MOOLARBEN COAL PROJECT

APPENDIX 11

Flora, Fauna and Aquatic Ecology Assessment

MOOLARBEN COAL PROJECT

FLORA, FAUNA AND AQUATIC ECOLOGY ASSESSMENT

MOOLARBEN BIOTA

AUGUST 2006

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MOOLARBEN COAL PROJECT

ENVIRONMENTAL ASSESSMENT - ECOLOGY

August 2006

1 DEFINITIONS

Terms used within this report are defined as follows:

- DA area	Land being the subject of this Environmental Assessment Report, which is marked with red outline on each figure.
- DEC	Department of Environment and Conservation
- Disturbed Vegetation	A mappable area containing a structurally and floristically unstable assemblage of plant species that is dominated by native and exotic flora species.
Ecological Significance	Refers to a mapped vegetation unit containing ecological values that are listed as threatened biodiversity under the *NSW Threatened Species Conservation Act 1995 and/ or Environment Protection and Biodiversity Conservation Act 1999*.
- Ecological Value	A qualitative statement defining the contained flora and fauna habitat values within a mapped vegetation unit.
- EEC	An ecological community listed as endangered under the *NSW Threatened Species Conservation Act 1995.*
- Endangered population	A population listed as endangered under the *NSW Threatened Species Conservation Act 1995*.
- EL area	Land within the EL6288 boundary, which is marked with yellow outline each figure. Also termed "the study area" for terrestrial flora and fauna reporting. Note that for the aquatic ecological assessment, the study area is of necessity larger than that defined by the EL and DA boundaries, as linkages of drainages and streams up-stream and down-stream of the defined EL plus DA boundaries are important with respect to downstream invertebrate drift, plus seed dispersal for aquatic plants and passage for fish.
- Intact	The term ‘intact’ is used to refer to areas of native vegetation that are relatively continuous, relatively weed-free, contain natural habitat features, and which appear to function as a

	native ecological community. The term may be applied to areas of vegetation which have been previously disturbed and/or cleared, but which have regenerated and recovered to the extent that natural functions have been restored, and the vegetation would be expected to progress unassisted towards a stable system.
- MCM	Moolarben Coal Mines Pty Limited
- MCP	Moolarben Coal Project
- Native Vegetation	A mappable area containing a structurally and floristically stable assemblage of plant species dominated by native flora species.
Region	The upper Goulburn River catchment
- Study area	Land within the EL6288 boundary, which is marked with yellow outline. Also termed "the study area" for terrestrial flora and fauna reporting. Note that for the aquatic ecological assessment, the study area is of necessity larger than that defined by the EL and DA boundaries, as linkages of drainages and streams up-stream and down-stream of the defined EL plus DA boundaries are important with respect to downstream invertebrate drift, plus seed dispersal for aquatic plants and passage for fish.
- Subject species	Flora species identified in Chapter 6.3.3 and fauna species identified in Chapter 4.3.2 of this report.
- Surrounding area	Land shown on aerial photographs represented within the figures outside of the EL area
- Target species	Threatened fauna species known to have occurred in the study area and/or region, and/or considered likely to occur, based on research findings and habitat assessment. Targeted surveys were conducted for these species to determine their presence/absence in the study area.
Terrestrial Stratification Unit	A map unit defining the extent of broad vegetation communities. Field survey stratification was based on this map unit.
- Threatened ecological community	An ecological community listed as endangered, vulnerable or threatened under either or both of the *NSW Threatened Species Conservation Act 1995* or the *Commonwealth Environment Protection & Biodiversity Conservation Act 1999.*
- Threatened species	Species listed as endangered or vulnerable under one or more of the following Acts: *NSW Fisheries Management Act 1994*, *NSW Threatened Species Conservation Act 1995* or the *Commonwealth Environment Protection & Biodiversity Conservation Act 1999*.
- Vegetation Association	An assemblage of plant species of specific floristic diversity within a spatially definable area. A subset of the terrestrial stratification unit.

EXECUTIVE SUMMARY

Moolarben Biota, a joint venture comprising Ecovision Consulting, Hayes Environmental and Marine Pollution Research Pty Ltd has prepared an ecological assessment for Stage 1 of the 'Moolarben Coal Project' (MCP). The MCP study area (i.e. EL6288) is located wholly within the upper Goulburn River catchment comprising of approximately 110km2, with the development application area (MCP DA Area) covering approximately 35 km2.

The study area is located in a transitional zone between the western slopes and coastal parts of NSW on a lowly elevated saddle within the Great Dividing Range (i.e. elevation approximately 500 m). Many plant species and communities representative of these regions intergrade within this area, with a distinctive example including, among others, the hybrid zone between White Box (Eucalyptus albens) and Coastal Grey Box (Eucalyptus moluccana). A large array of biodiversity, particularly plants, exhibit range limits into the area, particularly endemic plants to the Sydney sandstones (i.e. northern distribution limit).

Rainfall in the area is variable and low, with an average of only 610 mm per annum at Ulan and the average annual evapo-transpiration of the Ulan area is high, at about 1730mm. Geology of the study area is typically Permian conglomerates in the south, with Narabeen Sandstones occurring throughout the northern parts. Isolated alluvial and carboniferous geological formations are also known within the study area.

Scoping Study

An initial mine layout exhibiting resource recovery, infrastructure, overburden emplacement and rehabilitation areas was reviewed in October 2004 in combination with a preliminary field inspection to classify, in general terms, the extent of biological variability against factors such as topography, geology, land use and aspect. The scoping study was used to provide initial constraints information to mine planners and to develop appropriate survey designs for the three study components (flora, fauna and aquatic). Survey design was structured around industry standards for that time, these including:

- Working Draft Guidelines *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities*' (DEC 2004).
- State Groundwater Dependent Ecosystem policy guidelines (DLWC 2002);
- NSW DPI Guidelines for the assessment of aquatic habitat (NSW Fisheries 1999); and
- Aquatic invertebrate sampling and analysis using the recommended AusRivAs method.

Flora Study

Aerial photography interpretation (API) using 2004 photography at a scale of 1:25,000 was used to identify broad vegetation communities for digitisation into a Geographical Information System (GIS). An orthorectified image of the study area was used to ensure spatial accuracy of the resultant vegetation layer. Geological maps were also imported into the GIS to refine the boundaries of these broad vegetation communities. The resultant broad vegetation mapping delineated six 'Terrestrial Stratification Units' (i.e. TSU's) within the study area, these being:

10 Disturbed Vegetation (Study Area = 3964 ha; MCP DA Area = 1354 ha)
20 Sedimentary Ironbark Forests (Study Area = 2230 ha; MCP DA Area = 566 ha)
30 Box Woodlands (Study Area = 859 ha; MCP DA Area = 338 ha)
40 Tableland Redgum Woodlands (Study Area = 342 ha; MCP DA Area = 144 ha)
50 Sedimentary Scribbly Gum Woodlands (Study Area = 2159 ha; MCP DA Area = 983 ha)
60 Apple Alluvial Forests (MCP DA Area = 385 ha; MCP DA Area = 93 ha)

TSUs were further refined using similar methods to identify 34 sub-unit phototypes or vegetation associations. These together formed the base stratification layers for the design of the field ecological survey. Literature review and agency database searches were used to compile expected species lists especially for listed threatened species and endangered ecological communities (EECs).

The floristic makeup of defined TSUs was investigated in the field using a combination of systematic and opportunistic plant identification and plant cover survey methods; 20 x 20 m quadrats, 50 x 8 m transects and biodiversity searches. Survey effort was greatest in areas of potential direct impact as defined from the mine plans, with reduced replication in areas with limited to no impact. Field data were entered directly into the GIS database via a specialised mobile GIS software loaded onto a personal digital assistant (PDA) linked to a 20 station Geographical Positioning System (GPS).

A total of 143 quadrats were investigated over some 60 days in ten separate field excursions over five seasons (Summer 2004/2005, Autumn, Winter and Spring 2005 and Autumn 2006). Some 502 plants were identified, 428 from the systematic quadrat surveys and 74 from biodiversity surveys. Quadrat data were analysed using TWINSPAN, a non-parametric statistics package and a modified Braun Blanquet classification scheme to identify the floristic makeup of the defined TSUs. Criteria for categorising areas of high ecological value included presence of EECs, presence or possibility of threatened species, vegetation condition and location.

In general, the valley floor vegetation has been cleared and disturbed, with Alluvial Apple Forest occurring as narrow strips along creek line corridors. Box and Red Gum Woodlands occur as remnant vegetation on the valley floors and adjacent lower slopes. Ironbark Forests occur on ridgelines and upper slopes in the south (south of the Ulan-Wollar Road) and Scribbly Gum Woodlands occur on ridgelines and upper slopes in the north (north of the Ulan-Wollar Road). The total mapped extent of native vegetation within the study area that excludes disturbed landscapes is approximately 5976 ha, with the MCP DA Area containing approximately 2124 ha of the total vegetation cover.

The presence of the TSC Act listed White Box Yellow Box Blakely's Red Gum Woodland was determined using the NPWS (2002) identification guideline. Components of this community are also included within the threatened ecological community – Grassy White Box Woodlands, which is listed separately under the Commonwealth EPBC Act. The presence of this EEC within the study area was also examined using a TWINSPAN statistical analysis with weightings applied to the diagnostic species of this EEC, as listed by the NSW Scientific Committee (2002), to compliment the NPWS (2002) guideline approach. Both methods resulted in comparatively similar results, thereby increasing the confidence of the identification process for EECs within the MCP DA Area.

Six vegetation associations located within the MCP DA Area are consistent with the definition for the TSC Act and EPBC Act listed White Box Yellow Box Blakely's Red Gum Woodland EEC. Mapping identified 786.2ha of White Box Yellow Box Blakely's Red Gum Woodland within in the study area, with approximately 259.6ha contained within the MCP DA Area. Of this, the proposed MCP would result in the removal of 64.68 ha. In addition to the loss of EECs, the MCP will result in the removal of 351 ha non-EEC native vegetation, with the bulk of this vegetation loss assocaited with the Sedimentary Ironbark Forests (TSU 20).

Four threatened plant species were recorded in the study area. One, the Commonwealth listed Hoary Sunray *Leucochrysum albicans* var *tricolor* will not be impacted by the proposed mine. The other three will be impacted by OC1 including a loss of approximately 1000 individuals of Narrow-leaved Goodenia *Goodenia macbarronii* (or approximately 10% of the known local population), loss of one individual of Double-tailed Donkey Orchid *Diuris tricolor* and the loss of approximately seven individuals of Capertee Stringybark *Eucalyptus cannonii*.

Fauna Study

Threatened fauna species records obtained from agency databases and from literature review were used to compile a list of 28 threatened species plus a list of potential declining woodland birds with either known or potential occurrence within the study area. This list was then used to design a targeted study based around the defined TSUs and including most vegetation associations. Surveys were undertaken at the same time as the flora surveys (described above). Fauna species were identified through trapping (see below), visual and aural detection, and through traces, ie scats, tracks, chew marks etc, nocturnal surveys and targeted means (i.e. harp trapping, pitfall trapping, call playback).

Nineteen fauna survey sites were selected for standardised trapping surveys using Elliot Type A traps. Thirteen additional sites were surveyed using Elliot B tree-mounted traps, Elliot E, Cage Traps and hair tubes. Site selection was based on the combined literature survey and the broad TSU mapping. Fourteen pitfall traplines were set diurnally. Additional hair tube surveys were conducted in conjunction with the aquatic field sampling, to target the native Water Rat *Hydromys chrysogaster*. Other systematic surveys included bird searches (~80 sites), herpetofauna searches (22 sites), Anabat II Bat Detector searches to detect the ultrasonic echolocation calls of microchiropteran bats (40 sites), harp traps to target microchiropteran bats (20 sites), call playback to target threatened owls (33 surveys across ~24 sites) and also the Green & Golden Bell Frog, and spotlighting (31 sites) to target nocturnal fauna – also used in conjunction with call playback. All surveys were supplemented with opportunistic records. A specific targeted survey for the Regent Honeyeater was conducted in August 2005 to coincide with the flowering period of White Box (*E. albens*) and the national survey weekend for the Regent Honeyeater.

The fauna survey of the study area identified 256 fauna species comprising of 170 birds, 37 mammals, 32 reptiles and 7 amphibians. Of these, there were 29 threatened fauna species and 14 declining woodland birds known or considered likely to occur in the study area and MCP DA Area. The assessment of fauna occupation within the study area indicated a relationship between local species distribution and TSUs. A higher diversity of fauna species was observed within the Box Woodlands TSU, with the majority of the species composition being woodland birds. Sedimentary Scribbly Gum Woodlands provided habitat for many microchiropteran bat species and reptiles due to the increased abundance of trees with hollows and surface rock. The fauna habitat analysis indicating a requirement for splitting TSUs 10 and 40 into two sub-units, as woodland birds appeared to have a affinity for disturbed landscapes containing predominantly native grasses nearby Box Woodlands (i.e. plant association 10 and 11) and Blakely's Redgum Woodlands (plant association 40).

Aquatic Study

The initial catchment and scoping study indicated that most of the creeks and drainages in the EL area are ephemeral or intermittent and there are few creeks with permanent (or even semi-permanent) pond or riffle areas. Further, this review (and subsequent reviews of later regional impacts assessments and of Ulan Mine aquatic survey results) indicated that there were no threatened aquatic plants, fish or macroinvertebrate species or populations (as listed under Commonwealth EPBC Act or under the NSW Fisheries Management Act 1994) listed or found in the upper Goulburn River.

A sampling model, utilising 46 sampling sites was designed to separate out possible mining impacts from other catchment associated impacts, including from adjacent coal mines (Ulan and Wilpinjong). The sites were assessed for overall aquatic habitat condition using a standardised Riparian-Channel-Environment (RCE) ranking scheme. At each site, the main quantitative aquatic habitat study method targets aquatic macroinvertebrates, based on methods adapted for the National River Health Program, now referred to as the AusRivAS method. AusRivAS specifies sampling in Spring and Autumn. The overall condition of the macroinvertebrate communities at each site was analysed by computing Stream Invertebrate Grade Number Average Level (SIGNAL) pollution tolerance scores for each site/sampling period. AusRivAS surveys were supplemented with aquatic plant observations, physical water quality measurements (temperature, conductivity, dissolved oxygen, pH and turbidity) and fish trapping using bait traps. Searches plus habitat assessments were also made for Platypus and Native Water Rat (the latter aided by setting hair tubes at selected sites).

Field surveys were undertaken in Spring 2004, Autumn and Spring 2005 and in Summer 2006 targeting 82 sample sites. Survey intensity varied between 17 and 27 sites visited per season, with only 6 to 11 sites actually having sufficient water available for macroinvertebrate sampling. That is, only 27 sites from the 46 potential sites had sufficient water available for sampling over the sampling period. Aquatic macroinvertebrate seasonal diversity varied from 44 taxa in Autumn 2004 to 60 taxa in Spring 2005 and there were a total of 69 taxa for the study; 51 insect taxa, 6 crustaceans, 4 gastropod molluscs, 2 leeches, and one water mite, springtail, ostracod, worm, bivalve mollusc and flatworm. No aquatic mammals (platypus or native water rat) were found during the study and although they could occur (at least in the lower part of the study area catchment in Goulburn River) none are expected. There were no threatened species found during this study and none are expected.

Based on RCE analysis alone, the best aquatic habitat is located in the Goulburn River sections below the Ulan Creek confluence; including the lower Bobadeen Creek section above the confluence. Of the several sites assessed by RCE analysis as good potential aquatic habitat only sites in the lower portions of Moolarben Creek and in the middle Ryans Creek section actually had water to sample. The sites in the upper sections of Bora Creek plus the un-named creek north of Bora Creek did not have water over the study period. The remaining sites provide little suitable aquatic habitat by virtue of site disruption by agricultural pursuits plus site instability due to erosion.

Site by season diversities and site SIGNAL values were relatively similar across the study (diversity range 11 to 32 taxa) and site SIGNAL scores ranged from 3.45 to 5.48; 6 sites providing a 'very poor' rating, 19 sites registered 'poor' condition and 3 sites registered 'fair' condition. With regard to seasonal SIGNAL analysis there was very little variation between seasons for the total study with seasonal ranges all in the 'poor' band.

Water quality results confirm that most sampled sites had very little water holding capacity (mean depth around 0.4 m). Water conductivity showed a large variation with elevated conductivity readings (3000 to 6500 µS/cm occurring in Moolarben Creek sites above the dam with agradual decrease in conductivity downstream. Creeks feeding to the Goulburn River from the north to Bobadeen Creek contributed water with slightly elevated conductivity (300 to 700 µS/cm) whilst Ryans Creek flowing from the west to Moolarben Creek had the lowest conductivity (around 180 to 300 µS/cm). The deeper Moolarben Creek sites were generally stratified with depressed dissolved oxygen concentrations in bottom waters. Water acidity was relatively stable, with overall study values between 6.6 and 8.5 pH units. Whilst water turbidity varied widely most readings were between 20 and 200 NTU.

Groundwater Dependant Ecosystems

The possible occurrence of terrestrial, base flow and wetland groundwater dependant ecosystems (GDEs) was determined by examining mapped vegetation associations against their potential relationship with groundwater. The significance of possible GDEs was assessed using the eight-step rapid assessment process contained within The NSW State Groundwater Dependant Ecosystem Policy (DLWC, 2002).

No terrestrial GDEs mappable at the vegetation association level were identified within the MCP DA area or impact zone. ‘The Drip’, on the Goulburn River north of Underground 4, represents the only significant seep/spring GDE within the locality, with native vegetation reliant on this surface expression of groundwater clearly evident within the cliff line of ‘The Drip’. No impacts from the mine are expected on this GDE.

Parramatta Redgum (*Eucalyptus parramattensis*) located above Underground 4 is associated with high moisture retaining soils (i.e. shale influenced soils) within broad open drainage lines. This vegetation is not considered a GDE as the occurrence of this species is clearly assocaited with localised topographic and soil conditions. Further evidence supporting this claim is the limited extent of the potential groundwater catchment relative to the area containing Parramatta Redgum (*Eucalyptus parramattensis*).

Whilst groundwater is known to provide base-flow to the main creeks and the Goulburn River, assessment of riparian vegetation did not indicate any specific riparian plant communities, which could be considered groundwater dependent. Wetlands identified in the DA area between the confluence of Lagoon and Moolarben Creek and the Moolarben Dam were created as a consequence of constructed surface water constrictions and are not considered groundwater dependent.

Of the possible assessed GDEs considered during the flora and aquatic studies, it is concluded that are no GDE's within the study area that are likely to be of specific importance to any threatened fauna species. The only threatened fauna species recorded from the general locality with a fairly direct dependence on water is the Giant Barred Frog, which was not recorded from the DA area during the surveys undertaken for this project.

Mining Impacts

The MCP DA area has been classified in terms of its ecological value (*ie* High, Moderate, Low) using the following matters of significance to define the extent of mining related impacts on local biodiversity values:

- Threatened species, populations, EECs and their habitats;

- Woodland habitats of likely value for declining woodland birds;
- Native vegetation and habitats of importance due to their strategic location, corridor values, and critical or unique resources (i.e. riparian and aquatic zones); and
- The adjoining conservation reserve network.

Areas of high ecological value are generally associated with vegetated lands belonging to the following TSU's:

10 Disturbed Vegetation (unimproved grasslands located close to remnant stands of vegetation)

30 Box Woodlands (vegetation associations classified as EEC);

30 Box Woodlands (non-EECs containing woodland bird habitat);

40 Tableland Redgum Woodlands (vegetation association 40 which is classified as EEC);

60 Alluvial Apple Forests.

Areas of moderate ecological value are generally associated with vegetated lands belonging to the following TSU's:

20 Sedimentary Ironbark Forests;

50 Sedimentary Scribbly Gum Woodlands; and

40 Tableland Redgum Woodlands (other than vegetation association 40 which is classified as EEC).

Areas of low ecological value are generally associated with vegetated lands belonging to TSU 10 Disturbed Lands (other than unimproved grasslands located close to remnant stands of vegetation). Low ecological value areas are lands within the MCP DA area supporting disturbed native vegetation and habitats. These areas are generally in poor condition, and of low habitat value. Impacts on the contained biodiversity values within the MCP DA Area are summarised as follows:

Vegetation Association	OC1 (ha)	OC2 (ha)	OC3 (ha)	Infrastructure (ha)	Total (ha)
TSU 20 (Sub-total)	175.78	0.34	43.02	0	219.14
TSU 30 (Sub-total)	51.31	51.65	29.78	5.83	138.56
TSU 40 (Sub-total)	28.58	0.58	0	0	29.16
TSU 50 (Sub-total)	8.35	0.28	0	6.57	15.19
TSU 60 (Sub-total)	0.1	1.05	8.67	4.9	14.72
Total	264.1	53.9	81.47	16.61	416.77

The final MCP layout, when compared to the initial layout, has reduced the extent of proposed native vegetation clearing from 441.1 ha to 416.8 ha, representing a reduction of 24.3 ha or 5.7%. Most importantly, the reduction of clearing would be most pronounced for vegetation associations classified as White Box Yellow Box Blakely's Red Gum Woodland EEC. The initial mine layout would have resulted in the loss of 83.70 ha White Box Yellow Box Blakely's Red Gum Woodland EEC in comparison with the final MCP layout impacting 64.68 ha, a reduction of 19.02 ha or 22.7%. These statistics clearly demonstrate attempts to avoid vegetated areas of high ecological value (*ie* classified as EEC and providing habitat for threatened and declining woodland bird species). Another major avoidance strategy was implemented within proposed OC 3, with minable resources contained beneath Moolarben Creek and the adjoining riparian corridor excluded from mining activities. This further reduced the potential impact of mine activities on the adjoining Munghorn Gap Nature Reserve.

The MCP has been structured to avoid and minimise impacts on aquatic ecosystems. Other than several creek crossings for roads and other infrastructure plus the construction of a clean water dam on Bora Creek, there are no direct impacts on aquatic ecosystems. With regard to indirect impacts the potential problems of dust and spillages on aquatic habitats can be minimised to insignificance by proper safe practice. With regard to subsidence impacts on drainage lines above Underground 4 there may be some minor ponding but, given the lack of water retention in these drainage lines and creeks some ponding capacity is considered a beneficial impact.

With regard to possible cumulative impacts from combined coal mining in the district, the main consideration relates to total mine water cycle. Practicably there will be times when there are water surpluses. When this occurs, the mine will only discharge water which meets the ANZECC/ARMCANZ (2000) criteria for the protection of aquatic ecosystems and at discharge rates which do not cause a deleterious impact on base-flow. Given the overall low volume of water available for aquatic ecosystems in the upper Goulburn River catchment this discharge is on balance considered a beneficial impact.

Potential impact sources on the adjoining DEC estate (ie Goulburn River National Park and Munghorn River Nature Reserve) will be restricted to operations associated with Underground No. 4 and OC3. However, the mining impacts emanating from these sources will be negligible for the following reasons:

- Underground mining has been designed to minimise the occurrence of subsidence along the eastern boundary of Underground No. 4, such that no subsidence impact is expected on Goulburn River National Park;
- The disturbance footprint of OC3 will range from 200 – 1400 m from Munghorn Gap Nature Reserve, with no water drainage capable of entering the reserve. and
- There are no significant impacts on river or creek flow or water quality and there are no significant impacts on off-site groundwater flows. Consequently there are no significant impacts on offsite aquatic ecological attributes or GDEs.

Preferred Mitigation Strategy

The preferred mitigation strategy has been developed to deliver a net positive benefit for local biodiversity despite the loss of native vegetation and fauna habitats to the MCP. The key elements of the mitigation strategy are:

- Avoidance of ecologically important values;
- Dedication of significant ecological values to the conservation reserve network;
- Increase the net native vegetation cover within the locality;
- Enhance the contained ecological values within existing native vegetation;
- Conserve important ecological habitats through the salvage of fauna habitats contained within the open cuts and consequential emplacement throughout rehabilitated/ revegetated landscapes; and
- Enter into a Voluntary Conservation Agreement over existing native vegetation and revegetated/ rehabilitated landscapes to provide a secure long term beneficial outcome for local biodiversity.

The mitigation package is summarised as follows:

Mitigation Strategy	Area (ha)
Avoidance of White Box Yellow Box Blakely's Redgum Woodland EEC	19
Dedication of 2:1 White Box Yellow Box Blakely's Redgum Woodland EEC to conservation network	130
Avoidance of non-EEC native vegetation	24
Dedication of non-EEC native vegetation to the conservation reserve network	143
Dedication of potential revegetated lands to conservation reserve network	38
Revegetation Works	144
Rehabilitation Works	370
Extent of native vegetation excluded from the MCP	1262
Extent of Voluntary Conservation Area	1726

The total extent of mitigation represented by the extent of the dedication to Goulburn River National Park and Voluntary Conservation Agreement is 2037 ha.

2 INTRODUCTION

2.1 Background and Objectives

Moolarben Coal Mine Pty Limited (MCM) is seeking development consent under Part 3A of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) for underground and open cut coal mining and associated infrastructure east of Ulan in the upper Goulburn River catchment. The proposal is known and referred to as the 'Moolarben Coal Project' (MCP).

This *Environmental Assessment – Ecology* report has been prepared by the Joint Venture 'Moolarben Biota' (Ecovision Consulting, Hayes Environmental and Marine Pollution Research), as part of the Environmental Assessment required to accompany a Development Application (DA) for Stage 1 of the MCP.

The report has been prepared to specifically address ecological items set out in the Director-General's requirements dated the 20th January 2006, and revised on 16 March 2006, and to address relevant items set out by various agencies in correspondence accompanying the Director-General's requirements. The study team assembled for the completion of studies and associated reporting that is compliant with the Director-General's requirements is presented in **Appendix 1**.

2.2 Description of the Proposal

The MCP is located in the Western coalfield of New South Wales, east of the village of Ulan and approximately 40 km northeast of Mudgee and 25 kilometres east of Gulgong townships.

The Moolarben EL6288 covers an area of approximately 110 km^2 and in part borders Ulan Coal Mine, Goulburn River National Park, Munghorn Gap Nature Reserve and the recently approved and under construction Wilpinjong Coal Project. The location of the MCP site and the disturbance areas are shown in the main Environmental Assessment report.

A summary of the major project components of the MCP are:

- Three open cut mines to produce coals for the export and domestic markets;
- An underground coal mine to produce coal predominantly for the export market;
- Coal handling and preparation plant (CHPP), incorporating crushing plants, conveyors, raw coal and project coal stockpiles, coal preparation plant, coal stackers/reclaimers;
- Rail spur, rail loop, train loading infrastructure and transportation of product coals to market by train;
- Mine access roads, internal access roads and haul roads;
- Water management infrastructure including water supply bores, surface water storages and associated pump and pipeline system
- Placement of overburden and coarse reject within mined-out voids;
- Out-of-pit and in-pit tailings storages;
- Rehabilitation of final mine landforms and embellishment of nearby landscapes;
- Relocation, closure and temporary closure of public roads within the area to be mined; and
- Relocation of utility infrastructure such as electrical and communication facilities impacted by mining or the relocation of mine related infrastructure.

The main administration and visitor access point for the project will be located in the Main Infrastructure Area south of Underground No. 4. The CHPP, Open Cut 3 (OC3) and Open Cut 1 (OC1) facilities would contain essential facilities such as bathhouse and stores. Facilities at OC1 would include a workshop.

2.3 Study Area and Regional Context

2.3.1 General Features

The study area for the MCP is land within EL6288, located in the northern portion of the Western Coalfield, in the western end of the Hunter Valley, in the upper Goulburn River catchment. A large portion of the Goulburn River catchment, both upstream and immediately downstream of parts of the proposed development, is within Nature Reserves or National Park lands. The Goulburn River catchment is the largest sub-catchment of the Hunter River covering just under one third of the total Hunter River catchment (of 22000 km^2).

The study area is located wholly within the upper Goulburn River catchment (which is referred to as the 'region' for this report). The study area is approximately 20 km in length north to south, and varies from 3-9 km in width east to west. The total area is approximately 110km^2.

The majority of the study area is characterised as gently undulating agricultural land, mainly pasture, with moderate sized stands of native woodland vegetation retained along the steeper hillsides and ridgelines and in patches along creek or drainage lines. Surrounding lands support similar vegetation patterns.

Soils of the valley floor consist of narrow alluvials along the major creeklines, with adjoining terraces belonging to the Permian geological formation. Occasional conglomerate outcrops referred to as 'hard caps' are associated with 'tertiary channels', which occur as localised hills throughout the valley floor. Soils of the lower and central midslopes are generally derived from Permian conglomerates and claystones, with the upper slopes often characterised by Triassic sandstones. The Ridgelines tend to have poor soil fertility due to the underlying Triassic geological formation (Narrabeen Sandstones). Basaltic rocky outcrops occur in some areas.

The Goulburn River and Moolarben, Murragamba and Wilpinjong Creeks (all upper tributaries of the Goulburn River) drain most of the study area. The Goulburn River remains one of the few unregulated rivers flowing into the Hunter River.

A large portion of the Goulburn River catchment, both upstream and immediately downstream of the study area, is protected within Nature Reserves and National Parks. Goulburn River National Park adjoins most of the north-eastern boundary of the study area, and conserves approximately 70,200 hectares of dissected sandstone country. Munghorn Gap Nature Reserve adjoins most of the south-eastern boundary of the study area, with two narrow peninsulas jutting into the study area, and conserves just under 6,000 hectares of sandstone pagoda formation country (NSW NPWS 2003). Both of these reserves are listed as National Heritage Areas under the Commonwealth EPBC Act.

Land uses within the study area and region include agriculture (grazing, cropping), coal mining, extractive industries, tourism, recreation and conservation. Grazing is the predominant activity in the study area. Coal mines are also a feature of the region - the Ulan Coal Mine adjoins the small village of Ulan centrally along the western boundary of the study and the approved and under construction Wilpinjong Coal Project is located to the east.

2.3.2 Climate and Base-line Monitoring

Baseline monitoring for the MCP of air quality, surface waters, ground waters, and acoustical conditions have been ongoing since December 2004. Having regard to the local topographic, climatic conditions and elongated north-south extent of EL 6288, two weather stations were installed, one in the village of Ulan (Met 1) and the other in the southern portion of the area on the Rayner property (Met 2). The area's climatic conditions are summarised as follows:

- Rainfall in the area is variable, with an average of 610 mm per annum at Ulan. Rainfall occurs throughout the year with a slightly higher seasonal distribution in summer. Intense showers, particularly in summer, characterise much of the rainfall and account for falls of up to 130 mm in 24 hour;
- On an annual basis the most common winds for the area are generally from the west and east with some winds from the northeast and east-northeast near Ulan and from the southwest in the south of the MCP area. This pattern of winds is evident in all seasons with winds from the west being more common in winter and spring;
- Hot weather is experienced in the area from October to April, with average maxima ranging from the high twenties to the low thirties. During the summer months, very hot conditions occur with temperatures ranging from 32^{o}C to more than 38^{o}C are not uncommon during these periods;
- Conditions during the other months of the year are milder, with average winter maxima about 10^{o}C cooler than summer temperatures. Overnight temperatures occasionally drop below freezing point;
- Frosts may occur from mid-April through to September and as late as mid-November. For the Ulan area, the average frequency of frosts is about 45 days per annum;
- The average number of hours of bright sunshine per day in summer months is 9 hours and in the winter months 6 hours. The average annual evapotranspiration of the Ulan area is about 1730mm; and
- The average relative humidity varies throughout the year, the winter months are typically about 20% more humid then in the summer months, most likely due to the hot dry winds during summer. During the daytime humidity varies significantly between 60 to 80% in the mornings and 40 to 60% in the afternoons for summer and winter respectively. There is little change in the relief of the humidity from mornings to afternoons throughout the year.

2.4 Constraints and Limitations to the Study

Constraints and limitations to the study include:

- Limited accessibility of some parts of the study area due to ruggedness of terrain, distance from access roads/tracks, and landholder access agreements;
- Limited mass flowering of eucalypts occurred within the study area during the survey period. Flowering was mostly gradual across the study area, with different species flowering at different times. Exceptions include mass flowering of White Box (*Eucalyptus albens*) during July-August 2005 and Broad-leaved Ironbark (*E. fibrosa*) during December 2004. This limitation may have reduced detection of some honeyeaters and parrots which may use the study area, but whose movements are governed to some extent by mass flowering events, *eg* possibly the Regent Honeyeater or Swift Parrot. Mass flowering events are reported as occurring in the study area occasionally by landholders; and
- Limited pooling of water in many of the ephemeral drainages, resulting in aquatic ecological sampling sites being generally located at constructed pools (behind rail or road crossings) and generally at the lower ends of the drainages.

2.5 Compliance with Director-General's Requirements

This report has been prepared to meet the 16th March 2006 Director-General's requirements with regard Environmental Assessment – Ecology for Stage 1 of the MCP, taking into account the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI July 2005). **Appendix 1** indicates the compliance of this report with the requirements.

Field surveys were designed and conducted in accordance with the Working Draft Guidelines *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities*' (DEC 2004). Assessment of groundwater dependent ecosystems was undertaken in accordance with the State Groundwater Dependent Ecosystem policy guidelines (DLWC 2002), and assessment of aquatic habitat was undertaken in accordance with the NSW DPI Guidelines (NSW Fisheries 1999). Aquatic invertebrate sampling and analysis was undertaken using the recommended AusRivAs method.

3 METHODS – FLORA

3.1 Research

3.1.1 Review of existing information

Various documents containing information about the biological values of the Ulan district were reviewed as part of the investigation to assist in the identification of important issues prior to detailed survey. The following documents and resources were reviewed to assist floristic investigations, with review details for selected documents are summarised in **Appendix 2**:

- DEC Wildlife Atlas Database (10km buffer to EL6288 boundary, Goulburn River National Park and Munghorn Gap Nature Reserve);
- EPBC Act Protected Matters Report (10km buffer to EL6288 boundary);
- Watkins J.J., Cameron R.G., Yoo E.K. & Colquhoun G.P. (1999): Gulgong 1:100 000 Geological Sheet 8833, 1st Edition;
- Geo-spectrum (Australia) Pty Limited (2004): Aerial Photography Scale 1:25 000 Run 1 (Frames 0025-0030), Run 2 (Frames 0015-0024) and Run 3 (Frames 0005-0014);
- Kinhill Stearns Engineers (1983): Ulan Coal Mines Stage 2 Colliery Development and Expansion Environmental Impact Statement. This EIS was prepared before commencement of either the NSW TSC Act 1995, the Commonwealth EPBC Act 1999, or Part 3A of the NSW EP&A Act. None of the threatened plant species or communities known to occur in the study area were listed at the time of this study. The studies do provide some information relating to vegetation communities in the area, and these were considered in the formulation of vegetation associations for this report (details in Appendix 2);
- NPWS (2000): "*Goulburn River National Park and Munghorn Gap Reserve: Vegetation Survey for Fire Management*". Fourteen vegetation communities were described and considered in the formation of vegetation associations in this report (details in Appendix 2). Eight threatened plant species were recorded in the Goulburn River National Park. These species are included in discussions in Appendix 2;
- NPWS (2003): *"Plan of Management for Goulburn River National Park and Munghorn Gap Nature Reserve".*
- Resource Strategies Australia (2005): Wilpinjong Coal Project Environmental Impact Statement. Eight vegetation communities were described and considered in the formation of vegetation associations in this report (details in Appendix 2). No threatened plant species were recorded during this project; and
- International Environmental Consultants Pty Limited (2005): Wollar to Wellington 330kV Transmission Line Environmental Impact Statement. A section of this transmission line traverses the study area. Five vegetation communities were described along this section, and these were considered in the formulation of vegetation associations for this report (details in Appendix 2). One threatened species was recorded during this project, and several others assessed as likely to occur. These species are included in discussions in Appendix 2.

Recovery planning for threatened plant biodiversity was also reviewed, with the only relevant threatened species with published material being *Zieria obcordata*.

Information from these resources assisted in defining threatened species habitats and targeted survey programs, the extent of biological diversity within the district and the areas of limited existing data.

A list of threatened flora species, endangered populations and ecological communities known to occur in the region is provided in Appendix 2, together with details of their local occurrence, and habitat suitability in the study area.

3.1.2 Preliminary Project Consideration and Fieldwork

An initial mine layout plan exhibiting resource recovery, infrastructure, overburden emplacement and rehabilitation areas was reviewed to identify the following areas prior to the initiation of survey design and data collection.

- Direct impact (*ie* open cut and infrastructure placements);
- Indirect impact (*ie* subsidence from underground workings and dust); and
- Residual unaffected lands.

This initial mine layout plan allowed for the focusing of field survey design over areas of greatest impact.

Areas located outside the impact zone (*ie* areas of opportunity) were examined to identify lands that may potentially offset the mining impacts.

The field component of a preliminary scoping study was completed on 21st October 2004 to classify, in general terms, the extent of floristic variability against factors such as topography, geology, land use and aspect. The purpose of this initial site investigation was to provide a visual perspective to the details contained within the reviewed reference material and assisting the development of data collection protocols, survey stratification and sampling regime.

3.2 Identification of Terrestrial Stratification Units

3.2.1 Broad Vegetation Communities

Aerial photography interpretation (API) of 2004 photography at a scale of 1:25,000 was used in conjunction with preliminary field investigations to identify broad vegetation communities (*ie* vegetation stratification units) and their relative position within the topographic landscape.

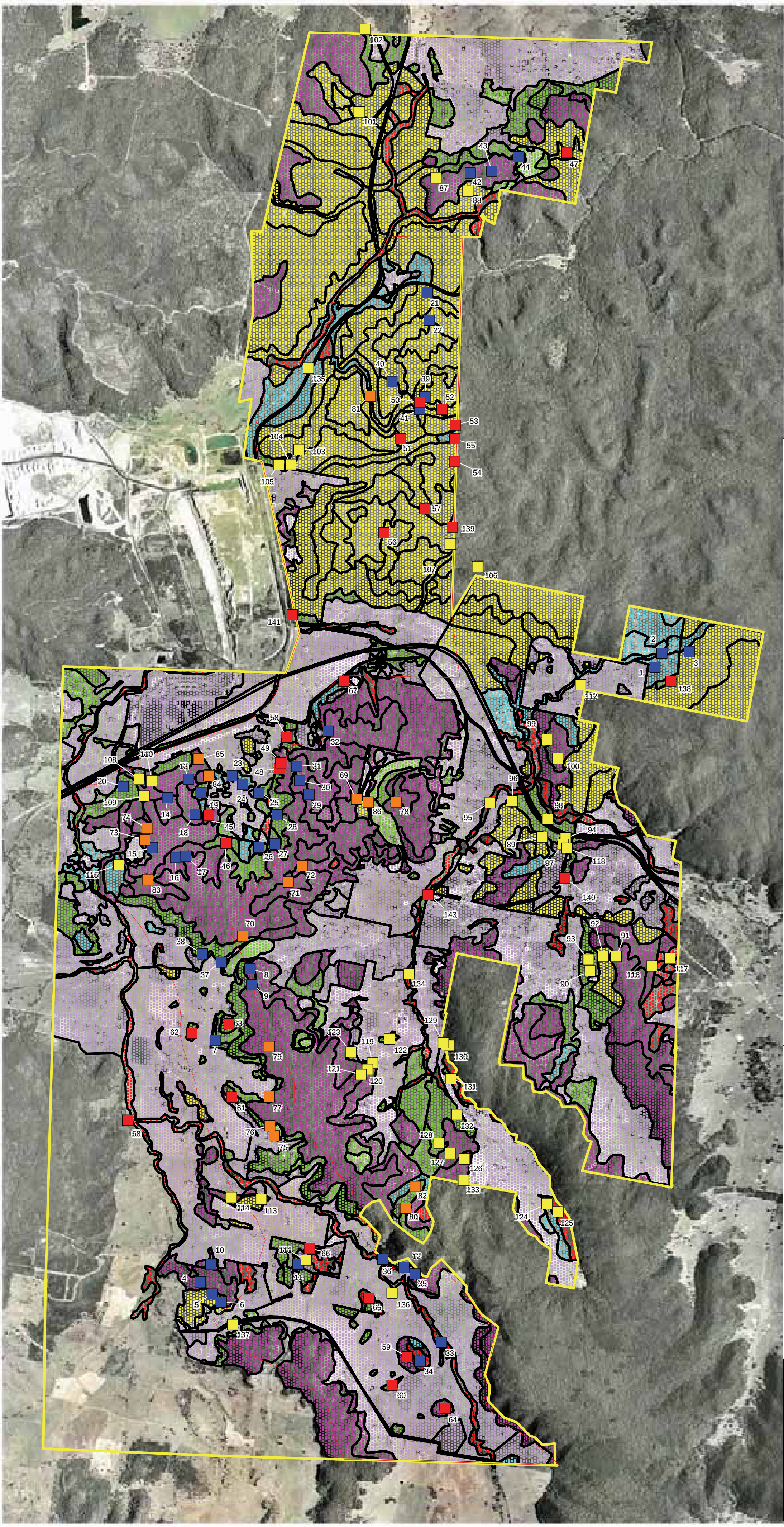
These broad vegetation types were digitised into the supporting Geographical Information System (GIS) using onscreen digitising methods on an ortho rectified image of the study area. Geological maps were also imported into the GIS, to further refine the boundaries of these broad vegetation communities.

3.2.2 Terrestrial Stratification Units

Map units derived from API and preliminary investigations, which resulted in the identification of 'Broad Vegetation Communities', were sampled using systematic methods (i.e. quadrats) to verify and describe these initial classifications (refer to Chapter 3.3 for description of survey methods). Verified broad vegetation communities map units were then referred to as 'Terrestrial Stratification Units' (i.e. TSU's), which formed the base stratification layers for the development of the terrestrial survey regime for the study area. The following TSU's have been identified throughout the study area:

10 Disturbed Vegetation
20 Sedimentary Ironbark Forests
30 Box Woodlands
40 Tableland Redgum Woodlands
50 Sedimentary Scribbly Gum Woodlands
60 Apple Alluvial Forests

Figure 3.1 identifies the distribution of these TSU's throughout the study area.



N

0 1.5 3

kilometres

Legend

- Summer (44)
- Autumn (29)
- Winter (19)
- Spring (51)

(Number refers to quadrat count)

Terrestrial Stratification Units (Broad Vegetation Communities)

- 10 Disturbed Vegetation
- 20 Ironbark Forests
- 30 Box Woodlands
- 40 Tablelands Redgum Woodlands
- 50 Scribbly Gum Woodlands
- 60 Alluvial Apple Forests

(Number refers to TSU type)

Other Mapped Features

- Field Verfieid Photoyping
- Development Application Area
- EL 6288 (Study Area)

Figure 3.1

Terrestrial Stratification Units (TSUs)

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_3_1_TSUs

Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

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3.2.3 Vegetation Associations

Stereoscopic analysis of aerial photography interpretation (API) also identified a range of sub-unit phototypes within each TSU. Sub-unit phototypes often correlated with changes in aspect and topography (*ie* ridge tops, midslopes and valleys). These subunit phototypes represent the potential occurrence of vegetation associations (*ie* variability within the broad vegetation communities), but may also appear due to structural differences resultant from historical land uses or changes in soil conditions.

These sub-unit phototypes were taken into account during the survey design, so that separate distinctive vegetation associations could be identified and used to enhance the understanding of each TSU. The black lines of Figure 3.1 represent the field verified phototyping contained within each of the TSU's for the study area. **Figure 3.2** identifies the vegetation associations of the MCP DA area.

3.3 Field Surveys

3.3.1 Survey methods

Investigating the floristic variation within the study area was completed by sampling the Terrestrial Stratification Units (as identified in Chapter 3.2.2 above) using a combination of systematic and opportunistic survey methods defined as follows:

Systematic: Represents observations collected within a predefined sample area and reflects the underlying survey regime designed to evaluate the main sources of landform/floristic variability such as aspect, slope, soil type/ geology and topographic position.

The locations of these systematic survey methods are defined through a combination of API, preliminary site visits, topographic analysis and review of geological maps. Systematic survey methods were replicated (repeated) to identify the characteristic species that define a mapped area. The greater the number of replicate samples the more accurate the definition of characteristic species.

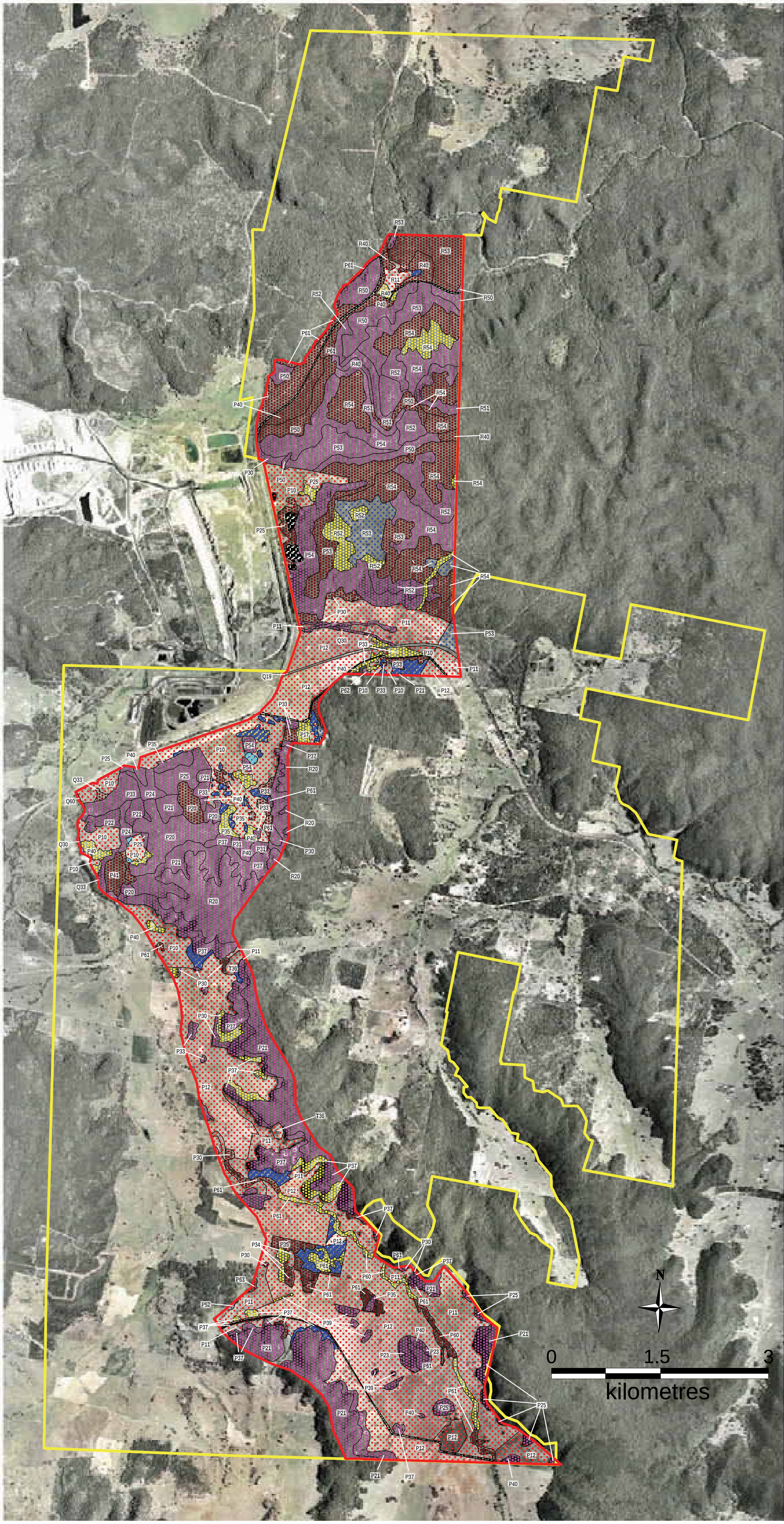
Opportunistic: Observations collected outside the structure of a stratified, randomised and replicated survey regime. These observations are generally biased by the observers' position within the landscape and the perception of the species importance (*eg* the observers subjective views). However, many opportunistic observations are a consequence of targeted surveys for threatened and/or seasonal species such as ground orchids.

While these observations do not provide meaningful input in the development of vegetation models (*ie* defining vegetation communities and associations based on characteristic species), they are useful in ascertaining the extent of floristic variability within a mapped area, particularly in disturbed areas or ecotones between vegetation communities/ associations.

The combination of the above two sampling methods provides opportunity to define the floristic character of a TSU (*ie* systematic survey results) and the extent of floristic diversity (*ie* systematic and opportunistic results). Sampling methods used in this survey are described in **Table 3.1** below.

Sampling was used to verify the TSU mapping, describe the variability within each TSU (*ie* sub-unit vegetation associations) and to assist the definition of vegetation association boundaries. A minimum of one systematic survey method (*ie* quadrat or transect) was placed within each sub-unit phototype.

Non-systematic survey methods (*ie* opportunistic observations) were generally restricted to areas linking systematic survey sites or targeted searches for cryptic, seasonal and/or threatened species.



Legend

- Grassland
- Shrubland
- Open Woodland
- Woodland
- Open Forest
- Hardstand
- Mineral Earth

istur ed e etation
Small map units

- Sifton Bush
- Mudgee Wattle
- Claystone Mine
- Roadside Vegetation

Other Mapped Features

- Development Application Area
- EL 6288 (Study Area)

A

10 Unimproved Ungra ed
11 Unimproved Gra ed
12 Improved Cropped
13 Sifton Bush
16 Mudgee Wattle
18 Roadside Vegetation
20 Broad leaved Ironbark Grey Gum
21 Ironbark Grey Gum Stringybark
22 Ironbark Black Cypress Pine
23 Black Cypress Pine
24 Narrow leaved Ironbark Red Stringybark
30 ellow Box Red Stringybark
Blakely s Redgum
31 White Box Narrow leaved Ironbark
33 Grey Box Narrow leaved Ironbark
Blakely s Redgum
34 Grey Box Ironbark Slaty Gum
35 Grey Box Ironbark
36 Grassy White Box
3 Shrubby White Box
39 Slaty Gum
40 Blakely s Redgum
41 Tumbledown Redgum
50 Inland Scribbly Gum Rough barked Apple
51 Inland Scribbly Gum Blue leaved Stringybark
52 Inland Scribbly Gum Black Cypress Pine
53 Inland Scribbly Gum Stringybark Ironbark
54 Inland Scribbly Gum Ironbark
60 ellow Box Rough barked Apple
61 Rough barked Apple
63 Rough barked Apple Grey Box
(P Permian R Narrabeen T Basalt
Alluvial C Carboniferous urasic)

Figure 3.2

egetation ssociations

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_3_3_Associations
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

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Table 3.1 Flora Survey Methods

Method	Survey Class	Dimensions and Area	Use	Position Selection Criteria
Quadrats	Systematic	20X20m (400m^2)	Non-linear homogenous phototypes	At least 20 m from ecotone or hard boundaries
Transects	Systematic	50X8m (400m^2)	Linear homogenous phototypes	Along targeted sampling gradient (*ie* riparian environment).
Random Meander	Opportunistic	Region defined as observation point with radius 5m (*ie* 75m^2)	Homogenous and heterogenous vegetation	Opportunistic observations in heterogenous vegetation (*eg* disturbed vegetation, ecotones, partially cleared lands).
Targeted	Opportunistic	Variable. Generally the entire ecotone or environmental gradient being targeted.	Homogenous and heterogenous vegetation	Targeted searches for threatened species, particularly in heterogenous vegetation (*eg* disturbed vegetation, ecotones, partially cleared lands).

3.3.2 Survey placement and intensity in relation to Terrestrial Stratification Units

Survey work was proportioned to adequately sample areas of impact in addition to locations suitable for the definition of TSU's and vegetation associations. The MCP mine layout was overlaid on the Terrestrial Stratification Unit map to identify the general extent of vegetation clearing, hence provide a focus for field surveys. Survey replication was greatest in areas of direct impact (*ie* open footprints), with reduced replication in areas of limited to no impact. **Table 3.2** identifies the extent of systematic surveys for the study area and DA area.

Table 3.2 Quadrat count and survey area for Terrestrial Stratification Units within the study area and MCP DA area.

