegetation Moderately dense mixed tall shrubs, dominated by *Melaleuca leiocarpa* / *Acacia ramulosa* var. *ramulosa*, over moderately dense *Philotheca sericea* medium shrubs.

Veg Condition Excellent

Fire None evident

Notes Moderate wood litter. Moderate leaf litter, mainly under shrubs.

Species List:

Quad	Name	Cover	Height
	<i>Acacia assimilis</i> subsp. <i>assimilis</i>	2	>2 sh
	<i>Acacia ramulosa</i> var. <i>linophylla</i>	2	>2 sh
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>	4	>2 sh
	<i>Aluta aspera</i> subsp. <i>hesperia</i>	2	1-2 sh
	<i>Drosera macrantha</i> subsp. <i>macrantha</i>	N	he
	<i>Drummondita microphylla</i>	3	1-2 sh
	<i>Eremophila georgei</i>	N	0.5-1 sh
	<i>Hibbertia arcuata</i>	1	1-2 sh
	<i>Melaleuca leiocarpa</i>	4	>2 sh
	<i>Melaleuca nematophylla</i>	3	>2 sh
	<i>Philotheca sericea</i>	4	1-2 sh
	<i>Thysanotus manglesianus</i>	N	climber
	<i>Calycopeplus paucifolius</i>	1	>2 sh

BHPC West **Site** SH

Described SH **Date** 10/08/2007 **Type:** **Q** 20m x 20m

Location Blue Hills

MGA Zone 50 487100 **mE** 6776413 **mN**

Habitat

Soil Red-orange clay, with loose Soil

Rock Type Lots of pebbles and fine gravel

Vegetation Open tall shrubs of *Acacia ramulosa* var. *ramulosa*, over sparse *Hakea recurva* subsp. *recurva* shrubs, over sparse *Cryptandra imbricata* / *Ptilotus obovatus* var. *obovatus* low shrubs, over mixed herbs and soft grasses.

Veg Condition Good

Fire

Notes Minimal grazing. Mallee fowl mound approximately 10 m NE of site.

Species List:

Quad	Name	Cover	Height
	<i>Acacia ramulosa</i> var. <i>ramulosa</i>	3	>2 sh
	<i>Acacia sclerosperma</i>	1	0.5-1 sh
	<i>Acacia tetragonophylla</i>	1	1-2 sh
	<i>Cheilanthes adiantoides</i>	3	he
	<i>Comesperma integerrimum</i>	N	climber
	<i>Cryptandra imbricata</i>	2	1-2 sh
	<i>Cyanicula amplexans</i>	N	he
	<i>Dianella revoluta</i> var. <i>divaricata</i>	1	he
	<i>Exocarpos aphyllus</i>	1	>2 sh
	<i>Hakea recurva</i> subsp. <i>recurva</i>	2	>2 sh
	<i>Melaleuca leiocarpa</i>	1	>2 sh
	<i>Monachather paradoxus</i>	2	gr
	<i>Ptilotus obovatus</i> var. <i>obovatus</i>	2	0-0.5 sh
	<i>Rhagodia</i> sp.	N	0-0.5 sh
	<i>Rhodanthe</i> sp.	1	he
	<i>Sida arenicola</i>	1	he

Appendix E: Regional Distribution of four of the Priority Flora Taxa and one species of interest Recorded at Blue Hills (from Woodman 2006b)