TSU	Quadrat Count and Area - Study Area	Quadrat Count and Area – MCP DA area
10	7 (0.28 ha)	3 (0.12 ha)
20	35 (1.40 ha)	12 (0.48 ha)
30	47 (1.92 ha)	31 (1.24 ha)
40	15 (0.60 ha)	7 (0.28 ha)
50	29 (1.16 ha)	17 (1.12 ha)
60	10 (0.40 ha)	4 (0.28 ha)
Total	143 (5.72 ha)	74 (2.96 ha)

Quadrat sampling was not undertaken within the ecotones between TSU's as ecotones influence the quality of the systematic dataset hence substantially affecting its value for describing TSU's and vegetation associations. Accordingly, opportunistic/ targeted surveys were employed as an alternative survey method within these areas to identify species that may restrict the majority of their natural distribution to these ecotones.

Opportunistic surveys were also completed to assist the definition and description of phototypes, particularly those located within unaffected lands. Repeated targeted survey methods were used to sample habitats capable of supporting threatened species such as ecotones and disturbed vegetation boundaries.

Survey intensity was calculated by summing the area of quadrats examined within each Terrestrial Stratification Unit as shown in Table 3.2 above. A more complete breakdown of seasonal survey effort within each TSU and sub-unit vegetation association is provided in **Appendix 3**.

3.3.3 Data Collection

Species observations were collected using two general sampling methods: systematic and opportunistic observations. Each observation was described using a set of predefined descriptors (*ie* fields). The extent of information collected for each observation is detailed in **Table 3.3** below.

Table 3.3 Species observations data fields

Information	**Format**
Site Number	Systematic methods - Incremental numbers starting from 1 Opportunistic methods – 2000 Autumn – 3999 Winter – 3999 Spring
Co-ordinates	Projection – Map Grid of Australia 1994 (MGA94) Australian Map Grid zone 55 Easting (6 digit number to 4 decimal places) Northing (7 digit number to 3 decimal places)
Date	Day-month-year
Observer's Name	Mark Aitkens
Observation Type	Quadrat, Transect, Opportunistic
Species Identification	Family, Genus and Species Name (Harden 1993, 1994, 2000, 2002)
Braun Blanquet	One digit number 1- Rare cover less than 5% 2- Common cover less than 5% 3- Cover between 5 and 25% 4- Cover between 25 and 50% 5- Cover between 50 and 75% 6- Cover between 75 and 100%
Stratum	1 – Tree Canopy 2 – Midstorey 3 – Groundcover 4 – Mistletoe and Vines
Maximum Species Height	Dominant Species – meters (2 digit number with 1 decimal place)
Minimum Species Height	Dominant Species – meters (2 digit number with 1 decimal place)
Maximum Stratum Height	Meters (2 digit number with 1 decimal place)
Minimum Stratum Height	Meters (2 digit number with 1 decimal place)
Stratum Cover	Percent (2 digit number)
Comments	Up to 255 characters.

The information identified in Table 3.3 (*ie* fields) were collected digitally using specialised software (*ie* GBM Mobile v3.11) as a field mapping extension to a desktop Geographical Information System (GIS) (*ie* MapInfo v7.5). GBM Mobile v3.11 was supported by a personal digital assistant (PDA) and Bluetooth enabled 20 station Geographical Positioning System (GPS). Hardware components were chosen for their enhanced display capabilities, stability (*ie* HP4700) and capability beneath the tree canopy (*ie* GlobalSat GPS). A handheld GPS (Magellan Explorist 100) combined with topographical maps (Gulgong 1:25 000; Wollar 1:25 000; Durridgere 1:25 000 map sheets) were used as an alternative/backup, where needed. Accordingly, no datasheets per quadrat sample were created, rather an interactive database that was editable both in the field and on desktop environments.

3.3.4 Seasonality and survey dates

Floristic surveys are often inherently biased by the absence of seasonal surveys. Seasonality is particular important when determining the extent of floristic diversity, hence availability of fauna habitat resources such as nectar supplies. Accordingly, the sampling regime incorporated seasonality into the survey design (*ie* 12 month timeframe including sampling within each of the seasons) to assess the extent of floristic diversity. Matters adequately addressed by a seasonally based survey design are:

- Temporal changes in floristic variability (*ie* orchid flowering); and
- Collection of sufficient plant material for definitive identification purposes (*ie* flowers and seed pods of *Acacia* species, which are often discrete events at different times of the year).

The field survey was designed to maximise the identification of the study area's floristic diversity using seasonality (minimum four seasons for a continuous 12 month period) in combination with a stratified, randomised and replicated sampling regime for phototypes identified through API. Floristic surveys involved the sampling of 143 quadrats during the survey dates detailed in **Table 3.4.**

Table 3.4 Flora Survey Dates

Dates	Survey Extent
21 October 2004	Preliminary field investigation
4-12 December 2004	Quadrats 1-22
23-26 January 2005	Quadrats 23-43
April 2005	Quadrats 44-68 and opportunistic records
26-30 June 2005	Quadrats 69-70 and opportunistic records
3-10 July 2005	Quadrats 71-83 and opportunistic records
4-8 August 2005	Quadrat 84 and opportunistic records
9-17 September 2005	Quadrats 85-109, opportunistic records, targeted orchid searches
10-14 October 2005	Quadrats 110-122, opportunistic records, targeted orchid searches
21-25 November 2005	Quadrats 123-138, opportunistic records, targeted orchid searches
1-4 April 2006	Quadrats 139-143, opportunistic records

3.3.5 Plant species identification and nomenclature

Plant identification and nomenclature follows guides and formats used in the following texts:

- Flora of NSW Volumes 1, 2, 3 and 4 (Harden, 1992; Harden 1993; Harden, 2000; Harden 2002);
- Grasses of NSW (Wheeler *et al* 2002);
- Pasture plants of the slopes and tablelands of NSW (Kahn et al 2003); and

- Grassland Flora; a Field Guide for the Southern Tablelands (NSW and ACT) (Eddy et al 1998).

The PlantNet (http://plantnet.rbgsyd.nsw.gov.au/) online identification guide was also used to assist with plant identifications, and to check with recent name changes.

Specimens of uncertain identity were collected and sent to the National Herbarium of NSW for formal identification.

3.3.6 Plant species determination of status

The conservation significance of plant species and vegetation communities recorded during the surveys was determined in accordance with the following:

- Schedules 1 and 2 of the NSW Threatened Species Conservation Act 1995;
- Schedules 1 and 2 of the Commonwealth Environment Protection and Biodiversity Act 1999.

The identification of White Box Yellow Box Blakely's Red Gum Woodland within the study area was determined using the identification guidelines published by the NPWS (2002) – refer to Chapter 3.4.4 below.

3.4 Interpretation of Data

3.4.1 Plant species richness as a test of survey methods

The study area was sampled using two methods with **Table 3.5** summarising the results of both survey methods in terms of species richness and survey area. The total area subject to systematic/ opportunistic seasonally adjusted surveys is equivalent to 9.88 ha or approximately 0.1% of the study area.

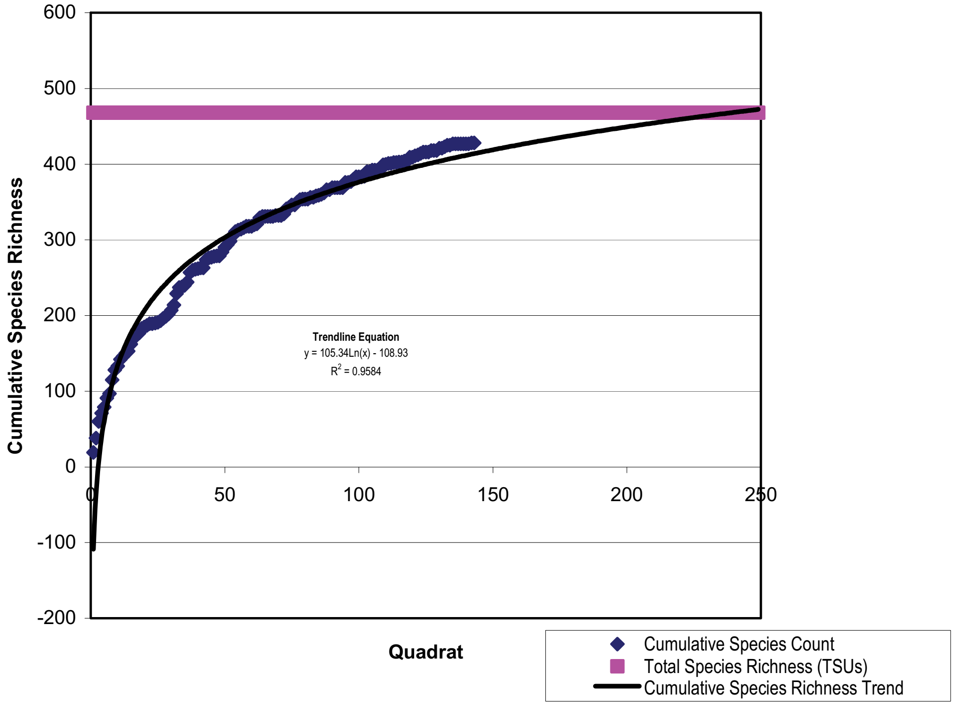
Table 3.5 Summary of flora survey results for each survey method.

Survey Method	Observation Count	Attributed Species Richness	Survey Area (ha)
Quadrats	4,161	428	5.72
Opportunistic/ Targeted - Broad Vegetation Communities	479	42	2.84
Opportunistic/ Targeted - Ecotones	320	30	1.32
Total	4,960	500	9.88

The systematic and opportunistic/targeted floristic survey identified 500 plant species from 4,960 observations. 4,161 observations are attributed to systematic quadrats with the remaining 799 from opportunistic/ targeted surveys. Of the total observed species diversity, 428 were observed during quadrat sampling with the remaining 72 observed during opportunistic/targeted surveys. Forty-two species observed exclusively by opportunistic/targeted methods that were located wholly within one of the six TSU's, with the remaining 30 species observed within the ecotone or disturbed boundaries between TSU's (*ie* ecotone determined to be a 20m buffer around each TSU).

A cumulative species count for observations collected from the 143 surveyed quadrats (*ie* 428 species) was plotted on a chart to review the 'survey completeness' by analysing the resultant 'species richness curve'. **Figure 3.3** illustrates the resultant 'Species Richness Curve', including the total number of species observations for TSU's for all survey methods (excluding observations from ecotone/ disturbed areas) and the mathematical relationship that describes the resultant trendline or species richness curve. Also shown on Figure 3.3 is an R^2 value, a correlation value that is indicative of the relationship strength between the raw quadrat values and derived mathematical formula. A R^2 value exceeding 0.95 is indicative of a statistically valid relationship.

Figure 3.3 Flora Species Richness Curve



The species richness curve was also compared with the total species count for observations collected wholly within TSU's (*ie* observations located within TSU's excluding those associated with ecotone areas). This value was derived from the results of systematic and opportunistic/targeted survey methods (*ie* 428 species from quadrats + 40 species from opportunistic surveys = 468 species). This comparison allowed for the estimation of the number of 'additional quadrats' required to observe the entire species list recorded during this study. This value was calculated by extrapolating the 'species richness curve' to meet the species richness value for all TSU's.

From Figure 3.3, it is estimated that the number of additional quadrats required to account for all species observations derived from systematic and opportunitic surveys within TSU's is approximately 96, which equates to an area of 3.84ha (*ie* estimated quadrats (96) X Quadrat Area (0.04ha)).

The estimated quadrat area was then compared with the 'actual total area' of opportunistic observations located wholly within broad vegetation communities (*ie* 40 plant species from 479 observations). The actual total area attributed to the 40 observations was calculated by aggregating the area of each opportunistic observation (*ie* area of each observation = 0.0074ha, calculated by a 5m buffer for each observation), with all buffer overlaps being eliminated. The actual total area attributed to opportunistic observations within TSU's was calculated to be 3.59ha.

In summary, it is considered that the opportunistic sampling regime within TSU's is comparatively similar in area to the estimated area associated with the additional 94 quadrats calculated from the species richness curve (*ie* 3.84ha for quadrats compared with 3.59ha for opportunistic observations). In the absence of opportunistic/ targeted surveys at least 40 species would have been missed by the quadrat sampling approach. This indicates that the use of opportunistic/targeted surveys, in combination with systematic survey methods, is an efficient survey approach that improves the data acquisition for species with low abundance, seasonal occurrence and/or habitats. The identification of 32 species exclusively within ecotones or disturbed boundaries also strengthens the value of a holistic survey approach that combines systematic and opportunistic/ targeted survey regimes.

3.4.2 Statistical Analysis of Systematic Quadrat Data

The systematically collected data (*ie* quadrats) was analysed using statistical software to aid the classification of vegetation associations. TWINSPAN (**Tw**o-way **in**dicator **sp**ecies **an**alysis), a windows based statistical package (Hill & Milauer, 2005), was used for this purpose.

TWINSPAN is a computer program designed primarily for ecologists and vegetation scientists who have collected data on the occurrence of a set of species in a set of samples. The statistical program first constructs a classification of the samples, and then uses this classification to obtain a classification of the species according to their ecological preferences. The two classifications are then used together to obtain an ordered two-way table that expresses the species' synecological relations as succinctly as possible.

To summarise, TWINSPAN makes its dichotomies by dividing ordinations in half. There are three ordinations involved:

1. The **primary ordination** (correspondence analysis), which is divided to obtain an initial, crude dichotomy;
2. The **refined ordination**, which is derived from the primary ordination through the identification of differential species; and
3. The **indicator ordination**.

With the exception of borderline cases, the refined ordination is the one that is used to determine the dichotomy. The indicator ordination is essentially an appendage, put there for the convenience of users who want a succinct characterisation of the dichotomy.

The analysis included a weighting for canopy dominants to assist the characterisation of the dichotomy. This analysis confirmed the variation identified within each TSU, otherwise referred to as phototypes or sub-unit vegetation associations (see Section 3.2.3), of which there are at least 35 vegetation associations within the study area. Mapping focusing on the MCP DA area has selected 31 of these vegetation associations. Descriptions for each of these vegetation associations are provided in Appendix 3.

3.4.3 Quantitative method to describe TSU's and sub-unit vegetation associations

Broad vegetation communities were initially identified qualitatively using aerial photography interpretation and preliminary site inspections (Chapter 3.1.4). TSU's and sub-unit vegetation associations were subsequently confirmed and described using data from the systematic quadrat sampling regime by grouping species observations for each TSU and vegetation association using the modified Braun Blanquet cover abundance values and the frequency of observations for each species.

Species were grouped in descending order of importance for each TSU and vegetation association (*ie* GIS query using the field verified TSU and vegetation association maps). The following algorithm determined species importance:

$$\text{Species Importance} = \text{Braun Blanquet Score}_{\text{Quadrat}} \times \text{observation count}_{\text{vegetation association}}$$

This algorithm identifies the most commonly encountered species within each vegetation association by limiting the prominence of infrequent observations with high modified Braun Blanquet scores. For example, a species importance ranking that utilises individual species observations would artificially elevate the significance of rarer species (*ie* one observation with a high modified Braun Blanquet score) against an abundant characteristic species with a consistently lower modified Braun Blanquet. Conversely, the single rarer observations were also examined to identify 'unique' diversity for each vegetation type (*ie* indicator species). The descriptions resulting from this analysis are provided in Appendix 3.

3.4.4 Determination of Endangered Ecological Community (EEC)

One endangered ecological community listed under the NSW TSC Act is of relevance to the study area – White Box Yellow Box Blakely's Red Gum Woodland. Components of this community are also included within the threatened ecological community – Grassy White Box Woodlands, which is listed separately under the Commonwealth EPBC Act. The presence of this EEC within the study area was examined and determined using the two following methods:

- The Identification Guidelines for White Box Yellow Box Blakely's Red Gum Woodland (NPWS, 2002); and
- A statistical analysis of quadrats using TWINSPAN with weightings applied to the diagnostic species of this EEC, as listed by the NSW Scientific Committee (2002).

Box – Gum Guidelines
Each vegetation association within the study area was tested against the Box-Gum identification guidelines, with the results shown in **Table 3.6** below (table adapted from NPWS 2002). Vegetation associations compliant with the identification guidelines are classified as White Box Yellow Box Blakely's Red Gum Woodland, which are presented in the last row of the table against identification item 5.

In summary, the Box-Gum Guidelines identify the following seven vegetation associations being similar to White Box Yellow Box Blakely's Red Gum Woodland:

- 10 – Unimproved Ungrazed Grasslands (where located immediately below basalt outcrops);
- 30 – Yellow Box/Red Stringybark/Blakely's Red Gum Woodland;
- 31 – White Box/Narrow-leaved Ironbark/Blakely's Red Gum Woodland;
- 33 – Grey Box/Narrow-leaved Ironbark/Blakely's Red Gum Woodland;
- 36 – Grassy White Box Woodland;
- 40 – Blakely's Red Gum Woodland;
- 60 – Rough-barked Apple/Yellow Box Woodland.

Table 3.6 Identification of White Box Yellow Box Blakely's Red Gum Woodland (NPWS 2002).

Key For Identifying Box–Gum Woodland (NPWS 2002)	Compliant Vegetation Associations	Non-compliant Vegetation Associations
1 The site is in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands or NSW South Western Slopes Bioregions: **1*** The site is outside the above bioregions: **(vegetation not classed as Box-Gum Woodland)**	All mapped vegetation **Go to 2**	N/A
2 There are no native species in the understorey, and the site is unlikely to respond to assisted natural regeneration. **(vegetation not classed as Box-Gum Woodland)** **2*** The understorey is otherwise:	10,11,13,14-24,30-31,33-41,50-54,59-63 **Go to 3**	12 **END**
3 The site has trees: **3*** The site is treeless, but is likely to have supported White Box, Yellow Box or Blakely's Red Gum prior to clearing:	10,11,13,14-24,30-31,33-41,50-54,59-63 **Go to 4**	N/A
4 White Box, Yellow Box or Blakely's Red Gum, or a combination of these species, are or were present: **4*** White Box, Yellow Box or Blakely's Red Gum have never been present: **(vegetation not classed as Box-Gum Woodland)**	10,11,13,30-31,33, 36-37,40, 60 **Go to 5**	15-24,34-35,41, 50-54,59,61-63 **END**
5 The site is predominantly grassy: **(vegetation is classed as Box-Gum Woodland)** **5*** The understorey of the site is dominated by shrubs excluding pioneer species: **(vegetation not classed as Box-Gum Woodland)**	10,30, 31,33,36,40, 60 **END**	10,11,13,37 **END**

Note that two vegetation associations, whilst displaying some characteristics to the above associations, are not part of the White Box Yellow Box Blakely's Red Gum Woodland EEC classification due to the following:

- 25 Ironbark Slaty Gum Forest – Q4 of Table 3.6 – this vegetation association does not currently and has never contained one or more of the dominants White Box and/or Yellow Box and/or Blakely's Red Gum, with the absence of these dominants attributed to the infertile soils rather than past clearing events. See further discussion of this point in Appendix 2;
- 37 Shrubby White Box Open Forest – Q5 of Table 3.6 - the landscape containing this vegetation association is steep and rocky (midslopes and upper slopes) and is characterised by non-pioneer shrubs such as Honeypots *Acrotriche rigida*, Peach Heath *Lissanthe strigosa* and Black Cypress Pine *C. endlicherii*. The grassy-herbaceous groundcover stratum is sparse rarely exceeding 20% cover, thereby not giving a 'grassy' appearance. The NPWS (2002) guidelines state "*shrubby woodlands, which generally occur in upper or midslope situations on shallower soils, are not part of the EEC*". See further discussion of this point in Appendix 2.

Statistical Analysis
A TWINSPAN analysis of quadrat data, with weightings applied to diagnostic species published in the final determination for White Box Yellow Box Blakely's Red Gum Woodland EEC, was also completed to compliment the conclusions from the Box-Gum Woodlands identification guide. This analysis identified a generally similar trend for the distribution of this EEC throughout the study area, which concluded the majority of Box-Gum Woodlands to be located throughout the valley floor. **Figure 3.4** illustrates the results of this statistical analysis using coloured themes to display floristically similar quadrats including those similar to White Box Yellow Box Blakely's Red Gum Woodland:

- Red - Quadrats considered similar to the White Box Yellow Box Blakely's Red Gum Woodland EEC definition;
- Green - Quadrats exhibiting transitional qualities between White Box Yellow Box Blakely's Red Gum Woodland and adjoining vegetation types with grassy understorey;
- Blue - Quadrats exhibiting transitional qualities between White Box Yellow Box Blakely's Red Gum Woodland and adjoining vegetation types with a shrubby understorey; and
- Pink - Quadrats exhibiting few similarities with the White Box Yellow Box Blakely's Red Gum Woodland EEC definition.

The general trend derived from the TWINSPAN analysis indicates the lower midslope and drainage line landscapes are likely to contain vegetation that is floristically similar to White Box Yellow Box Blakely's Red Gum Woodland EEC (*ie* quadrats coloured red and green). However, one of the red coloured quadrats is considered an anomalous result (*ie* 119), a quadrat that is highly disturbed and contains mainly native grass species, few herbs and no tree canopy species. None of the diagnostic tree canopy species occur within this quadrat or are likely to occur within the adjoining landscape.

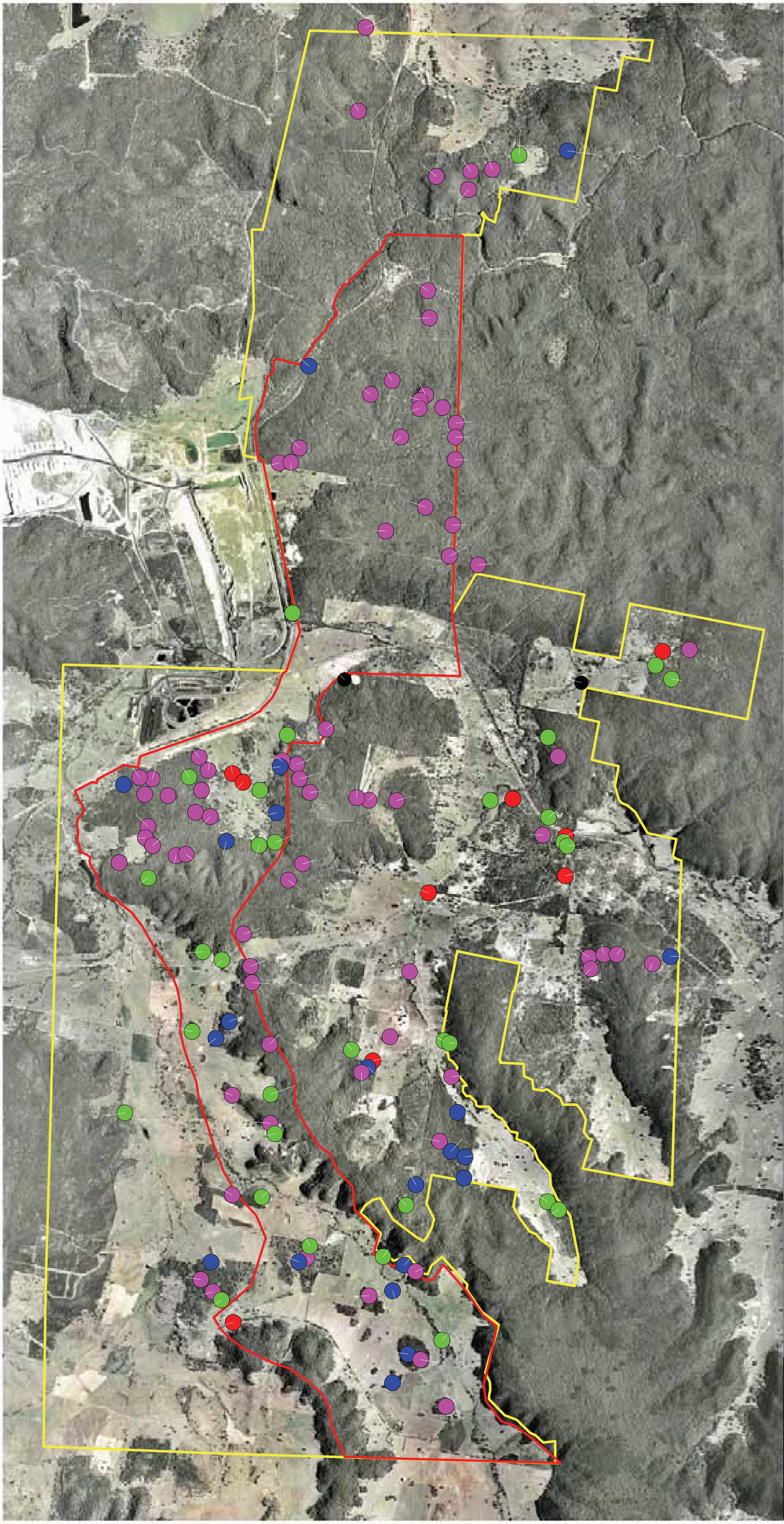
Quadrats coloured green on Figure 3.4 are characteristic of a transitional landscape between the Box Woodlands and Sedimentary Woodlands/ Forests, with the characteristics floristics being a grassy understorey with some shrubs. A canopy dominant characteristic of the White Box Yellow Box Blakely's Red Gum Woodland EEC may also be present. Green coloured quadrats occurring in the hilly portions of the study area are generally associated with basalt caps, a geological formation conducive to the occurrence of White Box Yellow Box Blakely's Red Gum Woodland EEC due to elevated soil fertility. Green coloured quadrats are generally located nearby the interface between cleared lands and existing native vegetation cover, which is potentially indicating lower soil fertility and reduced agricultural capability.

In contrast, the blue coloured quadrats generally represent vegetation containing a well developed shrubby understorey, reduced quantity of diagnostic species and lower grass coverage. Many of these areas of native vegetation are dominated by White Box *E. albens* on steep carboniferous claystones, which are not considered part of the White Box Yellow Box Blakely's Red Gum Woodland EEC.

Interestingly, quadrat 7 was placed within this category, with the floristics of the associated vegetation remnant containing both Yellow Box *E. melliodora* and Blakely's Redgum *E. blakelyi*. While it is considered that the vegetation remnant described by quadrat 7 is associated with the broader White Box Yellow Box Blakely's Red Gum Woodland EEC (i.e. Box-Gum Woodland Identification Guidelines), the TWINSPAN analysis has classed this vegetation as a shrubby intergrade that is not included within the EEC determination. This descrepency is likely to be attributed to the influence of the adjoining agricultural landscape and past clearing events, representing a disturbance history that favours the growth of shrubs.

Finally, pink coloured quadrats represent the distribution of native vegetation that contains a few diagnostic species. These quadrats are generally associated with conglomerate geologies derived from both the Permian and Narrabeen geological formations throughout the elevated parts of the study area. These quadrats are not part of the White Box Yellow Box Blakely's Red Gum Woodland EEC.

White Box Yellow Box Blakely's Redgum Woodland Distribution
Figure 3.5 illustrates the distribution of White Box Yellow Box Blakely's Redgum Woodland for the MCP area in accordance with the results of the Box-Gum Woodland Guideline and TWINSPAN statistical analysis. It is considered that this map represents a conservative estimate of the local distribution of this EEC.



N

0 1.5 3
kilometres

Legend

- Similar to WB BBRW
- Mod similar to WB BBRW (grassy)
- Mod dissimilar to WB BBRW (shrubby)
- Dissimilar to WB BRBW Woodland

(WB BBRW White Box ellow Box Blakely s Redgum Woodland)
(Number represents quadrat reference)

Other Mappin Features

Development Application Area

EL 6288 (Study Area)

Figure 3.

T S esults (eig ted anal sis)

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_3_4_Stats
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

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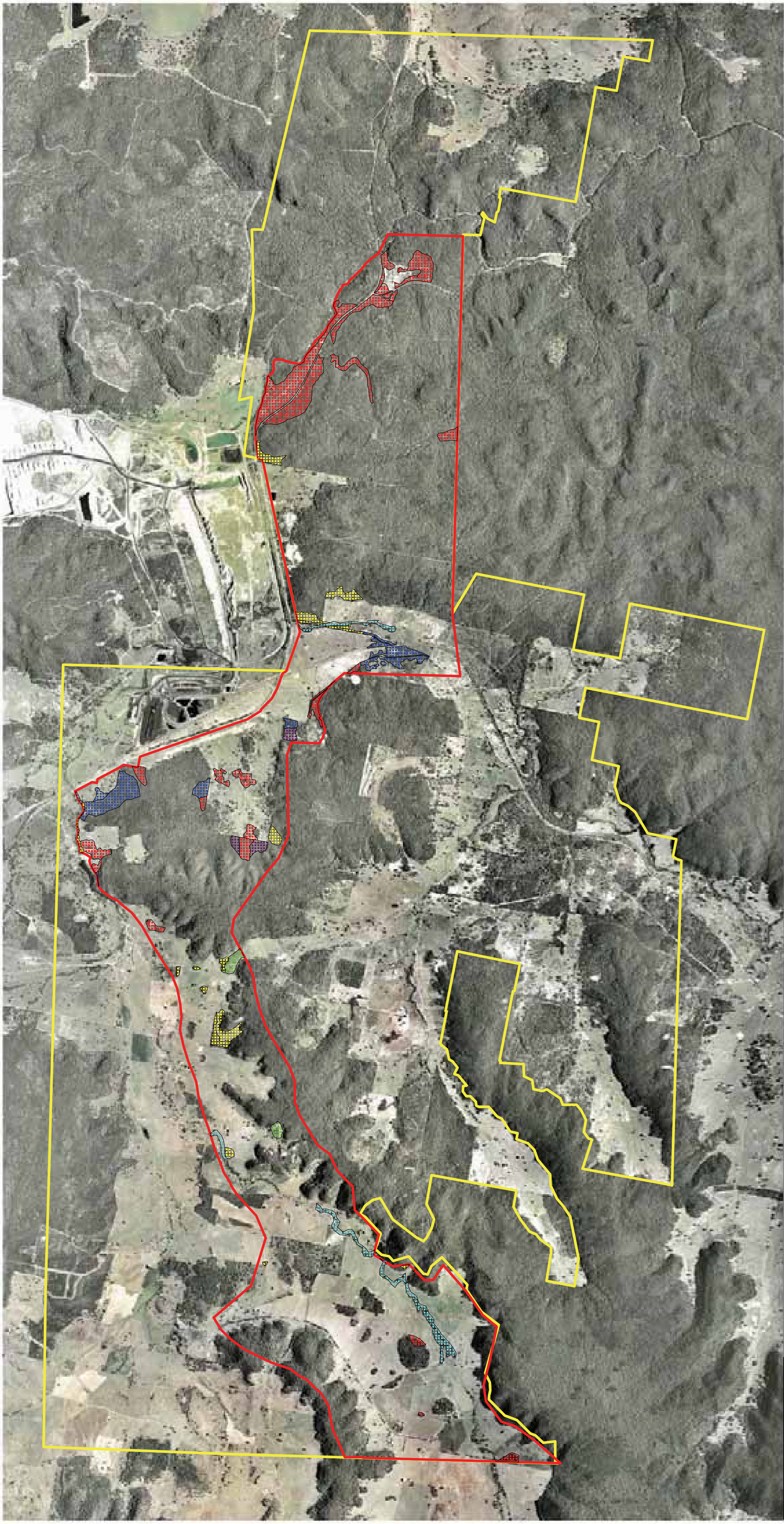


N

0 1.5 3

kilometres

Legend

- 30 Yellow Box/ Red Stringybark/ Blakely's Redgum
- 31 White Box/ Narrow-leaved Ironbark
- 33 Grey Box/ Narrow-leaved Ironbark/ Blakely's
- 36 Grassy White Box
- 40 Blakely's Redgum
- 60 Yellow Box/ Rough-barked Apple

(Numbers refer to Vegetation Association)

Other Mappin Features

- Development Application Area
- EL 6288 (Study Area)

Figure 3.5

istri ution o ndangered co ogica o unities

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_3_5_EECs
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

MOOLARBEN BIOTA

3.4.5 Identification of Groundwater Dependant Ecosystems

What is a Groundwater Dependant Ecosystem?
Shallow groundwater of high water quality can support terrestrial vegetation, such as forests and woodlands, either permanently or seasonally as a Groundwater Dependant Ecosystem (GDE). Typically these GDEs occur in coastal locations either on deep sands, around wetlands or alongside rivers and large creeks. However, examples of inland GDEs may include River Redgum on floodplains, hanging swamps or valleys on the tablelands or artesian mound springs.

A number of different types of GDEs area also described such as:

- Terrestrial;
- Base flow in streams;
- Aquifer and cave ecosystems; and
- Wetlands.

In relation to the floristic assessment of the MCP DA Area, only terrestrial, base flow and wetland GDEs will be considered.

Assessment of Groundwater Dependant Ecosystems
The eight-step rapid assessment process contained within *The NSW State Groundwater Dependant Ecosystem Policy* (DLWC, 2002) was used to identify and assess terrestrial, base flow and wetland GDEs within the MCP DA area. Assessment of GDE significance was made by examining the species composition, with high value GDEs represented by vegetation containing threatened biodiversity and/or regionally significant species.

Initial GDE identification was done by examining mapped vegetation units (i.e. vegetation associations) against their potential relationship with groundwater. Potential GDEs too small to map were assessed by overlaying the location of all known surface seepages with the native vegetation map for the MCP DA area. Wells Environmental Services supplied the location of known water seepages, which were collected during a field investigation with the relevant landholders using a hand held GPS location aid. Seepages that coincide with native vegetation such as ferns, sedges and other moisture affiliated species represent potential GDEs, which were then analysed to determine their status against the policy. Seepages occurring within disturbed agricultural landscapes were not considered GDEs.

3.4.6 Criteria to categorise areas of high ecological value

The following criteria have been used to categorise areas within the study area as being of high floristic ecological value:

- Areas of White Box Yellow Box Blakely's Red Gum Woodland (identified in Chapter 3.3.2 above);
- Known locations for threatened species, *ie* patches of habitat where the subject species have been recorded;
- Likely habitat for threatened species, *ie* vegetation associations that may contain threatened
- Vegetation condition - measured by examining the presence of weeds/exotics and existing structural status (i.e. grassland, woodland, forest) relative to the expected natural state vegetation structure; and
- Vegetation location - areas of vegetation of particular value due to their location include: vegetated lands offering connectivity between larger remnants, such as those contained in the adjoining reserve network; and disturbed vegetation with regeneration potential located in close proximity to areas of native vegetation.

4 METHODS – FAUNA

4.1 Research

4.1.1 Species records

Threatened fauna species records were obtained from:

- DEC Atlas - a search of records for the 8833 Gulgong 1:100 000 topographic map sheet from the NSW Department of Environment and Conservation (DEC) Atlas of NSW Wildlife (data obtained November 2004);
- Bionet – a search of records for the 8833 Gulgong 1:100 000 topographic mapsheet from the NSW Government's Bionet database (data updated April 2005);
- EPBC Protected Matters - a search using Environment Australia's EPBC protected matters search tool (data updated April 2005);
- Wilpinjong Coal Project EIS (May 2005), Volume 4 - Appendices HB and HC;
- Kinhill Stearns Engineers (1983): Ulan Coal Mines Stage 2 Colliery Development and Expansion Environmental Impact Statement;
- Ulan Underground Mine Extension - Fauna Monitoring Survey Program to satisfy Conditions of Consent for ML1341 and ML1468 - 2004 report;
- Plan of Management for Goulburn River National Park and Munghorn Gap Nature Reserve (NPWS 2003); and
- Fauna survey of the Goulburn River National Park;

These records were used to compile a list of threatened species known to have occurred within the study area and on surrounding lands, and also those potentially occurring in the study area. This list is provided in Appendix 5, along with researched known details of habits, habitat and foraging requirements, and distributions of these species.

This information has been used to assist in determining which threatened species may occur in the study area, and potentially be affected by the proposed coal mine operations.

4.1.2 Declining Woodland Birds

There has been recent concern amongst conservationists that a large number of previously common woodland bird species are in decline. Some of these species are now listed as threatened, but many are not.

Whilst this issue is not listed in the Director-General's requirements for the Environmental Assessment, nor in the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005), it has been given attention in this report.

Information pertaining specifically to declining woodland birds was obtained from:

- "*Threatened and declining birds in the New South Wales Sheep-Wheat Belt: I. Diagnosis, characteristics and management*" (Reid 1999);
- "*Threatened and declining birds in the New South Wales Sheep-Wheat Belt: II. Landscape relationships – modelling bird atlas data against vegetation cover*" (Reid 2000);
- "*Foraging ecology of ground-feeding woodland birds in temperate woodlands of southern Australia*" (Antos & Bennett 2006);

- "*North West Woodlands – Our Woodland Birds are disappearing*". National Parks Association Western Woodlands Project web site opening page. Joint initiative of the NSW NPWS and Birds Australia;
- "*Declining Biodiversity and Unsustainable Agricultural Production - Common Cause, Common Solution ?*" (Stevens 2001); and
- "*Finding the facts of life in the bush*", article written by Brad Collins for *Ground Cover* Issue 49 April 2004. Aust Govt Grains Research & Development Corporation.

This information has been used to assist in assessment of impacts of the proposed coal mine upon declining woodland birds, based on assessment of impacts upon their habitats.

4.1.3 Other information

The following additional sources were used to research specific information to assist with survey methods, assessment of impacts upon subject fauna species, and consideration of other key assessment criteria:

- Final Determinations of the NSW Scientific Committee to list threatened species on the TSC Act;
- Final Determinations of the NSW Scientific Committee to list Key Threatening Processes on the TSC Act, (including 'Alteration of habitat following subsidence due to long-wall mining');
- NPWS Recovery Plans (including in draft) for the Bush Stone-curlew, Large Forest Owls, and Barking Owl;
- Commonwealth Recovery Plans (including in draft) for the Regent Honeyeater and Large-eared Pied Bat; and
- Australian Heritage Database;

A full list of resources and references is provided in the bibliography at the end of this report.

4.1.4 Preliminary Site Inspection

A preliminary inspection of the study area was conducted by Ms Rebecca Hayes on the 25th of October 2004. The purpose of the inspection being to gain a general understanding of the nature, condition and ecological processes of the study area, ground-truth findings of the desktop review and research, and finalise details for an appropriate field survey program. Results of the preliminary survey were also used to provide constraints and opportunities results for the refinement of the mine plan (the Scoping Study).

The inspection was conducted along the existing public road network, and on several private properties for which permission was available at the time. The inspection focussed on remnant areas and stands of native vegetation present throughout the study area, and the general nature and condition of fauna habitats present.

4.2 Field Surveys

4.2.1 Target species

The key assessment requirements for fauna (listed in the Director-General's requirements) are threatened species. Further to this, the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) Step 2 Field Survey and Assessment state "*the objective of the field survey is to ensure that a reliable assessment of the presence of absence of threatened species can be made*".

The target species for this report, therefore, are threatened species known to have occurred in the study area, and/or those considered potentially occurring in the study area (refer to Appendix 5).

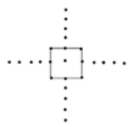
All records of native fauna were maintained throughout the field surveys, to provide additional information relating to diversity and abundance of fauna across the site generally, and to assist with assessment of declining woodland birds.

4.2.2 Survey methods, seasons and effort

Five (5) seasonal surveys were conducted within the study area, in Summer (Dec 2004 and January 2005), Autumn (April 2005), Winter (June/July 2005), early Spring (August and September 2005) and Late Spring (November 2005).

Nineteen fauna survey sites were selected for standardised trapping surveys using Elliot Type A traps (locations as illustrated on **Figure 4.1**). A range of other trap types was also used at most of these locations, including Elliot Type B and Type E traps and cage traps. Traps were mounted on the ground, in trees and when appropriate, in flowering shrubs. Bait was selected according to target species, being either standard bait of honey/rolled oats/peanut butter, sardines, or chicken necks. Full details in Appendix 6.

Standard Elliot Type A trap grid pattern used at each trapping site during the first survey. The square represents a 400m^2 flora quadrat. Subsequent surveys mainly used transects.



Thirteen additional sites were surveyed using Elliot B tree-mounted traps, Cage Traps and hair tubes. Fourteen pitfall traplines were set diurnally (locations illustrated on **Figure 4.3**) to target small ground fauna such as reptiles and small dasyurid marsupials such as dunnarts and planigales.

Numerous additional sites were surveyed using other methods including systematic bird searches (~80 sites), herpetofauna searches (22 sites), Anabat II Bat Detectors to detect the ultrasonic echolocation calls of microchiropteran bats (40 sites), harp traps to target microchiropteran bats (20 sites), call playback to target threatened owls (33 surveys across ~24 sites) and also the Green & Golden Bell Frog, and spotlighting (31 sites) to target nocturnal fauna – also used in conjunction with call playback. Survey site locations are illustrated on **Figures 4.1**, **4.2** and **4.3**. Full details in Appendix 6.

Additional hair tube surveys were conducted in conjunction with the aquatic field sampling, to target the native Water Rat *Hydromys chrysogaster*. Survey methods are described in the aquatic chapters of this report.

A specific survey was conducted in August 2005 to target the Regent Honeyeater. This survey was timed to coincide with surveys being conducted in the region by the National Regent Honeyeater Recovery Team, and occurred during a period of White Box flowering.

Opportunistic records of all species were maintained whilst travelling around the site, and whilst conducting other surveys. These included occasional targeted searches as appropriate, *eg* for birds at selected water bodies, and for frogs on roads following heavy summer rain. Details in Appendix 6.

4.2.3 Surveys within each Terrestrial Stratification Unit

A wide range of fauna survey methods was conducted within each of the six (6) Terrestrial Stratification Units (TSU) within the study area, and within most vegetation associations. Details are provided in Appendix 6.

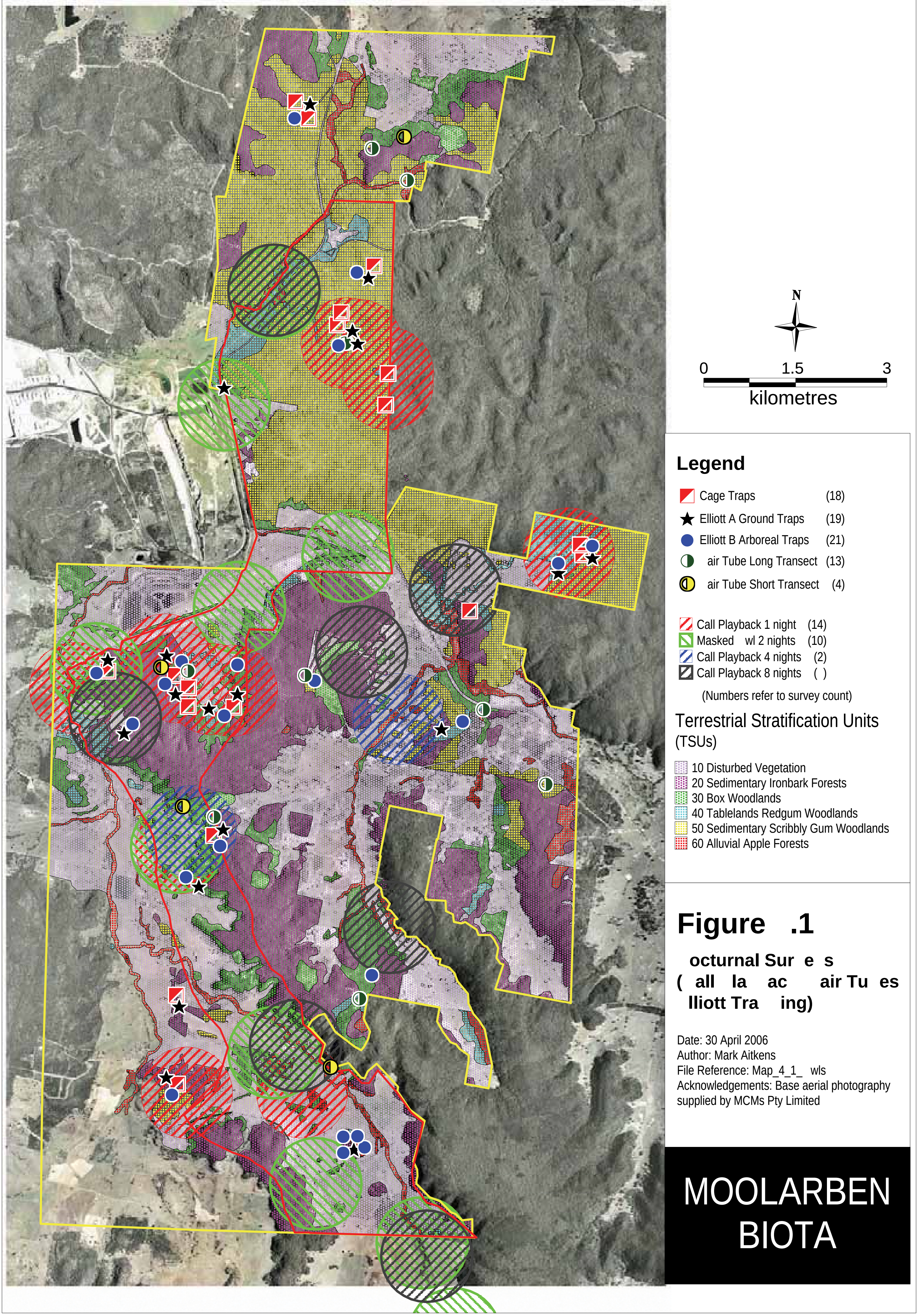


Figure .1

octurnal Sur e s (all la ac air Tu es lliott Tra ing)

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_4_1_ wls
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

MOOLARBEN BIOTA

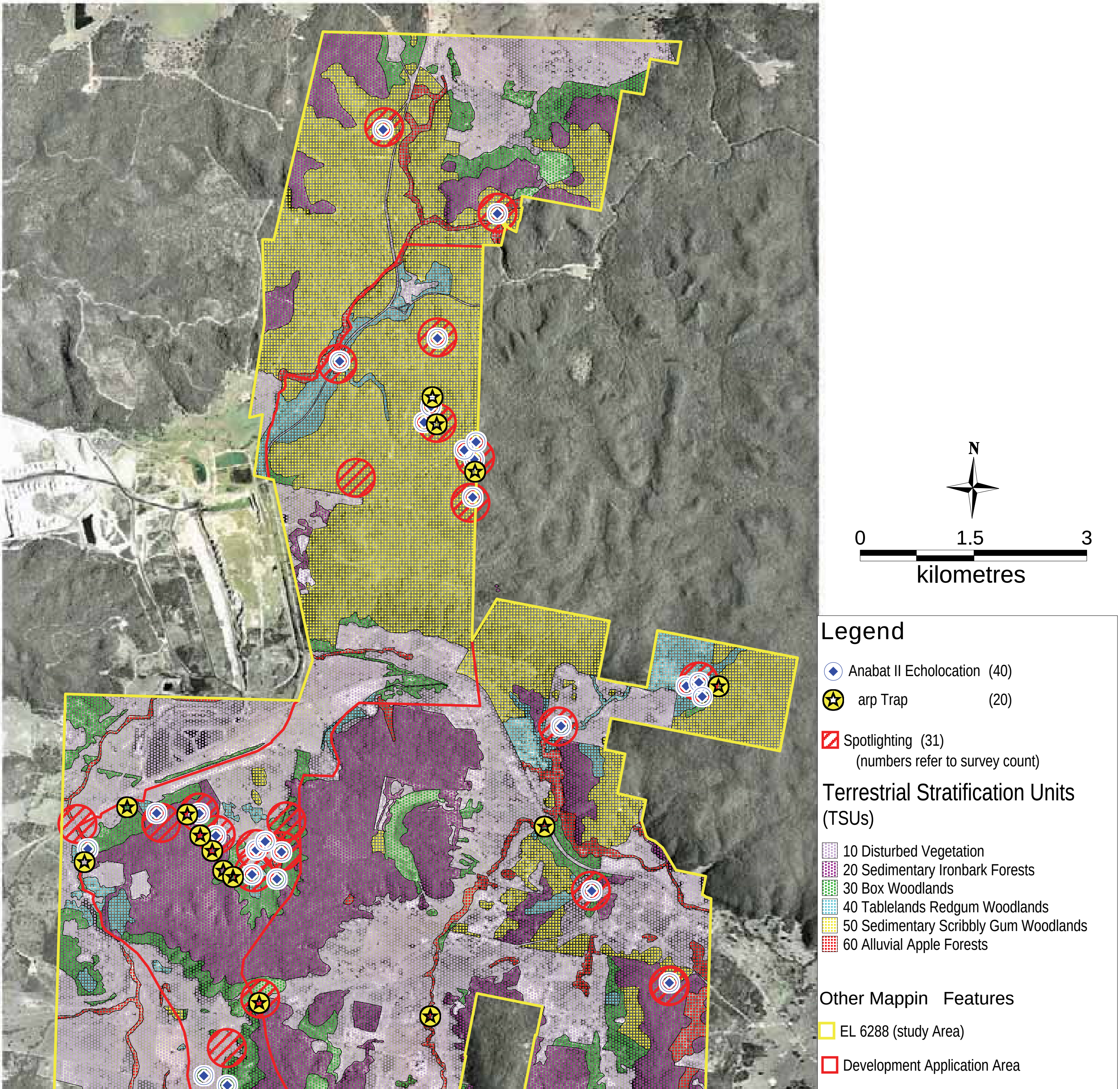


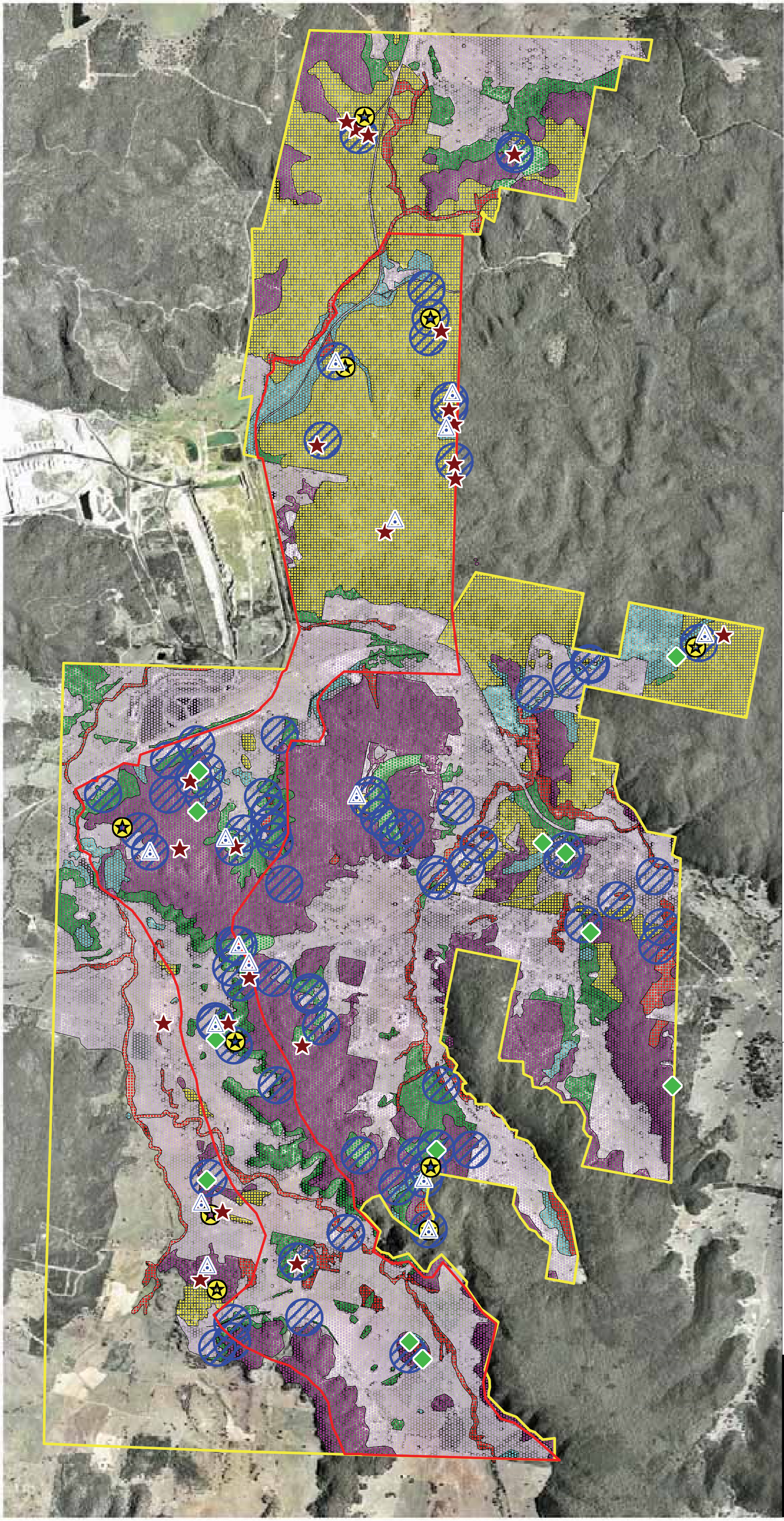
Figure .

octurnal Sur e s (ar Tra s na at S otlig ting)

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_4_2_Spotlighting

Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

MOOLARBEN BIOTA



N

0 1.5 3
kilometres

Legend

- Habitat Assessment (10)
- Herpetological (22)
- Pitfall Trap (14)
- Scats tracks traces (15)

- Bird Census (89)
  (Numbers refer to survey count)

Terrestrial Stratification Units (TSUs)

- Disturbed Vegetation
- Sedimentary Ironbark Forests
- Box Woodlands
- Tablelands Redgum Woodlands
- Sedimentary Scribbly Gum Woodlands
- Alluvial Apple Forests

Other Mappin Features

- EL 6288 (Study Area)
- Development Application Area

Figure .3

iurna ur e s
irds cats it a tra s
er eto ogica searc es

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_4_3_Diurnal
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

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4.2.4 Survey Dates and Weather Conditions

Summer surveys were conducted from the 5th to 11th of December 2004. Weather conditions varied from mild to hot (15-30°C) during the day and were generally mild to warm (18-25°C) in the evening. Rain periods occurred regularly between fine clear weather, with thunderstorms on two evenings. Full details in Appendix 6.

Autumn surveys were conducted from the 30th of March 2005 to the 8th of April 2005. Weather conditions during the day were good for surveying, with temperatures mostly 20-25°C and an occasional day in the high 20's. Most days were still or with a light breeze. Evenings were generally warm (15-20°C), dropping to around 15°C overnight, with the occasional cool night (13-17°C), dropping to 5-10°C. No rain except for a very few patches of fine drizzle. No moon during the nocturnal surveys. Full details in Appendix 6.

Winter surveys were conducted between the 28th of June 2005 and 10th of July 2005, with a short break in the middle due to inclement weather. Weather conditions were cool to mild (5-18°C) during the day and cool (4-10°C) during the evening. The first few days experienced heavy rain. After the break, weather was mostly fine with some rain periods. Full details in Appendix 6.

Early spring surveys were conducted between the 5th and 17th of September 2005. Weather conditions varied from cool to warm (8-26°C) during the day, and cool to mild (5-17°C) during the evening. The first part of the survey period was mostly fine, whilst the latter part was mostly cloudy to overcast, with regular light drizzle and rain, and gusty winds. Full details in Appendix 6.

Late spring surveys were conducted between the 4th and 18th of November 2005. Weather conditions varied during this period, with some days reaching 30°C and other cooler days only 15°C. Overnight temperatures varied from 10-15°C. Heavy rain preceded the survey making the region very green. Some heavy rain also occurred during the surveys, which encouraged frogs to call. The moon was out for some nights, but on most nights the moon was hidden by cloud. Full details are supplied in Appendix 6.

4.2.5 Fauna species identification and nomenclature

Fauna species were identified through visual and aural detection, and through traces, *ie* scats, tracks, chew marks *etc*.

Fauna surveyors for this project are experienced experts at field identification of native fauna (Appendix 1). In addition, various field guides were used to assist with identifications. These are listed in the bibliography at the end of this report.

Scats (including hair samples) collected were sent for expert identification to Ms Barbara Triggs.

The ultrasonic echolocation calls of microchiropteran bats were recorded using Anabat II Bat Detectors. Analysis of bat calls was undertaken by Mr Michael Welsh, with occasional confirmation/crosschecks by Mr Adam Fawcett (Forests NSW Hunter Region) and Mr Mark Aitkens. Reference calls were recorded from bats captured in harp traps during the survey. Reference calls were also used from Pennag *et al* (2000), the Forests NSW collection, and the personal libraries of Mr Michael Welsh and Mr Mark Aitkens. Samples of bat sonograms are provided in Appendix 6.

Nomenclature of native fauna species recorded conforms to Strahan (1995) for mammals, Lindsey (1992) for birds, and Cogger (1996) for reptiles and amphibians. Threatened species nomenclature conforms to that used by DEC.

4.2.6 Fauna species determination of status

The conservation significance of native fauna was determined according to schedules of the *NSW Threatened Species Conservation Act 1995* (TSC Act) and the *Commonwealth Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act).

A list of 'declining woodland birds' (see Chapter 6.3.4 below) was determined with reference to Reid (1999), and Stevens (2001). In Reid (1999) "*Declining species were defined … to be species identified as being at risk in at least three studies*". Stevens (2001) lists four additional species based on later reports.

4.3 Interpretation of data

4.3.1 Determination of fauna habitat units

The nature and diversity of fauna habitats vary according to structural and floristic characteristics of vegetation communities, prior disturbances, the age and condition of vegetation, and other variables such as altitude, prevailing winds and climate.

Following a review of vegetation mapping conducted across the study area for this project, and based on field habitat assessments, the broad terrestrial stratification units (TSU's) identified in Chapter 3.2.2 have been used as the basis for fauna habitat units. Detailed site specific habitat assessment sheets are provided at the end of Appendix 6.

The TSU's, with associated fauna habitat features, are described in detail in Chapter 6.2 - *Terrestrial Stratification Units*.

Fauna habitat units are mapped on **Figure 4.4**, and include the following:

TSU 10a	Disturbed Vegetation (except vegetation associations 10 and 11);
TSU 10b	Disturbed Vegetation (only veg. associations 10 and 11 – Unimproved Grasslands);
TSU 20	Sedimentary Ironbark Forests;
TSU 30	Box Woodlands;
TSU 40a	Tablelands Redgum Woodlands (except veg. association 40);
TSU 40b	Tablelands Redgum Woodlands (only veg. association 40 Blakely's Red Gum Woodland);
TSU 50	Sedimentary Scribbly Gum Woodlands;
TSU 60	Alluvial Apple Forests.

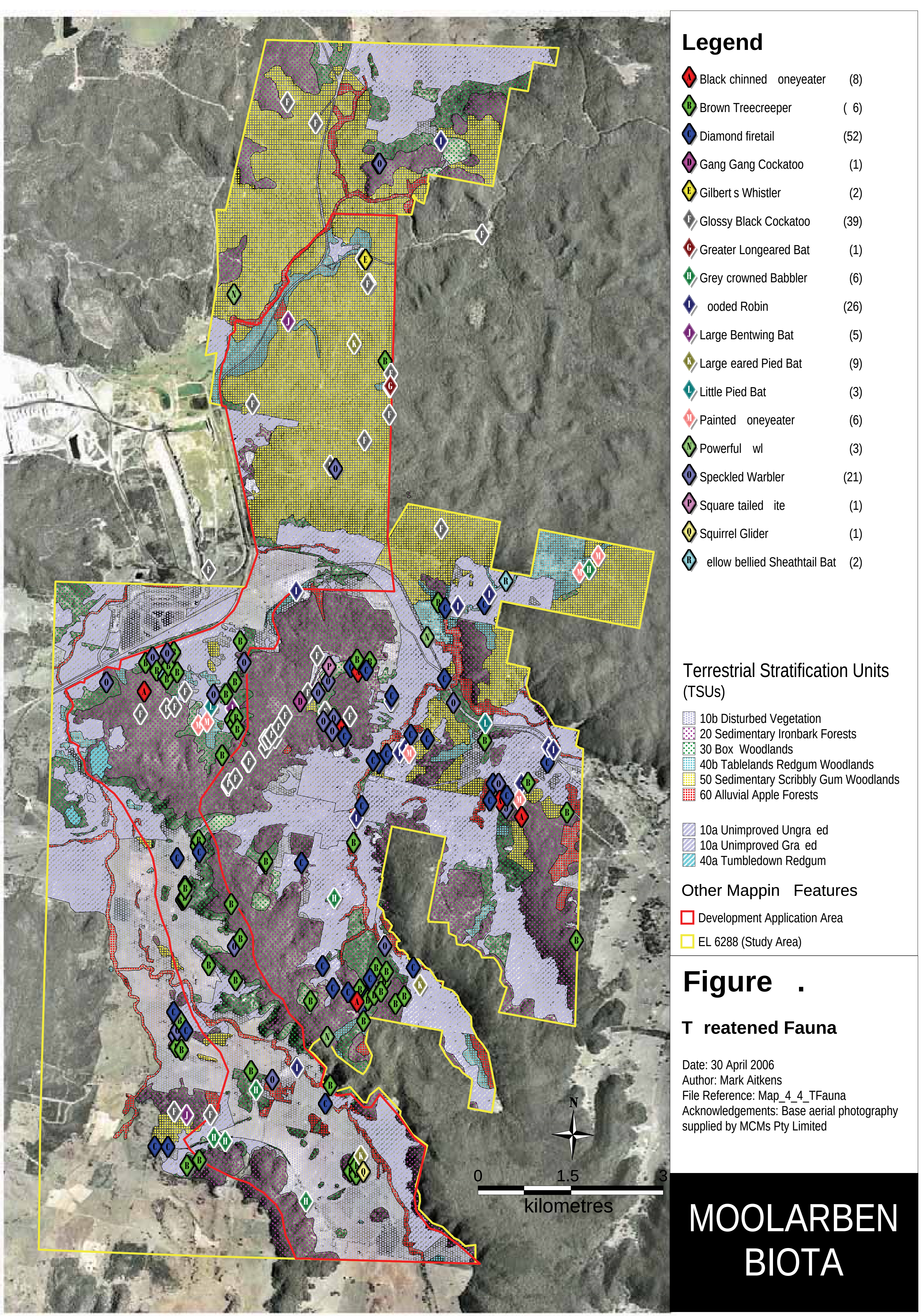
The splitting of two of the TSU's into two separate fauna habitat units (*ie* TSU 10 and TSU 40) was determined based on apparent substantially different relative importance of sub-units within the TSU as fauna habitat (identified through field survey).

4.3.2 Identification of fauna subject species

Threatened fauna species known to occur in the study area and/or in the region (refer to 'target species' in Chapter 4.2.1) are listed in Appendix 5 along with details of their habits, habitat requirements and known records. Known records of threatened fauna species are shown on Figure 4.4.

Table 4.1 below provides an assessment of the available information and likelihood of each of these species occurring in the DA area, and/or being affected by the proposed mine.

As shown in Table 4.1, 28 threatened fauna species are known or considered likely to occur in the DA area, and/or likely to be affected by the proposed mine. 'Declining woodlands birds' are also known to occur in the DA area and are likely to be affected by the proposed mine. These 28 threatened species, and 'declining woodland birds' as a group, are referred to as 'subject species', and are considered further in Chapter 8.



Legend
Black chinned oneyeater (8)
Brown Treecreeper (6)
Diamond firetail (52)
Gang Gang Cockatoo (1)
Gilbert s Whistler (2)
Glossy Black Cockatoo (39)
Greater Longeared Bat (1)
Grey crowned Babbler (6)
ooded Robin (26)
Large Bentwing Bat (5)
Large eared Pied Bat (9)
Little Pied Bat (3)
Painted oneyeater (6)
Powerful wl (3)
Speckled Warbler (21)
Square tailed ite (1)
Squirrel Glider (1)
ellow bellied Sheathtail Bat (2)
Terrestrial Stratification Units (TSUs)
10b Disturbed Vegetation
20 Sedimentary Ironbark Forests
30 Box Woodlands
40b Tablelands Redgum Woodlands
50 Sedimentary Scribbly Gum Woodlands
60 Alluvial Apple Forests
10a Unimproved Ungra ed
10a Unimproved Gra ed
40a Tumbledown Redgum
Other Mappin Features
Development Application Area
EL 6288 (Study Area)
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Figure .
T reatened Fauna
Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_4_4_TFauna
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited
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Table 4.1 Identification of fauna subject species (SS)

Species	Consideration	Assessment	SS*
Malleefowl *Leipoa ocellata*	Not known from study area, only 1 record in region. Builds conspicuous nest mounds.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Australian Painted Snipe *Rostratula australis*	Not known from study area, or region. Typical habitat not available.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Bush Stone-curlew *Burhinus grallarius*	Previous anecdotal records from landholders in the study area. Not known from region. Suitable habitat available. A cryptic species.	May occur in the DA area, in the vicinity of Munghorn Gap Nature Reserve.	✓
Square-tailed Kite *Lophoictinia isura*	Known to occur in study area and region. Observed foraging over woodland edges. Known to occur in Box-Ironbark woodlands and vegetation with *Callitris* spp.	Probably uses mainly the woodland/grassland interface areas, which are predominantly TSU 30 - Box Woodlands.	✓
Gang Gang Cockatoo *Callocephalon fimbriatum*	Known to occur in the study area, but not region. Recorded from area with *Callitris* sp. Known to occur particularly in Box-Ironbark associations.	Not likely to breed in DA area, but likely to disperse into it during winter. TSU 30 – Box Woodlands are likely to be of value. *Callitris* is common in many vegetation associations in the study area.	✓
Glossy Black Cockatoo *Calyptorhynchus lathami*	Known to occur in the study area, and region. Recorded from most TSU's.	Appears to occur in 2 main locations in the study area, based around important *Allocasuarina* feeding sites.	✓
Swift Parrot *Lathamus discolor*	Not known from the study area, only 1 record from region.	Winter visitor only. May occur in the DA area during mass flowering events.	✓
Turquoise Parrot *Neophema pulchella*	Not known from the study area. Known from region. Suitable habitat available.	May occur in the DA area occasionally – most likely in TSU 30 – Box Woodlands.	✓
Superb Parrot *Polytelis swainsonii*	Not known from study area, known from region. Typical habitat not present.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Powerful Owl *Ninox strenua*	Known to occur in study area and region, including many records in Munghorn Gap Nature Reserve.	Probably uses DA area for foraging, and nests in nearby NP estate. Recorded in area with Ironbark dominance.	✓
Masked Owl *Tyto novaehollandiae*	Anecdotal landholder records in study area, known from region in Munghorn Gap Nature Reserve.	Probably uses DA area for foraging, but may occur in the DA area, in the vicinity of Munghorn Gap NR.	✓
Barking Owl *Ninox connivens*	Not known from study area, known from region.	Probably uses DA area for foraging, and nests in nearby NP estate.	✓
Gilbert's Whistler *Pachycephala inornata*	Known to occur in study area, but not in region.	Recorded in TSU 10 - Disturbed, unimproved grasslands, and TSU 50 – Sedimentary Scribbly Gum Woodlands.	✓
Grey-crowned Babbler *Pomatostomus temporalis*	Known to occur in study area and region. Nests found.	Mainly recorded in TSU 30 – Box Woodlands, and TSU 10 – Disturbed, unimproved grasslands.	✓

Table 4.1 cont Identification of fauna subject species (SS)

Species	Consideration	Assessment	SS
Speckled Warbler *Pyrrholaemus sagittatus*	Known to occur in study area and region. Nests found.	Mainly recorded in TSU 30 – Box Woodlands, and ecotones between this and TSU 20 – Ironbark Forests	✓
Brown Treecreeper *Climacteris picumnus victoriae*	Known to occur in study area and widely in the region.	Occurs in all TSU's in the DA area, but predominantly TSU 30 – Box Woodlands, and TSU 10 - Disturbed, unimproved grasslands.	✓
Hooded Robin *Melanodryas cucullata cucullata*	Known to occur in study area and widely in the region. Breeding behaviour observed.	22 out of 26 records are from TSU 10 - Disturbed, unimproved grasslands. Seems to prefer habitats close to creeklines.	✓
Black-chinned Honeyeater *Melithreptus gularis gularis*	Known to occur in study area and widely in the region.	Mainly recorded in TSU 30 – Box Woodlands. Likely to occur only in larger remnants.	✓
Painted Honeyeater *Grantiella picta*	Known to occur in study area and widely in the region, during late spring and summer.	Recorded in most TSU's in the DA area. Particularly areas with Mistletoe of *Amyema* spp.	✓
Regent Honeyeater *Xanthomyza phrygia*	Not known from study area, but known from region. Irruptive, nomadic and partly migratory in behaviour.	May occur in the DA area, particularly during mass flowering events. Most likely in TSU 30 – Box Woodlands.	✓
Diamond Firetail *Stagonopleura guttata*	Known to occur in study area and widely in the region. Breeding behaviour observed.	Recorded in all TSU's in the DA area, but with very strong preference for TSU 10 - Disturbed, unimproved grasslands, and TSU 30 – Box Woodlands	✓
Declining Woodland Birds	Known to occur in study area and widely in the region.	Recorded in most TSU's in the DA area. Apparent preferences for TSU 10 and TSU 30	✓
Pink-tailed Legless Lizard *Aprasia parapulchella*	Not known from study area, one distant record in region.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Little Whip Snake *Suta flagellum*	Not known from study area, one record in region.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Broad-headed Snake *Hoplocephalus bungaroides*	Not known from study area, or region.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Giant Barred Frog *Mixophyes iteratus*	Not known from study area, one record in region, approx 4km downstream of study area.	Not likely to occur in DA area, but some potential to be affected by downstream impacts.	✓
Spotted-tailed Quoll *Dasyurus maculatus*	Anecdotal record from landholder in study area from approx 10 years ago. Not otherwise known from study area or region.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Koala *Phascolarctos cinereus*	Not known from study area, only one distant record in region within last 20 years.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Squirrel Glider *Petaurus norfolcensis*	Sparse records from study area and region.	Recorded in TSU 60 – Alluvial Apple Forests, likely close to nest site. Potential habitat includes TSU 30 – Box Woodlands.	✓

Table 4.1 cont Identification of fauna subject species (SS)

Species	Consideration	Assessment	SS
Brush-tailed Rock Wallaby *Petrogale penicillata*	Not known from study area, one distant record in region.	Not likely to occur in DA area, nor likely to be affected by proposed mine.	X
Large-eared Pied Bat *Chalinolobus dwyeri*	Known to occur in study area and region.	Recorded from TSU 10 - Disturbed, unimproved grasslands, and TSU 40 Blakely's Red Gum Woodland	✓
Little Pied Bat *Chalinolobus pictatus*	Known to occur in study area, but not in region.	Recorded from TSU 10 - Disturbed, unimproved grasslands, and TSU 40 Blakely's Red Gum Woodland	✓
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Not known from study area, but known from region.	Thought to prefer more extensive and less disturbed remnants	✓
Eastern Freetail Bat *Mormopterus norfolcensis*	Not known from study area, but known from region.	No details of preferences known.	✓
Eastern Bent-wing Bat *Miniopterus schreibersii*	Known to occur in study area and region.	Mainly recorded in TSU 40 - Blakely's Red Gum Woodland, and vegetation association 52.	✓
Little Bent-wing Bat *Miniopterus australis*	Not known from study area, but known from region.	All records in conjunction with Eastern Bent-wing Bat	✓
Greater Long-eared Bat *Nyctophilus timoriensis*	Known to occur in study area and region.	One record from TSU 40 - Blakely's Red Gum Woodland.	✓
Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*	Known to occur in study area and region.	Two records, from TSU 30 – Box Woodlands and TSU 40b.	✓
Eastern Cave Bat *Vespadelus troughtoni*	Not known from study area, but known from region.	No details of preferences known.	✓
* SS = Subject Species Likelihood of Occurrence. X = Unlikely and ✓ = Likely to occur			

4.3.3 Criteria to categorise areas of high ecological value

The following criteria have been used to categorise habitats within the study area as being of high ecological value:

- Known habitat for subject species *ie* patches of habitat where the subject species have been recorded;
- Likely habitat for subject species, *ie* areas of habitat which appear to resemble floristically, structurally and in terms of habitat features, patches where subject species have been recorded;
- Habitat supporting a high diversity of fauna species;
- Habitat enabling movement for seasonal migrations, for genetic viability, or between critical shelter features and critical foraging resources; and
- Habitat containing critical resources, *eg* tree-hollows, caves, large water resource, abundance of winter flowering plants.

5 METHODS – AQUATIC

5.1 Study Aims and Objectives

The aim of the aquatic ecology assessment was to assess the current mine plan, with particular respect to possible aquatic ecological constraints and mitigation opportunities. The aquatic ecological study incorporated the following elements of overall impact assessment:

- Literature Review for detailing available aquatic ecological information including searches of data-bases for threatened species and endangered ecological communities (Sections 5.2.1 and 5.2.2 below);
- Assessment of aquatic ecological features (including possible groundwater dependent ecosystems - GDEs - as per DLWC 2002), based on analysis of current aerial photography, on available topographic and on field stream assessments. Initial field work for characterising the aquatic ecological features of the river, creeks and drainages of the study area was undertaken in October 2004 with subsequent field work undertaken during the seasonal aquatic ecology field surveys (see below) plus a further survey in November 2005;
- Results of base-line and seasonal aquatic ecology quantitative sampling program undertaken over four seasons; Spring 2004, Autumn and Spring 2005 plus Summer 2006 (Section 7.2); and
- General impact assessment against the current mine plan - see Section 8.

5.2 Literature Review

5.2.1 Data-base Threatened Species Searches

In 1999 the Fisheries Management (Amendment) Act inserted threatened species provisions into the Fisheries Management Act 1994 (FMA) for the protection of these biota and for aquatic habitat protection. The FMA is administered by Department of Primary Industries (Fisheries branch) and the conservation aspects of the FMA are set out in two NSW Fisheries Policy and Guideline Documents (NSW Fisheries 1999a, 1999b).

The general area of the proposed mine is known to support specialised and threatened species of wildlife and, accordingly, preliminary literature review has comprised searches of the Environment Australia, NSW DEC (NPWS) and NSW DPI (Fisheries) databases for specific details on threatened species, ecological communities and key threatening processes:

- Bionet – a search of records for the Goulburn River from the NSW Government's Bionet database (data updated April 2005). This search yielded no records for fish so a broader search was made for the Hunter River, which provided some fish data for the total Hunter River catchment. There were no threatened aquatic species listed; and
- EPBC Protected Matters - a search using Environment Australia's EPBC protected matters search tool (data updated April 2005). This search yielded no threatened aquatic species (fish, invertebrates or aquatic plants).

Recent aquatic ecological surveys for the upper Goulburn River (see review in Section 5.2.2 below) were also inspected for threatened species information or occurrences.

In summary, there are no threatened aquatic plants, fish or macroinvertebrate species or populations for the upper Goulburn River listed, either under the threatened species provisions of the Commonwealth EPBC Act or under the threatened species provisions of the NSW Fisheries Management Act 1994. The DPI (Fisheries) Database did not provide any fish data from the upper

Goulburn River. There were no threatened species listed in the recent (2003 and 2004) aquatic surveys undertaken for Ulan Mine and Wilpinjong Mines.

5.2.2 Review of Literature for General Aquatic Ecological Data

The following EIS and Mine Monitoring reports were consulted to provide relevant aquatic biota species lists for the upper Goulburn River study area:

- Wilpinjong Coal Project EIS (May 2005), Specifically Volume 4 - Appendix HD, Aquatic Ecology Report (Bio-analysis 2005). Undertook a single seasonal study of fish, macroinvertebrates and aquatic plants at a number of sites within the potentially impacted catchments draining to Wilpinjong Creek plus in Wilpinjong Creek. The report noted that there were springs and saline groundwater seepages in the study area but did not conclude that there were any groundwater dependent ecosystems (GDEs) associated with these features. There is some overlap between the Bio-analysis (2005) upper Wilpinjong Creek sites and the Moolarben lower Wilpinjong Creek sites (WC4); and
- Ulan Coal Mine annual environmental reports prepared by Mt King Ecological Services, specifically aquatic ecology monitoring reports for one site in Ulan Creek and four sites in Goulburn River - one up-stream and four down stream of Ulan Creek (Mt King Ecological Services 2003 and 2004). The two Mt King Ecological Services lower Goulburn River sites are close to several of the MCP aquatic ecology sites (GR1, GR2). Mt King Ecological Services (2004) also provides a comparison of aquatic ecological data from the 2003/2004 surveys with earlier surveys undertaken during studies for the Ulan Mine MLA80 Development Application and Environmental Impact Statement (Kinhill 1998). There was no discussion of GDEs.

The following documents were consulted but did not provide any specific aquatic ecological information:

- Plan of Management for Goulburn River National Park and Munghorn Gap Nature Reserve (NPWS 2003); provides some overall indications of plant and animal communities with references to ‘abundant fish life and platypus’ but with no reference to fish lists or data sources; and
- Wollar to Wellington 330 KV Transmission Line EIS (International Environmental Consultants 2005); provides references to creek crossings but no assessment of aquatic biota and no reference to listed aquatic biota.

Literature review was supplemented by 'local knowledge' by asking individual landowners regarding particular sightings of animals in creeks. With regard to platypus and native water rat, the consensus was that neither species is known within the EL 6288 although platypus may have been found towards the lower end of the DA (*ie*, below GR3) in the past (see also Grant 1991). Platypus were reported from across the divide in the Cooyal Creek catchment and native water rat were reported from the creeks and rivers around Gulgong and Mudgee.

5.3 Preliminary Catchment Assessment and Study Site Selection

An initial field survey was undertaken to provide a basis for a quantitative aquatic ecology study design and to provide some indications as to potential aquatic ecological impact and to provide constraints and opportunity advice for preliminary mine planning. The initial survey indicated that whilst there were a number of springs and saline ground seepages observed in both the major Moolarben Creek and upper Goulburn River sub-catchments, in the main these were degraded or modified by intensive agricultural activities and provided little or no significant habitat, either via surface water or hyporheic zones. Inspections of the following creek/river sections were undertaken based on the three main catchment areas:

- The Moolarben Creek Catchment above the confluence with Sportsman Hollow Creek (this latter point being the start point of the Goulburn River);

- The Goulburn River Catchment through to the confluence with Wollar Creek; and
- The Wilpinjong Creek Catchment, which collects drainages through to the confluence with Wollar Creek which then drains to the Goulburn River.

The Goulburn River Study Catchment was further sub-divided into three sections, an upper section from the confluence to Ulan Creek (which includes licensed discharge points for Ulan Coal Mine), a middle section comprising drainages to the Goulburn River between Ulan Creek and the Cassilis Road crossing, plus a lower section comprising drainages to the Goulburn River below the Cassilis Road crossing. Each of these catchments/sections includes the following drainages and survey sites:

Moolarben Creek Catchment:

- Ryans and Lagoon Creeks provide potential mining- unimpacted feeder creek sites as monitoring reference sites;
- Moolarben Creek was inspected upstream of Moolarben Road to the catchment watershed in Munghorn Nature Reserve to understand the relationship of the DA area to the upstream creek area. Several sites were selected as possible "above mining" reference sites;
- A number of Moolarben Creek sites were established in the general area of OC 3 and OC 3 with additional possible "below mining" sites established in Moolarben Creek at and beyond the confluence with Lagoon Creek and downstream to the Ulan Wollar Rail Crossing; and
- Inspection of Munghorn Gap Nature Reserve Ridge drainages west to Moolarben Creek indicated that there are no permanent creek lines with most being deeply incised rock cascades with no water retention potential. That is these drainages facilitate the intermittent transport of stormwater from the ridge to Moolarben Creek without any significant water retention. Accordingly there is little or no aquatic habitat available in these drainages.

Goulburn River Catchment:

Upper Goulburn River Section (above Ulan Creek):

- Sites in Sportsmans Hollow Creek were established as possible un-mined reference sites;
- There are several small drainage lines running through the proposed OC1 area, which are ill defined and are piped under the existing airfield. These drainages are ephemeral with little or no potential for water retention. Accordingly, there is little or no aquatic habitat available in the drainage lines. A site was established at the potential lower ponded area for these drainages; and
- The Goulburn River between Sportsmans Hollow Creek and Ulan Creek has been diverted into a constructed channel and there are two small drainages entering the diversion from the east, Bora Creek and an un-named drainage north of Bora Creek. Sites were established on each of these drainages. Bora Creek is located in the area for mine facilities and both the un-named creek part of the upper arm of Bora Creek are located over the proposed underground mining area.

Middle Goulburn River Section (Ulan Creek to Cassilis Road Crossing):

- There are two creeks draining to the Goulburn River between the diverted section and Cassilis Road; Ulan Creek (which flows through the Ulan Coal Mine area) plus another un-named drainage from the east (termed the second un-named drainage north of Bora Ck in this study). This latter creek is located over the proposed underground mining lease. Accordingly, possible study sites were established on this latter creek. Two sites were also established on the Goulburn River one above and one below the confluence with this second unnamed creek.

Lower Goulburn River Section, Cassilis Road Crossing and downstream (to below the Wollar Creek confluence):

- This upper part of this section of the river is located just north of the proposed mining activities. Several 'downstream reference' sites have been established on the river and on a spring leading to the river to be monitored for potential mining impacts; and

- There is one major creek drainage entering the 'downstream reference' section of the river from the north (Bobadeen Creek), which includes two main sub-catchments; Spring Gully draining native forest and Bobadeen Creek draining pasture lands. Sites have been established on these drainages to allow for future discrimination of possible 'downstream mining' impacts from 'other land-use' impacts. Two additional downstream sites have been established on the basis of future possible 'downstream reference sites' below all combined mining activities; one site at Copelands, above the Wollar creek confluence (for assessing combined Ulan and Moolarben Mine impacts), and one below the Wollar Creek confluence (to monitor potential three mine impacts (Ulan, Moolarben and Wilpinjong). Note that both these potential sites are located on private land and have not been inspected for this study.

Wilpinjong Creek Catchment:

- There are several main drainages east of, and running more or less parallel to Moolarben Creek; Murragamba Creek plus an un-named drainage to the east of that (termed the eastern drainage in this report). Both these drainages discharge into Wilpinjong Creek which has its headwaters in the Goulburn River National park and runs to the south-east past the Wilpinjong Coal development to Wollar Creek which then drains to the north to the Goulburn River. A series of sites have been established on the upper Wilpinjong Creek (through to Spring Flat) and on the two sub-catchment drainages (Murragamba Creek and 'Eastern Creek'.

With regard to assessment of potential fish passage from the study area downstream to the Hunter River, large sections of the Goulburn River within the National Park through to Springvale (some 5 km east of Wollar) could not be inspected. Much of the remaining river was able to be accessed from the Wollar to Denham Road. Where sites could not be accessed, the field inspections were supplemented by preliminary analysis of available aerial photography (parts of photo runs obtained in Dec 2000 at a scale of 1:25,000) plus analysis of gradients from topographic maps. For the study area the photographs were also used to check differences between field site observations and topographic map information obtained from the Gulgong, Wollar, Munghorn, Gulgong and Durridgere 1:25,000 topographic maps.

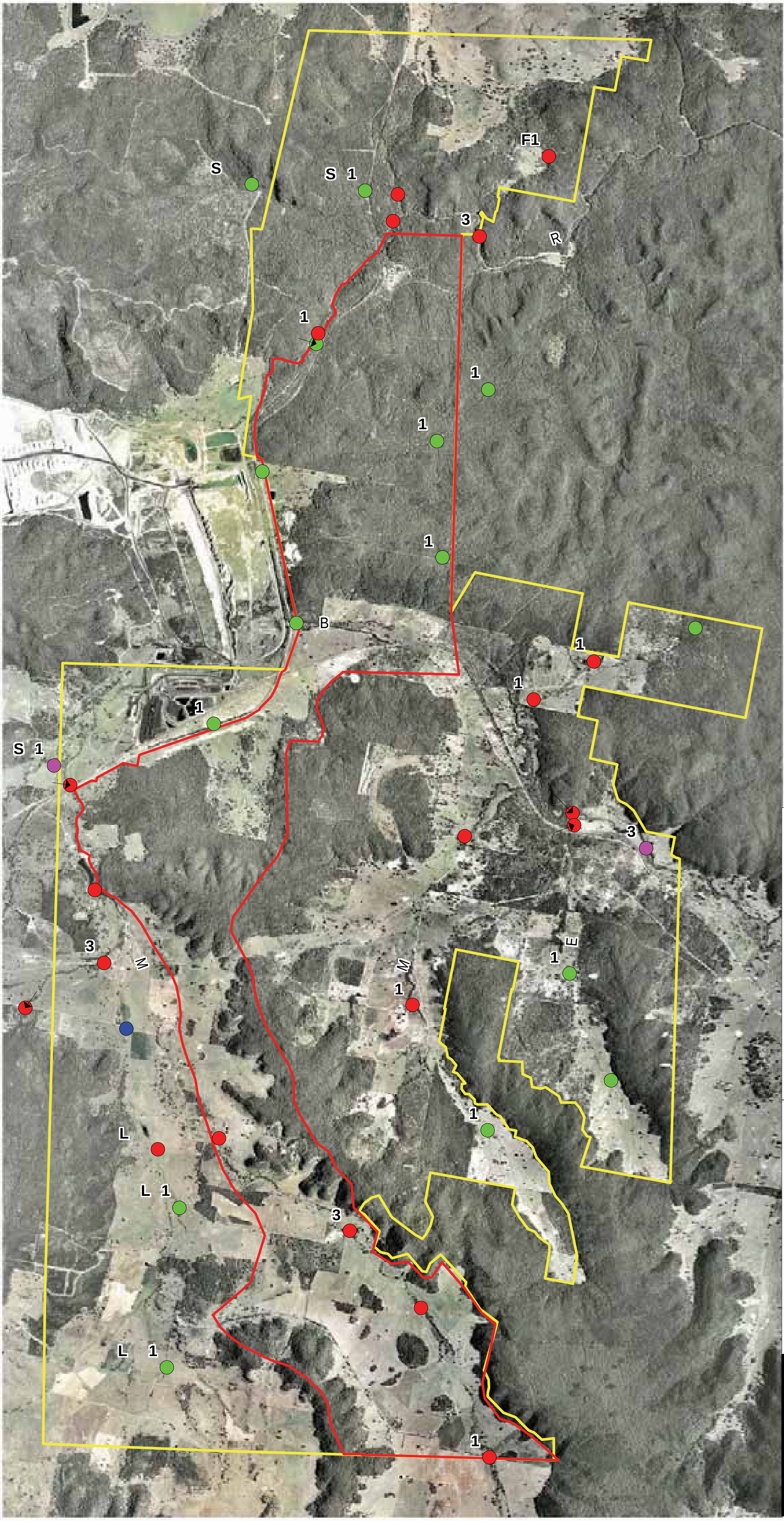
5.4 Quantitative Sampling Program

The proposed total set of sampling sites, derived from the preliminary sampling design outlined above is indicated in **Figure 5.1**. These 46 sites represent the present sampling model with regard to identifying all possible mining related impacts from the study area. The sampling model is based on a consideration of separating out possible mining impacts from other catchment associated impacts. In this regard sites are established above and below confluences and above, within and outside possible mining areas. Additional sites are included to isolate possible MCP impacts from other possible coal mine (Ulan and Wilpinjong) impacts. This model may change as the mine plan is further developed.

Note that not all sites are to be sampled at all times, and sites would be brought on line or off line as required for pre-, during and post mining related works. However, there are several sites, which represent long-term reference sites (generally upstream of potential mining activities) plus long-term ‘output’ sites (downstream of potential mining activities), which would be monitored more frequently. Note that the initial site selection also took into account (and where possible utilised) initial surface water sampling model sites, these also being based on a conceptual mine plan.

5.4.1 Aquatic macroinvertebrate and fish sampling program

The aquatic macroinvertebrate study methods follows the National River Process and Management Program River Bioassessment Manual methods (NRPMP 1994) as adapted for the National River Health Program; now referred to as the AusRivAS method (Turak et al 1999). Aquatic macroinvertebrate communities are generally sampled in Spring and Autumn each year. Note that for AusRivAS purposes Spring runs from 15 September to 15 December and Autumn runs from 15 March to 15 June.



Legend

Full Aquatic Sampling (22)
No Available Water for Sampling (1)
Insufficient Water for Sampling (3)
Site Not Sampled (4)

(Numbers refer to survey count)

ther Mapped Features

EL 6288 (Study Area)

Development Application Area

Figure .1

uatic Sa ling Sites

Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_5_1_Aquatic
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

MOOLARBEN BIOTA

From the preliminary study it was determined that most of the creeks and drainages in the study area are ephemeral or intermittent and there are few creeks with permanent (or even semi-permanent) riffle areas. It was also determined that, owing to the ephemeral and/or degraded nature of observed springs and seeps within the main DA area, (due primarily to agricultural disturbance and/or reliance on shallow surface aquifers), there would not be any GDEs of significance within the DA area. That is, the main contribution of groundwater within the study area would appear to be as base-flow to the main creeks (Lagoon, Ryans, Moolarben) plus the Goulburn River. Accordingly it was decided to concentrate sampling effort on 'pool edge' habitats of the main creeks and the Goulburn River as there was more certainty of finding this habitat type over time than 'riffle' habitat.

As per AusRivAS protocols, aquatic macroinvertebrate communities are sampled using a 250 µm mesh dip net over as many aquatic 'pool edge' habitat types as could be located within each of the pools along the defined stream reaches. Net samples are then placed into white sorting trays for in situ live sorting. Live sorting (picking) is undertaken for up to 1 person-hour, also as per the AusRivAS protocol.

Following cessation of live picking, further observations are made of the pool edge sample areas for surface aquatic macroinvertebrate taxa (e.g., water skaters and spiders) and any other taxa (such as freshwater crayfish) not collected by the dip netting process. Where possible (or necessary) representatives of these organisms are collected and added to the dip net samples.

At all macroinvertebrate sampling sites at least two fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream for the duration of the combined macroinvertebrate sampling and live picking survey (minimum 1 hour) and then retrieved. Fish trapping is supplemented by additional meshing and in-water observations (where possible).

Any fish captured in the traps or as part of the macroinvertebrate dip netting are identified *in situ* and released. Any further observations of fish during the pool condition survey are noted with fish species-name only given if the fish can be positively identified.

A Yeo-Kal 911 water quality data logger was used to record pool water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. Basic pool dimensions and condition are recorded as are water flow and general water condition (e.g., colour, presence of algae etc). These latter data are combined with other stream data to produce a stream condition index for the site location. The stream condition index used in this report is one based on the RCE method (Petersen 1992, as reported by Chessman *et al* 1997) for the greater Hunter River catchment.

Aquatic plants were noted and where necessary collected for identification. Searches were made for Platypus and Native Water Rat, and the likelihood of these aquatic mammals being present was assessed by searching for suitable bank conditions, possible burrow sites or feeding stations and inspection of scats. Hair tubes baited with sardines were also deployed along selected stream banks specifically to search for native water rats

In the laboratory, taxonomic identifications for the retained macroinvertebrates from each sample jar (sample site) are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols. These are as follows; family level for all insect taxa except Chironomids (which are taken to sub-family). Collembola arthropods (spring-tails) are classified as a single class and the arachnid arthropods (spiders and mites) are classified as two orders. For the mites (Order Acarina) we take them to sub-order classification level where possible. Crustaceans are taken to Family level where suitable keys are available. Ostracoda are left at Class level. The worm like taxa is shown at Phylum or Class level.

Hair tube analysis was not required as no hairs were deposited for analysis.

Table 5.1 MCP Aquatic Ecology Site Sampling Dates Dec 04 to Jan 06

Sub-catchment Creek	Site	Season and Sample Date Spring 04	 Autumn 05	 Spring 05	 Summer 06	Comments
Moolarben						
Lagoon Ck	LCX1			*	*	Mostly ploughed under
	LC1	*	*			No creek
	LC2	*	*	27 Sep 05	*	Generally dry
Ryans Ck	RC1	**	**	**	**	Erosion Gully
	RC2		**	**	16 Jan 06	
	RC3	15 Dec 04	18 May 05	20 Sep 05		Crossing Pond
Moolarben Ck	MCX1			*	*	Generally dry
	MCX2			*	*	Generally dry
	MC1	14 Dec 04	18 May 05	20 Sep 05		Crossing Pond
	MC2	14 Dec 04	18 May 05			
	MC3	**	**	20 Sep 05		
	MC4			27 Sep 05		Above Lagoon Ck
	MC5			**		Below Ryans Ck
	MC6				17 Jan 06	In Line Dam
	MC7	15 Dec 04	19 May 05	26 Sep 05	16 Jan 06	Permanent Pond
Upper Goulburn (above Ulan Ck)						
Sportsmans Hollow	SH0			**		Generally dry
	SH1					Broad Cumbingi
Airport Drainage	OC1	*	*	*	*	Generally dry
Bora Creek	BOX1	*	*	*	*	Generally dry
	BOX2	*	*	**	*	Generally dry
First Creek	BONX1			*	*	Generally dry
North of Bora	BONX2			*	*	Generally dry
Middle Goulburn River (Ulan Ck to Cassilis Rd)						
Second Ck	BNX1			*	*	Generally dry
North of Bora	BNX2			*	*	Generally dry
Goulburn River	GR1	14 Dec 04	19 May 05	21 Sep 05		Natural Pond
	GR2				18 Jan 06	Natural Pond
Lower Goulburn River (below Cassilis Rd to Wollar Ck)						
Bobadeen Creek	BC1	*	*	20 Sep 05	*	Generally dry
	BC2	*	*	22 Sep 05	*	Generally dry
Spring Gully	SG0	*	*	*	*	Generally dry
	SG1	*	*	*	*	Generally dry
Goulburn River	GR3	14 Dec 04	19 May 05	21 Sep 05		Sand bar Pond
	REF1			21 Sep 05		Spring fed pond

Notes:
* No water available for sampling
** Insufficient water for sampling

5.4.2 Field sampling program and sampling effort

Table 5.1 shows the sampling effort and actual sites where sampling could be undertaken for the MCP mine plan over the four seasonal sampling periods; late Spring 2004, Autumn 2005, Early Spring 2005 and Summer 2006. Hair tubes baited with sardines were also deployed at two sites during the Spring 2004 survey:

- On the Goulburn River 18 hair tubes were set at regular intervals along a 1.8 km length of Goulburn River around GR3 (1.2 m upstream and 600 m downstream) and left out for 24 hours; and
- On Moolarben Creek 6 hair tubes were set over 600 m upstream and downstream of site MC6 on the eastern side of the Moolarben Creek dam. These were also left out for 24 hours.

In all, there have been between 17 and 27 sites visited per season for sampling, with only 6 to 11 sites actually having sufficient water available for sampling. That is, from a potential sampling size of 82 sample sites over four surveys only 27 sites had sufficient water available for sampling. This is partly a consequence of overall dry weather conditions (with the exception of Spring 2005) and partly a consequence of the study area drainage lines which are all short with relatively small catchments and little or no capacity for water retention. That is, for many drainage lines there is only water during actual rain periods and there is little or no retention following cessation of rainfall.

5.4.3 Data analysis

The field site description data were quantified using a modified Riparian, Channel and Environment (RCE) inventory, using the RCE descriptors and scores (1 to 4) developed by Chessman et al (1997) for their study of the greater Hunter River catchment. For this study the RCE categories have been expanded by inserting a zero (null) score for each category to account for totally degraded stream characteristics. The RCE output is a set of scores representing the value of the creek section as aquatic habitat; ranging from 0 for totally degraded habitat to 52 for pristine and suitable aquatic habitat. These scores are also presented as percentages.

The AusRivAS macroinvertebrate data are in the form of taxa presence/absence at sites over time. The data have been summarised into tables showing individual site diversities per site per time which are then used to generate overall seasonal diversities. A standardised table layout has been adopted which indicates the relationship of the sites to overall main sub-catchments plus river sections (as described in 4.3 above). Given that not all sites are sampled over all times and that sampling conditions have been observed to be particularly variable from season to season, further statistical analysis has not been attempted.

Given the generally degraded condition of many of the sample sites plus the intermittent nature of remaining sites the data have not been subjected to AusRivAS analysis at this stage as it is considered that AusRivAS would not be sensitive enough to allow for meaningful within-site comparisons (as per Walsh 2006). Accordingly, the overall condition of the macroinvertebrate communities at each site have been analysed by assigning Stream Invertebrate Grade Number Average Level (SIGNAL) pollution tolerance scores for each taxa (Chessman 1995) and then computing a site SIGNAL index for each site/sampling period. SIGNAL analysis was found to provide overall more sensitivity for comparisons of degraded sites (Walsh 2006).

SIGNAL (Stream Invertebrate Grade Number Average Level) is an index for pollution tolerance for stream invertebrate animals. It is based on correlation analysis of aquatic invertebrate survey information with water chemical analysis and RCE scores for a wide range of different streams in NSW. Each invertebrate Family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). The water chemistry attributes generally used for pollution tolerance analysis are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus.

Once SIGNAL grades are assigned to the individual families found at the site (as binary presence-absence data), a site SIGNAL grade is derived by averaging the scores to provide an indication of the level of 'pollution' in the stream site at that time. Assessing the scores against actual site RCE scores plus against stream water chemistry over time provides a means of understanding which of the environmental variables are most likely to contribute to low scores at the site. Over time the combined assessments can also be used as a measure of site improvement via improved physical habitat conditions (RCE analysis) or improved water chemistry.

Individual taxa SIGNAL grades have been progressively refined since Chessman's' first published lists in 1995 (currently SIGNAL-2 values; Chessman 2003). However, Chessman et al (1997) published a comprehensive study of the macroinvertebrate fauna of the greater Hunter River catchment and provided revised SIGNAL grades for taxa in the Hunter River, termed SIGNAL-HU97. For the present study the HU97 grades as published have been adopted. For taxa where there were no published HU97 grades, published SIGNAL-2 grades have been used. The results tables provide both the HU97 and SIGNAL-2 grades for comparison.

The SIGNAL-HU97 data have been summarised into tables showing individual site grades per sample time, overall study means per sample site plus overall seasonal SIGNAL grades. For generating seasonal SIGNAL grades the site data were combined to provide a single SIGNAL grade for each taxa found within each season to provide an 'unweighted' seasonal SIGNAL index. A 'weighted' seasonal index was also generated by summing and averaging all seasonal occurrences of all taxa. Thus, taxa that occurred more frequently within the season would contribute proportionally more to the overall seasonal SIGNAL index than taxa that only occurred once. Comparison of the 'weighted' to 'unweighted' derived seasonal SIGNAL indices provides a measure of the evenness of the data.

Given the overall low diversity of the fish fauna and of aquatic plants, these have been summarised into tables with no further analysis (see Section 7).

6 TERRESTRIAL ECOLOGICAL VALUES OF THE STUDY AREA

6.1 General Description

The majority of the study area is characterised as gently undulating agricultural land, with moderate sized stands of native woodland vegetation retained along the steeper hillsides and ridgelines and in patches along creek lines. The Goulburn River and Wilpinjong Creek (an upper tributary of Goulburn River) drain much of the study area.

The study area is located in a transitional zone of plant species from the south-eastern, north-western and western parts of NSW. The western end of the Hunter Valley abuts the Great Dividing Range, which is at its lowest elevation in this region. This has resulted in the extension of many plants species into the area, which are characteristic of areas further west in NSW. In addition, a variety of plant species endemic to the Sydney sandstones reach their northern and western limits in this region.

Six Terrestrial Stratification Units (TSU's) based on broad vegetation communities have been recorded across the study area. These also form the basis of the fauna habitat units across the site. TSU's are described in detail in Chapter 6.2 below, and their distribution and extent illustrated on Figure 3.1.

In general, the valley floor vegetation has been cleared and disturbed, with Alluvial Apple Forest occurring as narrow strips along creek line corridors. Box and Red Gum Woodlands occur as remnant vegetation on the valley floors and adjacent lower slopes. Ironbark Forests occur on ridgelines and upper slopes in the south (south of the Ulan-Wollar Road) and Scribbly Gum Woodlands occur on ridgelines and upper slopes in the north (north of the Ulan-Wollar Road).

A detailed description of each of the vegetation associations within the Terrestrial Stratification Units is provided in Appendix 3. Complete species lists for flora and fauna are provided in Appendices 4 and 7 respectively.

6.2 Terrestrial Stratification Units (TSU)

6.2.1 Disturbed Vegetation, Code 10

Description: Cleared forest and woodland communities, including areas of early regrowth and regenerating shrublands. This unit also includes disturbed roadside vegetation, and chronically disturbed land due to previous claystone mining. Distribution illustrated on Figure 3.1.

Structure: The majority of lands within this TSU consist of grassland, with heights likely to vary due to seasonal and climatic conditions, and cover up to 80%. Some areas contain regrowth shrubs to 4-10m in height, with cover varying from 0-60%. Occasional remnant and regrowth trees occur with heights from 8-18m, and cover varying from 0-15%.

Floristics: Generally on soils of low fertility the vegetation is characterised as grassland dominated by native grasses such as Wire Grass *Aristida vagans*, Redleg Grass *Bothriochloa macra,* Speargrass *Austrostipa scabra*, Rats Tail *Sporobolus creber* and Wallaby Grass *Austrodanthonia spp*, and exotic naturalised grasses such as Catsear *Hypochaeris radicata,* Hairfoot Clover *Trifolium arvense*, Sheep Sorrel *Acetosella vulgare* and thistles. Native herbs and orchids appear frequently. Rare pioneer species may also appear. Shrubs include Sifton Bush *Cassinia arcuata*, Mudgee Wattle *Acacia spectabilis* and *Calytrix tetragona*, which may dominate under certain conditions. Occasional trees include Narrow-leaved Ironbark *Eucalyptus crebra*, Grey Box *Eucalyptus moluccana* and White Box *Eucalyptus albens*.

On soils of higher fertility, the land is maintained as pasture and native grasses have been replaced by seeded pasture species such as Ryegrass *Lolium* spp, Clover *Trifolium* spp, Medic *Medicago* spp and Fescue *Vulpia* spp, and weedy exotics such as Sheep Sorrel *Acetosella vulgare* and Prairie Grass *Briza minor*. Occasional shrubs include Black Cypress Pine *Callitris endlicherii*, *Cassinia* sp, *Acacia linearifolia* and Blackthorn *Bursaria spinosa*. Occasional trees include White Box *Eucalyptus albens*, Blakely's Red Gum *Eucalyptus blakelyi*, Rough-barked Apple *Angophora floribunda* and Grey Box *Eucalyptus moluccana*.

Some areas within this TSU exhibit early natural regeneration, with various shrub dominances. In ungrazed areas near naturally vegetated land on cleared mid-slopes of the valley floor, Sifton Bush *Cassinia arcuata* dominates. In a broad valley containing deep alluvial sands near the eastern boundary of the study area, *Banksia marginate* dominates. On well-drained sandy soils scattered through the study area, Mudgee Wattle Acacia *spectabilis dominates*. In moderately protected areas particularly at the foot slopes of steep gullies, Narrow-leaved Wattle *Acacia linearifolia* dominates.

Roadside vegetation is generally open woodland with wattles (*A spectabilis* and *A linearifolia*) and Sifton Bush *Cassinia arcuata* dominating the understorey, and relatively disturbance-tolerant grasses such as Three-awned Speargrass *Aristida vagans* and Ryegrass *Lolium* spp dominating the groundcover. Less disturbed areas support Kangaroo Grass *Themeda australis* and a variety of native herbs. Common trees include Grey Box *Eucalyptus moluccana*, Blakely's Red Gum *Eucalyptus blakelyi* and Narrow-leaved Ironbark *Eucalyptus crebra*.

Areas previously subjected to claystone mining are chronically disturbed, with many areas of bare ground remaining. A large variety of eucalypts and pioneer species are scattered sparsely through these areas, with limited groundcover species.

Condition: All vegetation within this TSU is regarded as highly disturbed due to previous clearing, earthworks, mining, weed invasions and pasture management. The vegetation within this TSU is not representative of any native vegetation community. However, portions of vegetation association 10 may contain elevated native species richness in close proximity to basalt caps, thereby forming highly localised native grasslands of varying condition.

Fauna Features: Mostly open pasture areas with scattered shelter shrubs and trees on the valley floors of the southern part of the study area. Generally abundant pasture grass seeds for granivores. Mistletoes occur in some parts of this TSU. Little roosting or shelter value for most species, but good foraging value for more disturbance-tolerant granivores. Water available in farm dams and creeklines.

Significance: Two threatened pioneer plants species have been recorded within this TSU, generally within ungrazed grasslands on soils of low fertility, *Diuris tricolor* (Vulnerable – TSC Act and EPBC Act) and *Goodenia macbarronii* (Vulnerable – TSC Act and EPBC Act).

Twelve threatened fauna species have been recorded within this TSU, including the Glossy Black Cockatoo, Large-eared Pied Bat, Little Pied Bat, Speckled Warbler, Brown Treecreeper, Painted Honeyeater, Hooded Robin, Black-chinned Honeyeater, Powerful Owl, Gilbert's Whistler, Grey-crowned Babbler and Diamond Firetail.

With regard to threatened fauna species, it is interesting to note that the majority (22 out of 26) of records of the Hooded Robin are from this TSU. Similarly, the majority of Diamond Firetail records and a large proportion of Brown Treecreeper records are from this TSU. These records are mainly from unimproved pasture, both grazed and ungrazed.

Critical fauna habitat features or resources within this TSU include Mistletoes of the *Amyema* genus for the Painted Honeyeater. No listed critical habitat under the TSC Act or EPBC Act occurs within this TSU.

6.2.2 Sedimentary Ironbark Forests, Code 20

Description: Open forest and woodland dominated by Ironbarks and/or Black Cypress Pine, occurring on conglomerate derived soils. Areas of Black Cypress Pine dominated woodland predominantly occur on dry sandy shallow soils. Distribution illustrated on Figure 3.1.

Structure: Trees within this TSU vary from 10-22m in height, with a cover varying from 5-60%. Shrubs occur from 0.5-4m in height, and up to 14m in height in areas with Black Cypress Pine, with a cover varying from 5-45%. The groundcover occurs up to 1m in height, with a cover varying from 0-30%.

Floristics: Dominant tree species within this TSU include Broad-leaved Ironbark *Eucalyptus fibrosa*, Narrow-leaved Ironbark *Eucalyptus crebra*, Grey Gum *Eucalyptus punctata*, Blue-leaved Stringybark *Eucalyptus agglomerata* and Red Stringybark *Eucalyptus macrorhyncha*. Dominance varies according to vegetation associations within this TSU.

Some parts of this TSU are dominated strongly by Black Cypress Pine *Callitris endlicherii*, which may potentially be indicative of past land clearing events. Other dominant shrub species within this TSU include Honey pots *Acrotriche rigida*, Geebung *Persoonia linearis*, Forest Goodenia *Goodenia hederacea*, Sheoak *Allocasuarina gymnanthera*, Blunt-beard Heath *Leucopogon muticus*, Urn-heath *Melichrus urceolatus*, Box-leaved Wattle *Acacia leucolobia, Babingtonia cunninghamia* and Sifton Bush *Cassinia arcuata*.

Few grasses occur within this TSU, with the dominant species being Three-awned Speargrass *Aristida vagans*, Short-haired Plumed Grass *Dichelachne micrantha* and Speargrass *Austrostipa scabra*. Common herbs include *Phyllanthus occidentalis*, *Pomax umbellata, Poranthera corymbosa,* and Rock Fern *Cheilanthes sieberi* ssp *sieberi*. A variety of terrestrial orchids were recorded. Increased grass diversity and spring flowering orchids occur more commonly in the Narrow-leaved Ironbark/Red Stringybark vegetation association, which is located on soils derived from tuffaceous claystones.

Condition: This TSU is predominantly void of weeds due to the limited amount of agriculture within these areas, the upslope position of these forests relative to agricultural activities and generally low soil fertility. Logging is evident throughout nearly all occurrences of this vegetation, presumably a consequence of timber harvesting for fence posts and mine props supporting the Ulan underground development. The vegetation is predominantly intact despite past disturbances and fragmentation by clearing sustained clearing events throughout the valley floor.

Fauna Features: Mostly open forest with sparse to moderate shrubs and a variable groundcover. Occurs mainly on elevated lands and rugged ridgelines in the south of the study area. A range of small to large tree-hollows occur, mainly within Ironbarks, providing potential roosting/nesting resources for bats, small to large arboreal mammals, and in some areas, for large forest owls. Some mistletoes occur in parts of this TSU. Fallen woody debris and leaf litter are a feature of this TSU, and generally with abundant fallen logs. *Callitris* sp is a feature of the understorey and canopy of many areas. Water is not generally readily available. Some areas have small to large surface rocks.

Significance: Seven threatened fauna species have been recorded within this TSU, including the Glossy Black Cockatoo, Speckled Warbler, Brown Treecreeper, Painted Honeyeater, Black-chinned Honeyeater, Powerful Owl and Diamond Firetail.

This TSU appears to be of particular value for the Glossy Black Cockatoo, and for the Speckled Warbler. The Glossy Black Cockatoo was recorded mainly from Broad-leaved Ironbark/Black Cypress Pine vegetation associations.

Critical fauna habitat features or resources within this TSU include Mistletoes of the *Amyema* genus for the Painted Honeyeater, and stands of *Allocasuarina* sp in the western parts of the proposed Underground No. 4 area for the Glossy Black Cockatoo. No listed critical habitat under the TSC Act or EPBC Act occurs within this TSU.

6.2.3 Box Woodlands, Code 30

Description: Forest and woodland vegetation dominated by Box eucalypt species on claystone and carboniferous derived soils. Distribution illustrated on Figure 3.1.

Structure: Trees within this TSU vary from 8-22m in height, with a cover varying from 5-45%. Shrubs occur from 0.5-10m in height, with a cover varying from 0-40%. The groundcover occurs up to 1.7m in height, with a cover varying from 0-60%.

Floristics: Dominant tree species within this TSU include Yellow Box *Eucalyptus melliodora*, Red Stringybark *Eucalyptus macrorhyncha*, Narrow-leaved Ironbark *Eucalyptus crebra*, Grey Box *Eucalyptus moluccana*, White Box *Eucalyptus albens*, Grey Box hybrid *Eucalyptus moluccana X albens*, Blakely's Red Gum *Eucalyptus blakelyi* and Slaty Gum *Eucalyptus dawsonii*. Dominance varies according to vegetation associations within this TSU.

Shrub species within this TSU are generally diverse, yet sparsely distributed. Common shrub species include Honey pots *Acrotriche rigida*, Peach Heath *Lissanthe strigosa*, Sifton Bush *Cassinia arcuata*, *Cassinia quinquefaria*, *Acacia* spp, Hop Bush *Dodonaea viscosa* ssp *cuneata* and Blackthorn *Bursaria spinosa*.

Box woodlands typically support a grassy understorey of relatively high plant species diversity. Common grasses include Weeping Grass *Dichelachne micrantha*, Three-awned Speargrass *Aristida vagans*, Wallaby Grass *Austrodanthonia racemosa* and Kangaroo Grass *Themeda australis*. Common herbs include Rock Fern *Cheilanthes sieberi* ssp *sieberi*, Kidney Weed *Dichondra repens*, *Calotis* spp, *Glycine tabacina* and Native Cranberry *Austroloma humifusum*. A variety of terrestrial orchids were recorded.

Condition: A variety of anthropogenic influences has adversely impacted the Box Woodlands of the study area. Logging and/or broad scale clearing have resulted in the patchy fragmented occurrence of this TSU throughout the study area. The majority of Box Woodlands share a boundary with TSU 10, resulting in a localised disturbed boundary of varying depths that has promoted various exotic flora and weedy natives such as Catsear *Hypochaeris* spp., Prairie Grass *Bromus* spp., *Vulpia* spp. and Sifton Bush *C. arcuata*. The latter species appears to represent a pioneer native occupying disturbed environs. However, the propensity for this species to dominate and its apparent allopathic qualities indicate that it is not a constructive pioneer species.

Fauna Features: Mostly woodland with sparse shrubs and a groundcover equally split between grassy vegetative cover and leaf litter. Occurs on lower slopes mainly in the southern part of the study area, forming the interface between cleared valley floors and vegetated more rugged ridgelines. A range of small to large tree-hollows occur, providing potential roosting/nesting resources for bats, small to large arboreal mammals, and maybe in some areas, for large forest owls. Mistletoes occur throughout this TSU. Availability of fallen woody debris and logs are variable within this TSU. Water is not generally readily available. Profusely flowering eucalypt species are a feature.

Significance: Many of the vegetation associations within this TSU are part of the endangered ecological community ‘White Box-Yellow Box-Blakely’s Red Gum Woodland’ which is listed under the TSC Act. One of these vegetation associations also meet the description for ‘Grassy White Box Woodlands’, a community listed as threatened under the Commonwealth EPBC Act.

One threatened plant species was recorded within this TSU, Hoary Sunray *Leucochrysum albicans* var *tricolor* (Endangered – EPBC Act).

One species of local conservation significance is the Grey Box hybrid *Eucalyptus moluccana X albens*. This species is locally restricted to the Merriwa Plateau, and within the study area is dominant throughout the northern parts of the study area on the Jurassic Pilliga sandstone formation.

Ten threatened fauna species have been recorded within this TSU, including the Glossy Black Cockatoo, Speckled Warbler, Brown Treecreeper, Painted Honeyeater, Square-tailed Kite, Hooded Robin, Black-chinned Honeyeater, Grey-crowned Babbler, Yellow-bellied Sheath-tail Bat and Diamond Firetail.

As expected, this TSU is of notable value particularly for the threatened woodland birds identified in Reid (1999) and Stevens (2001), *ie* Brown Treecreeper, Speckled Warbler, Grey-crowned Babbler and Diamond Firetail. Surprisingly however, only 1 record out of 26 for the Hooded Robin was from this TSU.

It is likely that this TSU represents the higher value habitats for declining woodland birds.

Critical fauna habitat features or resources within this TSU include Mistletoes of the *Amyema* genus for the Painted Honeyeater. No listed critical habitat under the TSC Act or EPBC Act occurs within this TSU.

6.2.4 Tablelands Red Gum Woodland, Code 40

Description: Forest and woodland vegetation dominated by Red Gum on alluvial deposits derived from basalt, carboniferous and/or claystone formations. Distribution illustrated on Figure 3.1.

Structure: Trees within this TSU vary from 6-20m in height, with a cover varying from 15-35%. Shrubs occur from 0.5-10m in height, with a cover varying from 5-40%. The groundcover occurs up to 1m in height, with a cover varying from 5-40%.

Floristics: The dominant tree species within this TSU is Blakely’s Red Gum *Eucalyptus blakelyi* (which occurs in near pure stands in some parts). A variety of canopy associates also occurs with this dominant species. Associated trees may include species such as Scribbly Gum *Eucalyptus rossii*, Rough-barked Apple *Angophora floribunda*, Grey Box *Eucalyptus moluccana,* Yellow Box *Eucalyptus melliodora*, White Box *Eucalyptus albens* and Blue-leaved Stringybark *Eucalyptus agglomerata*. Dominance varies according to vegetation associations within this TSU.

Tumbledown Red Gum *Eucalyptus dealbata* in association with Black Cypress Pine *Callitris endlicherii* forms a distinct vegetation association near the confluence of the Permian and Carboniferous geological formations near the western boundary of OC 1. Other shrub species within this TSU include Sifton Bush *Cassinia arcuata*, Beard-heath *Leucopogon virgatus*, Heath *Brachyloma daphnoides*, *Acacia linearifolia* and Common Fringe-myrtle *Calytrix tetragona*.

There is a high diversity of native herbs and grasses within this community. Common grass species include Three-awn Speargrass *Aristida vagans*, Reedgrass *Arundinella nepalensis*, Kangaroo Grass *Themeda australis* and Wallaby Grasses *Austrodanthonia* spp. Common herb species include Rock Fern *Cheilanthes sieberi* ssp *sieberi*, Narrow-leaved Goodenia *Goodenia macbarronii*, Stinking Pennywort *Hydrocotyle laxiflora*, Catsear *Hypochaeris radicata* and Raspwort *Gonocarpus tetragynus*. Waxlip Orchid *Glossodia major* and Sun Orchid *Thelymitra pauciflora* occur scattered throughout.

Condition: The majority of this TSU remans intact despite the occurrence of past land clearing events for agricultural lands. The least disturbed remnants are associated with parcels having a limited boundary with disturbed lands and/or limited quantity of land clearing in the preceding catchment. Weeds are generally low in abundance and are restricted to species capable of occupying moist soils Sifton Bush *Cassinia arcuata* occasionally forms a dominant shrub species in areas where the disturbance history is more pronounced. Generally the logging of this vegetation has been limited mostly to firewood collection, as the trunks of these redgums are generally unsuitable for structural purposes.

Fauna Features: Mostly woodland with sparse shrubs and a groundcover largely comprised of leaf litter. Discontinuous distribution on lower lying land in the northern part of the study area, generally continuous with TSU 50 - Sedimentary Scribbly Gum Woodlands. A good range of small to large tree-hollows occur, possibly some deep hollows in large trees, providing potential roosting/nesting resources for bats, small to large arboreal mammals, and for large forest owls. Some mistletoes occur in parts of this TSU. One site is in a rocky creekline area with small to large surface rocks, cliffs and potentially some shallow caves.

Significance: One of the vegetation associations within this TSU (Blakely's Red Gum Woodland) is part of the endangered ecological community 'White Box-Yellow Box-Blakely's Red Gum Woodland' which is listed under the TSC Act.

Blakely's Red Gum Woodland within this TSU provides core habitat for one threatened plant species Narrow-leaved Goodenia *Goodenia macbarronii* (Vulnerable – TSC Act and EPBC Act).

Eight threatened fauna species have been recorded within this TSU, including the Large-eared Pied Bat, Little Pied Bat, Painted Honeyeater, Hooded Robin, Common Bent-wing Bat, Greater Long-eared Bat, Yellow-bellied Sheath-tail Bat and Diamond Firetail. All of these records are from the Blakely's Red Gum Woodland vegetation association.

Whilst this TSU does not appear to be of particular value for any threatened fauna species, a higher number of threatened microchiropteran bat species was recorded within the Blakely's Red Gum Woodland association than in any other TSU.

Critical fauna habitat features or resources within this TSU include Mistletoes of the *Amyema* genus for the Painted Honeyeater. No listed critical habitat under the TSC Act or EPBC Act occurs within this TSU.

6.2.5 Sedimentary Scribbly Gum Woodlands, Code 50

Description: Woodlands dominated by Scribbly Gum and Black Cypress Pine on conglomerate derived soils. Distribution illustrated on Figure 3.1.

Structure: Trees within this TSU vary from 8-20m in height, with a cover varying from 5-40%. Shrubs occur from 0.5-16m in height, with a cover varying from 5-55%. The groundcover occurs up to 1m in height, with a cover varying from 0-30%.

Floristics: Dominant tree species within this TSU include Rough-barked Apple *Angophora floribunda*, Inland Scribbly Gum *Eucalyptus rossii*, Blue-leaved Stringybark *Eucalyptus agglomerata*, Broad-leaved Ironbark *Eucalyptus fibrosa*, Narrow-leaved Ironbark *Eucalyptus crebra* and Narrow-leaved Stringybark *Eucalyptus sparsifolia*. Dominance varies considerably according to intra-geological variability and disturbance history.

Black Cypress Pine *Callitris endlicherii* forms a dominant canopy in some parts of this TSU. This TSU is characterised by a diverse sclerophyllous shrubby understorey, with dominant species including Beard-heath *Leucopogon muticus*, Narrow-leaved Geebung *Persoonia linearis*, Heath *Brachyloma daphnoides*, *Acacia linearifolia*, Five Corners *Styphelia triflora*, Native Fuchsia *Correa reflexa*, Common Fringe-myrtle *Calytrix tetragona*, Box Wattle *Acacia leucolobia* and Sheoak *Allocasuarina gymnanthera*.

The groundcover is generally sparse, with mostly woody herbs and few grasses. Common herb species include *Platysace ericoides*, *Pomax umbellata*, *Poranthera microphylla*, *Phyllanthus occidentalis*, *Isotoma axillaris*, Forest Goodenia *Goodenia hederacea*, Flax Lily *Dianella revoluta*, *Patersonia sericea* and Mat-rush *Lomandra confertifolia*. Grasses include Wallaby Grass *Austrodanthonia* spp, *Poa* spp, Three-awned Speargrass *Aristida vagans* and Reedgrass *Arundinella nepalensis*. Several terrestrial orchid species occur.

Condition: This TSU is predominantly void of weeds due to the limited amount of agriculture within these areas, the upslope position of these woodlands relative to the surrounding agricultural activities and generally low soil fertility. Logging is evident throughout selected parts of this TSU, presumably a consequence of timber harvesting for fence posts and mine props supporting the Ulan underground development. The vegetation is predominantly intact despite past disturbances such as track construction works and exploration drilling for coal. Consequently, weeds are generally restricted to track margins and ephemeral creeklines.

Fauna Features: Open forest to woodland with moderate shrubs and a groundcover comprised largely of leaf litter. Mostly occurs in large continuous and relatively undisturbed stands on undulating land in the north of the study area. A good range of small to large tree-hollows occur, providing potential roosting/nesting resources for bats, small to large arboreal mammals, and in some areas, for large forest owls. Some mistletoes occur in parts of this TSU. There are generally abundant fallen logs.

Significance: One threatened plant species was recorded in this TSU, Narrow-leaved Goodenia *Goodenia macbarronii* (Vulnerable – TSC Act and EPBC Act).

One ROTAP species was recorded in this TSU, *Pseudanthus divaricatissimus* - 3Rca.

Eleven threatened fauna species have been recorded within this TSU, including the Gang Gang Cockatoo, Glossy Black Cockatoo, Large-eared Pied Bat, Speckled Warbler, Brown Treecreeper, Painted Honeyeater, Hooded Robin, Common Bent-wing Bat, Powerful Owl, Gilbert's Whistler and Diamond Firetail.

This TSU appears to be of particular value mainly for the Glossy Black Cockatoo.

Critical fauna habitat features or resources within this TSU include Mistletoes of the *Amyema* genus for the Painted Honeyeater, and stands of *Allocasuarina* sp in the vicinity of OC1 for the Glossy Black Cockatoo. No listed critical habitat under the TSC Act or EPBC Act occurs within this TSU.

6.2.6 Alluvial Apple Woodlands, Code 60

Description: Woodland vegetation dominated by Rough-barked Apple on quaternary geological formations. Distribution illustrated on Figure 3.1.

Structure: Trees within this TSU vary from 12-18m in height, with a cover varying from 15-50%. Shrubs occur from 0.5-10m in height, with a cover varying from 5-70%. The groundcover occurs up to 1m in height, with a cover varying from 15-60%.

Floristics: Dominant tree species within this TSU are Rough-barked Apple *Angophora floribunda*, Grey Box *Eucalyptus moluccana* and Narrow-leaved Ironbark *Eucalyptus crebra*. Dominance varies according to vegetation associations within this TSU.

The shrub layer is diverse with sclerophyllous species including Native Cranberry *Astroloma humifusum*, *Babingtonia cunninghamii*, *Daviesia acicularis*, Sifton Bush *Cassinia arcuata*, Black Cypress Pine *Callitris endlicherii* and *Pultenaea microphylla*.

The groundcover is grassy and dominated by Slender Speargrass *Austrostipa scabra*, Three awn Speargrass *Aristida vagans*, Weeping Meadow Grass *Microlaena stipoides*, *Dichelachne micrantha* and Reedgrass *Arundinella nepalensis*. Common herbs include Rock Fern *Cheilanthes sieberi* ssp *sieberi*, Native Cranberry *Astroloma humifusum*, Mat-rush *Lomandra confertifolia*, Tufted Bluebell *Wahlenbergia communis*. The Slender Onion Orchid *Microtis parviflora* occurs throughout.

A natural spring-fed vegetation association occurs within this TSU, in a small area near the confluence of Murragamba and Wilpinjong Creeks. No trees or shrubs occur in this area. A number of native grass and herb species characteristic of water-logged soils occur in this area, including *Juncus planifolius*, *Myriophyllum gracile* var *lineare*, *Utricularua dichotoma*, Narrow-leaved Goodenia *Goodenia macbarronii*, Rough Raspwort *Haloragis heterophylla* and *Schoenus moorei*. This association represents the only natural location within the study area for a number of the species recorded.

Condition: The majority of this TSU has either been cleared for agriculture due to the agricultural suitability of the underlying landscape. However, it is difficult to determine whether existing occurrences of this TSU are natural communities or the regenerating vegetation that is a consequence of widespread clearing. Weeds are generally low in abundance and are restricted to species capable of occupying sandy soils. Sifton Bush Cassinia arcuata occasionally forms a dominant shrub species in areas where the disturbance history is more pronounced. Generally no logging of this vegetation has occurred, as this vegetation is generally unsuitable for firewood or structural purposes.

Fauna Features: Generally woodland with moderate shrubs. This TSU is mostly located along narrow creek line corridors on the valley floor. Mistletoes occur throughout this TSU.

Significance: Two threatened plant species were recorded in this TSU. Narrow-leaved Goodenia *Goodenia macbarronii* (Vulnerable – TSC Act and EPBC Act) was recorded in a small area around the natural spring-fed vegetation association, and Cannon's Stringybark *Eucalyptus cannonii* was recorded in a restricted vegetation association on EL6288 (Vulnerable – TSC Act).

Six threatened fauna species have been recorded within this TSU, including the Glossy Black Cockatoo, Speckled Warbler, Brown Treecreeper, Common Bent-wing Bat, Squirrel Glider and Diamond Firetail.

This TSU does not appear to be of significant value for any of the threatened species recorded, with the exception of the Squirrel Glider. Only one record of he Squirrel

Glider was obtained for the study area, and it was from the Rough-barked Apple Open Forest of this TSU.

Critical fauna habitat features or resources within this TSU include Mistletoes of the *Amyema* genus for the Painted Honeyeater. No listed critical habitat under the TSC Act or EPBC Act occurs within this TSU.

6.3 Groundwater Dependant Ecosystems

As described and documented in Dundon and Associates (2006) "there is abundant evidence in the large number of springs and seeps that the groundwater discharges to the surface throughout the area. However, with few exceptions, the volumes of individual spring and seep discharges are very small. Many seeps were only visible as patches of dampness or lush grass. The flow rate of the largest spring flow observed in the study area is estimated at less than 0.1 L/s. Nevertheless, the accumulation of groundwater discharges is sufficient to maintain semi-perennial flow in the major tributaries and virtually permanent flow in the Goulburn River (either visible flow or flow within the sandy stream bed). Landowners report that a number of spring-fed dams are able to maintain permanent water through extended dry periods due to groundwater seepage".

Potential GDEs of the MCP DA area were identified using the eight-step rapid assessment (DLWC, 2002), with those conforming to this assessment method described below in accordance with its associated broad GDE classification.

6.3.1 Terrestrial GDEs

No terrestrial GDEs mappable at the vegetation association level were identified within the MCP DA area or impact zone. However, small unmappable vegetation assemblages occur within the MCP DA area that is often associated with moist to wet soils that may be considered GDEs. The following sections describe these occurrences.

The Drip

North of the MCP DA area and outside the impact area is a series of small vegetated pockets located within the cliff line of The Drip, comprising of coastal wetland species and moisture affiliated ferns such as *Cladium procerum* and Coral Fern respectively. Water discharging at The Drip is derived from perched groundwater in the Triassic sediments (Peter Dundon and Associates 2006). The water percolating through The Drip supports these vegetated pockets such that the removal of this water would almost certainly result in the loss of this vegetation. Accordingly, much of the vegetation in the cliff face of The Drip is considered a GDE, which is of highly localised and restricted occurrence. The significance of this GDE is high as the species assemblage and topographical characters are unique to the locality.

Underground 4

Identified within the impact area of Underground 4 are terrestrial woodlands and forests of dry sclerophyll character. Located midslope within a series of broad open drainage corridors is vegetation containing a localised occurrence of Parramatta Redgum (*Eucalyptus parramattensis*), a species that is known to be associated with wet soils (Harden, 2002). Also occurring with this canopy dominant is a range of other sclerophyllous shrubs that are also capable of occurring within moist soils such as *Melaleuca thymifolia* and *Melaleuca ericifolia*.

This area of open woodland is approximately 25.7 ha, with the associated topography being relatively flat (i.e. 2-4^0). Broad crests and ephemeral drainage lines predominate this area. Soils are generally poorly drained due to the gentle slope and elevated shale content, which retains soil moisture for prolonged periods after a rainfall event.

The small catchment preceding the mapped occurrence of Parramatta Redgum (*Eucalyptus parramattensis*) covers an area of approximately 42 ha, with the associated topography of this catchment characterised by an isolated elevated plateau, sheer cliff lines and moderately steep foot slopes (8-10^0). Free draining sandy soils characterise this catchment, with deeper free draining soils noted throughout the foot slopes.

The occurrence of the Parramatta Redgum (*Eucalyptus parramattensis*) vegetation appears to be a consequence of locally increased soil moisture levels. While it is possible that groundwater seepage sourced from the preceding catchment may contribute some of the water for soil uptake , it is considered that surface water flows following storms combined with the gentle slopes and the moisture-trapping shale soils are the main factors contributing to the occurrence of Parramatta Redgum (*Eucalyptus parramattensis*). That is, the Parramatta Redgum vegetation is not considered a GDE.

Also observed within the Underground 4 area are isolated occurrences of ferns and other moisture affiliated species, which are located below rocky outcrops containing shale exposures. While no groundwater was observed at these locations, it is considered that ephemeral groundwater flows may potentially occur. Recent drought conditions are likely to have stopped the flow of localised shallow groundwater resources, indicating that the isolated fern clumps located along the rocky outcrops are adapted to relatively dry ephemeral water flows. It is considered that the occurrence of these fern clumps is periodically reliant on local shallow groundwater flows. No threatened biodiversity or their habitats occur at these locations.

Whilst the presence of groundwater dependent ecosystems (GDEs) has not been surveyed in the adjacent National Park estate outside the study area, Peter Dundon and Associates (2006) reason that their presence is considered unlikely as the Narrabeen Sandstones in this area do not appear to be conducive to retaining water to the extent that would support a unique vegetation assemblage, due to the massive structure and lack of barriers. This conclusion is consistent with the results of the surveys within the study area as reported above.

6.3.2 Base flow GDEs

The Groundwater Report (Peter Dundon & Associates 2006) found that groundwater contributes to base flow in Moolarben Creek and the Goulburn River. Accordingly, riparian plus aquatic and fluctuating hyporheic zones may be groundwater dependent. Assessment of riparian vegetation (as presented in this chapter above) did not indicate any specific riparian plant communities, which could be considered groundwater dependent. Assessment of aquatic habitats including hyporheic zones is considered separately in Chapter 7 below.

6.3.3 Aquifer and Cave GDEs

Based on a consideration of the DA area geomorphology there are no aquifer or cave GDEs expected in the DA area.

6.3.4 Wetland GDEs

Aside from the shallow wetland area at the confluence of Lagoon and Moolarben Creeks plus the fringing wetland around the upper margin of Moolarben Dam there are no natural areas of wetland in the DA area. The two shallow wetland areas are created as a result of in-stream flow constrictions and consequently are dependent on, and respond to surface water level fluctuations. Neither is dependent on local seepages or spring water. Whilst surface water level is in turn dependent on groundwater base-flow, the fluctuations in water level are mainly governed by water draw down from the dam and by local evaporation. These fringing wetlands are not considered to be GDEs.

6.3.5 Terrestrial Fauna dependence on GDEs

Threatened fauna species in the study area are not generally distributed according to specific narrow vegetation associations (as is the nature of potential GDEs in the DA area), but are correlated instead with the broader terrestrial stratification units. The only threatened fauna species recorded from the general locality with a fairly direct dependence on water is the Giant Barred Frog, which was not recorded from the DA area during the surveys undertaken for this project.

Of the possible assessed GDEs considered above it is concluded that are no GDEs within the study area that are likely to be of specific importance to any threatened fauna species. This includes the Parramatta Redgum vegetation association discussed in Chapter 6.3.1 of this report.

6.4 Summary of Ecological Significance

6.4.1 Threatened Ecological Community

Six vegetation associations located within the MCP DA Area are consistent with the definition for the TSC Act listed White Box Yellow Box Blakely's Red Gum Woodland EEC (NSW Scientific Committee 2002) and Box-Gum identification Guidelines (NPWS 2002). One of these vegetation associations is also listed as an EEC under the EPBC Act (*ie* Grassy White Box Woodlands).

Approximately 786.2ha of vegetation White Box Yellow Box Blakely's Red Gum Woodland occurs in the study area, with approximately 259.6ha contained within the MCP DA Area. The distribution of this EEC for the MCP DA Area is illustrated in Figure 3.5, with **Table 6.1** providing details on the contained vegetation associations.

Table 6.1 Vegetation Associations identified as White Box Yellow Box Blakely's Red Gum Woodland EEC

TSU	Vegetation Association	DA Area (ha)	Study Area (ha)
30 Box Woodlands	30 Yellow Box/Red Stringybark/Blakely's Red Gum	36.7	60.9
30 Box Woodlands	31 White Box/Narrow-leaved Ironbark	8.8	30.5
30 Box Woodlands	33 Grey Box/Narrow-leaved Ironbark/Blakely's Red Gum	47.0	179.6
30 Box Woodlands	36 Grassy White Box	7.7	99.3
40 Tablelands Red Gum Woodlands	40 Blakely's Red Gum	130.8	325.7
60 Alluvial Apple Forests	60 Rough-barked Apple Yellow Box	28.7	92.2

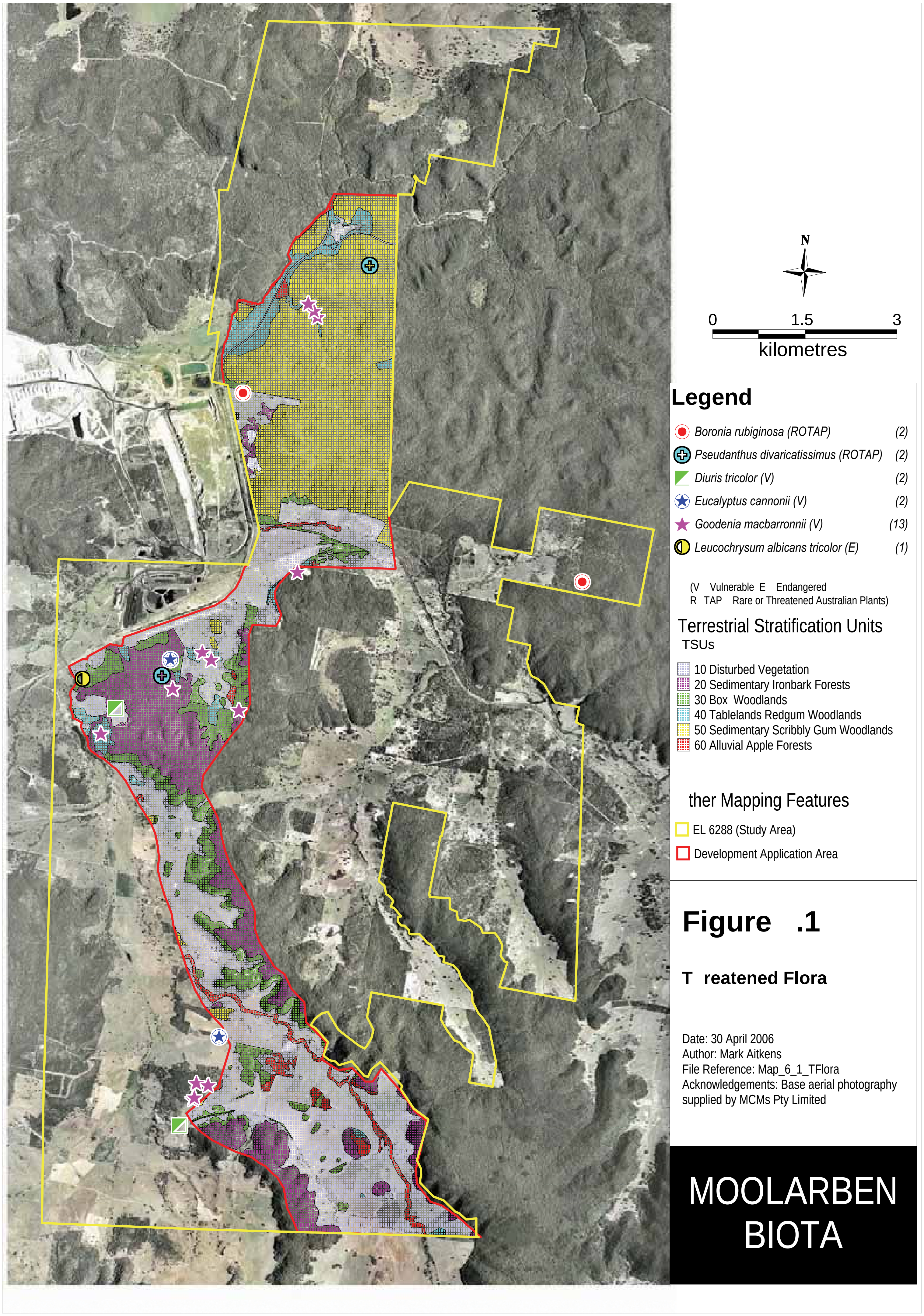
6.4.2 Threatened Populations

No flora or fauna species being part of any relevant listed endangered populations are known to occur in the MCP study area, or are likely to be affected by the proposed mine.

6.4.3 Threatened Species

Flora

Four threatened plant species have been recorded in the study area (**Figure 6.1**), in TSU's and vegetation associations as indicated in **Table 6.2**. These species are referred to as 'subject species', and are considered further in Chapter 8.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kilometres
Legend
Boronia rubiginosa (ROTAP) (2)
Pseudanthus divaricatissimus (ROTAP) (2)
Diuris tricolor (V) (2)
Eucalyptus cannonii (V) (2)
Goodenia macbarronnii (V) (13)
Leucochrysum albicans tricolor (E) (1)
(V Vulnerable E Endangered
R TAP Rare or Threatened Australian Plants)
Terrestrial Stratification Units
TSUs
10 Disturbed Vegetation
20 Sedimentary Ironbark Forests
30 Box Woodlands
40 Tablelands Redgum Woodlands
50 Sedimentary Scribbly Gum Woodlands
60 Alluvial Apple Forests
ther Mapping Features
EL 6288 (Study Area)
Development Application Area
Figure .1
T reatened Flora
Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_6_1_TFlora
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited
MOOLARBEN
BIOTA

Table 6.2 Flora subject species

Species	TSU	Vegetation Association	Details (MCP DA Area)
Goodenia macbarronii V (TSC Act & EPBC Act)	10 Disturbed Vegetation	11 Unimproved grazed grassland	Approximately 500 individuals, 1 location
	20 Sedimentary Ironbark Forests	20 Broad-leaved Ironbark/ Grey Gum	200-300 individuals, 1 location
	20 Sedimentary Ironbark Forests	23 Black Cypress Pine	Approximately 500 individuals, 1 location
	30 Box Woodlands	30 White Box Yellow Box Blakely's Red Gum	Undetermined individuals, 1 location
	40 Tablelands Red Gum Woodlands	40 Blakely's Red Gum (core habitat)	Approximately 3000 individuals, 7 locations
	50 Sedimentary Scribbly Gum Woodlands	52 Inland Scribbly Gum/Rough-barked Apple	Approximately 1000 individuals, 2 locations
Diuris tricolor V (TSC Act & EPBC Act)	10 Disturbed Vegetation	10 Unimproved ungrazed grassland	2 individuals over 0.25ha, 2 locations
Leucochrysum albicans var *tricolor* E (EPBC Act)	30 Box Woodlands	33 Grey Box/Narrow-leaved Ironbark/Blakely's Red Gum Open Forest	10 individuals over 0.5ha, 1 location
Eucalyptus cannonii V (TSC & EPBC)	30 Box Woodlands	33 Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	7 individuals, 1 location
	60 Alluvial Apple Forest	62 Rough-barked Apple/Ironbark Open Forest	1 individual, 1 location

Fauna

Listed in **Table 6.3** are 29 threatened fauna species known or considered likely to occur in the study area and in the MCP DA Area, and/or likely to be affected by the proposed mine. These species are referred to as 'subject species', and are considered further in Chapter 8.

Table 6.3 Fauna subject species (SS)

Species	Predominant/Likely TSU/Habitat Unit	Vegetation Association/Details
Bush Stone-curlew *Burhinus grallarius*	30 Box Woodlands 10b Disturbed Vegetation	Anecdotal landholder records in the southern part of the study area.
Square-tailed Kite *Lophoictinia isura*	30 Box Woodlands 10b Disturbed Vegetation	1 record in 36 Grassy White Box Woodland.
Gang Gang Cockatoo *Callocephalon fimbriatum*	Most vegetation association with *Callitris* sp. 30 Box Woodlands	1 record in 52 Scribbly Gum/Black Cypress Pine Woodland. Winter visitor.

Table 6.3 cont Fauna subject species (SS)

Species	Predominant/Likely TSU/Habitat Unit	Vegetation Association/Details
Glossy Black Cockatoo *Calyptorhynchus lathami*	Most TSU's.	39 records. Appears to occur in 2 main locations in the study area, based around important *Allocasuarina* feeding sites.
Swift Parrot *Lathamus discolor*	Not known.	May occur in the DA area during mass flowering events. Winter visitor.
Turquoise Parrot *Neophema pulchella*	30 Box Woodlands	May occur in the DA area occasionally.
Powerful Owl *Ninox strenua*	20 Sedimentary Ironbark Forests 50 Sedimentary Scribbly Gum Woodlands	3 records. Recorded in vegetation association with dominance or sub-dominance of Ironbark. Probably uses DA area for foraging, and nests in nearby NP estate.
Masked Owl *Tyto novaehollandiae*	Not known.	Anecdotal landholder records in the study area. Probably only uses DA area for foraging.
Barking Owl *Ninox connivens*	Not known.	Probably uses DA area for foraging, and nests in nearby NP estate.
Gilbert's Whistler *Pachycephala inornata*	10b Disturbed Vegetation 50 Sedimentary Scribbly Gum Woodlands	1 record in 10 Ungrazed Unimproved Grasslands and 1 record in 53 Scribbly Gum Stringybark Ironbark Woodland.
Grey-crowned Babbler *Pomatostomus temporalis*	30 Box Woodlands 50 Sedimentary Scribbly Gum Woodlands	6 records, mainly Box Woodlands – 34, 37, 39 Also 52 Scribbly Gum Black Cypress Pine Woodland
Speckled Warbler *Pyrrholaemus sagittatus*	30 Box Woodlands	Widespread, 21 records, mainly grassy TSU 30 Box Woodlands, and ecotones between this and TSU 20 Ironbark Forests.
Brown Treecreeper *Climacteris picumnus victoriae*	30 – Box Woodlands 10b Disturbed Vegetation	Widespread, 76 records across 24 vegetation associations.
Hooded Robin *Melanodryas cucullata cucullata*	Riparian habitats, which currently are mainly 10b Disturbed Vegetation (22 out of 26 records)	26 records. Seems to prefer habitats close to creeklines. Also recorded from vegetation associations 36, 40 and 52.
Black-chinned Honeyeater *Melithreptus gularis gularis*	30 Box Woodlands 10b Disturbed Vegetation 20 Sedimentary Ironbark Forests	8 records across 7 vegetation associations. 5 from Box Woodlands. Mainly associations with dominance or sub-dominance of Ironbarks. Likely to occur only in larger remnants.
Painted Honeyeater *Grantiella picta*	Most TSU's	6 records across 6 vegetation associations. Distribution likely to focus on areas with concentrations of Mistletoe of *Amyema* spp.
Regent Honeyeater *Xanthomyza phrygia*	30 Box Woodlands	May occur in the DA area, particularly during mass flowering events.
Diamond Firetail *Stagonopleura guttata*	10b Disturbed Vegetation 30 Box Woodlands	52 records across all TSU's and 18 vegetation associations, 32 records in TSU 10b and 13 in TSU 30.
Giant Barred Frog *Mixophyes iteratus*	Not known.	Not likely to occur in DA area, but some potential to be affected by downstream impacts.

Table 6.3 cont Fauna subject species (SS)

Species	**Predominant/Likely TSU/Habitat Unit**	**Vegetation Association/Details**
Squirrel Glider *Petaurus norfolcensis*	60 Alluvial Apple Forests Potentially also 30 Box Woodlands	1 record in 61 Rough-barked Apple Forest.
Large-eared Pied Bat *Chalinolobus dwyeri*	10b Disturbed Vegetation 40b Blakely's Red Gum Woodland	9 records across 4 vegetation associations. 5 records from TSU 10b, 3 records from TSU 40b and 1 record from 54 Scribbly Gum Ironbark Woodland.
Little Pied Bat *Chalinolobus pictatus*	10b Disturbed Vegetation 40b Blakely's Red Gum Woodland	3 records across 3 vegetation associations. 1 record from TSU 10b, 1 record from TSU 40b and 1 record from TSU 10a mine site.
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Not known.	Thought to prefer more extensive and less disturbed remnants
Eastern Freetail Bat *Mormopterus norfolcensis*	Not known.	No details of preferences known.
Eastern Bent-wing Bat *Miniopterus schreibersii*	40b Blakely's Red Gum Woodland 50 Sedimentary Scribbly Gum Woodlands	5 records across 3 vegetation associations. 2 records from TSU 40b, 2 records from 52 Scribbly Gum Black Cypress Pine, 1 record from 61 Rough-barked Apple Forest.
Little Bent-wing Bat *Miniopterus australis*	Not known.	All records from region recorded in conjunction with Eastern Bent-wing Bat.
Greater Long-eared Bat *Nyctophilus timoriensis*	40b Blakely's Red Gum Woodland	1 record from TSU 40b - Blakely's Red Gum Woodland.
Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*	40b Blakely's Red Gum Woodland 30 Box Woodlands	2 records, 1 from TSU 40b, and the other from 34 Grey Box Ironbark Slaty Gum Woodland.
Eastern Cave Bat *Vespadelus troughtoni*	Not known.	No details of preferences known. Cave roosting.

6.4.4 Declining Woodlands Birds

Declining woodland birds are treated collectively as a subject species in this report. Declining woodland birds for this report are non-threatened species[1] listed by Stevens (2001), and which were recorded in the study area for the MCP (14 species). These include:

Common Name	***Scientific name***	**Abundance in study area**
Emu	*Dromaius novaehollandiae*	Common
Whistling Kite	*Haliastur sphenurus*	Uncommon
Painted Button-quail	*Turnix varia*	Rare
Southern Whiteface	*Aphelocephala leucopsis*	Common
Jacky Winter	*Microeca fascinans*	Very comment
Red-capped Robin	*Petroica goodenovii*	Uncommon
Eastern Yellow Robin	*Eopsaltria australis*	Comment
White-browed Babbler	*Pomatostomus superciliosus*	Comment
Varied Sitella	*Daphoenositta chrysoptera*	Uncommon

1 Declining woodland birds which listed as threatened species are discussed individually in this report.

Common Name	*Scientific name*	Abundance in study area
Crested Shrike-tit	*Falcunculus cristata*	Uncommon
Rufous Whistler	*Pachycephala rufiventris*	Very comment
Restless Flycatcher	*Myiagra inquieta*	Common
White-browed Woodswallow	*Artamus superciliosus*	Uncommon
Dusky Woodswallow	*Artamus cyanopterus*	common

Based on a review of research findings and an overview of field results, the majority of records of declining woodland birds within the study area were obtained from and/or would be expected from the following TSU/habitat units:

- 10b Disturbed Vegetation - unimproved ungrazed and grazed grasslands;
- 30 Box Woodlands - all associations;
- 40b Tablelands Red Gum Woodlands - Blakely's Red Gum Woodland; and
- 60 Alluvial Apple Forests.

6.4.5 Native Vegetation and Habitats

The relative quality and habitat value of areas of native vegetation across the study area is described in **Table 6.4** below.

Table 6.4 Relative quality (including extent) and habitat value of TSU's within the study area.

TSU	Quality	Habitat Value
10	All vegetation within this TSU is regarded as highly disturbed due to previous clearing, earthworks, mining, weed invasions and pasture management. The vegetation within this TSU is not representative of any native vegetation community. However, portions of vegetation association 10 may contain elevated native species richness in close proximity to basalt caps, thereby forming highly localised native grasslands of varying condition.	No specific threatened flora habitats exist within this TSU. The occurrence of threatened flora is generally an artefact of disturbance rather than the contained habitat values. Species such as *Diuris tricolor* and *Goodenia macbarronii* have been found within this TSU. Unimproved grasslands within this TSU are notable habitat for a number of small seed and insect eating threatened bird species, in particular the Hooded Robin, Diamond Firetail and Brown Treecreeper. These grasslands are also likely to be of some foraging value for other 'declining woodland birds', the threatened Square-tailed Kite, Gilbert's Whistler, Black-chinned Honeyeater, and some microchiropteran bat species. Other vegetation associations within this TSU are of limited habitat value for native fauna, providing only occasional opportunistic resources, and in the case of some road-sides, potential movement corridors for more disturbance-tolerant species.

Table 6.4 cont Relative quality (including extent) and habitat value of TSU's within the study area.

TSU	Quality	Habitat Value
20	This TSU is predominantly void of weeds due to the limited amount of agriculture within these areas, the upslope position of these forests relative to agricultural activities and generally low soil fertility. Logging is evident throughout nearly all occurrences of this vegetation, presumably a consequence of timber harvesting for fence posts and mine props supporting the Ulan underground development. The vegetation is predominantly intact despite past disturbances and fragmentation by clearing sustained clearing events throughout the valley floor.	Threatened flora habitats are restricted to the Marrangaroo conglomerate outcrop located immediately adjacent to alluvial and carboniferous geological formations along the western boundary of the MCP area. Notable species include Capertee Stringybark *Eucalyptus cannonii*, *Diuris tricolor* and *Goodenia macbarronii*. Notable habitat for the threatened Speckled Warbler. Broad-leaved Ironbark/Black Cypress Pine vegetation associations appear to be of notable value for the Glossy Black Cockatoo, although it is likely that habitat value for this species depends partly on the distribution of suitable *Allocasuarina* feed trees. Other threatened fauna utilising this TSU include the Powerful Owl and Black-chinned Honeyeater
30	A variety of anthropogenic influences has adversely impacted the Box Woodlands of the study area. Logging and/or broad scale clearing has resulted in the patchy fragmented occurrence of this TSU throughout the study area. The majority of Box Woodlands share a boundary with TSU 10, resulting in a localised disturbed boundary of varying depths that has promoted various exotic flora and weedy natives such as Catsear *Hypochaeris* spp., Prairie Grass *Bromus* spp., *Vulpia* spp. and Sifton Bush *C. arcuata*. The latter species appears to represent a pioneer native occupying disturbed environs. However, the propensity for this species to dominate and its apparent allopathic qualities indicate that it is not a constructive pioneer species.	Threatened flora habitats are restricted to the Carboniferous geological formation located along the western boundary of the MCP area. Notable species include Hoary Sunray *Leucochrysum albicans* var *tricolor* and *Goodenia macbarronii*. White Box Yellow Box Blakely's Redgum Woodland also occurs within this TSU Most associations within this TSU are of notable habitat value for threatened woodland birds including the Brown Treecreeper, Speckled Warbler, Grey-crowned Babbler, Black-chinned Honeyeater and Diamond Firetail. This TSU is also likely to be of notable habitat value for 'declining woodland birds'. Box Woodlands in the study area provide known and/or likely habitat for a wide range of other threatened fauna species, including the Square-tailed Kite, Gang Gang Cockatoo, Glossy Black Cockatoo, Swift Parrot, Turquoise Parrot, Painted Honeyeater, Regent Honeyeater, Squirrel Glider, and microchiropteran bat species.
40	The majority of this TSU remans intact despite the occurrence of past land clearing events for agricultural lands. The least disturbed remnants are associated with parcels having a limited boundary with disturbed lands and/or limited quantity of land clearing in the preceding catchment. Weeds are generally low in abundance and are restricted to species capable of occupying moist soils Sifton Bush *Cassinia arcuata* occasionally forms a dominant shrub species in areas where the disturbance history is more pronounced. Generally, the logging of this vegetation has been limited mostly to firewood collection, as the trunks of these redgums are generally unsuitable for structural purposes.	Only one threatened flora habitat occurs within this TSU (*Goodenia macbarronii*), which is restricted to the creeklines and moister soils of this TSU. Vegetation Association 40 Blakely's Red Gum Woodland is also considered to form part of the White Box Yellow Box Blakely's Redgum Woodland EEC. Vegetation association 40 Blakely's Red Gum Woodland appears to be of particular habitat value for threatened microchiropteran bats. This vegetation association is also likely to be of habitat value for declining woodland birds. Few other threatened fauna species were recorded within this vegetation association. No threatened fauna species were recorded within other associations within this TSU.

Table 6.4 cont Relative quality (including extent) and habitat value of TSU's within the study area.

TSU	Quality	Habitat Value
50	This TSU is predominantly void of weeds due to the limited amount of agriculture within these areas, the upslope position of these woodlands relative to the surrounding agricultural activities and generally low soil fertility. Logging is evident throughout selected parts of this TSU, presumably a consequence of timber harvesting for fence posts and mine props supporting the Ulan underground development. The vegetation is predominantly intact despite past disturbances such as track construction works and exploration drilling for coal. Consequently, weeds are generally restricted to track margins and ephemeral creeklines.	Only one threatened flora habitat occurs within this TSU (*Goodenia macbarronii*), which is restricted to the creeklines with elevated clays and silts within the soil profile, thereby maintaining soil moisture levels. This TSU supports a high diversity of threatened fauna species and 'declining woodland birds', but is not of notable value for any except the Glossy Black Cockatoo. It is likely that habitat for the Glossy Black Cockatoo depends partly on the distribution of suitable *Allocasuarina* feed trees
60	The majority of this TSU has either been cleared for agriculture due to the agricultural suitability of the underlying landscape. However, it is difficult to determine whether existing occurrences of this TSU are natural communities or the regenerating vegetation that is a consequence of widespread clearing. Weeds are generally low in abundance and are restricted to species capable of occupying sandy soils. Sifton Bush *Cassinia arcuata* occasionally forms a dominant shrub species in areas where the disturbance history is more pronounced. Generally no logging of this vegetation has occurred, as this vegetation is generally unsuitable for firewood or structural purposes.	Vegetation association 60 Rough-barked Apple Yellow Box Woodland is considered to form part of the White Box Yellow Box Blakely's Redgum Woodland also occurs. Whilst a variety of threatened fauna species were recorded within this TSU, most species were recorded in substantially lower numbers in this TSU than other TSU's within the study area. It is possible that most records of threatened species within this TSU are due to is occurrence along creeklines, a water resource. The only record of the threatened Squirrel Glider in the study area is from this TSU.

7 AQUATIC ECOLOGICAL VALUES OF THE STUDY AREA

Full results of the aquatic ecological surveys are shown in Appendix 8 as the following appendix tables:

- Appendix Table 8.1 provides the modified Riparian, Channel and Environment (RCE) inventory for the study;
- Appendix Table 8.2 provides the full results of the field water quality analysis undertaken over the study period;
- Appendix Table 8.3 provides the full results of the AusRivAS macroinvertebrate surveys and provides the results of fish sampling and observations plus aquatic plant list; and
- Appendix Table 8.4 provides the site plus survey SIGNAL calculations for the study.

These results are summarised and discussed in sections 7.1 to 7.4 below.

7.1 General Description of EL Aquatic Habitats

Table 7.1 (below) summarises the results of the RCE analysis and Table 7.2 summarises field water quality of sampling sites.

Based on RCE analysis alone, the better aquatic habitat (RCE % scores between 79% and 92%) is located in the Goulburn River sections below the Ulan Creek confluence; including the lower Bobadeen Creek site just above the confluence with Goulburn River (BC2 near the Drip) plus the un-named spring fed creek draining to the river below GR3 (REF1).

Several sites, which provide good potential aquatic habitat (RCE % scores between 61% and 75%) are located in the lower portions of Moolarben Creek (MC4 and MC6), in the middle Ryans Creek section (RC2) and in the upper sections of Bora Creek plus the un-named creek north of Bora Creek. It should be noted however that these two latter sites have not retained water for sampling throughout the present study.

Table 7.1 Summary Statistics for RCE Assessments

Grouped Sites	Means	
	RCE Score	RCE %
Lagoon Ck (LCX1, LC1, LC2)	24	47
Ryans Ck below Ulan Rd (RC 1 to RC3)	31	60
Moolarben Ck above Moolarben Rd (MCX1 & 2)	24	46
Moolarben Ck (MC1 to 3)	27	52
Moolarben Ck (MC4, 6 7)	32	61
Moolarben Ck MC5	14	27
Sportsmans Hollow Ck (SH0 and 1)	24	45
Bora Creek (BOX1,2)	30	57
Unnamed Ck N of Bora (BONX1,2)	30	57
Goulburn R above Bobadeen Ck (GR1,2)	45	86
Bobadeen Ck (BC1,2)	36	68
Goulburn R below Bobadeen Ck (GR3,REF)	46	88

There were eight sub-optimal sites (51% to 60 % RCE) generally located within grazing or other agricultural land with lower scores mainly resulting from lack of riparian vegetation and cover. Several of these sites provide good drought resistant pools (e.g., MC1 and MC7 whilst several (BOX2 and BONX2) provide no water retention capacity.

The remaining sites provide little suitable aquatic habitat by virtue of site disruption by agricultural pursuits plus site instability due to erosion.

Table 7.2 Field Water Quality Summary Statistics

Parameter Units	Depth m	Temp °C	Cond µs/cm	Sal ppt	DO %Sat	DO mg/L	Acidity pH units	Turb NTU
Minimum	0.05	8.88	182	0.08	0.0	0.0	6.64	0
Maximum	2.00	26.79	6505	3.76	144.2	12.5	8.53	600
Mean	0.36	17.11	1619	0.87	59.5	5.8	7.44	133
SE of Mean	0.05	0.65	233	0.13	4.2	0.4	0.05	24
Median	0.20	16.85	698	0.34	60.6	5.7	7.44	34

The water quality summary statistics presented in Table 7.2 show that most sites have very little water holding capacity (mean depth around 0.4 m). Only four sites had water depths greater than 1 m (BC1, 1.1 m, MC7 1.2 m, MC2, 1.5 m and MC6 2 m). Of these sites BC1 only held water during one season (Spring 2005).

Water conductivity showed a large variation with elevated conductivity readings (3000 to 6500 µS/cm occurring in Moolarben Creek sites MC1 to MC 4. There was a gradual decrease in conductivity down Moolarben Creek with the addition of lower salinity groundwater plus additional surface water runoff from feeder creeks (MC6 in the dam and MC7 below the dam) and down the upper Goulburn River (sites GR1 to GR3. The creeks feeding from the north to Bobadeen Creek contributed water with slightly elevated conductivity (300 to 700 µS/cm) whilst Ryans Creek flowing from the west to Moolarben Creek had the lowest conductivity (around 180 to 300 µS/cm). The REF1 site said to be spring fed had a conductivity of around 200 µS/cm.

Dissolved oxygen (as % saturation) ranged from 0% to 144 % with a mean of 60 %. The deep Moolarben Creek site MC2 was highly stratified with low to no dissolved oxygen occurring with depth. Moolarben Creek sites MC6 and MC7 were also somewhat stratified with decreased dissolved oxygen levels with depth (to 2.6 % at MC6 and 16 % at MC7).

Water acidity (as pH units) was relatively stable with overall study values between 6.6 to 8.5 pH units; slightly alkaline when compared to the ANZECC/ARMCANZ 2000) guideline range for upland rivers (6.5 to 8.0 pH units).

Water turbidity (measured as NTU) varied widely from 0 to 600 NTU on the metre (i.e., across the range). However, most readings were moderate between 20 and 200 with two instances of elevated turbidity (MC7 in summer 06 and BC1 in Spring 05). The latter coincides with wet weather, which filled the BC1 pool for the first (and only) time during the survey.

The combined RCE field assessment plus topo/aerial photo inspections and field water quality sampling results lead to the following conclusions with respect to potential aquatic and fish habitat condition and with respect to potential mining related impact:

- Lagoons Creek has been heavily modified for pasture and grazing for almost its complete length, with much of the flood plain and parts of the creek line (including floodplain seeps and riparian springs) ploughed and contoured for pasture. Water quality suffers as a result and there is elevated conductivity and wide variation in oxygenation from total depletion to super-saturation. There are scattered and isolated narrow reed lined ponds along the creek of which some could hold water for some time. However, overall the creek does not provide significant aquatic habitat;
- Ryans Creek above the Ulan Road crossing flows through grazing land with all feeder creeks and much of the main creek constrained by in-line dams;

- Ryans Creek between the Ulan Road crossing and the confluence with Moolarben Creek provides some variable aquatic habitat in the form of shallow pools linked by grassy or reed swales. Water quality in the lower creek pools is variable, with generally low conductivity plus variable but adequate oxygenation and pH. The pools can be severely impacted by turbidity in the form of fine clay from deep erosion scars, particularly immediately below the Ulan Road crossing. Some limited fish passage could occur up part of the lower creek with no fish passage above the Ulan Road crossing;
- The headwater drainage of Moolarben Creek within the Munghorn Gap Nature Reserve comprises an undefined grassy swale with no continuous incised creek line but some unconnected small erosion ditches. These have not been observed holding water to date;
- Moolarben Creek below Munghorn Gap Nature Reserve and above Moolarben Road plus Spring Creek (the only named tributary draining to Moolarben Creek in this location) are greatly modified as a result of agricultural activities, with most of the floodplain (including floodplain seeps and riparian springs) ploughed and contoured for pasture and with parts of the creek lines also ploughed and contoured for pasture. Spring Creek and most of Moolarben Creek are dry, neither provides any significant aquatic habitat and neither is likely to provide any fish habitat. Consequently there would be no significant fish passage considerations for the upper portion of Moolarben Creek, including its tributaries (Spring Creek and numerous small first order un-named drainages).
- Moolarben Creek below Moolarben Road crossing and next to proposed OC3 does provide aquatic habitat in the form of large deep pools with some areas of reasonable riparian (shading) cover (e.g., MC2) and these pools could support some native fish species - even though native fish passage to this section of the creek would be limited by the large in-stream dam (downstream below the Lagoon Creek confluence). Note also that, based on the results of the water quality analysis for these pools habitat is severely limited by elevated conductivity/salinity (due to the intrusion of high salinity groundwater from deep alluvials), stratification and consequent severe de-oxygenation;
- From inspections of the aerial photographs plus site walk-overs, there would not appear to be any significant aquatic habitat in the area proposed for OC 2. There are no springs or seeps (consistent with the results of the groundwater analysis which indicated that the aquifers in this area were dry);
- There is no significant aquatic habitat in the west flowing feeder creeks in the vicinity of either the OC2 or OC3 areas, with drainage lines from the Munghorn Gap Nature Reserve spur either ill defined or consisting of deeply incised rock cascades with no water holding capacity, few if any seeps and only intermittent springs. Their drainage lines on the Moolarben Creek floodplain have been obliterated by ploughing and parts of the Moolarben Creek line are also ploughed and contoured for pasture;
- The connection of Moolarben Creek to Lagoon Creek has been modified by placement of a bund wall and there is a large shallow lagoon at the confluence (site LC2). This lagoon and the creek downstream through to the Dam could provide suitable habitat for native fish and does provide reasonable drought refuge habitat for aquatic biota;
- Moolarben Creek below the dam to the confluence with Sportsmans Hollow Creek provides some very good aquatic habitat in the form of large deep pools, which are likely to support native fish species. They have good riparian cover around the edges, support a mixed fringing emergent rush and reed habitat and would appear to have reasonable water quality (see site MC7 results);
- Sportsmans Hollow Creek drains modified agricultural land (mainly pasture) and is generally dry in the upper to middle reaches. In the lower reaches the creek flows along a deeply incised erosion gully through to Ulan Village. There is little or no standing water as the gully bed is deep sand. There is likely to be some sub-surface flow through the sand beds. The connection of the creek to the Goulburn River comprises a broad flat and shallow basin with an almost total cover of Cumbungi. This area of the creek would probably provide some fish habitat with the remaining upper creek providing almost no habitat by virtue of lack of surface water;

- The Goulburn River diversion adjacent to the Ulan Mine lease area provides a broad, relatively level cumbungi-lined drainage system which probably has the effect of providing good water quality filtering – at least in respect to suspended sediments, between the upper river and the lower river;
- The OC1 drainages from high forested ground to the south are ill defined grassy swales with a few short courses of narrow and shallow erosion gullies in the flood plain above the air field. There is little or no standing water, no obvious springs or seeps and consequently little or no aquatic habitat. The drainages are diverted via pipe flow under the air field and dispersed over the old Goulburn River flood plain to shallow ponded areas isolated from the river by the CHPP and rail sidings for the Ulan Mine. There are no fish passage opportunities into or through this sub-catchment;
- Bora Creek flows along a well defined creek line with some areas of deeply eroded steep but stable banks. There are no significant seeps and few if any retention features in the creek and consequently there is little or no ponded water;
- Beyond the Goulburn River diversion and through to the exit point at the south-eastern corner of Authority 428, the Goulburn River provides good aquatic and fish habitat. The river above the Cassilis Road comprises mainly rock bar sectioned pools whilst the river below the road crossing (within Authority 428) comprises long sandy pools with river bend sand bars. This sand-bar limited section of the river provides the only viable area of partial base-flow groundwater dependent ecosystem (in the sense of Boulton and Hancock 2006) in the study area. This upper river area supports native fish but is unlikely to support Platypus (T Grant pers. comm.). There could be Native Water Rats (although none have been seen to date and none were detected via hair tube trapping), and Fishing Bats are known from the area; and
- The two un-named creeks draining to the Goulburn River from above the proposed long-wall mining area are similar to Bora Creek in that there is a well-defined creek line with some areas of deeply eroded steep banks. There are no significant seeps and few if any retention features in the creeks and there are some deep sand drifts. Consequently, (other than boggy ground supporting Parramatta Redgum - as described in Section 6.3.1 above, there is little or no ponded water. These creeks do not provide any significant aquatic habitat by virtue of the inability to hold ponded water for any length of time. Consequently, there are no significant fish passage opportunities in these two creeks

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7.2 Aquatic Biota

The full results of the aquatic biota survey are contained in Appendix 8. **Table 7.3** provides a summary of site diversity and SIGNAL statistics and Table 7.4 provides a summary of seasonal SIGNAL statistics.

SIGNAL (Stream Invertebrate Grade Number Average Level) is an index of pollution tolerance for stream invertebrate animals ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). The scores are derived from correlation analysis of aquatic macro-invertebrate survey information with RCE and water chemical analysis for a range of different streams. In the Hunter River the appropriate SIGNAL index is SIGNAL HU97 (Chessman et al 1997). Pollution tolerances, as related to water quality are as follows; 7 to 10 relate to excellent water quality, 6-7 to good water quality, 5-6 indicates fair conditions, 4-5 is poor condition and less than 4 generally indicated very poor water quality.

Aquatic macroinvertebrate seasonal diversity varied from 44 taxa in Autumn 2004 (from 7 sites sampled) to 60 taxa in Spring 2005 (from 16 sites sampled) and there were a total of 69 taxa for the study. There were a total of 51 insect taxa, 6 crustaceans, 4 gastropod molluscs, 2 leeches, and one each of water mites, springtails, ostracods, worms, bivalve molluscs and flatworms.

The pollution tolerance of the taxa found throughout the study ranged from very pollutant tolerant (1) to extremely intolerant (10) with mean and median values for all taxa around the middle (mean 4.7 and median 5) indicating that there was a relatively even spread of taxa over the total study. The most pollution intolerant taxa (a Leptophlebiidae mayfly) occurred in every season and in 9 of the total 39 samples, with 4 occurrences in the lower Goulburn River (GR1, GR3, BC2), 4 in Ryans Creek (RC2 and RC3) and once at MC7. With the exception of two SIGNAL score 7 taxa (a Baetidae mayfly which occurred at 27 of the 39 sites and a Leptoceridae caddis fly which occurred at 23 sites), the other pollution intolerant taxa were seldom encountered (between 1 and 7 times).

Table 7.3 Site Macro-invertebrate Diversity & SIGNAL-HU97 Indices

Season	Date	Site	Diversity	SIGNAL
Su 06	16 01 06	RC2	24	5.48
Sp04	14 12 04	GR3	30	5.11
Sp04	15 12 04	RC2	22	5.05
Au 05	18 05 05	RC2	25	5.00
Sp 05	20 09 05	RC3	23	4.90
Sp04	14 12 04	GR1	28	4.85
Sp 05	22 09 05	BC2	28	4.81
Au 05	19 05 05	GR1	23	4.76
Sp 05	20 09 05	BC1	25	4.67
Sp 05	21 09 05	GR3	31	4.54
Sp 05	21 09 05	REF1	17	4.53
Sp 05	21 09 05	GR1	27	4.48
Sp 05	27 09 05	MC4	20	4.24
Su 06	17 01 06	MC6	15	4.21
Sp 05	26 09 05	MC7	24	4.18
Sp04	14 12 04	MC1	21	4.17
Au 05	19 05 05	GR3	17	4.13
Sp04	14 12 04	MC2	20	4.12
Su 06	16 01 06	MC7	32	4.10
Sp04	15 12 04	MC7	28	4.08
Au 05	18 05 05	MC1	21	4.06
Au 05	19 05 05	MC7	24	3.95
Sp 05	20 09 05	MC3	13	3.90
Sp 05	20 09 05	MC1	20	3.83
Su 06	18 01 06	GR2	16	3.60
Sp 05	27 09 05	LC2	16	3.54
Au 05	18 05 05	MC2	11	3.45

There were 22 species tolerant of fair to good water quality and 30 taxa, which could withstand poor to very poor water quality. Of the 17 taxa, which occurred in more than half the samples, 13 had SIGNAL scores between 1 and 5.

As indicated in Table 7.3, individual site by season diversities and site SIGNAL values were relatively similar across the study with site diversities ranging from 11 taxa (MC2 in Autumn 2005) to 32 (MC7 in summer 2006). The low diversity occurrence at MC2 also provided the lowest SIGNAL score of 3.45. SIGNAL scores ranged from 3.45 to 5.48 with 6 sites providing a 'very poor' rating; 4 sites in spring 2005 (MC1, MC3, GR2 and LC2) and two sites in autumn 2005 MC2 and MC7). There were 19 sites that registered 'poor' condition (SIGNAL 4 to 5) and there were 3 sites, which registered 'fair' condition (5 to 6); RC2 in spring 2004 and summer 2006 plus GR3 in spring 2004.

With regard to seasonal analysis there was very little variation between seasons for the total study (see Table 7.4 below). Seasonal means plus the unweighted median values was all within the 4 to 5 band (poor conditions). Two analyses were made using unweighted SIGNAL means (where any occurrences of a taxa is only counted once regardless of how frequently it was encountered) and weighted means (where frequency of occurrence was included). Inspection of these results indicates that weighted means are generally lower than un-weighted means indicating that the proportion of pollutant-tolerant taxa was greater than the proportion of pollution intolerant taxa. However, the similarities indicate that the spread of taxa across sites and seasons was relatively even.

Table 7.4 Summary of Seasonal SIGNAL Indices.

	Seasonal Scores				Total
	Spring 04	Autumn 05	Spring 05	Summer 06	Seasons
No. samples	8	7	16	8	39
SIGNAL Stats					
Min SIG	3.79	3.45	3.15	3.60	3.15
Max SIG	5.11	5.00	4.90	5.48	5.48
Un-weighted Means					
Mean SIG	4.60	4.70	4.58	4.58	4.67
SE SIG	0.30	0.33	0.28	0.32	0.26
Median SIG	4.50	5.00	5.00	4.00	5.00
Weighted Means					
Mean SIG	4.53	4.26	4.24	4.31	4.32
SE SIG	0.16	0.18	0.11	0.16	0.07

7.3 Summary of Significance

The results of the aquatic ecological survey may be summarised as follows:

- Overall; water availability for sustaining aquatic ecosystems is almost totally confined to the lower parts of the main creeks (Ryans Lagoons , Moolarben and Bobadeen Creeks), the Goulburn River and possibly the confluence with Sportsmans Hollow Creek. All these systems are dependent on groundwater for base flow to varying degrees (see Groundwater report - Peter Dundon & Associates 2006). The smaller creeks such as Bora Creek, the un-named creeks north of Bora Creek plus Spring Gully (to the north) do not hold water for any length of time and have no significant spring fed base-line flow such that aquatic ecosystems can develop. The same holds for the many smaller drainages from the various ridges draining to the main creeks. Spring Creek plus the many other small un-named creeks draining to Moolarben Creek are mostly heavily modified by agricultural practices, including being ploughed under, and provide no aquatic ecosystem functions;
- Overall water quality is variable, with generally poor water quality in Moolarben and Lagoon Creeks due primarily to high saline groundwater intrusion from deep aquivers, fair water quality in Goulburn River and Bobadeen Creek (when water is available) and generally fair to good water quality in the lower Goulburn River and the lower Ryans Creek. This is reflected in the macroinvertebrate sampling results, with Ryan creek and lower Goulburn River sites having overall higher diversities and overall better SIGNAL scores;
- The main measured field parameter affecting water quality is conductivity (especially in Moolarben and Lagoon Creeks above the dam) and sometimes in Goulburn River. Dissolved oxygen may be poor to very poor with depth in deeper pools due in part to stratification. Both these parameters are also influenced by low rainfall and drought conditions;
- Turbidity is expected to be a factor during stormwater flows for almost all sites. In fact, the high taxa diversity found in sites such as Bobadeen Creek BC2 may be due to 'catastrophic drift' whereby macroinvertebrate taxa residing in farm dams throughout the upper catchment are either physically flushed downstream by flood flows or allow themselves to drift downstream to avoid high turbid or high conductivity waters;
- Sites which are able to hold water for any length of time (due to pool drought protection and/or due to additional groundwater base-flow - as in Moolarben Creek) or are downstream from farm dams during flood flows support diverse macroinvertebrate communities with a mix of pollution tolerant and intolerant taxa. Whilst there are changes in site diversity and community structure with season and rainfall history, the overall site SIGNAL indices are

generally similar with most sites providing 'Poor" scores and sites in Ryans Creek plus the lower Goulburn River providing "Fair' scores;

- There were no threatened species listed under the Fisheries Management Act 1994 found during the study and none are expected;
- No aquatic mammals (platypus or native water rat) were found during the study and although they could occur (at least in the lower part of the study area catchment in Goulburn River) none are expected;
- The only frogs and reptiles encountered were common species.
- Other than the pest fish species (Plague Minnow), which was found throughout the main streams (Ryans and Moolarben creeks and in the Goulburn River), the other native fish (two gudgeons, long-finned eel, and Australian smelt) were confined to the Goulburn River and the lower Bobadeen Creek; and
- Aquatic plants are confined to the more permanent pools in the main creeks and in Goulburn River, with Cumbungi and Common Reed being the most locally abundant emergent species. Aquatic plants are generally confined to larger more stable drought resistant pools such as at MC7 and at GR2.
- With regard to groundwater dependent ecosystems (GDEs) it is concluded that seeps or springs within the study are generally those fed by alluvials, which are located in the main on the agricultural lands. As a consequence, they are generally degraded by agricultural practices including being ploughed under. Shallower alluvial springs and seeps are located on the higher slopes of the creek valleys and is either ploughed under of associated with in-line dams. Rock fracture seeps and springs are almost all ephemeral with little or no significant GDE plant growth and no aquatic GDE habitats;
- An area supporting Parramatta redgums occurs in one location above Underground 4 (see Section 6.3.1). The area is not an area of confined surface groundwater (as in a hanging swamp) but rather an area of enhanced soil water retention within an unconfined broad upper catchment ephemeral creek line and is not considered a GDE;
- Peter Dundon & Associates (2006) state that surface flow in Goulburn River and its tributary streams is supported by groundwater base flow. However, the water quality of the groundwater component in the Moolarben and Lagoon Creeks is poor and probably has an adverse impact on any vegetation reliant on stream flow in those tributary catchments;
- Aside from the shallow wetland area at the confluence of Lagoon and Moolarben Creeks plus the fringing wetland around the upper margin of Moolarben Dam there are no natural areas of wetland in the DA area. The two shallow wetland areas are created as a result of in-stream flow constrictions and consequently are dependent on, and respond to surface water level fluctuations. Neither is dependent on local seepages or spring water. Whilst surface water level is in turn dependent on groundwater base-flow, the fluctuations in water level are mainly governed by water draw down from the dam and by local evaporation. These fringing wetlands are not considered to be GDEs; and
- Within the main Goulburn River in the northern part of EL6288, the main groundwater base-flow contribution is believed to derive from the Triassic sandstones, not from the Permian coal measures aquifers (Peter Dundon & Associates 2006). It is therefore predicted that the project will not directly impact on stream flows in Goulburn River, and its impact on reducing the base-flow contribution from the Moolarben-Lagoon Creek tributary catchments is likely to be beneficial rather than adverse.

8 IDENTIFICATION OF IMPACTS

8.1 Likely Impacts of the Proposed Mine

The MCP is described briefly in Chapter 2.2 of this report, with a full description of activities, timing and duration provided in Chapter 4 of the main Environmental Assessment report.

Impacts of the mine would be associated generally with the following four activities:

- Construction and operation of the main infrastructure area on the northern side of the Ulan-Wollar Road, in the vicinity of Bora Creek;
- OC1, just south of the proposed main infrastructure area and south of the existing Ulan Coal Mine facilities;
- OC2, south of OC1 between a prominent vegetated ridgeline to the east and Moolarben Creek to the west;
- OC3, in the far south of the DA area, between Moolarben Creek in the west, and a prominent vegetated ridgeline in the east; and
- Underground No. 4, in the northern part of the DA area, north of the Ulan-Wollar Road and main infrastructure area, between the Goulburn River National Park to the east and the existing Ulan Coal Mines to the west.

The impacts of these activities have been mapped and quantified in the following sections of the report in terms of 'native vegetation' and 'disturbed vegetation' losses.

8.1.1 Main Infrastructure Area

Impacts on native vegetation would essentially be limited to clearing of small currently isolated and/or disturbed strips or vegetation, and paddock trees. The surface infrastructure would result in the displacement of native vegetation, fauna habitats and some (mostly dry) aquatic environs for in-line water storage. Losses, in terms of native and disturbed vegetation types, are as follows:

<u>Native Vegetation Loss (total = 17.1 ha)</u>

- 5.7 ha of TSU 30 Box Woodlands of varying condition, of high ecological value due to classification of some sub-units as an EEC (endangered ecological community – White Box Yellow Box Blakely's Red Gum Woodland), and due to value as habitat for threatened species and declining woodland birds;
- 6.5 ha of TSU 50 Sedimentary Scribbly Gum Woodlands, poor condition, of low ecological value in terms of community classification and threatened species habitat; and
- 4.9 ha of TSU 60 Alluvial Apple Forests, of generally moderate quality and ecological value.

<u>Disturbed Vegetation Loss (total = 102.5 ha)</u>

- 64.0 ha of TSU 10b unimproved grasslands. Unimproved grasslands adjoining remnant vegetation are of high ecological value due to their potential foraging values for threatened and declining woodland birds;
- 38.5 ha of TSU 10a disturbed vegetation other than unimproved grasslands, of little to no ecological value (i.e. cleared grazing lands and areas of low value regrowth).

Significant ecological values likely/potentially affected include:

- EEC - White Box Yellow Box Blakely's Red Gum Woodland;
- Threatened and declining woodland birds; and

- Likely foraging habitat for threatened microchiropteran bats.

There is no adjacent DEC estate. There would be no significant loss of aquatic habitat (due to the lack of significant aquatic habitat in the DA area), with aquatic habitat created in the form of an in-line clean water dam.

8.1.2 OC1

Impacts on native vegetation would involve clearing of relatively intact native vegetation in the southern part of the proposed OC1 area, and clearing of a mosaic of disturbed vegetation associations and structures in the northern part of the proposed OC1 area. OC1 and associated infrastructure would result in the displacement of native vegetation, fauna habitats and some low order ephemeral aquatic environs. Losses, in terms of native and disturbed vegetation types, are as follows:

<u>Native Vegetation Loss (total = 264.1 ha)</u>

- 175.8 ha of TSU 20 Sedimentary Ironbark Forest, relatively intact, of low ecological value in terms of community classification and threatened species habitat;
- 51.3ha of TSU 30 Box Woodlands of varying condition, of high ecological value due to classification of some sub-units as an EEC (endangered ecological community – White Box Yellow Box Blakely's Red Gum Woodland), and due to value as threatened species habitat;
- 9.4 ha of TSU 40a Tablelands Red Gum Woodlands (excl vegetation association 40), fair condition, of low ecological value in terms of community classification and threatened species habitat;
- 19.2 ha of TSU 40b Tablelands Red Gum Woodlands (vegetation association 40), fair condition, of high ecological value due to classification as EEC, and due to value as threatened species habitat; and
- 8.4 ha of TSU 50 Sedimentary Scribbly Gum Woodlands, fair condition, of low ecological value in terms of community classification and threatened species habitat.

<u>Disturbed Vegetation Loss (total = 154.9 ha)</u>

- 99.7ha of TSU 10b unimproved grasslands, areas close to remnant stands of vegetation are of high ecological value due to their potential foraging values for threatened and declining woodland birds; and
- 55.2 ha of TSU 10a disturbed vegetation other than unimproved grasslands, of little to no ecological value (i.e. cleared grazing lands and areas of low value regrowth).

Significant ecological values likely/potentially affected include:

- EEC - White Box Yellow Box Blakely's Red Gum Woodland;
- threatened plant - Narrow-leaved Goodenia (*Goodenia macbarronii*);
- threatened plant - Capertee Stringybark (*Eucalyptus cannonii*)
- threatened and declining woodland birds;
- foraging habitat for the threatened Glossy Black Cockatoo;
- habitat for the threatened Painted Honeyeater;
- habitat for threatened microchiropteran bats;
- potential occasional foraging habitat for the threatened Regent Honeyeater.

There is no adjacent DEC estate. There would be no significant loss of aquatic habitat (due to the lack of significant aquatic habitat in the DA area).

8.1.3 OC2

Impacts on native vegetation would generally be limited to clearing of fringe areas of native vegetation on the mid-slopes to the east of OC2, clearing of small currently isolated and/or disturbed strips or vegetation, and clearing of paddock trees. OC2 and associated infrastructure would result in the displacement of native vegetation, fauna habitats and some low order ephemeral and disturbed aquatic environs. Losses, in terms of native and disturbed vegetation types, is as follows:

Native Vegetation Loss (total = 53.89 ha)

- 51.65 ha of TSU 30 Box Woodlands of varying condition, of high ecological value due to classification of some sub-units as an EEC, and due to value as threatened species habitat; and
- 2.24 ha of other vegetation communities, of low to moderate ecological value.

Disturbed Vegetation Loss (total = 173.5 ha)

- 36.8 ha of TSU 10b unimproved grasslands, areas close to remnant stands of vegetation are of high ecological value due to their potential foraging values for threatened and declining woodland birds; and
- 136.7 ha of TSU 10a disturbed vegetation other than unimproved grasslands, of little to no ecological value (i.e. cleared grazing lands and areas of low value regrowth).

Significant ecological values likely/potentially affected include:

- EEC - White Box Yellow Box Blakely's Red Gum Woodland;
- threatened and declining woodland birds;
- midslopes vegetation that supports local fauna movements; and
- potential occasional foraging habitat for the threatened Regent Honeyeater.

There is no adjacent DEC estate and there are no significant GDEs. There would be no significant loss of aquatic habitat (due to the lack of significant aquatic habitat in the DA area). There would be no significant change to the groundwater flow to Moolarben Creek as OC2 does not intercept the deep alluvial groundwater that discharges to Moolarben Creek.

8.1.4 OC3

Impacts on native vegetation would generally be limited to clearing of fringe areas of native vegetation on the mid-slopes to the west of OC3, clearing of small currently isolated and/or disturbed strips or vegetation, and clearing of paddock trees. OC3 and associated infrastructure would result in the displacement of native vegetation and fauna habitats, with aquatic/riparian environs other than some low order ephemeral and disturbed drainage lines generally excluded from the proposed mining footprint. The Moolarben Creek riparian is excluded from the mining footprint as is Spring Creek. Losses, in terms of native and disturbed vegetation types, are as follows:

Native Vegetation Loss (total = 81.5 ha)

- 29.8 ha of TSU 30 Box Woodlands of varying condition, of high ecological value due to classification of some sub-units as an EEC, and due to value as threatened species habitat;
- 8.7 ha of TSU 60 Alluvial Apple Forests, of generally poor quality and moderate ecological value;
- 43.0 ha of fringe areas of TSU 20 Sedimentary Ironbark Forest, fair condition, of low ecological value in terms of community classification and threatened species habitat.

Disturbed Vegetation Loss (total = 272.4 ha)

- 14.5 ha of TSU 10b unimproved grasslands, areas close to remnant stands of vegetation are of high ecological value due to their potential foraging values for threatened and declining woodland birds; and

- 257.9 ha of TSU 10a disturbed vegetation other than unimproved grasslands, of little to no ecological value (i.e. cleared grazing lands and areas of low value regrowth).

Significant ecological values likely/potentially affected include:

- threatened woodland bird - Grey-crowned Babbler;
- threatened mammal - Squirrel Glider;
- other threatened and declining woodland birds;
- habitat for threatened microchiropteran bats;
- potential occasional foraging habitat for the threatened Regent Honeyeater.

The Munghorn Gap Nature Reserve is located east of Moolarben Creek, and would not be directly impacted by mining operations. However, there may be some noise and dust impacts on fringe areas of this nature reserve.

Aside from the culverts and earth works for the haul road across Moolarben Creek, and any road easement requirements for the Moolarben Road diversion, OC3 and associated facilities are located well away from Moolarben Creek and its riparian habitats, and there are thus no direct impacts on Moolarben Creek aquatic habitats or biota. Indirect impacts can be mitigated to insignificance by suitable construction methods to limit sediment transport to the creek. There are no significant impacts on creek GDEs and there would be no significant change to the groundwater flow to Moolarben Creek as OC3 does not intercept the deep alluvial groundwater that discharges to Moolarben Creek.

8.1.5 Underground No. 4

Underground No. 4 area is situated adjacent to the western boundary of the Goulburn River National Park. The design of the underground mine incorporates adequate setbacks to ensure no impacts on the Goulburn River National Park. The entrance to Underground No. 4 would be located on currently cleared land near the main CHPP infrastructure area and rail loop. Almost no native vegetation would be cleared or removed for the operation of Underground No. 4. There would be a need to maintain existing tracks and potentially construct additional access pathways for the purposes of subsidence monitoring and implementation of various works such as erosion control and fire management.

Strata Engineering (2006) predict almost no potential interaction between continuous and surface cracking events resulting from the underground mining, thereby indicating a very low potential for surface waters to enter the underground void. However, based on conservative estimates, Strata Engineering (2006) predicts some potential for continuous cracking above underground panel 1 to interact with surface cracking. Vegetation located above this portion of the mining operation is cleared disturbed grasslands, which are of limited ecological value. Based on the conservative estimates prepared by Strata Engineering (2006) there would be no significant loss of surface or ground water to mining operations in the Underground No. 4 area. Based on the subsidence modelling prepared by Strata Engineering (2006), no major upsidence is expected on the creek lines throughout the area.

Subsidence impacts are to be expected to affect the cliff-lines, with the resultant change being isolated rock falls from overhangs and increased cracking. No closures in existing cliff face cracks are expected during the operation, rather the cracking is expected to enlarge momentarily during the movement of mining under the cliff areas.

The ephemeral creeks of the underground 4 area flow from east to west into the Goulburn River and not directly into the Goulburn River NP. There are three minor creek systems draining west from the Goulburn River National Park to the Goulburn River, which have little or no capacity to intercept and store flood waters for any length of time and consequently there is little or no permanent aquatic habitat, no fish passage requirements and no significant aquatic GDEs. Possible subsidence impacts could introduce some ponding into the lower sections of these creek systems. Given the present low capacity for permanent or semi-permanent aquatic habitat formation in these creeks additional ponding is on balance considered a beneficial impact.

Parramatta Redgum (as described in Section 6.3.1) is located in an area of enhanced soil moisture and is not dependent on groundwater flow. Consequently, as there would be no significant impact on surface floodwater flow through this area there would be no significant impact on soil water uptake. Thus no significant impact is expected on the Parramatta Redgum vegetation.

Vegetation/habitats present in the Underground No. 4 area, which would be subject to potential subsidence impacts includes:

- 10.9 ha of TSU 30 Box Woodlands, of high ecological value due to classification of some sub-units as an EEC, and due to value as threatened species habitat;
- 27.9 ha of TSU 40b Tablelands Red Gum Woodlands, fair to good condition, high ecological value due to classification of some sub-units as an EEC, and due to value as threatened species habitat;
- 17.7 ha of TSU 10b unimproved grasslands, areas close to remnant stands of vegetation are of high ecological value due to their potential foraging values for threatened and declining woodland birds;
- 1.5 ha of TSU 60 Alluvial Apple Forests, good condition, moderate ecological value;
- 851.3 ha of TSU 50 Sedimentary Scribbly Gum Woodlands, of generally intact condition, and moderate ecological value. This community is not classified as EEC, and provides some habitat of value for threatened species;
- 13.2 ha of TSU 20 Sedimentary Ironbark Forests, of generally intact condition, and low ecological value. This community is not classified as EEC, and provides some habitat of value for threatened species;
- 49.0 ha of TSU 10a disturbed vegetation other than unimproved grasslands, of little to no ecological value (i.e. cleared grazing lands and areas of low value regrowth).

8.2 Impacts on Native Vegetation and Habitats

8.2.1 Vegetation and Habitat Loss

The MCP would result in the sequential disturbance of native vegetation and associated fauna habitats throughout the duration of mining and future recovery period (*ie* period of habitat regeneration). The extent of this vegetation loss was quantified by examining the disturbance boundary associated with the MCP and the underlying existing vegetation cover. **Table 8.1** identifies the extent of intact native vegetation loss for each vegetation association and TSU.

Table 8.1 Intact Vegetation Loss arising from the MCP

Vegetation Association	OC1 (ha)	OC2 (ha)	OC3 (ha)	Infrastruct (ha)	Total (ha)
20 Broad-leaved Ironbark/ Grey Gum	81.14	0	0	0	81.14
21 Ironbark/ Grey Gum/ Stringybark	61.68	0.13	43.02	0	104.83
22 Ironbark/ Black Cypress Pine	3.11	0	0	0	3.11
23 Black Cypress Pine	6.83	0	0	0	6.83
24 Narrow-leaved Ironbark/ Red Stringybark	4.54	0.21	0	0	4.75
25 Ironbark/ Slaty Gum	18.47	0	0	0	18.47
TSU 20 (Sub-total)	**175.78**	**0.34**	**43.02**	**0**	***219.14***
30 Yellow Box/ Red Stringybark/ Blakely's Redgum	2.36	14.18	0	2.25	18.8
31 White Box/ Narrow-leaved Ironbark	8.8	0	0	0	8.80
33 Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	6.48	0	0	3.17	9.65
34 Grey Box/ Ironbark/ Slaty Gum	0	0	6.14	0	6.14
35 Grey Box/ Ironbark	13.16	1.16	3.08	0	17.41
36 Grassy White Box	0	2.76	0	0	2.76
37 Shrubby White Box	20.52	33.54	11.59	0	65.64
39 Slaty Gum	0	0	8.97	0	8.97

Vegetation Association	OC1 (ha)	OC2 (ha)	OC3 (ha)	Infrastruct (ha)	Total (ha)
TSU 30 (Sub-total)	**51.31**	**51.65**	**29.78**	**5.83**	***138.56***
40 Blakely's Redgum	19.19	0.58	0	0	19.77
41 Tumbledown Redgum	9.39	0	0	0	9.39
TSU 40 (Sub-total)	**28.58**	**0.58**	**0**	**0**	***29.16***
51 Inland Scribbly Gum/ Blue-leaved Stringybark	2.76	0	0	0	2.76
52 Inland Scribbly Gum/ Black Cypress Pine	0	0.28	0	0	0.28
53 Inland Scribbly Gum/ Stringybark/ Ironbark	0	0	0	6.29	6.29
54 Inland Scribbly Gum/ Ironbark	5.59	0	0	0	5.87
TSU 50 (Sub-total)	**8.35**	**0.28**	**0**	**6.57**	***15.19***
60 Yellow Box/ Rough-barked Apple	0	0	0	4.9	4.90
61 Rough-barked Apple	0.1	1.05	8.67	0	9.82
TSU 60 (Sub-total)	**0.1**	**1.05**	**8.67**	**4.9**	***14.72***
Total	**264.1**	**53.9**	**81.47**	**16.61**	**416.77**

8.2.2 Corridor Reduction

The mining of OCs 1, 2 and 3 would reduce the overall width of a north-south orientated tract of intact ridgetop and midslopes vegetation (*ie* vegetated corridor) located immediately to the east of these proposed mining developments. The total width of this vegetated corridor, prior to mining, ranges from 590 m to 2.8km with the narrowest section at Carrs Gap. The average width of this vegetated corridor ranges between 1.0 - 1.4km, with the Carrs Gap section of the study area representing a small proportion of the narrow sections less than 1km width.

In the post mined landscape, prior to rehabilitation and revegetation works, this vegetated corridor would be narrowed by an average of 7-10% relative to existing vegetation widths. In rare cases, the corridor would be narrowed by as much as 51% of its current width (*ie* from 2.84km to 1.39km). In other cases, the vegetated corridor would not be altered from its existing status.

The main consequence of mining on local vegetated corridors will be the removal of midslopes vegetation along the western margin of the north-south orientated corridor. This vegetation consists of forests dominated by Broad-leaved Ironbark *Eucalyptus fibrosa* or White Box *Eucalyptus albens*. These midslopes forests represent seasonally important nectar rich movement pathways and foraging grounds for a variety of woodland and forest birds. The post mine occurrence of the White Box *Eucalyptus albens* vegetation outside the impact area will be restricted to residual remnants along the midslopes and scattered basalt caps along the main ridgeline.

8.3 Specific Impacts on Threatened Species, Populations and Ecological Communities

8.3.1 White Box Yellow Box Blakely's Red Gum Woodland

General Information

White Box – Yellow Box – Blakely's Red Gum Woodland is typically described as grassy woodlands containing one or more of the characteristic tree species; White Box (*E. albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent due to past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common (NSW Scientific Committee 2002).

Woodlands with White Box (*E. albens*) are most common on the undulating country of the slopes region while Blakely's Red Gum (*E. blakelyi*) and Yellow Box (*E. melliodora*) predominate in grassy woodlands on the tablelands. Drier woodland areas dominated by White Box (*E. albens*) often form mosaics with areas dominated by Blakely's Red Gum (*E. blakelyi*) and Yellow Box (*E. melliodora*) occurring in more moist situations, while areas subject to waterlogging may be treeless (NSW Scientific Committee, 2002).

The understorey may be highly modified by grazing history and disturbance. A number of native species appear not to tolerate grazing by domestic stock and are confined to the least disturbed remnants (*Dianella revoluta, Diuris dendrobioides, Microseris lanceolata, Pimelea curviflora, Templetonia stenophylla*). Dominant pasture species typically change from *Themeda australis, Austrostipa aristiglumis* and *Poa* spp. to *Austrostipa falcata, Austrodanthonia* spp. and *Bothriochloa macra* as grazing intensity increases. This may reflect differences in palatability of these species and their ability to tolerate grazing pressure. Light grazing and burning may also be a problem and lead to *Aristida ramosa* dominance (NSW Scientific Committee 2002).

Woodlands with White Box (*E. albens*) are most common on the undulating country of the slopes region while Blakely's Redgum (*E. blakelyi*) and Yellow Box (*E. melliodora*) predominate in grassy woodlands on the tablelands. Drier woodland areas dominated by White Box (*E. albens*) often form mosaics with areas dominated by Blakely's Redgum (*E. blakelyi*) and Yellow Box (*E. melliodora*) occurring in more moist situations, while areas subject to waterlogging may be treeless. Inland Grey Box (*E. macrocarpa*) is often found in association with Yellow Box (*E. melliodora*) and White Box (*E. albens*) on the south western slopes. Woodlands including Narrow-leaved ironbark (*E. crebra*), Slaty Gum (*E. dawsonii*) and Grey Box (*E. moluccana*) (and intergrades with White Box (*E. albens*)), for example in the Merriwa plateau, Goulburn River National Park and western Wollemi National Park, are also included. Intergrades between Blakely's Redgum (*E. blakelyi*) and Forest Redgum (*E. tereticornis*) may also occur here (NSW Scientific Committee 2002).

Box-Gum Woodlands, being a broad vegetation community that includes White Box Yellow Box Blakely's Red Gum Woodland, is found on relatively fertile soils on the tablelands and western slopes of NSW, extending from an altitude of approximately 170 m on the lower slopes to and including the tablelands. Rainfall is between 400 and 800 mm with slight winter dominance in the south to slight summer dominance in the north.

The White Box Yellow Box Blakely's Red Gum Woodland Final Determination states this vegetation to be confined to following bioregions: Southwestern Slopes, Brigalow Belt South, Nandewar, New England Tableland, North Coast, Sydney Basin and Southern Highlands (NPWS 2002).

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *NA*

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Clearing

The proposal would result in the direct loss of this community and its habitat from the site. The proposal would remove 64.68 ha of this EEC in accordance with the following proportions (*ie* vegetation associations):

Table 8.2 Loss of White Box Yellow Box Blakely's Redgum Woodland from the MCP DA Area

Vegetation Association	**OC1 (ha)**	**OC2 (ha)**	**OC3 (ha)**	**Infrastruct (ha)**	**Total (ha)**
30 Yellow Box/ Red Stringybark/ Blakely's Redgum	2.36	14.18	0.00	2.25	18.8
31 White Box/ Narrow-leaved Ironbark	8.80	0.00	0.00	0.00	8.80
33 Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	6.48	0.00	0.00	3.17	9.65
36 Grassy White Box	0.00	2.76	0.00	0.00	2.76
40 Blakely's Redgum	19.19	0.58	0.00	0.00	19.77
60 Yellow Box/ Rough-barked Apple	0.00	0.00	0.00	4.90	4.90
Total	36.83	17.52	0.00	10.73	64.68

This represents a localised loss of 64.68 ha from 259.60ha contained within the MCP area. **Table 8.3** identifies these losses in terms of the MCP DA Area and study area.

Table 8.3 Loss of White Box Yellow Box Blakely's Redgum Woodland from the MCP DA Area relative to the study area.

Vegetation Association	**Total (ha)**	**Loss MCP DA Area (%)**	**Loss Study Area (%)**
30 Yellow Box/ Red Stringybark/ Blakely's Redgum	36.71	51.21	31.54
31 White Box/ Narrow-leaved Ironbark	8.80	100.00	28.81
33 Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	46.94	20.56	5.37
36 Grassy White Box	7.67	35.97	2.81
40 Blakely's Redgum	130.75	15.12	6.07
60 Yellow Box/ Rough-barked Apple	28.72	17.06	5.32
Total	259.60	25.07	8.27

Dust

Increased levels of dust would occur in the vicinity of residual vegetation remnants. Reduced photosynthesis may decrease plant vigour and reproduction. This represents a short term impact of negligible consequence.

Irreversible/Permanent Impact

The impacts are reversible. Appropriate planning and management (*i.e.* mitigation) during and after the activity will include the dedication of offsite 'like for like' EECs at a ratio of 2:1, local revegetation works and management of existing vegetation within the MCP DA area and rehabilitation of mined landscapes to restore, maintain and enhance the local coverage of this EEC. This approach will provide immediate mitigation to provide a no net loss, with a positive long term result (*ie* 75years +) benefiting the general health, extent and distribution of this EEC throughout the locality achieved through revegetation, rehabilitation and enhancement works. Areas suitable for revegetation works exist throughout the adjoining agricultural lands including creeklines and cleared edges adjoining retained EECs. Accordingly, it is considered that the impacts are not permanent.

3) *NA*

4) *How is the proposal likely to affect current disturbance regimes?*

In the short term, the proposal would exacerbate current disturbance regimes by further contribution to the clearing of native vegetation. In the short term, it is proposed to mitigate immediate loss through dedications to the national park estate. The preferred strategy in the medium to long term will include maintain and enhance works such as revegetation unaffected cleared agricultural landscapes, rehabilitation, management of existing vegetation cover and use of voluntary conservation agreements. A future commitment to the revegetation of the affected lands to reflect the existing and past floristic values of locality would essentially cease current disturbance regimes (agriculture and logging), which is considered a desirous outcome. A timeframe of at least 75 years would be required to return the native vegetation cover to a stable functioning state.

5) *How is the proposal likely to affect habitat connectivity?*

Habitats containing this EEC are mostly fragmented by past clearing events for agriculture. In the short to medium term further fragmentation is expected. However, the expected results from revegetation/rehabilitation strategy would not only reverse the mining related fragmentation from additional clearing works, but also substantially reduce existing extent of native vegetation fragmentation throughout the locality. This particularly applies to the Box Woodlands, notably the vegetation associations that are classified as part of White Box Yellow Box Blakely's Red Gum Woodland.

6) How is the proposal likely to affect critical habitat?

No critical habitat relevant to this ecological community is declared under the TSC Act.

8.3.2 Goodenia macbarronii

General Information

Narrow-leaved Goodenia *G. macbarronii* is a small annual, sometimes perennial herb growing to 30cm (max 40cm) with a short tap root and developed secondary root system. The thick, narrow-obovate to linear-oblanceolate leaved generally range from 5-11cm and are generally erect from a basal rosette (Harden 1992; IEC 2005). Flowering generally occurs from December to April, with occasional spot flowering evident in large populations after substantial periods of rainfall.

Narrow-leaved Goodenia *G. macbarronii* is predominantly distributed west of the Great Dividing Range where it spans three states from southeast Queensland through New South Wales and into central Victoria. It is classified with a risk code of 3VC-; meaning that it has a range of greater than 100 km, is vulnerable and is present within at least one conservation reserve (Warrumbungle NP) - where the population size is unknown (Briggs and Leigh 1995).

Harden (1992) identifies this species as occurring within the NSW botanical subdivisions of Northern Tablelands, Central Tablelands, Southern Tablelands, North West Slopes, Central West Slopes, North West Plains and South West Plains. It is recorded as being south of the Guyra and Inverell districts.

Database records provided by the NPWS show populations distributed throughout districts west of the Great Dividing Range. Locations known to contain this species are at Yarrabandai (50 km west of Parkes), Weddin Mountains NP (70 km west of Cowra), Goobang NP (20-30 km east of Newell Highway between Peak Hill and Parkes), Warrumbungle NP (west of Coonabarabran), Ulan, Wybong, Pilliga NR (70 km west of Gunnedah) and Narran Lake NR (65 km southwest of Lightning Ridge) (NPWS 2003).

Throughout its NSW distribution, Narrow-leaved Goodenia *G. macbarronii* appears to restrict its occurrence to sedimentary geologies consisting of sandstone, shale, siltstone, claystone, mudstone and limestone. Marine sediments are associated with some of these sites (*ie* coal outcrops). The age of these sediments ranges from 65 and 395 million years BP.

Prior to this study the local recorded distribution of this species shows isolated occurrences north of the Ulan coal mine (DEC 2005) and a single location 4km to the WNW of the Ulan township (IEC 2005). At Wybong, approximately 70km east of the study area is the most easterly known population consisting of at least 5000 throughout drainage lines and open paddocks.

Narrow-leaved Goodenia *G. macbarronii* was regularly observed throughout the study area principally in the Box broad vegetation community. This species was consistently observed occupying moist sandy loam soils within drainage lines and areas of impeded drainage. **Table 8.4** provides an estimate of the population size in the study area based on observations.

Table 8.4 Narrow-leaved Goodenia *Goodenia macbarronii* in the study area

Vegetation Association	No. of Observations	Observed Density	Total Observed
11	1	1-10/m^2	500
20	1	1-10/m^2	300
23	1	1-10/m^2	500
30	2	10-100/m^2	1000
31	1	10-100/m^2	200
35	3	10-100/m^2	200
39	1	10-100/m^2	1500
40	11	1-10/m^2	3950
41	1	10-100/m^2	400
50	3	1-10/m^2	100
52	2	1-10/m^2	500
All	28	1-10/m^2	9150

Table 8.4 indicates vegetation association 40 (Blakely's Redgum Woodland) as the most important habitat type for Narrow-leaved Goodenia (*G. macbarronii*) within the study area. Assuming an average density of 1-10/m^2, an area of 325 ha for Blakely's Redgum Woodland and 1% contained suitable habitat (*ie* creek beds), it is estimated that the study area's total population size is between 32,500 and 325,000 individuals. It is considered that the lower estimate is a more accurate reflection of the actual population size, indicating that approximately 30% of the local population has been observed.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   This species is well distributed throughout the study area and is located within areas that would not experience impacts from mining operations. A reduction of the local population's size and distribution would temporarily impact the lifecycle of this species. However, given the capability of this species to recolonise disturbed lands, it is considered that the future rehabilitated landscape may offer a substantially greater range of potential habitats for this species. The proposal would not significantly impact the local lifecycle of this species.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Clearing	The proposal would result in the direct losses of specimens and its habitat. It is estimated that the project would result in the loss of approximately 10% of the local population.
Dust	Increased levels of dust would occur near known specimens. Reduced photosynthesis may decrease plant vigour and reproduction. However, this species is an annual living in ephemeral creeklines capable of experiencing periodic inundation and sediment on leaves, simulating the effects of dust deposition.
Irreversible	The impacts are irreversible.
Permanent	The impacts are permanent. The rehabilitated landscape may be modified to contain areas of suitable habitat for this species, thereby permitting the future recolonisation of disturbed ground.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

Narrow-leaved Goodenia *Goodenia macbarronii* is not at its limit of distribution. This species is mostly from wet of the Great Dividing Range, with population outliers known from the Sandy Hollow – Wybong district.

4) *How is the proposal likely to affect current disturbance regimes?*

Current disturbance regimes include grazing, selective logging, feral animals (*ie* pigs) and cropping. The proposal would reduce many of these existing disturbances by limiting the occurrence of agricultural activities, with proactive management of feral animals also significantly contributing to the reduction of current disturbances.

5) *How is the proposal likely to affect habitat connectivity?*

Habitats would be fragmented by clearing for mining. However, this species naturally exhibits a disjunct distribution throughout the landscape, with most occurrences restricted to drainage lines and seepage areas. The overall impact of the proposed mining operations on this species would be low.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.3 Diuris tricolor

General Information

Double-tailed Donkey Orchid *D. tricolor*, previously referred to as *Diuris sheaffiana*, is a spring flowering yellow orchid to 50cm with red to purple markings and long green to brown lateral sepals. Flowers appear in early October and can last for a week before initiating the formation a fruit capsule. Fruit are a dehiscent, dry capsule, borne on the plant during summer.

This species is known to occur as small to large restricted populations in dry sclerophyll forest, grassy forests and woodland, grasslands (including pastures). It may be found on a variety of geological formations. However, observations from the Hunter Valley catchment indicate this species appears to favour sandy soils derived from Permian conglomerates. Many of the records from the Hunter Valley are in habitats dominated by Kangaroo Grass (*Themeda australis*), a grass species that is sensitive to grazing pressure. It is classified with a risk code of 3K; meaning that it has a range of greater than 100 km and poorly known (Briggs and Leigh 1995).

The Double-tailed Donkey Orchid (*D. tricolor*) exhibits a wide distribution throughout the western slopes and tableland districts of NSW and central eastern QLD. The eastern margin of this species distribution is typically defined as the Great Dividing Range, with numerous records from the Muswellbrook area representing the most easterly known extent of this species range in NSW. Harden (1992) identifies this species as occurring within the NSW botanical subdivisions of Northern Tablelands, Central Tablelands, North West Slopes, Central West Slopes, North West Plains and South West Slopes.

Prior to this study the locally recorded distribution of this species shows one occurrence 12 km south of the study area in the Cooyal Creek catchment (DEC 2005). At Muswellbrook, approximately 100km east of the study area is the most easterly known population consisting of at least 200 individuals within a property managed to conserve this species and its habitats (Ecovision Consulting 2004).

Despite the completion of extensive targeted surveys during the October flowering period, the Double-tailed Donkey Orchid *D. tricolor* was observed only twice as single individuals in two vegetation associations. **Table 8.5** describes the observations within the study area.

Table 8.5 Donkey Orchid *Diuris tricolor* in the Study Area

Vegetation Association	No. of Observations	Observed Density	Total Observed
10	1	-	1
16	1	-	1
All	2	-	2

The two observations share the following habitat similarities:

- Sandy soils derived from the Marrangaroo Conglomerates (Permian Illawarra formation);
- Moist soils near natural seepages;
- The presence of numerous other orchid species such as Onion Orchid (*Microtis parviflora*), Sun Orchid (*Thelymitra pauciflora*), Mauve-tufted Sun Orchid (*Thelymitra malvina*), *Pterostylis bicolor*, Western Donkey Orchid (*Diuris goonooensis*); and
- Absence of grazing.

The abundance of orchids and grasses indicates the absence of grazing substantially improves the viability of ground orchid populations. Accordingly, it is considered that the areas of prolonged grazing are unlikely to contain populations of this threatened species.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   This species clearly exhibits a disjunct fragmented distribution throughout the study area, with the two records separated by 6.9 km. It is likely that agriculture has substantially diminished habitat occurrences throughout the study area. The MCP would result in the loss of one specimen in OC1 thereby reducing the size of the population within the study area to 1. However, the viability of either individual specimen remains indifferent irrespective of the proposal as the low population size indicates a likelihood that this species would become locally extinct.

   However, targeted management programs addressing this issue may be integrated into the proposal, thereby intervening in what otherwise appears to be an already declining local population facing local extinction. It is regarded that the short term loss may be mitigated by targeted management such that the future vegetated landscape of the MCP area may contain greater quantities of potential and known habitat.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Clearing	The proposal would result in the direct losses of one specimen and its immediate habitat. It is estimated that the project would result in the loss of approximately 50% of the local population (one specimen out of two observed within the study area).
Dust	Increased levels of dust would occur near remaining specimens. Reduced photosynthesis may decrease plant vigour and reproduction success.
Irreversible	The impacts are irreversible.
Permanent	The impacts are permanent.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

Double-tailed Donkey Orchid *D. tricolor* is not at its limit of distribution. This species is mostly from west of the Great Dividing Range, with proactively managed population outliers known from the Muswellbrook district.

4) *How is the proposal likely to affect current disturbance regimes?*

Current disturbance regimes for known habitat are restricted to grazing, with land clearing, feral animals (*ie* pigs) and cropping potentially compromising the remaining areas of potential habitat. The proposal would reduce many of these existing disturbances by limiting the occurrence of agricultural activities, with proactive management of feral animals also significantly contributing to the reduction of current disturbances. Future revegetation works throughout cleared lands would improve local habitat values.

5) *How is the proposal likely to affect habitat connectivity?*

This species exhibits a disjunct local distribution with pollen transfer between these two individuals considered remote. Therefore, the proposal would not further diminish habitat connectivity.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.4 Leucochrysum albicans var tricolor

General Information

The Hoary Sunray *Leucochrysum albicans* var *tricolor* is an erect perennial woolly herb with woody rootstock growing to 45 cm high. Leaves linear to narrow-oblong, 2.5-10 cm long, 0.5-1.5 mm wide, crowded around base of stems and are woolly. Flower heads are solitary on slender peduncles 7-15 cm long; involucre spreading from base, 2-4 cm diameter. Involucral bracts multiseriate, outer sessile oblong to ovate, obtuse to acute, brown to purple; inner bracts with long stipe and triangular to narrow-elliptic white lamina, woolly at base. Flowers generally in spring and summer (PlantNet, 2006).

This species is generally restricted to grassy woodlands west of the Great Dividing Range, particularly Grassy White Box Woodlands. The distribution of this species is south from Mudgee, indicating that the population observed within the site is at its northern limit of occurrence.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The MCP would not impact this species. The environmental bund surrounding the southern boundary of OC1 has been altered to avoid impacts to this species and its habitat.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Clearing	The proposal would not result in the direct loss of this species and its habitat.
Dust	Increased levels of dust would occur near known specimens. Reduced photosynthesis may decrease plant vigour and reproduction.
Irreversible	The impacts are reversible.
Permanent	The impacts are not permanent.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The MCP would occur adjacent to the most northern known population of this species. However, no individuals are to be impacted by the proposed coal mine.

4) *How is the proposal likely to affect current disturbance regimes?*

Existing threats to the local population of Hoary Sunray *Leucochrysum albicans* var *tricolor* is restricted to damage from feral animals and land clearing. The proposal would provide management for this species, such that the existing threats are substantially reduced.

5) *How is the proposal likely to affect habitat connectivity?*

In the short term, the proposal would increase the already fragmented distribution of Box Woodlands. However, the proposal would seek to replace and increase the quantity of potential habitat (*ie* Box Woodlands) during the revegetation/rehabilitation program. It is considered that the MCP would increase habitat connectivity in the medium to long term, an unlikely outcome should the mine not proceed.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.5 Eucalyptus cannonii

General Information

Tree to 15 m high; bark persistent throughout, grey to red-brown, stringy. Juvenile leaves disjunct, broad-lanceolate, glossy green, hispid. Adult leaves disjunct, lanceolate, 10-19 cm long, 1.5-2.5 cm wide, green, dull to semi-glossy, concolorous. Umbellasters 7-flowered; peduncle angular, 10-20 mm long; pedicels terete or angular, 1-4 mm long. Buds fusiform with a distinct medial rim, 8-16 mm long, 5-8 mm diam., scar absent; calyptra conical, as long and as wide as hypanthium, +/- angular. Fruit globose or turbinate, often with a distinct medial rim, +/- angular, 7-12 mm long, 10-15 mm diam.; disc raised; valves exserted. Flowers January – April.

The Capertee Stringybark *E. cannonii* is predominantly distributed between Rylstone and the Upper Wolgan valley of the Central Tablelands and Central West Slopes botanical subdivisions. (Hunter and White (1999) confirm this by stating the distribution between east of Mudgee and east of Bathurst. It is classified with a risk code of 2VCi; meaning that it has a range less than 100 km, is vulnerable and is present within at least one conservation reserve (Avisford NR, Gardens of Stone NP, Wollemi NP, Winburndale NR), with the population size in Winburndale NR numbering approximately 6,000 individuals (Briggs and Leigh 1995; Hunter and White, 1999). The total population of this species throughout its entire range is estimated to be greater than 10,000 individuals and is adequately conserved (Hunter and White, 1999). Further, Hunter and White (1999) consider that the vulnerable listing for this species is no longer appropriate due to the variation and size of populations within conservation reserves and the number of populations in non-productive lands of private ownership.

Database records indicate populations distributed to the south of the study area, with the nearest herbarium lodged record approximately 15km to the south. Throughout its distribution, The Capertee Stringybark *E. cannonii* is locally frequent but restricted, in sclerophyll woodland on shallow soil on rises. Prior to this study the Capertee Stringybark (*E. cannonii*) has been recorded approximately 5km to the E near the Wollar – Mudgee Road (RS 2005). This population would be retained in the final developed landscape of the Wilpinjong coal mine.

The Capertee Stringybark *E. cannonii* was observed in two locations within the study area:

1. Inland Scribbly Gum/Stringybark/Ironbark Woodland. A single tree located near the boundary between the Quaternary and Permian Illawarra geological formations (*ie* Marrangaroo Conglomerates); and
2. Ironbark/Slaty Gum Forest. Seven trees of various age classes were observed in a small stand near the confluence between Box Woodlands and Sedimentary Ironbark Forests. The geological setting appears to be coal seam outcrops containing tuffaceous claystone material.

Conversely, numerous hybrids with the closely related Red Stringybark *E. macrorhyncha* have been observed throughout the study area in a variety of vegetation associations. These hybrids vary considerably in their fruit and bud characteristics (DEC 2003), with none of the observed hybrid specimens displaying all the distinctive characteristics of the threatened species.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The MCP would result in the removal of known habitat contained within OC1. Approximately seven individuals would be removed from this area, leaving the only remaining observed specimen between OC2 and OC3. Numerous hybrids with Red Stringybark *Eucalyptus macrorhyncha* would also be retained in the post developed landscape.

2) How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?

Capertee Stringybark *Eucalyptus cannonii* is reported to occupy a range of habitats that show little similarities (Hunter and White, 1999). Observations from the study area indicate that the Marangaroo conglomerates and tuffaceous claystones in the adjoining coal seams may provide the most important habitat values for this species in the locality. This is supported by the extent of hybridisation observed throughout parts of the study area characterised by this geological setting.

The proposal would remove habitats associated with the tuffaceous claystones as this is where the coal is to be extracted. Selected parts of the Marangaroo conglomerates would also be impacted by the placement of infrastructure such as environmental bunds and haul roads. Overall the local habitats for this species would be reduced by the mine in the short term.

3) Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Capertee Stringybark *Eucalyptus cannonii* is located at its northern limit of distribution. The scarcity of local records indicates that this species is uncommon throughout Ulan district, a result probably associated with past land clearing for agriculture. Land clearing has been identified as a historical threat to this species and is now longer considered a threat to the conservation status.

4) How is the proposal likely to affect current disturbance regimes?

Current disturbance regimes are limited to grazing and selective logging. Recent selective logging within the OC1 area was located close by the seven individuals suggesting that unmanaged timber harvesting still remains a local threat to this species. Ongoing grazing regimes would prevent the reestablishment of this species within the adjoining agricultural landscape, thereby restricting the ongoing lifecycles to existing tracts of intact native vegetation.

5) *How is the proposal likely to affect habitat connectivity?*

Habitat for this species appears to be restricted to the confluence between Box Woodlands and Sedimentary Ironbark Forests. This zone has experienced substantial historical impacts from land clearing and grazing activities, which has consequently resulted in a fragmented landscape of varying environmental conditions. The short term impacts would reduce habitat connectivity. However, the proposed rehabilitation program would seek to restore existing connectivity, with associated revegetation of adjoining farmland to improve local corridor values.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.6 Bush Stone-curlew Burhinus grallarius

General Information

Distribution has contracted to isolated areas on the central and mid-north coast of NSW, and the western slopes and plains of the Great Dividing Range and the Riverina district of central NSW (NPWS 1999).

Inhabits lightly timbered open forest and woodland areas with a grassy understorey (NPWS 1999; Blakers *et al* 1984; DEC 2006). Preferred habitat usually has good visibility at ground level, with this structure being more important than floristics (DEC 2006). In western NSW this species is known to utilise Box-Ironbark forests and patches of she-oaks (DEC 2006). Will also use dry open grassland and cropland with cover nearby (NPWS 1999).

Nests in a shallow scrape on the ground (Lindsey 1992), near dead timber, usually under trees in open woodland with a short grassy understorey (NPWS 1999). Grass height should be less than 15cm (DEC 2006).

Nocturnal, especially active on moonlit nights (NPWS 1999). Pairs defend approx 10-25ha when breeding, but may forage over an area of 250-600ha (DEC 2006). Small flocks may roam over 100km^2 in the non-breeding season (Blakers *et al* 1984). At night, birds will travel up to 3km from a roost site to feeding grounds in open paddocks, wetlands, woodland remnants *etc* (DEC 2006).

This species was not recorded by Moolarben Biota surveys, and is not previously known from the region. However two separate anecdotal records were obtained from landholders in the southern part of DA area (recently by M Swords and in the late 1940's by Mayberry). Due to the unique appearance and call of the Bush Stone-curlew, these anecdotal records are assumed to be accurate.

If present, this species would be expected to use grassy Box Woodland remnants and vegetation fringing cleared farmland in the very southern part of the DA area for occasional foraging.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

Anecdotal records and analysis of habitats indicate that the Bush Stone-curlew may use woodland and grassland areas fringing the Munghorn Gap Nature Reserve in the southern part of the study area and DA area.

No nesting sites are known from the study area or DA area. It seems unlikely that any regular nesting sites are located in these parts, given the distinctive call of this species during the breeding season, yet the paucity of records.

The species is known to roam over quite large areas, particularly during the non-breeding season, and it is likely that the few anecdotal records of the Bush Stone-curlew for the study area and DA area relate to roaming and foraging birds.

OC3 of the proposed mine is set back approximately 1km from the Munghorn Gap Nature Reserve, across Moolarben Creek. No other part of the mine proposal affects likely Bush Stone-curlew habitat. The proposed mine would not be likely to result in an increase in predation of this species, nor an increase in human disturbance of nest sites.

The proposed mine would not be likely to notably or significantly affect the lifecycle of the Bush Stone-curlew.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Proposed OC3 would require some clearing of vegetation remnants and fringes around cleared farmland in the very southern part of the DA area (including on the Mayberry landholding). Approximately 18 ha of potentially suitable TSU 30 Box Woodland remnants would be removed for OC3, and then replaced with approx 200 ha of similar vegetation following completion of coal extraction. This impact would be a temporary and reversible loss of foraging habitat for the Bush Stone-curlew (approx 2 years during OC3 operation – maximum production, and a further 25 years for habitat regeneration - refer to Chapter 9). Note that the Bush Stone-curlew does not require a complex understorey, nor significant old-growth features such as mature hollow trees. Woody debris is required by this species and would be placed on the ground in newly regenerating areas, as part of the habitat restoration – refer to Chapter 9.

Operation of the mine may also result in some indirect impacts upon potential Bush Stone-curlew habitat, due to increased noise, light, traffic and dust. It is likely that such indirect impacts would deter the Bush Stone-curlew from using retained habitats in the vicinity of OC3. This is a temporary (approx 2 years – maximum production) relatively minor issue, due to the substantial buffer zone to the east across Moolarben Creek, between OC3 and the Munghorn Gap NR, and given that vegetation immediately adjacent to the OC3 pit on its western side would be Sedimentary Ironbark Forests, which are not typically grassy in the understorey, and therefore unlikely to be of particular value for the Bush Stone-curlew in any case.

No underground mining is proposed within likely Bush Stone-curlew habitat in the DA area. Therefore subsidence issues are not of relevance to this species.

The proposal is not likely to increase the extent of any known threats upon Bush Stone-curlew habitat, such as predation by foxes, pigs, dogs and cats, hazard reduction burning or overgrazing (threats taken from NPWS 1999).

In summary, the likely impacts of the proposal upon Bush Stone-curlew habitat in the DA area are temporary and reversible, and are not regarded as significant for this species.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Bush Stone-curlew is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Potential habitat for the Bush Stone-curlew in the DA area is currently disturbed through extensive clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances in the short term (2 years – maximum production), and then gradually reduce them. The final outcome of the proposal would be an increase in extent and quality of habitat for the Bush Stone-curlew, and probably a return to existing agricultural disturbances.

5) *How is the proposal likely to affect habitat connectivity?*

Habitats in the southern part of the DA area are currently highly fragmented, and consist of a loose arrangement of small patches scattered through agricultural land. Munghorn Gap NR provides an extensive tract of potential habitat immediately to the east of the DA area. A rugged ridgeline supporting Sedimentary Ironbark Forests (which is not likely Bush Stone-curlew habitat) occurs within the western boundary of the DA area.

The proposed OC3 would remove the scattered small patches of potential habitat for the Bush Stone-curlew in the very southern part of the DA area. This is regarded as a habitat contraction rather than fragmentation, given that Bush Stone-curlews would not be expected to currently travel across the DA area from Munghorn Gap NR to the western ridgeline, based on habitat types.

The habitat contraction would be temporary, for approx 2 years during OC3 operation, and a further 25 years for habitat regeneration. In the long term, the proposal would increase connectivity through this part of the DA area (refer to Chapter 9).

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act or EPBC Act.

8.3.7 Square-tailed Kite Lophoictinia isura

General Information

Has a widespread distribution across virtually all of mainland Australia, excepting waterless desert (NPWS 1999). Typically inhabits tropical and temperate coastal forests and woodlands, and also inland along timbered watercourses (NPWS 1999). Appears to migrate seasonally, south in summer, north in winter (Blakers *et al* 1984).

In NSW, it is often associated with forests dominated by *Eucalyptus longifloria*, *Corymbia maculata* or *E elata, E smithii*. Also sighted within forests containing other eucalypts, *Angophora* spp and *Callitris* spp with a shrubby understorey and Box-Ironbark woodland (NPWS 1999).

Feeds on passerine birds, especially honeyeaters, nestling birds, rabbits, reptiles and carrion (NPWS 1999; Lindsey 1992).

Nest is a substantial structure of sticks, usually constructed in a fork or on a large horizontal limb of *Angophora* spp or *Eucalyptus* spp approx 15-20m above the ground, along or near watercourses (Lindsey 1992; NPWS 1999).

This species has been recorded from a number of widely scattered locations within the region, including 1 sighting by Moolarben Biota within the study area, TSU 30 (but just outside the DA area). Records of the Square-tailed Kite in the surrounding area are mainly of it foraging over woodland/grassland ecotones. These ecotones are predominantly TSU 30 Box Woodlands and TSU 40b Blakely's Red Gum Woodland in the DA area. However, this species is also reported in the literature as occurring in eucalypt forests containing *Callitris* spp and a shrubby understorey. Large portions of the study area support such vegetation associations, mainly within TSU 20 Sedimentary Ironbark Forests and TSU 50 Sedimentary Scribbly Gum Woodlands.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The Square-tailed Kite nests along or near watercourses. No nests likely to belong to this species were recorded during the field surveys. Further, the proposed mine layout has been designed to avoid creekline areas. With the exception of a very small area located just south of proposed OC2 where a proposed environmental bund crosses Moolarben Creek, virtually all riparian vegetation in the DA area is to be retained.

The Square-tailed Kite is likely to forage over a wide range of habitats within the DA area, including cleared and disturbed areas, and feed on a range of prey animals, including rabbits. The Square-tailed Kite is a highly mobile and wide ranging species, unlikely to have it's lifecycle significantly affected by temporary changes to extent, location and condition of foraging habitat.

The proposed mine would not be likely to significantly affect the lifecycle of the Square-tailed Kite.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Square-tailed Kite from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of woodland habitat for the Square-tailed Kite would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 15 years regeneration and habitat restoration)

Underground mining is proposed in the northern part of the DA area (Underground No. 4). This area supports extensive areas of Sedimentary Scribbly Gum Woodlands, which are of potential habitat value for the Square-tailed Kite. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Square-tailed Kite on a broad scale.

Operation of the mine may result in some other indirect impacts upon Square-tailed Kite habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Square-tailed Kite, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon potential Square-tailed Kite habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Square-tailed Kite is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Square-tailed Kite in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Square-tailed Kite, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Square-tailed Kite, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.8 Gang Gang Cockatoo Callocephalon fimbriatum

General Information

Inhabits tall montane forests and woodlands in summer, particularly heavily timbered mature wet sclerophyll forests. Also occurs in sub-alpine Snow Gum woodland and occasionally in temperate rainforests. Undertakes nomadic and seasonal movements, and in winter tends to occur at lower altitudes in drier, more open eucalypt forest and woodland, particularly Box-Ironbark associations, and in dry forest in coastal areas (NSW Scientific Committee).

Feeds on green acacia seeds, eucalypt seeds, fruits and berries, including seeds, fruits and berries of introduced plant species (Lindsey 1992; Blakers *et al* 1984). Tends to exhaust one food supply before moving to another (Blakers *et al* 1984).

Nests in hollows in large old trees, usually close to water. Shows strong nest site fidelity. Breeding occurs mainly in tall mature wet sclerophyll forests with a dense understorey (NSW Scientific Committee).

Moolarben Biota recorded one sighting of this species from vegetation association 52, which is dominated by Scribbly Gum and Black Cypress Pine. This species is not otherwise known from the region.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The DA area does not contain likely breeding habitat for this species (*ie* tall wet sclerophyll forest), and is situated generally within the broad valleys of Moolarben Creek and the Goulburn River, rather than in a montane environment.

The Gang Gang Cockatoo is probably an occasional visitor to the area in winter. This species is known to utilise vegetation associations within TSU 30 Box Woodlands, and was recently recorded in TSU 50 Sedimentary Scribbly Gum Woodlands. The DA area, study area and surrounding lands contain extensive tracts of potential foraging habitat for this species.

The proposed mine would not be likely to affect the lifecycle of this species.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 172ha of potential foraging habitat for the Gang Gang Cockatoo from the DA area (including 137ha of Box Woodlands, 20ha of TSU 40b Blakely's Red Gum Woodland and 15ha of Sedimentary Scribbly Gum Woodlands). Subsequent regeneration and habitat restoration works are detailed in Chapter 9. The loss of woodland habitat for the Gang Gang Cockatoo would be a temporary and reversible loss (approx 2-5 years during each open pit operation, followed by approximately 25 years regeneration and habitat restoration).

Underground mining is proposed in the northern part of the DA area (Underground No. 4). This area supports extensive areas of Sedimentary Scribbly Gum Woodlands, which are of potential habitat value for the Gang Gang Cockatoo. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Gang Gang Cockatoo on a broad scale.

Operation of the mine may result in some other indirect impacts upon Gang Gang Cockatoo habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 9 years total – maximum production) and relatively minor for a wide-ranging temporary visitor to the area such as the Gang Gang Cockatoo, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon potential Gang Gang Cockatoo foraging habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Gang Gang Cockatoo is not located at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for the Gang Gang Cockatoo in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Gang Gang Cockatoo, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Gang Gang Cockatoo, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.9 Glossy Black Cockatoo Calyptorhynchus lathami

General Information

Inhabits drier eucalypt forest and woodland, characteristically on sites with low soil nutrient status (Blakers *et al* 1984; NPWS 1999; DEC 2004a). Prefers intact landscapes (NPWS 1999; DEC 2004a).

Feeds almost exclusively on seeds of *Allocasuarina* spp - predominantly *A littoralis* and *A torulosa* (Lindsey 1992; Blakers *et al* 1984; NPWS 1999). Inland birds use a more diverse range of species, including *A cristata* (Blakers *et al* 1984). In the central west of NSW they also eat the seeds of Cypress Pine (DEC 2004a). Birds favour individual trees, which produce seeds with high nutrient content, and may sample a few trees before selecting one to feed in (DEC 2004a).

Nests in a large tree hollow (Lindsey 1992; NPWS 1999). Lives in loose groups which occupy an area permanently (Blakers *et al* 1984)

There are numerous records of the Glossy Black Cockatoo in the study area, on surrounding lands, and in the region. Most of the records within the study area are from either a vegetated broad ridgeline in the central part of the study area, immediately east of proposed OC1, or from woodlands north of the Ulan-Wollar Road in the proposed Underground No. 4 area. These records appear to indicate important *Allocasuarina* feeding sites and/or may be based around nest sites.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   It seems likely that there are two Glossy Black Cockatoo nest sites in the study area, one located in TSU 50 Sedimentary Scribbly Gum Woodlands north of the Ulan-Wollar Road within the proposed Underground No. 4 area, and the other located on a broad ridge of TSU 20 Sedimentary Ironbark Forests immediately east of the proposed OC1 (and just outside of the DA boundary). There are a few scattered records of the species from within the proposed OC1 lands.

   The proposed mine is not likely to directly affect either existing nests sites, or significant feeding sites for the Glossy Black Cockatoo. Some lesser value or occasional feeding areas may be cleared for OC1.

   Indirect impacts, such as noise from the mine, may affect feeding and/or nesting areas on the western side or on top of the ridge located to the east of OC1. Noise would gradually affect different parts of the ridge over a 5 year period (maximum production). Noise may deter Glossy Black Cockatoo’s from nesting/breeding in this area during one or more seasons.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   The proposed mine would involve the removal of approximately 170ha of vegetation likely to contain patches of suitable *Allocasuarina* spp foraging habitat for the southern group of Glossy Black Cockatoo’s (*ie* TSU 20 Sedimentary Ironbark Forests within the proposed OC1 area). The apparent ‘core’ area of habitat for this southern group of Glossy Black Cockatoos is located on the broad ridge immediately east of proposed OC1, and is outside of the DA area. Subsequent regeneration and habitat restoration are detailed in Chapter 9. The temporary loss (approx 5 years during OC1 operation, and then 5 years *Allocasuarina* regeneration) of a relatively small area of occasional foraging habitat is not likely to be of significance for this group.

   Underground mining is proposed in the northern part of the DA area, beneath lands supporting extensive areas of TSU 50 Sedimentary Scribbly Gum Woodlands, and which are of importance for the northern group of Glossy Black Cockatoo’s. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to ‘balance out’ across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Glossy Black Cockatoo on a broad scale.

   Operation of the mine may result in some other indirect impacts upon Glossy Black Cockatoo habitat, mainly upon the southern group, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 5 years) and generally located in the valley on the west side of the ridgeline. It is expected that Glossy Black Cockatoos could avoid noise and disturbances by keeping to habitats located more on the broad top and eastern side of the ridgeline (where they were recorded during field surveys for this report) for that 5 year period.

In summary, the clearing impacts of the proposal upon Glossy Black Cockatoo habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant. Noise impacts would be temporary and are of some concern, but would probably not be significant in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Glossy Black Cockatoo is not located at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Glossy Black Cockatoo records in the study area appear to be restricted to larger and more intact areas of vegetation, in areas not subject to extensive noise and human disturbances. This situation would not be likely to change for the northern group of Glossy Black Cockatoos located in the proposed underground area.

The habitat for the southern group of Glossy Black Cockatoos would be located immediately east of proposed OC1, and overlooking the mine facilities. This group would be subject to increased noise and light during the operation of the pit (5 years – maximum production), and mine facilities (9 years – maximum production). These impacts are temporary and it is expected that individual birds would be able to avoid the disturbance to some degree by keeping to habitats on the broad top and eastern side of the ridgeline.

The final outcome of the proposal would be an increase in extent and quality of habitat for the Glossy Black Cockatoo, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

The proposal is not likely to result in isolation or further isolation of any area of known foraging or nesting habitat for the Glossy Black Cockatoo. Links between the two groups of Glossy Black Cockatoos would be retained. A small area of vegetation would be retained on the western side of OC1, and would be temporarily isolated. However, there are no records of the Glossy Black Cockatoo from this area, and no reason to expect that this is an area of important habitat.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.10 Swift Parrot Lathamus discolor

General Information

Breeds only in Tasmania, (Lindsey 1992, Blakers *et al* 1984; NSW Scientific Committee). Occurs in forests and woodlands of NSW from May to August (NSW Scientific Committee).

Forages in the upper tree canopy for nectar, pollen and lerps (Blakers *et al* 1984). Lives in small flocks, which appear in areas where eucalypts are flowering in profusion (Blakers *et al* 1984). Dependent on flowering resources across a wide range of habitats in its wintering grounds of NSW (NSW Scientific Committee).

This species was not recorded by Moolarben Biota, but is known to have occurred approx 5km to the south of the study area, in Munghorn Gap Nature Reserve. A winter only visitor to the region, the Swift Parrot is likely to occur in the DA area on rare occasions, more likely in years when the flowering of eucalypts in the area coincide to produce a mass flowering event.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The Swift Parrot breeds only in Tasmania, migrating north to mainland Australia in winter. It does not appear to be a regular visitor to the region.

The DA area, study area and surrounding lands contain extensive tracts of potential foraging habitat for this species. The proposed mine would result in a graduated and temporary loss of potential flowering resources across the DA area, and is not likely to significantly affect the lifecycle of the Swift Parrot.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Swift Parrot from the DA area (assuming that this species could utilise all habitats except TSU 10a Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of winter foraging habitat for the Swift Parrot would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 25 years regeneration and habitat restoration - refer to Chapter 9).

Underground mining is proposed in the northern part of the DA area. This area supports extensive areas of Sedimentary Scribbly Gum Woodlands, which theoretically provide a potential foraging resource for the Swift Parrot, although probably of lesser value than other TSU's in the area. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Swift Parrot on a broad scale.

Operation of the mine may result in some other indirect impacts upon Swift Parrot habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 9 years total – maximum production) and relatively minor for a wide-ranging temporary visitor to the area such as the Swift Parrot, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon potential Swift Parrot foraging habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Swift Parrot would be nearing its northern limit of distribution in the DA area, but is not at its northern limit of known distribution. Distribution into this area usually coincides with mass flowering events, and would not be not expected to occur every year.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for the Swift Parrot in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Swift Parrot, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the extremely wide-ranging Swift Parrot.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.11 Turquoise Parrot Neophema pulchella

General Information

Inhabits open eucalypt woodland and forest, especially with a grassy understorey and rocky outcrops (Lindsey 1992). Prefers the edge of eucalypt woodland adjoining clearings and also timbered ridges and creeklines in farmland (Blakers *et al* 1984; NPWS 1999). Birds may move from eucalypt woodland to pasture after the breeding season in some places (Blakers *et al* 1984).

Usual forests/woodlands have mixed assemblages of Cypress Pine *Callitris* sp and a variety of eucalypts including White Box, Yellow Box, Red Box, Blakely's Red Gum, Red Stringybark, Bimble Box or Mulga Ironbark (NPWS 1999).

Usually occurs in small family groups, forages on the ground for seeds (native and introduced) (Lindsey 1992; Blakers *et al* 1984). Requires a reliable drinking supply (NPWS 1999).

Nests may be located in hollows of small trees, in holes or stumps of dead eucalypts, fence posts or even logs lying on the ground (NPWS 1999).

Suffered a major decline in numbers early this century (NPWS 1999; Lindsey 1992), possibly due to competition with livestock during drought and/or trapping (Blakers *et al* 1984). Appears now to have regained much of its former range (Blakers *et al* 1984; Lindsey 1992).

The Turquoise Parrot was not recorded during Moolarben Biota surveys and is not known to occur in the study area. However, there are numerous records of this species to the east and southeast of the study area, including within Munghorn Gap Nature Reserve. This species could be expected to utilise the grassy Box Woodland vegetation associations occurring throughout the southern part of the study area, on occasions. The Sedimentary Ironbark Forests, which are a notable feature of the southern part of the study area, do not typically have a grassy understorey, and are probably not of value for this species. These dominant forests could be a reason for lack of records of this species venturing into the study area from the adjacent Munghorn Gap Nature Reserve.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The Turquoise Parrot is not known to occur in the DA area, and would only be expected as an occasional visitor. The proposal is not likely to significantly affect the lifecycle of this species.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 88ha of potential foraging habitat for the Turquoise Parrot from the DA area (suitable associations within TSU 30 Box Woodlands and TSU 40b Blakely's Red Gum Woodland, south of the Ulan-Wollar Road). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of occasional foraging habitat for the Turquoise Parrot would be a temporary and reversible loss (approx 9 years during open pit operations – maximum production, and then 25 years regeneration and habitat restoration - refer to Chapter 9).

Underground mining is proposed in the northern part of the DA area. This area is not likely to be of habitat value for the Turquoise Parrot, based on distance from nearest records, and habitat type (generally more of a shrubby understorey rather than grassy).

Operation of the mine may result in some other indirect impacts upon Turquoise Parrot habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 9 years – maximum production) and relatively minor for a temporary visitor to the area such as the Turquoise Parrot, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon potential Turquoise Parrot foraging habitat in the DA area would be temporary and reversible, and are not likely to be significant for this species. Subsidence impacts are not likely to be of relevance to this species.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Turquoise Parrot would not be located at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for the Turquoise Parrot in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. The final outcome of the proposal would be an increase in extent and quality of habitat for the Turquoise Parrot, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Turquoise Parrot.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.12 Powerful Owl Ninox strenua

General Information

Inhabits tall moist productive eucalypt forests of the eastern tableland edge, and the mosaic of wet and dry sclerophyll forests occurring on undulating, gentle terrain near the coast. Ideally with a tall shrub layer and/or abundant hollows supporting a high density of arboreal marsupials (DEC 2005a; Blakers *et al* 1984; Lindsey 1992).

A nocturnal sedentary species, which lives alone or in pairs, occupies permanent territories up to 1500 ha in size, which contains several roost sites (Blakers *et al* 1984; Lindsey 1992; DEC 2005a).

Roosts by day in dense foliage of mid-canopy trees (including *Allocasuarina* spp, rainforest species, Turpentine and eucalypts), often amongst groves of up to 2ha of similar-sized trees in the height range of 3-15m (DEC 2005a), in sheltered gullies, often along streams and wide creek flats between ridges covered with eucalypt forest (DEC 2005a; Blakers *et al* 1984).

Prefers to forage in moist unlogged forest in gully systems, but also forages in dry and regrowth forest. Preys on arboreal mammals (80% of diet), birds (18%) and insects and some terrestrial mammals (2%) (Blakers *et al* 1984). The Common Ringtail Possum is a primary prey species in lowland areas, and the Greater Glider in highland areas (DEC 2005a).

Nests in a large tree-hollow (greater than 45cm wide and 100cm deep), usually high (at least 20m from the ground) in a very large eucalypt (with a DBH of at least 80cm) (Lindsey 1992; DEC 2005a). Nesting sites are typically in unlogged unburnt gullies and lower slopes, within 100m of streams, and surrounding by trees or tall shrubs (DEC 2005a).

The Powerful Owl has been recorded in the study area and is known to occur in the region. One of the Moolarben Biota sites was on the very edge of the study area, bordering Munghorn Gap Nature Reserve, another site was in roadside vegetation along the Ulan-Wollar Road, not far from the boundary of Goulburn River National Park.

The Powerful Owl appears to forage within the study area, but is not likely to breed, nest or roost in the study area. The study area does not contain typical habitat for the Powerful Owl, and few areas contain an abundance of suitable hollows for nesting[2]. It is likely that Powerful Owls would roost and nest in the adjacent Goulburn River National Park and/or Munghorn Gap Nature Reserve. TSU's of apparent value include TSU 20 Sedimentary Ironbark Forests, and TSU 50 Sedimentary Scribbly Gum Woodlands. However, the Powerful Owl could forage over most relatively intact types of vegetation.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The Powerful Owl is not expected to breed or roost within the study area. However, it is likely that parts of the study area are included within the permanent territory of one or more Powerful Owls.

   The Powerful Owl is a highly mobile and wide ranging species, unlikely to have it's lifecycle significantly affected by temporary changes to extent, location and condition of foraging habitat. Its main prey species, the Common Ringtail Possum, is a relatively disturbance-tolerant species, which does not rely on tree-hollows (since it builds 'dreys') or old growth forest forms.

   The proposed mine would not be likely to significantly affect the lifecycle of the Powerful Owl.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Powerful Owl from the DA area (all TSU's except TSU 10 – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of woodland habitat for the Powerful Owl would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 25 years regeneration and habitat restoration)

   Underground mining is proposed in the northern part of the DA area (Underground No. 4). This area supports extensive areas of Sedimentary Scribbly Gum Woodlands, which are of potential habitat value for the Powerful Owl. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Powerful Owl, or its prey species, on a broad scale.

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[2] There is a general paucity of mature and senescent trees in many parts of the study area, possibly due to previous selective logging for mine supports (the adjacent Ulan mine has been in operation for around 100 years ?), fence posts and other construction purposes.

Operation of the mine may result in some other indirect impacts upon Powerful Owl habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Powerful Owl, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Powerful Owl habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Powerful Owl is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Powerful Owl in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Powerful Owl, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Powerful Owl, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.13 Masked Owl Tyto novaehollandiae

General Information

Inhabits eucalypt forest and woodland from the coast to the western plains (DEC 2005a). It is most abundant within 300km of the coast (DEC 2005a; Blakers *et al* 1984). Optimal habitat includes a mosaic of sparse (grassy) and dense (shrubby) groundcover on gentle terrain (DEC 2005a).

A sedentary species, which occupies permanent territories 500-1000 ha in size (Blakers *et al* 1984). Nocturnal, roosts by day in hollows, in cover of dense vegetation in gullies or in caves (Blakers *et al* 1984; Lindsey 1992; DEC 2005a). Roosts at least 5m above the ground (DEC 2005a). Forages at forest edges or in partial clearing for small terrestrial mammals including rabbits, supplemented by some arboreal mammals, bats and birds (Blakers *et al* 1984; Lindsey 1992; DEC 2005a)).

Nests in tree hollows greater than 40cm wide and greater than 100cm deep. No relationship with distance to streams. Entrances are at least 3m above the ground in trees with DBH of at least 90cm. Generally faithful to traditional hollows (DEC 2005a).

The Masked Owl was not recorded in the study area during surveys conducted for this report, but was apparently recently sighted by M Swords (landholder) in the southern part of the DA area. There is one record of this species from the region, calling from a densely vegetated gully within the Munghorn Gap Nature Reserve (Wilpinjong Coal Project EIS).

It is likely that one or more Masked Owls reside in densely vegetated gullies within the Munghorn Gap Nature Reserve, emerging to occasionally forage over forest and woodland edges within the southern part of the DA area.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The Masked Owl is not expected to breed or roost within the DA area. However, it is likely to forage across some southern parts of the DA area, in woodland remnants and fringes near the boundary of Munghorn Gap Nature Reserve.

OC3 of the proposed mine is set back approximately 1km from the Munghorn Gap Nature Reserve, across Moolarben Creek. No other part of the mine proposal affects likely Masked Owl foraging habitat.

The proposed mine would not be likely to significantly affect the lifecycle of the Masked Owl.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Proposed OC3 would require some clearing of vegetation remnants and fringes around cleared farmland in the southern part of the DA area. Approximately 30ha of TSU 30 Box Woodland and TSU 40b Blakely's Red Gum Woodland remnants would be removed for OC3, and then replaced with approx 200 ha of similar vegetation following completion of coal extraction. This impact would be a temporary and reversible loss of potential foraging habitat for the Masked Owl (approx 2 years during OC3 operation – maximum production, and a further 25 years for habitat regeneration - refer to Chapter 9).

Operation of the mine may also result in some indirect impacts upon potential Masked Owl foraging habitat, due to increased noise, light, traffic and dust. It is likely that such indirect impacts would deter the Masked Owl from using retained habitats in the vicinity of OC3. This is a temporary (approx 2 years – maximum production) relatively minor issue.

No underground mining is proposed within potential Masked Owl habitat in the DA area. Therefore subsidence issues are not of relevance to this species.

In summary, the clearing impacts of the proposal upon Masked Owl potential foraging habitat in the DA area would be temporary and reversible, and not likely to be significant for this species.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Masked Owl is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for the Masked Owl in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances in the OC3 area in the short term (2 years – maximum production), and then gradually reduce them. The final outcome of the proposal would be an increase in extent and quality of habitat for the Masked Owl, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitats in the southern part of the DA area are currently highly fragmented, and consist of a loose arrangement of small patches scattered through agricultural land. Munghorn Gap NR provides an extensive tract of potential habitat immediately to the east of the DA area.

Habitat connectivity would not be likely to be significantly affected by OC3, which would be located within an essentially cleared valley.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.14 Barking Owl Ninox connivens

General Information

Lives in pairs in forests and woodlands typically dominated by eucalypts, often Red Gum species in temperate and semi-arid areas (Blakers *et al* 1984; NPWS 2003). Has been recorded in remnant patches on farms and golf courses (NPWS 2003).

Usually roosts in or under dense foliage in large trees including rainforest species, *Casuarina* and *Allocasuarina* spp, eucalypts, *Angophora* spp or *Acacia* spp. Roost sites are often near watercourses or wetlands (NPWS 2003).

Forages from dusk to dawn (occasionally in daylight) for a variety of birds, mammals and insects (Blakers *et al* 1984; Lindsey 1992; NPWS 2003). Most prey birds and mammals are hollow-dependent, prefers native arboreal mammals, but will also prey on rabbits (NPWS 2003; Lindsey 1992).

Nests in a large open hollow, often vertical or sloping, in large eucalypts or paperbarks. Nest entrances are usually 2-35m above the ground, with a diameter of 20-46cm and depth of 20-300cm (NPWS 2003). Nests are usually near watercourses or wetlands (NPWS 2003).

Presumed to breed in traditional permanent territories ranging in size from 30ha up to 200ha in southern Qld (Blakers *et al* 1984; NSW Scientific Committee; NPWS 2003). Forages over a larger area (Blakers *et al* 1984).

This species was not recorded in the study area, but is known to occur in the adjacent Goulburn River National Park. It is not likely that the Barking Owl roosts or breeds in the study area, given:

(i) the lack of a response or sighting despite targeted call playback surveys during a range of seasons and in a range of habitat types (refer to Appendix 6); and

(ii) the general paucity of large trees, and trees containing large hollows suitable for nesting.

The study area does provide extensive areas of low value foraging habitat (low value given the levels of clearing and disturbance across the study area, and given that the study area does not contain areas of habitat likely to support large numbers of hollow-dependent prey species for the Barking Owl), and may be of some importance during poor seasons when the Barking Owl may need to forage over a wider area and/or come to rely on Rabbits to some degree.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The Barking Owl is not expected to breed or roost within the DA area. However, it is likely that parts of the DA area are included within the foraging range of the Barking Owl.

The proposed mine would involve graduated temporary changes to extent, location and condition of areas of low value foraging habitat for the Barking Owl.

The proposed mine would not be likely to significantly affect the lifecycle of the Barking Owl.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Barking Owl from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Barking Owl would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 25 years regeneration and habitat restoration)

Underground mining is proposed in the northern part of the DA area (Underground No. 4). This area supports extensive areas of TSU 50 Sedimentary Scribbly Gum Woodlands, of low value foraging habitat for the Barking Owl. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Barking Owl, or its prey species, on a broad scale.

Operation of the mine may result in some other indirect impacts upon Barking Owl foraging habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Barking Owl, particularly given the extent of foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Barking Owl foraging habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Barking Owl is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the foraging habitat for the Barking Owl in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Barking Owl, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Barking Owl, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.15 Gilbert's Whistler Pachycephala inornata

General Information

Usually occurs in mallee, but also taller dry eucalypt woodland, melaleuca thickets, lignum, and partly cleared country (Blakers *et al* 1984; Lindsey 1992).

Lives in pairs that defend permanent territories (Lindsey 1992). Forages mainly on the ground for large insects such as caterpillars and beetles (Blakers *et al* 1984; Lindsey 1992).

Nests approximately 2-3 metres from the ground in a cup of bark and dry grass in an upright fork, on a dead stump, or occasionally in the disused nest of another bird (Lindsey 1992).

Gilbert's Whistler was recorded twice during the surveys conducted for this report, but is not otherwise known from the region. One record was from TSU 50 Sedimentary Scribbly Gum Woodlands in the proposed Underground No. 4 area, the other record was from TSU 10b – unimproved grassland in the eastern part of the study area, outside of the DA area.

Large portions of the study area support potential habitat for this species.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   No areas of known Gilbert's Whistler habitat would be cleared for the proposed mine. However, the proposed mine would involve the removal of approximately 160ha of potential woodland habitat for Gilbert's Whistler from the DA area (mainly TSU 30 and 40b Box Woodlands, and TSU 10b unimproved grasslands). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of these habitats would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 10 years regeneration and habitat restoration, including re-colonisation of rehabilitated areas with invertebrates - refer to Chapter 9).

   Underground mining is proposed in the northern part of the DA area. This area supports extensive areas of TSU 50 Sedimentary Scribbly Gum Woodlands, of known and potential habitat for this species. Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Gilbert's Whistler on a broad scale.

   Operation of the mine may result in some other indirect impacts upon potential Gilbert's Whistler habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 9 years total – maximum production), and probably not significant in that these impacts would not affect known Gilbert's Whistler habitat.

   In summary, the clearing impacts of the proposal upon potential Gilbert's Whistler foraging habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Gilbert's Whistler is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for Gilbert's Whistler in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for Gilbert's Whistler, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although these areas are not known habitat for the Gilbert's Whistler.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.16 Grey-crowned Babbler Pomatostomus temporalis

General Information

Inhabits forests and woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs and an intact groundcover of grasses and forbs (NSW Scientific Committee; Lindsey 1992). Also occurs in acacia scrub and farmland (Blakers *et al* 1984).

Lives in sedentary communal groups of 2-13 birds, which inhabit permanent territories of 12-20ha (Lindsey 1992; NSW Scientific Committee).

Forages mostly on the ground amongst leaf litter for insects (Lindsey 1992; Blakers *et al* 1984), and also on the bark of trees (NSW Scientific Committee; Blakers *et al* 1984).

Nests and breeds co-operatively, building a bulky dome of sticks and twigs placed conspicuously in a tree fork up to 12m above the ground (Lindsey 1992; NSW Scientific Committee).

The Grey-crowned Babbler was recorded mainly from TSU 30 Box Woodlands and adjacent unimproved grasslands fringing a prominent ridgeline in the very southern part of the study area, along the western border of the proposed OC3. It appears that there are two separate pairs/groups of this species.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed OC3 would result in a gradual clearing of all of the known habitat for this species in the study area. This is a significant impact upon the Grey-crowned Babbler, given its sedentary habit and that it occupies permanent territories. The clearing would affect the northern group first, and then the southern group, over a period of approximately 2 years (maximum production).

Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of these habitats would be a graduated temporary and reversible loss (2 years of open cut operations - maximum production, and then 10 years regeneration and habitat restoration, including re-colonisation of rehabilitated areas with invertebrates - refer to Chapter 9). However, the individual birds may be lost during the clearing process or during the interim between clearing and satisfactory restoration of habitats.

Operation of the mine may result in some other indirect impacts upon potential Gilbert's Whistler habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 9 years total – maximum production), and probably not significant in that these impacts would not affect known Gilbert's Whistler habitat.

In summary, the clearing impact of the proposal upon Grey-crowned Babbler habitat in the DA area would be significant, albeit temporary and reversible.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Grey-crowned Babbler is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for Grey-crowned Babbler in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the OC3 area in the short term (2 years – maximum production), and then gradually reduce them. The final outcome of the proposal would be an increase in extent and quality of habitat for Grey-crowned Babbler, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would not be likely to be significantly affected by OC3, which would be located within an essentially cleared valley. The proposal involves restoration of habitats in this area, such that connectivity would be improved following the mine operations.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.17 Speckled Warbler Pyrrholaemus sagittatus

General Information

Inhabits woodland with a grassy understorey, often on rocky ridges or in gullies. Mainly recorded from the hills and tablelands of the Great Dividing Range (Blakers *et al* 1984; NSW Scientific Committee).

A sedentary species, apparently social, with breeding territories approx 10 ha in size. Forages mainly on the ground for seeds and insects, seldom wandering far from the shelter of bushes and shrubs (Blakers *et al* 1984; Lindsey 1992). Preferred foraging habitat is areas with a combination of open grassy patches, leaf litter and shrub cover (NSW Scientific Committee).

Nests on the ground in grass tussocks, dense litter and fallen branches (NSW Scientific Committee).

The Speckled Warbler has been recorded throughout most parts of the study area in a variety of grassy woodland habitat types, and has been widely recorded in the region. Most records are from

TSU 30 Box Woodlands, and the ecotones between these habitats and TSU 20 Sedimentary Ironbark Forests and TSU 10b unimproved grasslands.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Areas of known habitat to be particularly affected include:

(i) Box Woodlands in the OC1 area, which would be completely cleared, for a period of 5 years – maximum production;
(ii) habitat fringing the south-eastern part of OC2, which would not be cleared but would be subject to noise and other indirect disturbances for a period of 2 years – maximum production;
(iii) a patch of habitat to be cleared for out-of-pit emplacement at OC3.

Areas of known habitat in the study area not likely to be affected include:

(i) Box Woodland/Ironbark Forest to the north of the 'The Drip' in the northern part of the study area;
(ii) three separate areas of Box Woodlands in the eastern part of the study area, outside of the DA area;
(iii) a patch of habitat located between and south of the confluence of Lagoon Creek and Moolarben Creek, also outside of the DA area.

The proposed mine would involve the removal of approximately 189ha of potential woodland habitat for the Speckled Warbler from the DA area (approx 139ha of TSU 30 with a 50m buffer). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of these habitats would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 10 years regeneration and habitat restoration, including re-colonisation of rehabilitated areas with invertebrates - refer to Chapter 9).

The proposed underground mining in the northern part of the DA area is not likely to affect habitat for the Speckled Warbler.

In summary, the proposed mine would result in clearing of two areas of known habitat for the Speckled Warbler, and significant noise disturbance to a third area. Whilst the clearing is a temporary and reversible impact, some individuals or family groups of this species may be lost in the interim.

However, given the wide-spread distribution of this species in the study area and region, and given that its apparent habitat preferences would be targeted for restoration following mine operations, it is likely that this species would recover from the impacts of the mine in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Speckled Warbler is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for Speckled Warbler in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Speckled Warbler, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would be located within essentially cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation. This is not considered to be a significant impact for the Speckled Warbler.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.18 Brown Treecreeper Climacteris picumnus

General Information

Inhabits a variety of drier vegetation types across eastern Australia, commonly eucalypt woodland, sometimes adjacent forest where there is dead timber (Lindsey 1992; Blakers *et al* 1984). Mainly occurs in the central-west of NSW. Prefers open woodland lacking a dense understorey (NSW Scientific Committee).

A sedentary species that lives in small groups and occupies permanent home territories of about 5-10ha (Blakers *et al* 1984; Lindsey 1992).

Forages on tree trunks and amongst leaf litter for insects, spending approx half of its time on the ground (NSW Scientific Committee; Blakers *et al* 1984). Nests in a tree-hollow (Lindsey 1992).

The Brown Treecreeper has been recorded widely in the study area and region, from a variety of habitat types, but predominantly TSU 30 Box Woodlands and TSU 10b unimproved grasslands.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Areas of known habitat to be particularly affected include:

(i) Box Woodlands in the OC1 area, which would be completely cleared, for a period of 5 years – maximum production;
(ii) habitat fringing the eastern boundary of OC2, some of which would be cleared, and the remainder subject to noise and other indirect disturbances, for a period of 2 years – maximum production;
(iii) various (approx 4) remnant patches in the vicinity of OC3, none of which would be cleared, but all would be subject to noise and other indirect disturbances, for a period of 2 years – maximum production.

The Brown Treecreeper has been recorded from virtually all patches of Box Woodland in the study area. Substantial areas of habitat for this species occur in the study area and DA area which would not be affected by the proposed mine.

The proposed mine would involve the removal of approximately 224ha of potential woodland habitat for the Brown Treecreeper from the DA area (approximately 139ha of TSU 30 and 20ha of TSU 40b, with a 50m buffer). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of these habitats would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 10 years regeneration and habitat restoration, including re-colonisation of rehabilitated areas with invertebrates - refer to Chapter 9).

The proposed underground mining in the northern part of the DA area may affect some lesser value habitat for the Brown Treecreeper (lesser value based on percentage of records). Subsidence impacts for this area may include some cracking and minor alteration to surface water flows and ponding (Strata 2006). These effects may alter some patches of the existing vegetation, due to localised changes in availability of water, but would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter existing vegetation or habitats for the Brown Treecreeper on a broad scale.

In summary, the proposed mine would result in clearing of two areas of known habitat for the Brown Treecreeper, and significant noise disturbance to several other areas. Whilst the clearing is a temporary and reversible impact, some individuals or family groups of this species may be lost in the interim.

However, given the wide-spread distribution of this species in the study area and region, and given that its apparent habitat preferences would be targeted for restoration following mine operations, it is likely that this species would recover from the impacts of the mine in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Brown Treecreeper is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for Brown Treecreeper in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Brown Treecreeper, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would be located within essentially cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation known to provide habitat for the Brown Treecreeper. The area to be isolated would be relatively large (approx 50ha), and would be buffered from the OC1 pit by an environmental bund. This is not considered to be a significant impact for the Brown Treecreeper.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.19 Hooded Robin Melanodryas cucullata cucullata

General Information

Occurs throughout SE Australia, although mainly west of the Great Dividing Range, in a range of drier eucalypt woodlands, acacia shrublands and open forests, often in or near clearings (Blakers *et al* 1984; Lindsey 1992).

Possibly seasonally migratory in some areas (Blakers *et al* 1984). Lives in small family groups within large home ranges (NSW Scientific Committee).

Forages mainly on open ground by pouncing from a perch. Forages in areas with a mix of bare ground, ground cover and litter (Blakers *et al* 1984; NSW Scientific Committee).

Nests in a cup of grass in a fork or small tree hollow usually within a few metres of the ground (Lindsey 1992).

The Hooded Robin has been recorded widely in the study area and region, predominantly from disturbed vegetation TSU 10b unimproved grasslands. This species seems to prefer habitats close to creeklines in the study area, which are generally within essentially cleared valleys. Hence 22 out of 26 records being from TSU 10b.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   Hooded Robin habitat in the study area is associated with riparian vegetation along Moolarben Creek, Murragamba Creek, Wilpinjong Creek and the Goulburn River. All of these areas have been avoided in the proposed mine plan.

   Proposed Underground No. 4, OC1 and OC2 would not clear or indirectly disturb any areas of known or likely habitat for the Hooded Robin.

   Proposed OC3 is located adjacent to Moolarben Creek, but at a buffer distance of approximately 500m. No areas of known or likely habitat for the Hooded Robin would be cleared. Some areas of habitat may be affected by noise and other indirect disturbances.

   Considerable areas of habitat for this species occur in the study area and DA area which would not be affected by the proposed mine.

   In summary, the proposed mine may indirectly disturb one area of known habitat for the Hooded Robin. However, given the wide-spread distribution of this species in the study area and region, and given that its apparent habitat preferences would be targeted for restoration following mine operations, it is likely that impacts upon this species would be minimal, and would be reversed in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

   The Hooded Robin is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for Hooded Robin in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Hooded Robin, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity for this species would be retained along creeklines throughout the study area, and enhanced as the mine works progress.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.20 Black-chinned Honeyeater Melithreptus gularis gularis

General Information

Inhabits mainly eucalypt forest and woodland, paperbark woodland, acacia scrub and Spinifex, particularly where there are patches of flowering shrubs, across northern and eastern Australia (Lindsey 1992; Blakers *et al* 1984).

In NSW, it occurs generally inland of the Great Dividing Range, mainly in eucalypt woodlands containing Box-Ironbark associations and River Red Gum (Blakers *et al* 1984; NSW Scientific Committee).

A sedentary species, which lives in small groups, which maintain permanent, extensive territories. It is an active bird, forever on the move, and forages high in the tree canopy (Lindsey 1992). Feeds on nectar, honeydew and insects (Blakers *et al* 1984).

Occurs mainly in larger remnants, reportedly affected by competition for food and by nest predation in smaller remnants (NSW Scientific Committee).

The Black-chinned Honeyeater was recorded only in the eastern part of the study area, feeding in White Box during winter, mainly in larger Box Woodland patches in the Murragamba Creek catchment. There are numerous records of this species from the Munghorn Gap Nature Reserve to the southeast of the study area, within the upper Murragamba Creek catchment.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The Black-chinned Honeyeater has not been recorded utilising habitats present in the DA area. All of the records of this species are from the eastern side of the prominent north-south aligned ridgeline, which approximately forms the eastern boundary of the DA area.

The Black-chinned Honeyeater may utilise the DA area on occasions, particularly during mass flowering events, but does not appear to be particularly reliant on habitats present in this area.

The Black-chinned Honeyeater is unlikely to be affected by the proposed mine, either through direct impacts such as habitat loss, or through indirect impacts such as noise and human disturbances.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Black-chinned Honeyeater is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

The proposal is unlikely to affect current disturbance regimes for the Black-chinned Honeyeater.

5) *How is the proposal likely to affect habitat connectivity?*

The proposal is unlikely to affect habitat connectivity for the Black-chinned Honeyeater.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.21 Painted Honeyeater Grantiella picta

General Information

Inhabits forest and woodland throughout most of eastern Australia, generally where there is an abundance of mistletoe (Blakers *et al* 1984; Lindsey 1992). Strongly migratory, breeding mainly in the interior southeast during spring and summer, and dispersing northward to spend the winter (Lindsey 1992).

Unusual amongst honeyeaters in its almost complete dependence upon berries or drupes of mistletoes of the *Amyema* genus (Lindsey 1992). Locally nomadic, with movements reportedly governed by the flowering and fruiting of mistletoes (Lindsey 1992; Blakers *et al* 1984).

Forages mainly in the upper canopy of trees. Nests in a frail dish suspended in the outer foliage of a bush or tree, from 3-10m above the ground (Lindsey 1992).

Painted Honeyeater distribution in the study area is likely to reflect distribution of concentrated patches of Mistletoes of the *Amyema* genus. *Amyema* spp occur in all TSU's in the study area.

Painted Honeyeaters were recorded from 3 general areas during the field surveys, including from TSU 30 Box Woodlands in the proposed OC1 area, and from 2 locations in or near TSU 20 Sedimentary Ironbark Forests to the east of the DA area, near Murragamba Creek, and near the eastern boundary of the study area. All Painted Honeyeater records in the study area were recorded during late spring surveys, suggesting that the species migrates to the region in summer to breed.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

Proposed OC1 would remove one of the three general areas from which Painted Honeyeaters were recorded in the study area. This would be a graduated temporary loss over a period of 5 years – maximum production, followed by 15 years habitat rehabilitation, including recruitment of new Mistletoes.

Amyema spp mistletoes were recorded commonly throughout most of the study area, suggesting that potential habitat for this species occurs quite widely through the study area, and would be available for use in the interim between clearing of OC1 and its restoration to effective habitat.

Given the wide-ranging, migratory, and nomadic behaviour of this species, the temporary nature of impacts, and given the apparent extent of potential habitat available in the study area and region, it is likely that this species would recover from the impacts of the mine in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Painted Honeyeater is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for Painted Honeyeater in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Painted Honeyeater, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would be located within essentially cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, which may provide habitat for the Painted Honeyeater. The area to be isolated would be relatively large (approx 50ha), and would be buffered from the OC1 pit by an environmental bund. This is not considered to be a significant impact for the Painted Honeyeater.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.22 Regent Honeyeater Xanthomyza phrygia

General Information

Semi-nomadic, usually recorded on western slopes of the Great Dividing Range, in open eucalypt forest and woodland. Usually recorded in box-ironbark associations, also wet lowland coastal forests.

Forages in the upper canopy of flowering eucalypts for nectar, fruits and insects (NPWS 1999; Lindsey 1992; Blakers *et al* 1984). Nectar taken from approximately 16 species of eucalypt (NPWS 1999).

A noisy, aggressive and conspicuous species, gregarious when not breeding. Observed bathing in roadside puddles.

Nests in the fork of a tree 1-20m above the ground (Lindsey 1992). Specific requirements in mature Ironbark and Red-Yellow Box communities (NPWS 2003).

The Regent Honeyeater has been recorded widely in the region, but is not known to have occurred in the study area.

The study area supports areas of apparently suitable habitat for this species, and it is thought that the Regent Honeyeater could utilise the study area on occasions, such as during seasons when mass-flowering of eucalypts occurs.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   The proposed mine would involve the removal of approximately 160ha of potential woodland habitat for the Regent Honeyeater from the DA area (mainly habitats TSU 30 and TSU 40b). The loss of these habitats would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 25 years regeneration and habitat restoration - refer to Chapter 9), and would not be likely to be significant for the Regent Honeyeater given its migratory and nomadic habits.

   The proposed underground mining in the northern part of the DA area is not likely to affect potential Regent Honeyeater habitat.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

   The Regent Honeyeater is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

   Much of the potential foraging habitat for Regent Honeyeater in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Regent Honeyeater, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

   Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would be located within essentially cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation potential providing foraging habitat for the Regent Honeyeater. The area to be isolated would be relatively large (approx 50ha), and would be buffered from the OC1 pit by an environmental bund. This is not considered to be a significant impact for the Regent Honeyeater.

6) *How is the proposal likely to affect critical habitat?*

   No critical habitat relevant to this species is declared under the TSC Act.

8.3.23 Diamond Firetail Stagonopleura guttata

General Information

Inhabits eucalypt woodland, forests and mallee where there is a grassy understorey, including agricultural land, mainly inland of the Great Dividing Range (Lindsey 1992; Blakers *et al* 1984; NSW Scientific Committee).

Generally sedentary, lives in pairs or small groups, consolidating into flocks during winter (Lindsey 1992; Blakers *et al* 1984; NSW Scientific Committee). Forages on the ground for grass seeds, other plant material and insects (NSW Scientific Committee; Lindsey 1992; Blakers *et al* 1984).

Nests in a bulky flask-shaped structure with a side entrance approached by a woven tunnel, usually placed in dense foliage in a bush or mistletoe clump, several metres from the ground (Lindsey 1992).

The Diamond Firetail has been recorded widely in the study area and region, mainly from habitats associated with TSU 10b – unimproved grasslands, and TSU 30 Box Woodlands.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   Areas of known habitat to be particularly affected include:
   (iv) Box Woodlands on the north-western side of the OC1 area, which would be temporarily isolated over a 5 year period – maximum production. Noise impacts would be reduced by the proposed environmental bund, and would probably not be significant for this species;
   (v) Box Woodland habitats fringing the eastern boundary of OC2, some of which would be cleared, and the remainder subject to noise and other indirect disturbances, for a period of 2 years – maximum production;
   (vi) remnant riparian forest in the vicinity of OC3, which would not be cleared, but would be subject to noise and other indirect disturbances, for a period of 2 years – maximum production.

   The Diamond Firetail has been recorded from virtually all parts of the study area, excluding the dominant Scribbly Gum Woodlands to the north of the Ulan-Wollar Road. Substantial areas of habitat for this species occur in the study area and DA area which would not be affected by the proposed mine.

   The proposed mine would involve the removal of approximately 224ha of potential habitat for the Diamond Firetail from the DA area (mainly habitats TSU 30 and TSU 40b, with a 50m buffer). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of these habitats would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 10 years regeneration and habitat restoration - refer to Chapter 9).

   The proposed underground mining in the northern part of the DA area would not be likely to affect Diamond Firetail habitat.

   In summary, the proposed mine would result in clearing one area of known habitat for the Diamond Firetail, with significant noise disturbance to several other areas. Whilst the clearing is a temporary and reversible impact, some individuals or family groups of this species may be lost in the interim.

However, given the wide-spread distribution of this species in the study area and region, and given that its apparent habitat preferences would be targeted for restoration following mine operations, it is likely that this species would recover from the impacts of the mine in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Diamond Firetail is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for the Diamond Firetail in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Diamond Firetail, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would be located within essentially cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation known to provide habitat for the Diamond Firetail. The area to be isolated would be relatively large (approx 50ha), and would be buffered from the OC1 pit by an environmental bund. This is not considered to be a significant impact for the Diamond Firetail.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.24 Giant Barred Frog Mixophyes iteratus

General Information

Associated with permanent flowing creeklines, from shallow rocky rainforest streams to slow moving rivers in lowland open forest. Is not known to utilise still water (NSW Scientific Committee).

Does not appear to be restricted to particular vegetation forms, although apparently prefers rainforest and wet sclerophyll forest (NSW Scientific Committee; Cogger 1996; Robinson 1998). Will also use cleared land (NSW Scientific Committee).

The Giant Barred Frog is not known or expected to occur in the study area, but has been recorded previously in the region, approximately 4km downstream of the study area in the environs of Wilpinjong Creek.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine is not located in the catchment of Wilpinjong Creek, and would not be likely to affect the lifecycle of this species.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would not be located in the catchment of Wilpinjong Creek, and would not directly or indirectly affect habitat for the Giant Barred Frog.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Giant Barred Frog is not at the limit of its known distribution in the surrounding area.

4) *How is the proposal likely to affect current disturbance regimes?*

The proposed mine would not be likely to affect current disturbance regimes for the Giant Barred Frog.

5) *How is the proposal likely to affect habitat connectivity?*

The proposed mine would not be likely to affect habitat connectivity for the Giant Barred Frog.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.25 Squirrel Glider Petaurus norfolcensis

General Information

Inhabits dry sclerophyll forest and woodland with an abundant supply of hollow-bearing trees and a mix of eucalypts, acacias and banksias (NPWS 1999). Within a suitable vegetation community, at least one flora species should flower heavily during winter, and one or more eucalypts should be smooth-barked (NPWS 1999).

Potential habitat in NSW includes Box-Ironbark forests and woodlands in the west, River Red Gum Forests of the Murray Valley and eucalypt forests in the northeast (NPWS 1999).

The Squirrel Glider is nocturnal, shelters in leaf-lined tree hollows, and feeds primarily on nectar, pollen, flowers, acacia gum and insects (NPWS 1999; Suckling 1995).

Squirrel Gliders can glide for up to 50m, and occupy home ranges estimated as between 0.65 and 8.55ha (NPWS 1999). There is some anecdotal evidence that this species will cross paddocks to utilise small remnants.

One Squirrel Glider was recorded in the study area, in early spring in a diverse remnant patch of vegetation (approx 25ha in size) located just east of the proposed OC3 area. This species was spotlighted at dusk, but was not detected again, despite intensive targeted trapping in the area. It is likely that the Squirrel Glider passes through this area on occasions. This species is also known to occur in the Munghorn Gap Nature Reserve and Goulburn River National Park.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed OC3 would result in a gradual clearing over 2 years of small patches of vegetation located to the west of the Squirrel Glider remnant, but would not involve any clearing of the Squirrel Glider remnant.

Moolarben Road would be redirected from its current route, and would pass between the OC3 pit and the Squirrel Glider remnant. The proposed pit would come as close as 50-100m from the edge of the known Squirrel Glider habitat, and would affect the habitat indirectly through noise, light and human disturbances, for a temporary period of 2 years – maximum production. Some ameliorative measures are proposed – refer to Chapter 9.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Squirrel Glider is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for Squirrel Gliders in the study area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the OC3 area in the short term (2 years – maximum production), and then gradually reduce them. The final outcome of the proposal would be an increase in extent and quality of habitat for the Squirrel Glider, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would not be likely to be significantly affected by OC3, which would be located within an essentially cleared valley. The proposal involves restoration of habitats in this area, such that connectivity would be improved between Munghorn Gap Nature Reserve, Moolarben Creek, the Squirrel Glider remnant, and the prominent ridgeline to the west of the OC3 area.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.26 Large-eared Pied Bat Chalinolobus dwyeri

General Information

Inhabits dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range, from Queensland to Bungonia. Has also been recorded occasionally in sub-alpine woodlands above 1500m, and at the edge of rainforest and moist eucalypt forest (Hoye & Dwyer 1995). First recorded in a dis-used mine tunnel near Copeton, NSW in early 1960's.

Probably forages for insects below the forest canopy (Hoye & Dwyer 1995).

Roosts by day in tree-hollows, caves and dis-used mine-tunnels (DEC NRMAS-7 2004; Hoye & Dwyer 1995). In caves it often selects positions close to the entrance in the 'twilight zone'. Appears to hibernate during winter (Hoye & Dwyer 1995).

The Large-eared Pied Bat has been recorded from 7 widespread locations in the study area, and is known to occur in the Goulburn River National Park and Munghorn Gap Nature Reserve. The species was recorded mainly in TSU 10b disturbed vegetation within the study area, and in TSU 40b Blakely's Red Gum Woodland, usually within 1km of escarpment country. These TSU's probably represent typical foraging habitat in the study area.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

Considering that the Large-eared Pied Bat usually roosts in the ‘twilight zone’ of caves, such as are common in sandstone cliff lines, and does not require deep dark caves such as those associated with limestone formations, this species is likely to roost in sandstone cliffs in the northern part of the DA area.

The proposed underground mine (Underground No. 4) in the northern part of the DA area is therefore likely to affect roosting habitat for the Large-eared Pied Bat. Subsidence impacts for this area may include some cracking (Strata 2006), and may de-stabilise some cliff areas. Some small caves and crevices may be damaged or lost, whilst others would be created. The broad effect would be a temporary speeding up of natural processes. It is expected that there would be no net loss of potential roosting features for the Large-eared Pied Bat in the study area. The proposed mine is not likely to affect caves of particular value for this species for breeding.

There is, however, some potential for individual bats to be injured or killed during rock falls or cave closures, particularly during winter hibernations.

In summary, the proposed mine would not be likely to significantly affect the lifecycle of the Large-eared Pied Bat.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Large-eared Pied Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Large-eared Pied Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to ‘balance out’ across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Large-eared Pied Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon Large-eared Pied Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Large-eared Pied Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Large-eared Pied Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Large-eared Pied Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the habitat for the Large-eared Pied Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Large-eared Pied Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Large-eared Pied Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.27 Little Pied Bat Chalinolobus pictatus

General Information

Inhabits dry areas of southern Qld, NSW and SA. Very little is known about this species (Richards 1995c).

It roosts in tree-hollows, dry caves and mine shafts, but has also been recorded in an abandoned house (DEC NRMAS-7 2004; Richards 1995c).

Capable of dealing with aridity and heat, provided water is available with flight range (Richards 1995c).

The Little Pied Bat was recorded from two locations in the eastern part of the study area, but is not otherwise known from the region. As with the Large-eared Pied Bat, this species was recorded in TSU 10b disturbed vegetation, and in TSU 40b Blakely's Red Gum Woodland. These TSU's probably represent typical foraging habitat in the study area.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

Little is known regarding the Little Pied Bat. Like the Large-eared Pied Bat, this species is known to roost in tree-hollows and caves, suggesting that it too probably roosts in the 'twilight zone', and therefore would be likely to roost in sandstone cliffs in the northern part of the DA area.

The proposed underground mine (Underground No. 4) in the northern part of the DA area is likely to affect roosting habitat for the Little Pied Bat. Subsidence impacts for this area may include some cracking (Strata 2006), and may de-stabilise some cliff areas. Some small caves and crevices may be damaged or lost, whilst others would be created. The broad effect would be a temporary speeding up of natural processes. It is expected that there would be no net loss of potential roosting features for the Little Pied Bat in the study area. The proposed mine is not likely to affect caves of particular value for this species for breeding.

There is, however, some potential for individual bats to be injured or killed during rock falls or cave closures, particularly during winter hibernations.

In summary, the proposed mine would not be likely to significantly affect the lifecycle of the Little Pied Bat.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Little Pied Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Little Pied Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Little Pied Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon Little Pied Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Little Pied Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Little Pied Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Little Pied Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the habitat for the Little Pied Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Little Pied Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Little Pied Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.28 Eastern False Pipistrelle Falsistrellus tasmaniensis

General Information

Thought to forage above the forest canopy, in open woodland or over water. Occurs along the Great Dividing Range of SE Australia, and east to the coast. Is more common at cooler elevations (Phillips 1995).

Has been recorded roosting in tree hollows (Phillips 1995). Occasionally found in caves (DEC NRMAS-7 2004). Apparently hibernates during winter, and may sexually segregate for part of the year (Phillips 1995).

The Eastern False Pipistrelle was not recorded in the study area, but is known to occur in the region, with all locations to the east of the study area. This species is thought to prefer more extensive and less disturbed areas of vegetation.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   Clearing for the proposed mine is located within essentially cleared valleys, and would predominantly affect disturbed small remnants and fringe areas of native vegetation. The only area of relatively intact native vegetation to be disturbed for the proposed mine is approximately 175 ha of TSU 20 Sedimentary Ironbark Forests in the OC1 area. This TSU does not appear to be of particular value for microchiropteran bats generally, and the area to be disturbed is located in the far west of the study area, a long way from known locations of the Eastern False Pipistrelle. Subsequent regeneration and habitat restoration are detailed in Chapter 9.

   In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to ‘balance out’ across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Eastern False Pipistrelle on a broad scale.

   Operation of the mine may result in some other indirect impacts upon potential Eastern False Pipistrelle habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Eastern False Pipistrelle, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

   In summary, the clearing impacts of the proposal upon Eastern False Pipistrelle habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

   The Eastern False Pipistrelle is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

   Much of the potential habitat for the Eastern False Pipistrelle in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Eastern False Pipistrelle, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Eastern False Pipistrelle, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.29 Eastern Freetail Bat Mormopterus norfolcensis

General Information

Usually recorded in dry eucalypt forest and woodland east of the Great Dividing Range, but has also been recorded in rainforest and wet sclerophyll forest (Allison & Hoye 1995).

Apparently solitary. Predominantly tree-dwelling, but has been recorded roosting in the roof of a hut (Allison & Hoye 1995).

The Eastern Freetail Bat was not recorded in the study area, but was recorded in the Wilpinjong Coal Project area to the east of the study area

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Eastern Freetail Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Eastern Freetail Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Eastern Freetail Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon potential Eastern Freetail Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Eastern Freetail Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Eastern Freetail Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Eastern Freetail Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Eastern Freetail Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Eastern Freetail Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Eastern Freetail Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.30 Eastern Bent-wing Bat Miniopterus schreibersii oceanis

General Information

Typically inhabits well-timbered valleys where it forages above the tree canopy (Dwyer 1995b).

Roosts in caves, old mines, stormwater channels and comparable structures (DEC NRMAS-7 2004; Dwyer 1995b). In SE Australia it seeks cold roosts through winter to allow hibernation. Depends upon specific mass nursery sites in Spring to rear its young (Dwyer 1995b), thus prone to mass damage from catastrophic events (DEC NRMAS-7 2004).

The Eastern Bent-wing Bat was recorded in the study area and is known from the region. The species was recorded from a range of habitat types in the study area.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The Eastern Bent-wing Bat is not expected to roost or breed in the study area, given the nature of caves present. The proposed mine would not disturb any specific nursery sites.

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Eastern Bent-wing Bat from the DA area (all habitats except TSU 10a – Disturbed

Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Eastern Bent-wing Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to ‘balance out’ across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Eastern Bent-wing Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon potential Eastern Bent-wing Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Eastern Bent-wing Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Eastern Bent-wing Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Eastern Bent-wing Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Eastern Bent-wing Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Eastern Bent-wing Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Eastern Bent-wing Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.31 Little Bent-wing Bat Miniopterus australis

General Information

Forages beneath the tree canopy of well-timbered habitats including rainforest, *Melaleuca* swamps and dry sclerophyll forests (Dwyer 1995a).

Roosts in caves and old mines, depends upon specific nursery sites to rear its young (Dwyer 1995a), thus prone to mass damage from catastrophic events (DEC NRMAS-7 2004).

The Little Bent-wing Bat was not recorded in the study area, but was recorded in the Wilpinjong Coal Project study area, always in conjunction with the Eastern Bent-wing Bat.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The Little Bent-wing Bat is not expected to roost or breed in the study area, given the nature of caves present. The proposed mine would not disturb any specific nursery sites.

   The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Little Bent-wing Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Little Bent-wing Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

   In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Little Bent-wing Bat on a broad scale.

   Operation of the mine may result in some other indirect impacts upon potential Little Bent-wing Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Little Bent-wing Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

   In summary, the clearing impacts of the proposal upon Little Bent-wing Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

   The Little Bent-wing Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

   Much of the potential habitat for the Little Bent-wing Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Little Bent-wing Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Little Bent-wing Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.32 Greater Long-eared Bat Nyctophilus timoriensis

General Information

Little is known regarding this species. It reportedly occurs in a variety of habitats, including tall forests, woodland and mallee (Parnaby 2005).

Roosts in tree hollows and under loose bark (Parnaby 2005).

The Greater Long-eared Bat was recorded from one location in the study area, in a small patch of TSU 40b Blakely's Red Gum Woodland on the eastern boundary of the study area, adjacent to Goulburn River National Park. This species is known to occur in the Goulburn River National Park, with all records from the region except 1 being from the NP.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

The proposed mine would not be likely to affect the lifecycle of this species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Greater Long-eared Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Greater Long-eared Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Greater Long-eared Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon potential Greater Long-eared Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Greater Long-eared Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Greater Long-eared Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species.

Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Greater Long-eared Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Greater Long-eared Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Greater Long-eared Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Greater Long-eared Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.33 Yellow-bellied Sheath-tail Bat Saccolaimus flaviventris

General Information

Occurs throughout eastern and northern Australia, foraging above the canopy in eucalypt forests, and closer to the ground in mallee or open country (Richards 1995a).

Usually solitary, occasionally occurring in colonies of less than 10 individuals (Richards 1995a).

Roosts in tree hollows (Richards 1995a), occasionally in caves (DEC NRMAS-7 2004), and has been found in the abandoned nests of Sugar Gliders (Richards 1995a). Possibly migratory in southern Australia (Richards 1995a).

The Yellow-bellied Sheath-tail Bat was recorded in the study area, and is known to occur in the region

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

Considering that the Yellow-bellied Sheath-tail Bat roosts in tree-hollows as well as occasionally caves, this species is likely to roost in sandstone cliffs in the northern part of the DA area.

The proposed underground mine (Underground No. 4) in the northern part of the DA area is therefore likely to affect roosting habitat for the Yellow-bellied Sheath-tail Bat. Subsidence impacts for this area may include some cracking (Strata 2006), and may de-stabilise some cliff areas. Some small caves and crevices may be damaged or lost, whilst others would be created. The broad effect would be a temporary speeding up of natural processes. It is expected that there would be no net loss of potential roosting features for the Yellow-bellied Sheath-tail Bat in the study area. The proposed mine is not likely to affect caves of particular value for this species for breeding.

There is, however, some potential for individual bats to be injured or killed during rock falls or cave closures, particularly during winter hibernations.

In summary, the proposed mine would not be likely to significantly affect the lifecycle of the Yellow-bellied Sheath-tail Bat.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Yellow-bellied Sheath-tail Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Yellow-bellied Sheath-tail Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to 'balance out' across the whole of the Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Yellow-bellied Sheath-tail Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon potential Yellow-bellied Sheath-tail Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Yellow-bellied Sheath-tail Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Yellow-bellied Sheath-tail Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Yellow-bellied Sheath-tail Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Yellow-bellied Sheath-tail Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Yellow-bellied Sheath-tail Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Yellow-bellied Sheath-tail Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.34 Eastern Cave Bat Vespadelus troughtoni

General Information

Inhabits drier forest and tropical woodlands along the east coast of Australia, from the coast to Great Dividing Range to the semi-arid zone (Strahan 1995).

Roosts in caves, including sandstone overhangs, mine tunnels and occasionally in buildings, usually in well-lit areas (Strahan 1995; DEC NRMAS-7 2004).

Little else is known regarding this species (Strahan 1995).

The Eastern Cave Bat was recorded not recorded during recent Moolarben Biota surveys, but was recorded in the study area of the Wollar to Wellington Transmission Line EIS. This species is not otherwise known from the region. No indication of habitat preferences is known.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

Considering that the Eastern Cave Bat is known to roost in well-lit areas of caves, this species is likely to roost in sandstone cliffs in the northern part of the DA area.

The proposed underground mine (Underground No. 4) in the northern part of the DA area is therefore likely to affect roosting habitat for the Eastern Cave Bat. Subsidence impacts for this area may include some cracking (Strata 2006), and may de-stabilise some cliff areas. Some small caves and crevices may be damaged or lost, whilst others would be created. The broad effect would be a temporary speeding up of natural processes. It is expected that there would be no net loss of potential roosting features for the Eastern Cave Bat in the study area. The proposed mine is not likely to affect caves of particular value for this species for breeding.

There is, however, some potential for individual bats to be injured or killed during rock falls or cave closures, particularly during winter hibernations.

In summary, the proposed mine would not be likely to significantly affect the lifecycle of the Eastern Cave Bat.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

The proposed mine would involve the removal of approximately 416ha of potential foraging habitat for the Eastern Cave Bat from the DA area (all habitats except TSU 10a – Disturbed Vegetation). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of foraging habitat for the Eastern Cave Bat would be a temporary and reversible loss (approx 2-5 years per section of open cut operations, and then 10 years regeneration and habitat restoration).

In terms of subsidence impacts on foraging habitat in the northern part of the study area, effects may include some cracking and minor alteration to surface water flows and ponding (Strata 2006), and may alter some patches of the existing vegetation, due to localised changes in availability of water. These changes would be likely to 'balance out' across the whole of the

Underground No. 4 area, and therefore not significantly alter the extent or nature of existing foraging habitat for the Eastern Cave Bat on a broad scale.

Operation of the mine may result in some other indirect impacts upon potential Eastern Cave Bat habitat, due to increased noise, light, traffic and dust. These impacts would be temporary (approx 2-5 years for each open cut) and relatively minor for a wide-ranging species such as the Eastern Cave Bat, particularly given the extent of similar foraging habitat in nearby conservation reserves and surrounding farmland.

In summary, the clearing impacts of the proposal upon Eastern Cave Bat habitat in the DA area would be temporary and reversible, and not likely to be significant for this species. Subsidence impacts would be permanent and non-reversible, but also not likely to be significant.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Eastern Cave Bat is not at the limit of its known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential habitat for the Eastern Cave Bat in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years total – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the Eastern Cave Bat, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would essentially be located within cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation, although this is not likely to be of significance for the Eastern Cave Bat, given the wide-ranging nature and mobility of the species.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to this species is declared under the TSC Act.

8.3.35 Listed Fish

There are several freshwater fish and one freshwater macroinvertebrate listed under the Threatened Species Provisions of the Fisheries Management Act 1994 (FMA), and proponents are obliged to consider the threatened species provisions of the FMA for any development.

The combination of literature review plus the results of sampling for the present study indicates that there are no 'endangered fish' species reported or expected from the study area. Specifically, neither of the two endangered fish reported from NSW coastal river systems (the Eastern Freshwater Cod and the Oxleyan Pigmy Perch) are reported or expected from the study area. Llewellyn (1983) reported that the Eastern Freshwater Cod lives in the larger northern rivers such as the Clarence, Nymboida and Mann. The Oxleyan Pygmy Perch lives in coastal swampy drainages, reedy and weedy lake margins and slow-flowing rivers with sandy bottoms possibly in and north of the Richmond River (Kuiter et al 1996).

There are no 'vulnerable fish' species reported or expected from the study area or region. Specifically, the Macquarie Perch is reported from the Hawkesbury and Shoalhaven River systems but is not reported from the Hunter River system (Harris and Rowland 1996). In the areas where it occurs, Macquarie Perch live mostly upstream of Australian Bass.

Adams Emerald Dragonfly *Archaeophya adamsi* Fraser, 1959 (family Gomphomacromiidae) is listed as vulnerable under the FMA. It is the only NSW species of this genus and family, and the majority of its life-cycle is aquatic. The larvae of *A. adamsi* have an estimated aquatic life span of more than 7 years, which is the vast majority of its total life span. Low population sizes and a long larval period indicate an extremely low rate of natural recruitment and therefore slow recovery from population declines. Specimens of *A. adamsi* are extremely rare, having only been found in small perennial streams, with occasional finds of single aquatic larvae or exuviae. Prior to 1998, only 5 adult specimens were known, indicating that this species has extremely low local population sizes.

A. adamsi has been collected from 4 localities in NSW: Somersby Falls and Floods Creek in Brisbane Waters National Park near Gosford; Tunks Creek near Berowra and Hornsby; Bedford Creek in the Lower Blue Mountains and Hungry Way Creek in Wollemi National Park. The species has not been found elsewhere in the Hawkesbury watershed or in the Sydney/Hunter region, despite active collecting over the last 30 years and none have been collected from other adjacent coastal catchments.

The most frequent habitat type identified for this species is 'small low-land feeder streams with clear running stream water and high riparian vegetation cover'. Accordingly MPR (2001) concluded that "owing to the poor level of knowledge of this species state-wide plus the presence of 'small feeder streams with clear running stream water and high riparian vegetation cover' in the Hunter River catchment, the presence of this species in the region cannot be entirely discounted".

Notwithstanding this conclusion no Gomphomacromiidae have been recorded in any of the studies known from the upper Goulburn River:

- Chessman et al (1997) sampled macroinvertebrate fauna from 42 sites in the Hunter River catchment. This study had five sites in the upper Goulburn River above the Bow River confluence (including a site on Ryans Creek at the Lagoon Road crossing);
- Bio-analysis (2005) sampled three feeder creeks running to Wilpinjong Creek for the Wilpinjong Coal project;
- Mt King Ecological Services has sampled two sites in Ulan Creek and four sites in Goulburn River over a number of years; and
- This study has sampled 39 sites over four seasonal sampling periods.

Further, as outlined in Section 7.1 above, there are no 'low-land' feeder streams with clear running stream water and high riparian vegetation cover.' Accordingly, the potential for finding *A. adamsi* in the streams feeding into the Goulburn River from the study area is considered remote.

Several fish species, whilst not listed as threatened species under the FMA are listed as protected species and these species must be considered in planning decisions (NSW Fisheries 1999a). One protected species, the Freshwater Catfish, is recorded from upper Hunter River sites including Pages River (MPR unpublished data) but not from the upper Goulburn River as yet (although there are some anecdotal references to Catfish by local residents). To date five fish species have been recorded from the Upper Goulburn River by the combined mining studies (including this study); Australian Smelt, Cox's Gudgeon, Striped Gudgeon and Long-finned Eel. At least two introduced species are known, Plague Minnow and gold fish.

It is concluded that no threatened fish species, as currently listed in the Schedules of the Fisheries Management Act 1999 have been reported from the study area in spite of intensive field study and that none are expected. Consequently there are no impacts expected on threatened fish species arising from the proposal.

8.4 Impacts on Declining Woodland Birds

General Information

Declining woodland birds considered in this report include those listed in **Table 8.6**.

Table 8.6: Declining Woodland Birds

Common Name	*Scientific name*
Emu	*Dromaius novaehollandiae*
Whistling Kite	*Haliastur sphenurus*
Painted Button-quail	*Turnix varia*
Southern Whiteface	*Aphelocephala leucopsis*
Jacky Winter	*Microeca fascinans*
Red-capped Robin	*Petroica goodenovii*
Eastern Yellow Robin	*Eopsaltria australis*
White-browed Babbler	*Pomatostomus superciliosus*
Varied Sitella	*Daphoenositta chrysoptera*
Crested Shrike-tit	*Falcunculus cristata*
Rufous Whistler	*Pachycephala rufiventris*
Restless Flycatcher	*Myiagra inquieta*
White-browed Woodswallow	*Artamus superciliosus*
Dusky Woodswallow	*Artamus cyanopterus*

Declining woodland birds are generally associated with grassy woodland habitats in the study area, such as most habitats contained within TSU 30 Box Woodlands, TSU 40b Blakely's Red Gum Woodland, and some adjacent TSU 10b unimproved grasslands. Some of these species are also particularly associated with creeklines and associated TSU 60 Alluvial Apple Forest habitats.

Likely Impacts (following Appendix 3 of DEC & DPI 2005)

1) *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

   The proposed mine would not generally be likely to affect the lifecycle of these species, other than through habitat loss, discussed in Q2 below.

2) *How is the proposal likely to affect the habitat of a threatened species, population or ecological community ?*

   Areas of known habitat to be particularly affected include:

   (vii) Box Woodlands and adjacent unimproved grasslands in the OC1 area, which would be completely cleared, for a period of 5 years – maximum production;

   (viii) habitat fringing the eastern boundary of OC2, some of which would be cleared, and the remainder subject to noise and other indirect disturbances, for a period of 2 years – maximum production;

   (ix) various remnant patches in the vicinity of OC3, of which only several tiny patches would be cleared, but all would be subject to noise and other indirect disturbances, for a period of 2 years – maximum production; and

   (x) various tiny remnant patches and disturbed unimproved grasslands in the proposed main infrastructure area, just north of the Ulan-Wollar Road.

   The proposed mine would involve the removal of approximately 224ha of potential woodland habitats for declining woodland birds from the DA area (mainly habitats TSU 30, TSU 40b and TSU 60, with a 50m buffer). Subsequent regeneration and habitat restoration are detailed in Chapter 9. The loss of these habitats would be a graduated temporary and reversible loss (9 years of open cut operations - maximum production, and then 10 years regeneration and habitat restoration, including re-colonisation of rehabilitated areas with invertebrates - refer to Chapter 9).

   Substantial areas of similar habitats for declining woodland birds occur elsewhere in the study area and DA area which would not be affected by the proposed mine. These areas can provide a time buffer between clearing of habitats in each of the above listed areas, and subsequent regeneration of these areas.

The proposed underground mining in the northern part of the DA area does not affect high value habitat for most declining woodland birds.

In summary, the proposed mine would result in clearing of several areas of likely habitat for declining woodland birds, and significant noise disturbance to several other areas. Whilst the clearing is a temporary and reversible impact, some individuals or family groups of declining woodland bird species may be lost in the interim.

However, given the wide-spread distribution of most declining woodland bird species in the study area and region, and given that their apparent habitat preferences would be targeted for restoration following mine operations, it is likely that these species would recover from the impacts of the mine in the medium to long term.

3) *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

None of the declining woodland bird species are at their limit of known distribution in the DA area.

4) *How is the proposal likely to affect current disturbance regimes?*

Much of the potential foraging habitat for declining woodland birds in the DA area is currently disturbed through clearing for farmland, subsequent grazing, and human disturbances including pasture management, traffic, noise, light *etc*. The proposal would increase the clearing and human disturbances through the southern part of the DA area (*ie* south of the Ulan-Wollar Road) in the short term (9 years – maximum production), and then gradually reduce them. Current disturbances to the northern part of the DA area are unlikely to notably change. The final outcome of the proposal would be an increase in extent and quality of habitat for the declining woodland birds, and a return to existing disturbances (refer to Chapter 9).

5) *How is the proposal likely to affect habitat connectivity?*

Habitat connectivity would be unlikely to be affected by the underground mining in the northern part of the DA area, and would not be likely to be significantly affected by OC2 and OC3, which would be located within essentially cleared valleys. OC1, however, would result in some temporary fragmentation of native vegetation likely to provide habitat for declining woodland birds. The area to be isolated would be relatively large (approx 50ha), and would be buffered from the OC1 pit by an environmental bund. This is not considered to be a significant impact for the most declining woodland birds.

6) *How is the proposal likely to affect critical habitat?*

No critical habitat relevant to declining woodland birds is declared under the TSC Act.

8.5 Impacts on Aquatic Systems

Possible impacts on aquatic ecosystems include direct construction impact due to road crossings for OC haul roads and train loops, construction of in-line dams for clean water interception and storage possible minor creek works for CHPP and other infrastructure and minor diversions to collect and train insignificant drainages currently lost into ploughed fields:

- Initial mine infrastructure (CHPP) within the Bora Creek sub-catchment, includes a rail loop, roads, vehicle parking areas, stockpiles, workshops, plant, water storages, conveyors plus the portal for Underground No. 4. For the most part these facilities have been located on currently cleared and disturbed areas of land or on areas of land that would necessarily be disturbed as part of the mine operation. An in-line clean water dam is to be established on

Bora Creek to collect and store water for mining purposes. This storage would be supplemented where necessary by water obtained from a bore field located along the eastern side of Underground No. 4, but outside the National Park boundary.. These facilities can be constructed and operated without significant impact by implication of suitable construction and rehabilitation methods as outlined in DPI Fisheries guidelines (DPI Fisheries 1999a, b and Rutherford *et al* 2000);

- Aside from the culverts plus earth works for the haul road across Moolarben Creek and any road easement requirements for the Moolarben Road diversion, OC3 and associated faculties are located well away from the creek and its riparian habitats and there are thus no direct impacts on Moolarben Creek aquatic habitats or biota;
- There could be minor potential water quality issues arising from dust and spillage from haul roads/train and CHPP areas; and
- Subsidence from underground mining could be a benefit by providing some water retention capacity in upper creek sections, which currently has no significant water retention capacity.

The main consideration with regard to possible cumulative impacts from combined coal mining in the district relates to total mine water cycle. Whilst the intent is to operate the MCP as a 'no discharge mine', practicably, there will be times when there are water surpluses. When this occurs, the mine will only discharge water, which meets the ANZECC/ARMCANZ (2000) criteria for the protection of aquatic ecosystems. Given the overall low volume of water available for aquatic ecosystems in the upper Goulburn River catchment this discharge is considered, on balance, a beneficial impact.

8.6 Impacts on Groundwater Dependant Ecosystems

Groundwater Dependant Ecosystems (GDEs) are defined as ecosystems that have their species composition and their natural ecological process determined by groundwater (DLWC, 2002). Groundwater-dependent ecosystems can be located in marine, coastal, riparian, in-stream, terrestrial and in cave and aquifer environments (Eamus *et. al*, 2006). Within the study area, it is considered that only in-stream, riparian, terrestrial and aquifer GDEs are possible given the absence of coastal, marine and cave environments.

Three distinct primary classes of GDEs are recognized, these being:

- Aquifer and cave ecosystems;
- Ecosystems dependent on the surface expression of groundwater; and
- Ecosystems dependent on the subsurface presence of groundwater.

8.6.1 GDEs of the MCP DA Area

Terrestrial GDEs
For the purposes of assessment native vegetation growing within and adjacent to the drainage corridors of Moolarben Creek and the Goulburn River are considered potential GDEs that may experience an impact through changes to local groundwater resources. The following impacts for each of the open cut and underground 4 developments are predicted.

Open Cut 1
Groundwater occurs within the coal seam aquifer that is to be removed by this open cut operation. This will be permanently removed as a consequence of open cut mining, hence temporarily displacing the associated groundwater for the period of the mining operation. Some springs occur within the open cut area (i.e. discharge sites), with the majority of these springs being within cleared lands. These will be lost through mining activities. As the ecological value and significance of these springs is assessed as low, this loss is also assessed as insignificant.

Water entering the regional groundwater aquifer (i.e. recharge) will proceed down dip through the coal seam into a regional groundwater reserve, with the discharge location being unknown. Dundon and Associates (2006) identify the contribution of the area impacted by open cut mining to the regional groundwater aquifer as negligible, with the likely change in the aquifer's discharge being within the expected limits of seasonal variation. No deleterious impact is expected as a consequence.

Open Cut 2
Limited groundwater occurs within the coal seam aquifer of open cut 2. Few springs occur within or down slope of the open cut area, indicating limited scope for a direct impact on potential GDEs. The landscape containing these springs is heavily modified by agriculture, with the resultant ecological value of these potential GDEs being low.

Water entering the regional groundwater aquifer (i.e. recharge) will proceed down dip through the coal seam into a regional groundwater reserve of unknown discharge location. Dundon and Associates (2006) identify the contribution of the area impacted by open cut mining as negligible to the regional groundwater aquifer, with the likely change in the aquifer's discharge being within the expected limits of seasonal variation. No deleterious impact is expected as a consequence.

Open Cut 3
Groundwater contained within the coal seam aquifer that is being removed by the proposed mining operations is highly saline and of limited quantity relative to other groundwater resources of the locality. This groundwater aquifer is located in a perched position relative to Moolarben Creek and has been shown by Peter Dundon and Associates (2006) as not directly contributing to the groundwater base flow into the creek. Base flows into Moolarben Creek are from a deeper separate aquifer that will not be adversely impacted by mining operations. No deleterious impact is expected on the riparian vegetation of Moolarben Creek as a consequence of mining, rather a potential improvement in water quality through the removal of a salinity source would be expected.

Underground 4
Underground 4 is located east and south of the Goulburn River, and setback limits have been fixed so as to prevent impacts on river GDEs. Further, GDEs located in the north wall of the Drip will also avoid any direct or indirect mining impacts.

None of the vegetation located above the underground mining operations has been classified as a GDE. Some vegetation is considered reliant on elevated soil moisture levels obtained through surface flow regimes, such as ephemeral creeklines, which may experience some surface cracking hence potentially modify surface water flows. However, these potential changes to the surface water flows are localised and have been demonstrated by Strata Engineering (2006) to have almost no potential for an interaction with groundwater aquifers such as those associated with the deeper coal seams. Rerouting of surface water through surface cracking is highly likely to result in a surface expression of this water down slope of the cracking and upslope of the Ulan – Cassilis Road.

Aquatic GDEs
Open cut pits would intercept rainwater, which would have contributed to shallow surface groundwater. However these areas of shallow surface groundwaters do not make any significant contribution to creek flow (see Dundon and Associates 2006) and thus their loss is considered insignificant with respect to receiving creek ecosystems.

Groundwater extraction from the proposed bore field on the eastern side of Underground 4 would be utilising groundwater from the Permian coal seams and thus would not affect groundwater interactions with Bora Creek to any significant degree (see Dundon and Associates 2006). Accordingly there would not be any impacts expected on creek ecosystems.

Overall, the main contribution of groundwaters to aquatic ecosystems in the study area relate to base-flow contributions to the major creeks and to Goulburn River from deep aquifers. As there are no interceptions of the deep aquifers by the proposed open cut pits (OC1 to OC3) there are insignificant impacts on groundwater interactions with Moolarben Creek and Goulburn River. That is, there are no impacts expected on aquatic ecosystems (including GDEs) in these creek and river systems.

As noted above, water entering the regional groundwater aquifer (i.e. recharge) will proceed down dip through the coal seam into a regional groundwater reserve, with the discharge location being unknown. Dundon and Associates (2006) identify the contribution of the area impacted by open cut mining to the regional groundwater aquifer as negligible, with the likely change in the aquifer's discharge being within the expected limits of seasonal variation. No deleterious impact on Goulburn River GDEs downstream of the study area is expected as a consequence.

With regard to aquatic ecosystem dependence on surface water flow the Mine Surface Water Management Strategy (MSWMS - Patterson Britton & Partners 2006) includes a comprehensive dewatering plus water storage and treatment system to ensure no significant changes to surface water base flows in Goulburn River and no deterioration in river water quality. This is achieved by the construction of a 50 ML 'clean water' pond in the infrastructure area which will receive excess groundwater make from the Open cut pits and from Underground 4. This water will be conveyed to a linked system of oxidation ponds which will provide water treatment to ANZECC/ARMCANZ (2000) quality standards suitable for discharge via the lower (constructed) section of Bora Creek which would discharge into the (constructed) Goulburn River diversion channel.

For the first 12 years of mining operations the balance of water make and water demand is predicted to result in variable amounts of surplus water from 4 ML/year (year 1) to a peak of 364 ML in year 3, with variable quantities (14 to 228 ML/year) over the remaining 9 years. Thus, the maximum water release to Goulburn River over this period would be up to 1 ML/day (in Year 3), which is not considered a significant alteration to base-flow. Indeed, from an aquatic ecological perspective, the introduction of this additional base-flow water with good water quality is considered beneficial.

From years 13 to 16 the volume of excess makeup water is predicted to increase (from 1,270 to 2422 ML/yr). This water would be available for off-site water usages for an expanded Moolarben Coal project (to be considered in a forthcoming EA). In the event that this mine expansion does not take place, the MSWMS includes a number of contingencies for dealing with this excess water:

- There will be adequate storage capacity for the excess untreated groundwater in the void remaining in OC1 and this void would be suitably lined to confine the water.
- An additional set of oxidation ponds would be linked to the original chain of ponds to provide sufficient water treatment capacity.
- The oxidation ponds would then be operated to discharge clean water to the Goulburn River (via the Bora Creek/Goulburn River diversion) at a n agreed rate.

From Year 18 to 21 the balance of surplus makeup water would drop from 3 Ml/yr in Year 18 to zero for the remaining 3 years.

In summary, with respect to the provisions of the State Groundwater Dependent Ecosystem Policy (DLWC 2002), it is concluded that there are no significant aquatic GDEs within the creek and river systems in the defined study area and that the GDEs which exist (mainly as base-flow hyporheic zone systems in the lower portion of the Goulburn River would not be significantly impacted by the proposal.

8.7 Impacts on Adjacent DEC Estate

8.7.1 Goulburn River National Park

The Goulburn River National Park borders the eastern boundary of the northern section of the MCP DA area. This northern section of the DA area is proposed for underground mining (Underground No. 4). The underground design incorporates adequate setbacks to ensure no subsidence or assocaited erosion impacts on the Goulburn River National Park.

The MCP will not directly contribute to any other existing impacts on the Goulburn River National Park such as inappropriate fire regimes, road kill, and introduction of weeds, pathogens or feral animals. To the contrary, proposed management plans will seek to reduce the extent of local existing impacts on this conservation reserve, particularly the localised control of feral animals such as wild pigs.

There would be no impediment to existing access pathways to Goulburn River National Park during the mine operation. However, temporary delays in gaining access to the Goulburn River National Park may be experienced from the Mudgee approach during blasting operations associated with OC1. Notification of these delays will be posted on the roadside.

8.7.2 Munghorn Gap Nature Reserve

Munghorn Gap Nature Reserve borders the south-eastern corner of the MCP DA area. No part of the mine operations would be located immediately adjoining Munghorn Gap Nature Reserve.

OC3 would be located in the vicinity of Munghorn Gap Nature Reserve, but at an average distance of approximately 1km, across Moolarben Creek and associated riparian vegetation. This is a substantial buffer that will reduce the impacts upon the Munghorn Gap Nature Reserve. The short term impacts (approximately 2 years – maximum production) will be limited to matters such as noise, light and dust. The MCP will not directly contribute to any other existing impacts on the Munghorn Gap Nature Reserve such as inappropriate fire regimes, road kill, and introduction of weeds, pathogens or feral animals. To the contrary, proposed management plans will seek to reduce the extent of local existing impacts on this conservation reserve.

8.7.3 Aquatic Ecosystems and GDEs

As noted in Section 8.6 above, there would be no significant impacts on surface water volumes or surface water quality in the Goulburn River arising from this mining proposal and there would be no significant change in river base-flow. Accordingly it is concluded that there would be no significant impacts on aquatic ecosystems of river aquatic ecosystems within the national estate downstream of the DA area.

As noted in Section 6.3.1 above, whilst the presence of groundwater dependent ecosystems (GDEs) has not been surveyed in the adjacent National Park estate outside the study area, Peter Dundon and Associates (2006) reason that their presence is considered unlikely, as the Narrabeen Sandstones in this area do not appear to be conducive to retaining water to the extent that would support unique vegetation assemblages, due to the massive structure and lack of barriers. This conclusion is consistent with the results of the surveys within the study area, as reported above.

9 MITIGATION

9.1 Identification of Local Ecological Values

The MCP DA area has been classified in terms of its ecological value (*ie* High, Moderate, Low) using the following matters of significance:

- Threatened species, populations, EECs and their habitats;
- Woodland habitats of likely value for declining woodland birds; and
- Native vegetation and habitats of importance due to their strategic location, corridor values, and critical or unique resources.

These areas are identified on **Figure 9.1**, with their respective ecological values discussed in the following sections.

9.1.1 High Ecological Value

Areas of high ecological value are generally associated with vegetated lands belonging to the following TSU's:

10 Disturbed Vegetation (unimproved grasslands located close to remnant stands of vegetation)

30 Box Woodlands (vegetation associations classified as EEC);

30 Box Woodlands (non-EECs containing woodland bird habitat);

40 Tableland Redgum Woodlands (vegetation association 40 which is classified as EEC);

60 Alluvial Apple Forests.

These areas contain the highest local ecological value based on EEC classification, the diversity and number of threatened fauna species recorded, the prevailing habitat values for declining woodland birds, the locally restricted extent of these habitats and limited representation within the adjoining Goulburn River National Park and Munghorn Gap Nature Reserve.

Of particular value for many threatened woodland birds (namely the Speckled Warbler, Brown Treecreeper, Hooded Robin, Black-chinned Honeyeater, Grey-crowned Babbler and Diamond Firetail), and for other declining woodland birds, is the ecotone between Box Woodland vegetation and adjacent unimproved grasslands. Consequently, unimproved grasslands located adjacent to areas of Box Woodland vegetation have been assigned a much higher ecological value than would normally be expected given their condition.

The majority of microchiropteran bat records in the study area were obtained from vegetation association 40 'Blakely's Red Gum Woodland', which has been defined in this study as part of the White Box Yellow Box Blakely's Red Gum Woodland EEC.

Box Woodland vegetation is also generally located on lower mid-slopes through the study area, particularly down slope of tuffaceous/carboniferous claystone outcrops and basalt caps. These tracts of vegetation offer substantial value for fauna movements through the landscape, and include two main structural types:

(i) Box Woodlands classified as belonging to the White Box Yellow Box Blakely's Red Gum Woodland EEC, as defined by the Box-Gum Woodlands guidelines (NPWS 2002), which generally coincide with quaternary alluviums, basalt-enriched sedimentary soils and basalt caps; and

(ii) The remainder of Box Woodlands within the study area, which are generally shrub dominated and not part of the EEC classification.

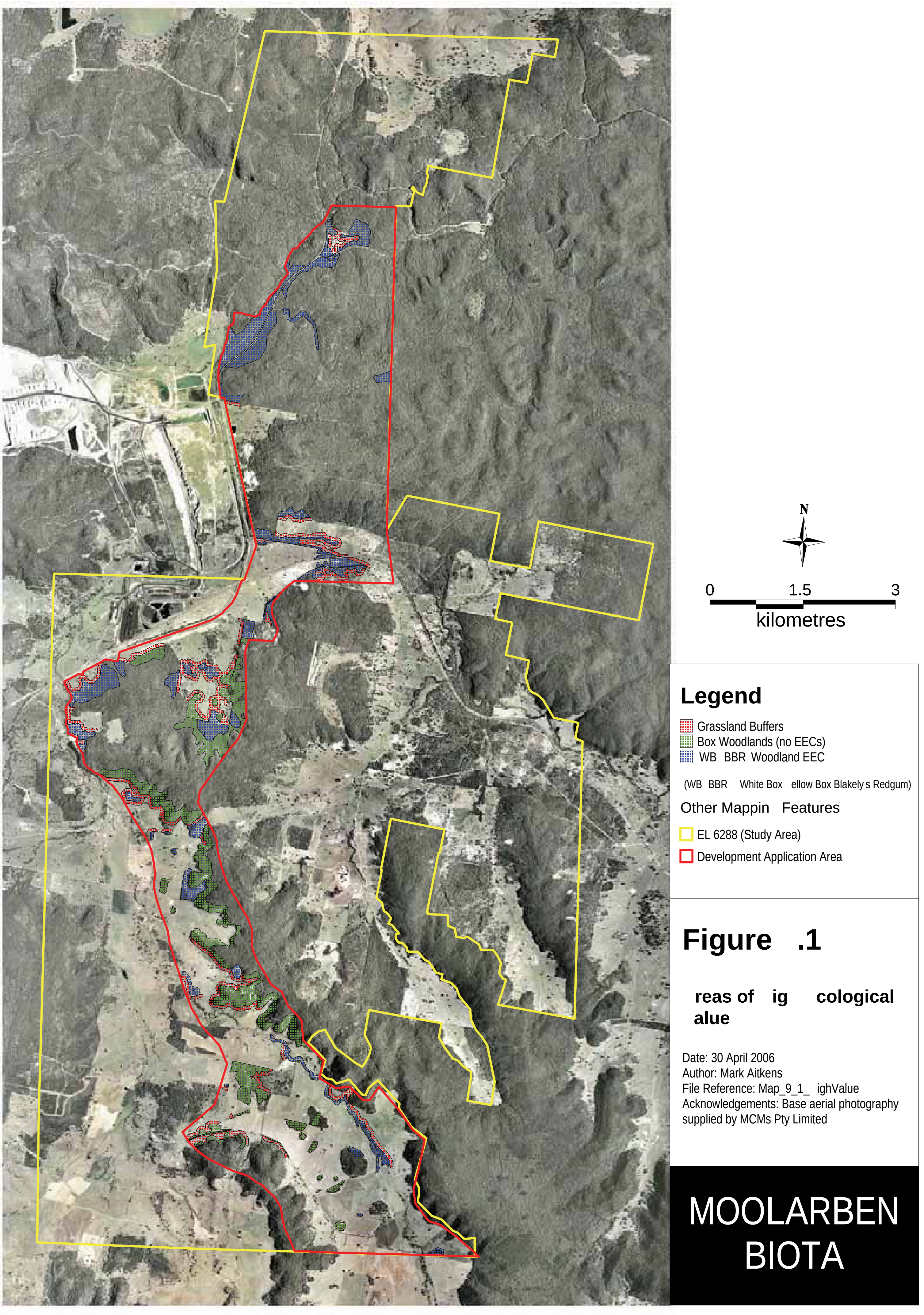

Figure .1

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Date: 30 April 2006
Author: Mark Aitkens
File Reference: Map_9_1_ ighValue
Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

Aerial photography suggests that Box Woodland vegetation associations have historically been targeted for clearing in the region, due to their location on valley floors and gentle mid-slopes, which are generally of higher agricultural value than the more rugged, shallow soiled and less accessible ridgelines.

Other areas of high ecological value have been determined based on threatened species locations and likely habitat use. These include:

- The prominent ridgeline located immediately east of OC1. This area appears to be of particular value for a group of Glossy Black Cockatoos;
- Fringe areas of the prominent ridgeline located immediately west of OC3. Fringe vegetation in this area appears to be the only area of habitat within the MCP DA area that is of value to the Grey-crowned Babbler;
- A moderate-sized remnant patch of vegetation located immediately west of the proposed OC3 area, which may be of particular importance for the Squirrel Glider;
- Ephemeral creeklines with elevated soil nutrients and moisture levels, which support known habitat for the Narrow-leaved Goodenia (*Goodenia macbarronii*);
- The confluence between Permian and Carboniferous geological formations, located along the western margin of Moolarben Creek in the vicinity of OCs 1, 2 and 3, which appears to support the majority of threatened flora species of the locality (*ie* Capertee Stringybark *E. cannonii*, Double-tailed Donkey Orchid *Diuris tricolor* and Hoary Sunray *Leucochrysum albicans* var. *tricolor*).
- With regard to aquatic ecosystems the Goulburn River corridor below the Ulan-Cassilis Road bridge (including the lower section of Bobadeen Creek) are considered to have high ecological value by virtue of the diversity of habitats, water quantity and quality and known fish habitat attributes.

9.1.2 Moderate Ecological Value

Areas of moderate ecological value are generally associated with vegetated lands belonging to the following TSU's:

20 Sedimentary Ironbark Forests;

50 Sedimentary Scribbly Gum Woodlands; and

40 Tableland Redgum Woodlands (other than vegetation association 40 which is classified as EEC).

Areas of moderate value are those that support relatively intact native vegetation and habitats, large continuous tracts of native vegetation, and/or native or disturbed vegetation of importance due to corridor value, critical or unique resources, revegetation value or other strategic value. They generally do not contain locally restricted threatened biodiversity habitat types, rather represent a replicate of widespread vegetation types that are well represented in Goulburn River National Park and Munghorn Gap Nature Reserve

The lower portion of Moolarben Creek (below the dam) plus the upper portion of Goulburn River above the Ulan-Cassilis Road bridge and deep pools within the section of Moolarben Creek from the Moolarben Road crossing to the Moolarben Dam are considered to have moderate ecological value as they provide some drought resistant aquatic habitat with some potential for fish habitat or, as is the case for Moolarben Creek, are compromised by water quality deterioration, particularly during periods of low flow when groundwater re-charge via low water quality groundwater is the predominant source of base-flow. Other smaller creek systems such as Bora Creek are included as they provide potential good aquatic habitat but are dry to an extent that they would only provide aquatic habitat for a short time after rain events.

9.1.3 Low Ecological Value

Areas of low ecological value are generally associated with vegetated lands belonging to TSU 10 Disturbed Lands (other than unimproved grasslands located close to remnant stands of vegetation). Low ecological value areas are lands within the MCP DA area supporting disturbed native vegetation and habitats. These areas are generally in poor condition, and of low habitat value. However, these areas offer potential opportunity for revegetation works that will be further explored in the following sections.

In general the sections of upland creeks which are located within disturbed lands used for pasture or cropping provide no or negligible aquatic ecological habitat; in some cases due to complete removal by ploughing (e.g., Spring Creek, parts of Moolarben Creek and parts of Lagoon Creek).

9.2 The Preferred Mitigation Strategy

The preferred mitigation strategy for the MCP has been designed to achieve a 'maintain and enhance' ecological outcome resulting in a net positive biodiversity benefit in the post-developed landscape. This mitigation strategy forms part of a global strategy for EL 6288, which has been designed to:

- Avoid impacts on areas of high ecological value;
- Enhance local vegetation cover;
- Increase patch utilisation of isolated vegetation remnants by local biodiversity such as woodland birds;
- Improve connectivity between Munghorn Gap Nature Reserve and Goulburn River National Park;
- Improve connectivity between Dexter Mountain and Munghorn Gap Nature Reserve through revegetation, management and Voluntary Conservation Agreements; and
- Secure the local conservation of Endangered Ecological Communities, their habitats and important local biodiversity.

The strategy for EL 6288 will involve the mitigation of impacts from the proposed development within the MCP DA area, as discussed in this report, and the future impacts associated with the development of further coal resources to the east. This strategy will not be achieved until the coal resource to the east have been fully defined in terms of the mining approach, approvals obtained and associated mitigation implemented.

The mitigation strategy for this development proposes land dedication to the national park estate to provide immediate offsets for impacts on EECs, revegetation of cleared lands, Voluntary Conservation Agreements and enhancement of existing native vegetation. Landholder agreements will be required prior to the initiation of mining activities in OC 2 and OC 3, with the implementation of a staged mitigation approach to coincide with the active mining of these areas.

The core elements that underpin this component of the strategy are:

- Avoid impacts (where possible) on White Box Yellow Box Blakely's Redgum Woodland and Woodland bird habitat;
- Dedication of lands to the National Parks and Wildlife conservation reserve network, with dedicated lands to contain EECs of similar like for like values (i.e. species composition and condition) to provide an immediate offset for the loss of EECs within the MCP DA area;
- Revegetation of vegetated lands within the MCP DA area that are outside the impact zone and under the direct control of the proponent;
- Rehabilitation of the OC1 footprint using native vegetation;
- Management of ongoing non-mine related impacts to enhance the value of the residual vegetation cover;

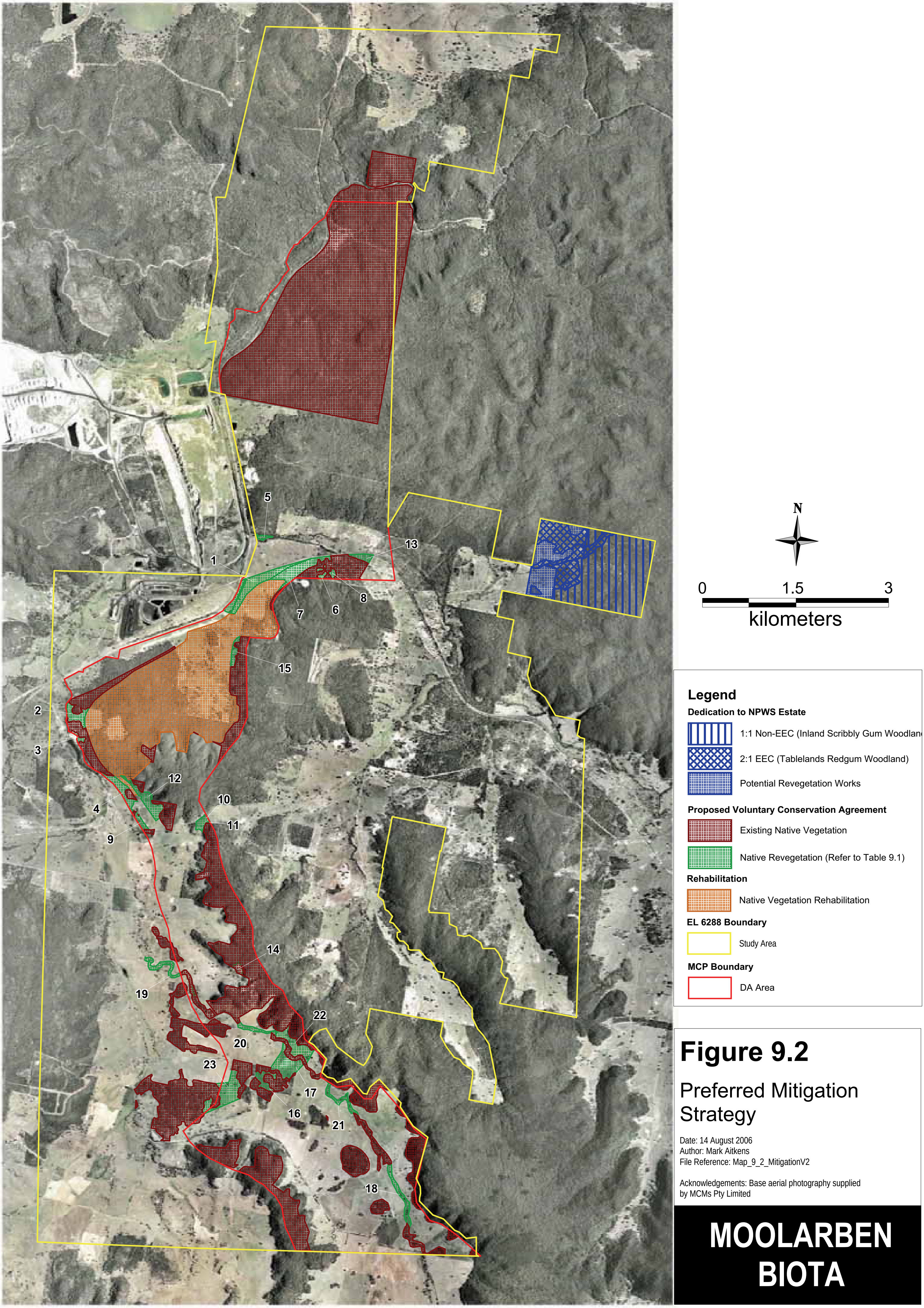

Figure 9.2

Preferred Mitigation Strategy

Date: 14 August 2006
Author: Mark Aitkens
File Reference: Map_9_2_MitigationV2

Acknowledgements: Base aerial photography supplied by MCMs Pty Limited

MOOLARBEN BIOTA

- Preparation of Farm Management Plans (FMPs) including strategic revegetation works to integrate farm management practices with the improvement of local biodiversity outcomes;
- The use of Voluntary Conservation Agreements to secure long term outcomes for biodiversity initiatives located on private lands;
- Use of ameliorative works to reduce the extent of direct impacts on local biodiversity values;
- Revegetate parts of Moolarben Creek to improve/ restore ecological function within this disturbed landscape including vegetation connectivity.

The impact areas of the proposed MCP are discussed in the following sections as independent mitigation zones, with broad references to the mitigation strategy presented. Details of the mitigation strategy are presented thereafter.

9.2.1 OC1

The southern extent of OC1, which is currently characterised by a large area of intact native vegetation, would be rehabilitated to a functioning ecosystem that would promote over time the development of vegetation and habitats similar to the existing environment within that area. Local seed collection, propagation, weed and soil management, habitat rehabilitation and monitoring would be undertaken using industry best practice to facilitate this outcome.

The majority of the northern parts of OC1 are currently cleared, but support small remnants and fringes of Box Woodland associations in a mosaic with unimproved grasslands. This vegetation, whilst in a disturbed condition, is of some value for a range of threatened woodland bird species. The post developed landscape would target the revegetation of these disturbed Box Woodlands to suit the formation of White Box Yellow Box Blakely’s Red Gum Woodland and habitats for threatened and declining woodland birds lost through development. Cleared lands mined within the OC1 footprint will also be rehabilitated in a manner consistent with the vegetated lands impacted by the development resulting in a localised long-term increase of native vegetation cover. Voluntary Conservation Agreements will be used to ensure the long-term security of this rehabilitation program.

Soil and contour maps of the northern OC1 area would be used to determine an appropriate boundary between the Sedimentary Ironbark Forests of the ridgeline, and the Box Woodlands of the mid-slopes. The midslopes would then be revegetated to include primarily Box Woodland associations. Topsoils recovered prior to mining would be stockpiled and appropriately managed in readiness for progressive revegetation works after the completion of inpit overburden placements. Subsoil material that may potentially enhance the revegetation works would be investigated, with suitable materials to be stockpiled and used in the revegetation works. One such subsoil material that may be of importance for re-establishing Box Woodlands includes the tuffaceous claystones contained within the coal seam profile.

Revegetation works would initially rely on local pioneer species to condition the soil for successive plant regeneration. These are likely to include various wattles and grasses that are known to occupy disturbed environments throughout the study area. Successive plantings (including various box and gum species) would follow at an appropriate stage to maximise the successful rehabilitation of woodland mosaics. It is considered that this approach would hasten the establishment of Box Woodland vegetation in a manner that recognises the harsh climatic and environmental conditions that prevail within the Ulan district.

The Box Woodland mosaic would contain some areas of relatively dense tree and/or shrub cover providing good shelter habitat, and some areas of open unimproved natural grassland with only occasional scattered trees and logs, to provide preferred foraging habitat for various threatened and declining woodland species (predominantly birds). This mosaic vegetation pattern would maximise diversity of habitats in the area, and maximise the ecotone between Box Woodlands and grasslands.

The final mosaic would also include several large stands of *Allocasuarina* sp, to replace cleared stands known to be of foraging value for the Glossy Black Cockatoo. *Allocasuarina* spp would also be used as an understorey plant in many rehabilitated woodland areas.

Some additional permanent water storages would be created on the lower slopes within the OC1 area. These would provide additional water resources for fauna in the area, a resource likely to be a limiting factor of habitat value in the region.

9.2.2 OC2

Lands adjoining the northern part of the OC2 area and haul road linkage with OC1 that are under the control of MCMs will be revegetated to enhance vegetation cover and connectivity. These lands will be revegetated with Box Woodland species, as this landscape appears more suited to this vegetation type. Enhancement of Grassy White Box Woodland on basalt soils, in close proximity to Carrs Gap, that are located within the MCP DA area will also be completed through weed removal, exclusion of grazing and tree plantings. Native revegetation throughout the remaining parts of OC2 will be subject to a negotiated outcome with the landowner in a FMP, with existing cleared lands within the proposed open cut footprint to be reinstated as agricultural lands.

9.2.3 OC3

Revegetation throughout the lands that adjoin OC3 will be subject to a negotiated outcome with the landowner in a FMP, with existing cleared lands within the proposed open cut footprint to be reinstated as agricultural lands. Revegetation works would focus on the development of Riparian Alluvial Apple Forest vegetation along Moolarben Creek to improve local vegetation connectivity. Linkages between isolated vegetation patches will be considered in the FMP to improve patch usage by local biodiversity such as woodland birds.

9.2.4 Underground No. 4

Virtually no native vegetation or habitats would be removed for operation of Underground No. 4. Subsidence impacts are expected to be relatively minor, given the topography and nature of the landscape and the current extent and condition of vegetation. It is expected that impacts related to subsidence would emulate natural processes, sped up to some degree, and would balance out across the Underground No. 4 area.

There is minimal loss of vegetation or habitats expected from this area. Surface contour changes may result in localised modifications to native vegetation structure and floristics. However, no groundwater or surface water dependant native vegetation exists throughout this area, thereby suggesting that the likely impact of underground mining on native vegetation would be minor.

Management of lands located above Underground No. 4 would be undertaken as part of the ‘Enhancement’ strategies discussed in the following sections. This area of land supports vast tracts of intact native vegetation, borders an environmentally sensitive section of the Goulburn River (which also contains 'The Drip'), and is located immediately adjacent to the western boundary of the Goulburn River National Park.

9.2.5 Avoidance

An initial mine layout was reviewed during the baseline ecological studies to identify likely constraints and opportunities. Whilst this initial layout incorporated a number of constraints such as nominated set-backs from the Goulburn River to avoid ecological impact it was modified in several areas to avoid and further reduce the disturbance of native vegetation, fauna habitats and aquatic systems.

Avoidance of impacts focused on:

- The re-location of infrastructure within the Bora Creek catchment to minimise the extent of creek and vegetation impacts, despite a previous (and current) approval which allows this creek line to be significantly impacted;

- Reduction in mine area at OC3 to avoid the Moolarben Creek and Spring Creek and adjoining sensitive vegetation remnants;
- Reducing the clearing of White Box Yellow Box Blakely's Red Gum Woodland EEC and associated Box Woodland environs;
- Location and design of the environmental bund to the southwest of OC1 such that a substantial area of fringe Box Woodland vegetation is retained, and such that the widest part of the bund is located primarily on previous cleared land; and
- Design of a mine water management system to minimise changes in base-flow, prevent deterioration in water quality and minimise potential impacts on the Goulburn River alluvial groundwater dependent ecosystems.

The final MCP layout, when compared to the initial layout, has reduced the extent of proposed native vegetation clearing from 441.1 ha to 416.8 ha, representing a reduction of 24.3 ha or 5.7%. Most importantly, the reduction of clearing would be most pronounced for vegetation associations classified as White Box Yellow Box Blakely's Red Gum Woodland EEC. The initial mine layout would have resulted in the loss of 83.70 ha White Box Yellow Box Blakely's Red Gum Woodland EEC in comparison with the final MCP layout impacting 64.68 ha, a reduction of 19.02 ha or 22.7%. These statistics clearly demonstrate attempts to avoid vegetated areas of high ecological value (*ie* classified as EEC and providing habitat for threatened and declining woodland bird species).

The economic loss resultant from avoiding ecological values of importance may be quantified by valuing, in dollar terms, the sterilised coal resource. The area of avoidance in OC3 is represented by the coal beneath Moolarben Creek and the adjoining riparian buffer zone, which has been excised from the proposed MCP layout due to its local importance as a riparian corridor. As a consequence of excising the Moolarben Creek from the OC3 mine footprint, the minable extent of coal on the eastern side of Moolarben Creek has been significantly reduced to a point where it is unviable to mine. The gross monetary loss attributed to this avoidance of Moolarben Creek and lands to the east is estimated to be approximately AU$325 million based on the current market value of domestic coal.

The surface water management strategy has been designed to minimise changes in base-flow, prevent deterioration in water quality and minimise potential impacts on groundwater dependent ecosystems (Patterson Britton & Partners 2006).

9.2.6 Land Dedication to the Conservation Reserve Network

The proponent and the Department of Environment and Conservation are in the process of finalising an agreement whereby MCMs will dedicate an area of land to a local conservation reserve to provide immediate mitigation for the loss of EECs. This dedication has been agreed to contain 'like for like' biodiversity values at a ratio of 2:1 (i.e. species composition), with the dedication to also consider a condition analysis between what is being destroyed by mining and the vegetation being included within the conservation reserve network.

It is anticipated that the 2:1 land dedication will result in the addition of 130 ha of similar EECs to the local conservation reserve network. Contained within the proposed dedication area outlined in Figure 9.2 is an area of White Box Yellow Box Blakely's Redgum Woodland EEC totalling 56.84 ha, which represents an initial contribution to the 130 ha of proposed dedication. In addition to this dedication are potential opportunities to revegetate disturbed landscapes to a condition similar to the surrounding vegetation (i.e. Blakely's Redgum Woodland). The area of this potential revegetation opportunity is 37.95 ha.

Other non-EEC land will also be dedicated to Goulburn River National Park in a land parcel that is contiguous with the EEC dedication to offset the immediate loss of native vegetation. The area of non-EEC dedication is approximately 143 ha, bringing the current land dedication ledger to approximately 238 ha. The value of other mitigation measures offered in this strategy such as revegetation works, rehabilitation, vegetation enhancement, Voluntary Conservation Agreements and FMPs are considered important in rationalising the mitigation of development impacts on both EECs and non-EECs with the aim of providing a net positive impact on local vegetation cover, fauna habitat availability and local ecological function.

9.2.7 Proposed Revegetation Works within the MCP DA Area

The preferred mitigation strategy proposes to revegetate existing cleared low value agricultural lands within the MCP DA area and selected local properties to minimise the local impacts experienced through staged mining activities. The focus of this revegetation program would be to provide native woodland on areas of sub-optimal agricultural land plus restore pasture/ cropping lands on areas considered to be prime agricultural lands. Revegetation for native woodland would primarily focus on the establishment of Box Woodlands to increase the cover of this vegetation type throughout the locality, thereby enhancing habitat values for locally occurring threatened species, EEC's and habitat for declining woodland birds. **Figure 9.2** identifies the extent of the proposed revegetation areas and its potential contribution to the enhancement of local wildlife corridors.

Revegetation works using native vegetation is also proposed for lands surrounding OC2 and OC3. However, given the extent of farming throughout these areas and the likely continuation of this land use practice, it is proposed to undertake strategic revegetation works in areas that will benefit existing farming practices and biodiversity outcomes. These revegetation works will be a negotiated outcome with the landowners consent and will be formalised in a FMP with Voluntary Conservation Agreements to ensure the long term security of these revegetation works.

Revegetation works conducted under this strategy would seek to improve local wildlife connectivity and patch utilisation within existing native vegetation cover. Revegetation works are likely to occur within creeklines and along existing fence lines to minimise the impact on agricultural land uses. The extent of these works will be governed by the localised loss of native vegetation cover resultant from the activity and a suitable ratio that ensures net improvement of local vegetation cover. **Table 9.1** identifies the aerial extent for each patch of proposed revegetation works and the expected vegetation association to be revegetated.

Table 9.1 Revegetation works on lands outside of the mine footprint

Map Label	**Proposed Revegetation Outcome (Association)**	**Area (ha)**
1	Yellow Box White Box Blakely's Redgum	17.68
2	Yellow Box White Box Blakely's Redgum	6.58
3	Yellow Box White Box Blakely's Redgum	1.54
4	Yellow Box White Box Blakely's Redgum	7.57
5	Yellow Box White Box Blakely's Redgum	1.17
6	Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	2.10
7	Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	13.53
8	Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	1.47
9	Grey Box Ironbark	2.31
10	Grassy White Box	3.11
11	Grassy White Box	0.12
12	Shrubby White box	9.97
13	Blakely's Redgum	3.30
14	Grassy White Box	1.79
15	Shrubby White Box	3.56
16	Grey Box/ Ironbark	5.66
17	Yellow Box White Box Blakely's Redgum	13.25
18	Yellow Box/ Rough-barked Apple	6.57
19	Yellow Box/ Rough-barked Apple	7.24
20	Yellow Box/ Rough-barked Apple	3.18
21	Yellow Box/ Rough-barked Apple	4.31
22	Yellow Box White Box Blakely's Redgum	11.63
23	Yellow Box White Box Blakely's Redgum	16.71
Total		**144.35**

The area associated with the proposed native woodland revegetation works is primarily throughout the non-impacted cleared lower slopes and along drainage lines that surround OC1. This represents an area of 128.93 ha, with the breakdown for each proposed vegetation association presented in **Table 9.2**.

Table 9.2 Extent of Proposed Revegetation works (Vegetation Associations)

Vegetation Association	**Area (ha)**
Yellow Box White Box Blakely's Redgum	76.1288
Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	17.0953
Grey Box Ironbark	2.3119
Grassy White Box	5.02847
Shrubby White box	13.5257
Blakely's Redgum	3.29956
Grey Box/ Ironbark	5.65945
Yellow Box/ Rough-barked Apple	21.298

9.2.8 Proposed Rehabilitation of Open Cut Mining Areas

It is proposed to rehabilitate the open cut mine footprints to a state that is consistent with the dominant surrounding land use. For OC1, this represents an opportunity to increase native vegetation cover. The expected extent of native vegetation rehabilitation for OC1 will be approximately 370 ha, thereby increasing the extent of local native vegetation cover by 110 ha through the rehabilitation of currently cleared lands (i.e. extent of cleared lands within the OC1 footprint currently stand at 155 ha relative to the 264 ha of native vegetation). Combined with the reintroduction of salvaged fauna habitats contained within the OC1 impact envelope, it is considered that the resultant landscape will maintain in the long term local biodiversity values. A Voluntary Conservation Agreements will be applied to this area to secure the benefits for biodiversity in the long term.

Conversely, the proposed mining operations for OC2 and OC3 will have a limited impact on native cover, as the majority of this area is already cleared or agricultural land uses. The likely final landform for these areas is a return to agricultural land uses combined with targeted revegetation works to maintain local vegetation cover and improve existing patch utilisation for vegetation isolated from larger contiguous areas.

9.2.9 Vegetation and Fauna Habitat Enhancement

A variety of management strategies are proposed to address existing non-mine related impacts in addition to any indirect impacts from the MCP. Management methods described in a Land Rehabilitation Management Plan (LRMP), which would contain performance goals and criteria for fulfilling MCM's 'Statement of Commitments', would govern these proposed enhancements. Vegetation and fauna habitat enhancement works will be conducted within an area of approximately 1048 ha, which will also be subject to a Voluntary Conservation Agreement.

The following management works would be applied to native vegetation cover within the MCP DA area, that is under the control of MCMs, to improve the contained ecological values hence minimise the net impact of the MCP:

- Monitoring of native vegetation health including factors such as direct/indirect mine impacts and non-mine related impacts to target enhancement works;
- Management of exotic flora and fauna for the duration of the project, including control of weeds, cats, foxes, rabbits, goats and pigs;
- Management of weedy native plants (*ie* Sifton Bush) to reduce the impact of this pioneer species on revegetation works and existing native vegetation;
- Removal of grazing/cropping including the use of fencing to assist the natural regeneration of native grasses and herbs hence woodland habitats;
- Management of fire regimes using appropriate ecological thresholds;

- Introduction of fauna habitat features salvaged from land clearing events (*eg* tree hollows, rocks, and fallen timber) to enhance existing habitats affected by past logging and clearing activities; and
- Improvement of riparian corridors such as the management of erosion and vegetation cover.

9.2.10 Voluntary Conservation Agreement

The area to which the enhancement management works apply, as described in **9.3.4**, will be restricted to land owned or managed by MCMs. A Voluntary Conservation Agreement is proposed for these lands, including some lands above Underground 4, vegetation surrounding OC1 and native vegetation surrounding OC 2 and OC 3, as shown in **Figure 9.2.** This Voluntary Conservation Agreement will ensure the delivery of a long term secure net positive biodiversity benefit within the locality. The extent and type of residual intact native vegetation cover that is to be managed within the area managed as a Voluntary Conservation Agreement is described in **Table 9.3**.

Table 9.3 Extent of Native Vegetation within Proposed Voluntary Conservation Agreement

Vegetation Association/TSU	**Enhancement of residual vegetation (ha)**
Broad-leaved Ironbark/ Grey Gum	31.62
Ironbark/ Grey Gum/ Stringybark	179.20
Ironbark/ Black Cypress Pine	6.29
Black Cypress Pine	46.03
Narrow-leaved Ironbark/ Red Stringybark	28.07
Ironbark/ Slaty Gum	25.13
TSU 20 (Sub-total)	***316.34***
Yellow Box/ Red Stringybark/ Blakely's Redgum	6.77
Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum	21.18
Grey Box/ Ironbark/ Slaty Gum	9.01
Grey Box/ Ironbark	8.17
Shrubby White Box	95.43
TSU 30 (Sub-total)	***140.55***
Blakely's Redgum	65.55
Tumbledown Redgum	3.83
TSU 40 (Sub-total)	***69.38***
Inland Scribbly Gum/ Rough-barked Apple	94.89
Inland Scribbly Gum/ Blue-leaved Stringybark	42.82
Inland Scribbly Gum/ Black Cypress Pine	69.01
Inland Scribbly Gum/ Stringybark/ Ironbark	194.96
Inland Scribbly Gum/ Ironbark	268.26
TSU 50 (Sub-total)	***669.94***
Yellow Box/ Rough-barked Apple	18.99
Rough-barked Apple	39.54
Rough-barked Apple/ Ironbark	0.74
Rough-barked Apple/ Grey Box	6.71
TSU 60 (Sub-total)	***65.98***
TOTAL	**1262.20**

The proposed Voluntary Conservation Agreement will also include lands to be revegetated, as described in chapter 9.3.2, and rehabilitated, as described in chapter 9.3.3. The area associated with these revegetation and rehabilitation works is approximately 514 ha, thereby resulting in a Voluntary Conservation Agreement area containing approximately 1726 ha.

9.2.11 Impact Amelioration

Impacts of vegetation clearing would be minimised through the implementation of various ameliorative works within the framework of targeted management planning. Ameliorative works may include, but not be limited to, the following actions:

- Removal/deterrence of native fauna from an area prior to clearing;
- Timing of clearing to avoid threatened fauna breeding seasons and microchiropteran bat hibernation seasons;
- Collection of endemic seed for propagation and use in proposed revegetation schemes;
- Early planting of additional lands outside of the mine footprint, particularly adjacent to the OC2 and OC3 area, to enable improved connectivity of vegetation prior to indirect mine impacts such as noise, dust and light;
- Retention and stockpiling of significant hollows for use in rehabilitation and retention; and
- Stockpiling of cleared native vegetation as whole sections, and as mulch, for use in rehabilitation and erosion control.

Ongoing management of impacts and associated monitoring of rehabilitated/revegetated landscapes and other indirectly impacted vegetation will occur, through the implementation of targeted management with measurable key performance indicators monitored to determine the success of mitigation works.

Impacts from the construction of culverts and other infrastructure within creek riparian habitats and over creeks would be minimised by adherence to standard construction guidelines and additional construction guidelines published by DPI Fisheries (NSW Fisheries 1999). Any necessary rehabilitation works would be undertaken using recommended guidelines (Rutherford et al 2000).

9.3 Preparation of Management Plans Supporting the Preferred Mitigation Strategy

MCM would prepare and implement a Construction Flora, Fauna and Aquatic Management Plan (CFFAMP) and Flora, Fauna and Aquatic Management Plan (FFAMP) for the operational and closure phases of the MCP under the guidance of the LRMP. The plans would identify key performance indicators and the manner in which they would be measured to ensure compliance with the principles of ecologically sustainable development.

The implementation of these management plans would be expected to result in the maintenance and improvement of local biodiversity values in the medium to long term. The focus of these management plans would be the matters discussed in Chapter 9.1.3 “Preferred Mitigation Strategy”. Management plans would describe the methods used to successfully implement the preferred mitigation strategy. Matters that should be accurately defined in the management plans include:

- The methods used for measuring the expected outcomes;
- The timing of revegetation/rehabilitation activities relative to clearing events;
- The type of plant materials to be used and their source;
- The collection and use of fauna habitat features;
- The methods associated with introducing plant material to cleared environments;
- The proposed monitoring methods; and
- Potential rectification methods for revegetation works deemed unsuccessful.

Issues that are more specific may include the investigation of various useful (*eg* wattles) and potentially damaging (*eg* Sifton Bush) pioneer species and their relative values in assisting the recovery of native vegetation and fauna habitats. The use of locally uncommon species may also be considered to enhance local biodiversity values such as the Capertee Stringybark *Eucalyptus cannonii*.

9.4 Potential Rehabilitation Timeframe

Table 9.4 estimates a potential timeframe for revegetation/rehabilitation mitigation works, which is based on the nature of vegetation, habitats currently present in the study area, the extent of natural regeneration, soils, climate and knowledge gained from similar local projects.

Table 9.4 Estimated rehabilitation timeframes

Year	Expectation of stage of vegetation/habitat rehabilitation
0	Initial planting of colonising species such as *Acacia* spp and native grasses. Placement of habitat features such as logs and woody debris.
5	Semi-mature *Acacia* spp regrowth with some minimal ground debris and increasing invertebrate abundances. Initial planting of canopy eucalypts.
10	Early regrowth woodland with relatively low dense vegetation. *Acacia* sp Mistletoes recolonising rehabilitated areas. Woodland birds returning to rehabilitated areas.
15	Early regrowth woodland with saplings and some semi-mature eucalypts. Acacia's starting to die back. Grassy nature of understorey becoming characteristic in some areas. Abundance of invertebrates.
25	Young open woodland with a characteristic structure, but lacking mature woodland features such as tree-hollows and abundant leaf and woody debris. Arboreal mammals returning to rehabilitated areas.
50	Mature functional open woodland.
75	Progression towards open forest densities in some more sheltered areas. Complex habitat features starting to develop (such as tree hollows).

9.5 Summary

The preferred mitigation strategy has been developed to deliver a net positive benefit for local biodiversity despite the loss of native vegetation and fauna habitats impacted by the MCP. The key elements of the mitigation strategy are:

- Avoidance of ecologically important elements;
- Dedication of EECs and native vegetation to the local conservation reserve network;
- Increase the net native vegetation cover within the locality;
- Enhance the ecological elements contained within existing native vegetation outside the impact area;
- Conserve important ecological habitats through the salvage of fauna habitats contained within the open cuts and consequential emplacement throughout rehabilitated/ revegetated landscapes; and
- Enter into Voluntary Conservation Agreements over lands containing native vegetation outside the impact area and revegetated/ rehabilitated landscapes to provide a secure long term beneficial outcome for local biodiversity.

The statistics presented in **Table 9.5** support the claim of a positive net biodiversity gain as a consequence of the MCP proceeding.

Table 9.5 Summary of Mitigation Outcomes

Mitigation Strategy	Area (ha)
Avoidance of White Box Yellow Box Blakely's Redgum Woodland EEC	19
Dedication of 2:1 White Box Yellow Box Blakely's Redgum Woodland EEC to conservation network	130
Avoidance of non-EEC native vegetation	24
Dedication of non-EEC native vegetation to the conservation reserve network	143
Dedication of potential revegetated lands to conservation reserve network	38
Revegetation Works	144
Rehabilitation Works	370
Extent of native vegetation excluded from the MCP	1262
Extent of Voluntary Conservation Area	1726

The total extent of mitigation, in terms of land area, as represented by the dedication to Goulburn River National Park and Voluntary Conservation Agreements is estimated at 2037 ha.

10 CONCLUSION

10.1 Summary of Impacts of Proposal upon Key Assessment Criteria

10.1.1 Threatened Species, Populations, Ecological Communities, and their habitats

White Box Yellow Box Blakely's Red Gum Woodland EEC

The MCP will result in the removal of native vegetation including areas classified as White Box Yellow Box Blakely's Red Gum Woodland EEC. The total area of this EEC to be removed is 64.68 ha leaving a residual of 194.92 ha within the MCP DA area. To mitigate, it is proposed to offset this immediate loss by dedicating like for like EECs, in a ratio of 2:1 for a total of 130 ha, to the local conservation reserve network. Further, it is proposed to rehabilitate OC1 mostly with Box-Gum Woodlands together with the revegetation of adjoining cleared agricultural landscapes, resulting in the establishment of 370 ha representing a net increase of 110 ha of native vegetation cover. Approximately 144 ha of cleared agricultural lands is to be revegetated to a state that will either reflect or enhance the biodiversity values of White Box Yellow Box Blakely's Red Gum Woodland EEC within the locality, thereby addressing the local cumulative loss of this habitat type and maintain/ improve wildlife linkages throughout the landscape. Approximately 5 ha of these revegetation works will focus on Grassy White Box Woodlands on basalts.

The total rehabilitation/revegetation package for mined areas/adjoining cleared environs is expected to be approximately 514 ha of mostly lower and midslopes landscapes, a net increase of at least 98 ha native vegetation after considering the loss of 416 ha from open cuts 1-3 and the main infrastructure area. Rehabilitated/ revegetated lands will be incorporated with existing native vegetation to form an area subject to a Voluntary Conservation Agreement. This Voluntary Conservation Agreement will be subject to various management regimes to conserve and enhance local native biodiversity values. The area proposed under the Voluntary Conservation Agreement is estimated at 2037 ha.

Table 10.1 Summary of Impacts upon threatened flora species and their habitats.

Species	Nature of Likely Impacts	Significant Impact
Narrow-leaved Goodenia *Goodenia macbarronii*	Would only be affected by OC1: Permanent maximum loss of ~ 1000 individuals; Restoration of Box Woodlands (i.e. potential habitat) considered sufficient mitigation.	No
Double-tailed Donkey Orchid *Diuris tricolor*	Would only be affected by OC1: permanent loss of ~ 1 individuals. The potential success of seed collection and use in revegetation works considered low. Single individual considered unviable and likely to become locally extinct in the absence of immediate intervention.	No
Hoary Sunray *Leucochrysum albicans* var *tricolor*	Will not be impacted by the proposed mine as it is located outside the disturbance envelope. Monitoring recommended to ensure viability of local population	No
Capertee Stringybark *Eucalyptus cannonii*	Would only be affected by OC1: temporary loss of ~ 7 individuals. Collection of seed and use in revegetation works considered sufficient mitigation.	No
Bush Stone-curlew *Burhinus grallarius*	Would only be affected by OC3: temporary loss of ~ 18ha of woodland foraging habitat (~ 2 year mine operation plus ~25 years rehabilitation to open woodland structure); some temporary noise impacts on habitats adjacent to OC3 (~ 2 years mine operation).	No

Table 10.2 Summary of Impacts upon threatened fauna species and their habitats.

Species	Nature of Likely Impacts	Significant Impact
Square-tailed Kite *Lophoictinia isura*	Expected to forage widely across the DA area: graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~15 years rehabilitation to regrowth woodland structure likely to support prey species).	No
Gang Gang Cockatoo *Callocephalon fimbriatum*	Likely winter visitor to the DA area: graduated temporary loss of ~172ha of foraging habitat (2-5 years for each pit operation plus ~25 years rehabilitation to open woodland structure).	No
Glossy Black Cockatoo *Calyptorhynchus lathami*	Two groups. Northern group not likely to be affected by the mine. Southern group would only be affected by OC1: core area would not be directly affected; graduated temporary loss of ~170ha of vegetation likely to contain patches of suitable *Allocasuarina* spp (~ 5 years for OC1 operation plus ~5 years rehabilitation of stands of *Allocasuarina* spp).	No
Swift Parrot *Lathamus discolor*	Winter visitor only, expected to forage widely across the DA area: graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~25 years rehabilitation to open woodland structure likely to provide suitable nectar resources).	No
Turquoise Parrot *Neophema pulchella*	Probable occasional visitor to grassy woodland habitats in the DA area: graduated temporary loss of ~ 88ha of foraging habitat (~ 2-5 years for each pit operation plus ~25 years rehabilitation to open woodland structure likely to provide suitable nectar resources).	No
Powerful Owl *Ninox strenua*	Expected to forage widely across the DA area: graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~25 years rehabilitation to open woodland structure likely to support prey species).	No
Masked Owl *Tyto novaehollandiae*	Probably forages across the southern part of the DA area, would only be affected by OC3; temporary loss of ~ 30ha of woodland foraging habitat (~ 2 year mine operation plus ~25 years rehabilitation to open woodland structure likely to support prey species).	No
Barking Owl *Ninox connivens*	Expected to forage widely across the DA area: graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~25 years rehabilitation to open woodland structure likely to support prey species).	No
Gilbert's Whistler *Pachycephala inornata*	No known habitat to be affected; graduated temporary loss of ~ 160ha of potential woodland habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to early regrowth woodland structure likely to provide suitable foraging habitat).	No
Grey-crowned Babbler *Pomatostomus temporalis*	Two pairs/groups occur in the southern part of the DA area, in woodland fringes to be cleared for OC3. All of the known habitat for this species in the DA area would be cleared.	Yes
Speckled Warbler *Pyrrholaemus sagittatus*	Occurs widely in woodland habitats in the DA area: graduated temporary loss of ~ 189ha of potential woodland habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to early regrowth woodland structure likely to provide suitable foraging habitat).	No
Brown Treecreeper *Climacteris picumnus victoriae*	Occurs widely in woodland habitats in the DA area: graduated temporary loss of ~ 224ha of potential woodland habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to early regrowth woodland structure likely to provide suitable foraging habitat).	No
Hooded Robin *Melanodryas cucullata cucullata*	Habitat appears to be associated with creeklines: virtually no areas of habitat to be directly disturbed; some temporary noise impacts on habitats adjacent to mine operations (~ 2-5 years per pit).	No

Table 10.2 Summary of Impacts upon threatened fauna species and their habitats.

Species	Nature of Likely Impacts	Significant Impact
Black-chinned Honeyeater *Melithreptus gularis gularis*	No known habitat to be affected; this species not likely to be significantly affected by the proposed mine.	No
Painted Honeyeater *Grantiella picta*	Dependent on *Amyema* spp mistletoes, recorded in three main locations in the study area: graduated temporary loss of one of the three areas by OC1 (~ 5 years for pit operation plus ~15 years rehabilitation to early regrowth woodland structure likely to support *Amyema* spp mistletoes).	No
Regent Honeyeater *Xanthomyza phrygia*	Occasional visitor only to woodland habitats: graduated temporary loss of ~ 160ha of foraging habitat (~ 2-5 years for each pit operation plus ~25 years rehabilitation to open woodland structure likely to provide suitable nectar resources).	No
Diamond Firetail *Stagonopleura guttata*	Occurs widely in woodland habitats in the DA area: graduated temporary loss of ~ 224ha of potential woodland habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to early regrowth woodland structure likely to provide suitable foraging habitat).	No
Giant Barred Frog *Mixophyes iteratus*	Not likely to be adversely affected by the proposed mine.	No
Squirrel Glider *Petaurus norfolcensis*	One area of known occasional habitat in a remnant adjacent to proposed OC3: no clearing of known habitat, but significant noise and other indirect impacts due to proximity of mine to vegetation remnant.	Possibly
Large-eared Pied Bat *Chalinolobus dwyeri*	Possible loss of roosting individuals due to rock falls; graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Little Pied Bat *Chalinolobus pictatus*	Possible loss of roosting individuals due to rock falls; graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Eastern Freetail Bat *Mormopterus norfolcensis*	Graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Eastern Bent-wing Bat *Miniopterus schreibersii*	Graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Little Bent-wing Bat *Miniopterus australis*	Graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Greater Long-eared Bat *Nyctophilus timoriensis*	Graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*	Graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No
Eastern Cave Bat *Vespadelus troughtoni*	Possible loss of roosting individuals due to rock falls; graduated temporary loss of ~ 416ha of foraging habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to open woodland structure likely to support suitable insect prey).	No

10.1.2 Native Vegetation and Habitats

The total rehabilitation/revegetation package for mined areas and the adjoining cleared environs is expected to be approximately 514ha of mostly lower and midslope landscapes, a net increase of at least 98 ha native vegetation when compared with the area to be lost through mine related activities. The revegetation/rehabilitation works will focus on the regeneration of Box Woodlands, a vegetation formation containing the greatest quantity of biodiversity within the locality including White Box Yellow Box Blakely's Red Gum Woodland.

The MCP is a sequenced mining operation that will permit the staged revegetation works in accordance with the preferred mitigation strategy. This sequencing will potentially offer opportunity to establish vegetation prior to clearing activities, creating alternative habitats for displaced biodiversity in the medium (*ie* plants) and long term (*ie* fauna).

10.1.3 Aquatic Systems

The MCP has been structured to avoid and minimise impacts on aquatic ecosystems. Other than several creek crossings for roads and other infrastructure plus the construction of a clean water dam on Bora Creek, there are no direct impacts on aquatic ecosystems. With regard to indirect impacts the potential problems of dust and spillages can be minimised to insignificance by proper safe practice. With regard to subsidence impacts on drainage lines above Underground 4 there may be some minor ponding but given the lack of water retention in these drainage lines and creeks some ponding capacity is considered a beneficial impact.

With regard to possible cumulative impacts from combined coal mining in the district, the main consideration relates to total mine water cycle. Practicably there will be times when there are water surpluses. When this occurs, the mine will only discharge water which meets the ANZECC/ARMCANZ (2000) criteria for the protection of aquatic ecosystems and at discharge rates which do not cause a deleterious impact on base-flow. Given the overall low volume of water available for aquatic ecosystems in the upper Goulburn River catchment this discharge is on balance considered a beneficial impact.

10.1.4 Adjacent DEC Estate

Potential impact sources on the adjoining DEC estate (*ie* Goulburn River National Park and Munghorn River Nature Reserve) will be restricted to operations associated with Underground 4 and OC3. However, mining impacts emanating from these sources will be negligible for the following reasons:

- Underground mining has been designed to minimise the occurrence of subsidence along the eastern boundary of Underground No. 4, such that no subsidence impact is expected on Goulburn River National Park; and
- The disturbance footprint of OC3 will range from 200 – 1400 m from Munghorn Gap Nature Reserve, with no water drainage capable of entering the reserve. Further, revegetation works assocaited with the preferred mitigation strategy will substantially improve the buffering qualities between open cut operations and the biodiversity values of Munghorn Gap Nature Reserve.
- There are no significant impacts on river or creek flow or water quality and there are no significant impacts on off-site groundwater flows. Consequently there are no significant impacts on offsite aquatic ecological attributes or GDEs.

10.2 Summary of Impacts of Proposal upon Other Assessment Criteria

10.2.1 Declining Woodland Birds

Table 10.3 Summary of Impacts upon Declining Woodland Birds

Species	**Nature of Likely Impacts**	**Significant Impact**
Declining Woodland Birds	Occur widely in woodland habitats in the DA area: graduated temporary loss of ~ 224ha of potential woodland habitat (~ 2-5 years for each pit operation plus ~10 years rehabilitation to early regrowth woodland structure likely to provide suitable foraging habitat).	No

10.3 Evaluation of Proposal against Key Thresholds

"*Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.*"

Land clearing will result in impacts to various forms of vegetation cover ranging from disturbed landscapes to intact native vegetation. The more pronounced impacts are on Box Woodlands, which was recognised as an area of high priority for avoidance (*ie* reduced the impacts on White Box Yellow Box Blakely's Red Gum Woodland by 19.02 ha). The avoidance of White Box Yellow Box Blakely's Red Gum Woodland has consequently retained important local biodiversity element that may potentially accelerate the recovery of revegetated and rehabilitated lands. Immediate actions including the dedication of 'like for like' EECs to the local conservation reserve network will improve long term conservation security of White Box Yellow Box Blakely's Redgum Woodland.

Of particular importance is the extent of land clearing, the sequencing of this activity and the proposed replacement of cleared biodiversity values. Vegetation will be cleared progressively from OC1, with ensuing mining operations moving onto OC2 and OC3. Progressive rehabilitation using native vegetation will occur throughout OC1 to minimise the time differential between clearing and successful revegetation works. Similarly, opportunity will exist for the revegetation of existing cleared lands within the adjoining agricultural landscape prior to mining events, thereby further diminishing the immediate impacts of mining. These actions will assist the restoration of wildlife corridors, particularly throughout the midslopes and lower elevations where Box Woodlands have historically been cleared for agricultural purposes. Given existing disturbance regimes, it is considered that the MCP represents an opportunity to improve local biodiversity values by altering the focus of local land uses.

In the short term, biodiversity values will be detrimentally affected by the extent of land clearing works. Early rehabilitation and revegetation works, combined with the avoidance and sequential mining strategies, will maximise the speed of habitat restoration, with the medium to long term outlook (*ie* 25 years +) considered to deliver an improved biodiversity outcome for the locality. This prediction has also considered the benefits of eliminating/managing current disturbance regimes that are negatively impacting the existing environment.

Some individual fauna species may be lost and/or some local populations may be lost in the short term. However, fauna habitats would be improved in the DA area and on some adjacent lands in the long term, in condition, extent and connectivity. It would be expected that the DA area would be recolonised by 'lost' species in time, given restoration of habitats, improved connectivity of habitats, and that other populations of all threatened species likely to be significantly affected do occur in the surrounding area and region.

"Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community."

Other than for the Hoary Sunray *Leucochrysum albicans* var. *tricolor*, populations of threatened flora species will experience direct impacts from mining operations. The extent of mining impacts on the Narrow-leaved Goodenia *Goodenia macbarronii* is considered small (*ie* loss of approximately 1000 individuals), relative to the extent of the known (approximately 9,500 specimens) and estimated (approximately 32,500 specimens) local population size. The loss of Capertee Stringybark *Eucalyptus cannonii* will substantially reduce the size of the known local population. However, the use of seed material from this species in the revegetation program is considered a viable method for adequately mitigating the impact. The loss of one specimen of the Double-tailed Donkey Orchid *Diuris tricolor* is considered a relatively minor loss given the extremely low population size (*ie* 2 individuals) and fragmentation (*ie* 9.5 km separation). It is likely that this species, without targeted intervention, will become locally extinct from existing disturbance regimes that are not linked to this proposal or its associated activities.

The loss of White Box Yellow Box Blakely's Red Gum Woodland EEC will represent in the short term a loss of important vegetation cover and fauna habitats. However, the long-term viability of these environs will not be placed at risk given the balance of vegetation excluded from the MCP layout and outcomes derived the preferred mitigation strategy (i.e. namely 2:1 dedication to conservation reserve network). The long term view is the establishment of Box Woodlands throughout currently cleared agricultural landscapes that will substantially increase the store of local biodiversity values and corridors between currently fragmented lands.

The proposed OC3 may destroy a local population of the Grey-crowned Babbler. It is difficult to predict whether a new population of this species would recolonise the area following mining.

The proposed OC3 may significantly affect a local population of the Squirrel Glider in the short term through indirect impacts such as noise, light and dust. However, this would not be expected to reduce long-term viability of this population.

"Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction."

The MCP is unlikely to result in the acceleration of local plant extinctions, with the exception of the Double-tailed Donkey Orchid *Diuris tricolor*. Intensive targeted surveys during the appropriate flowering period resulted in two specimens at separate locations being identified, with one being to be removed by the footprint of OC1. The MCP will be final contributor to the loss of this species from the central parts of the MCP area, with long-term agricultural disturbance regimes being the primary reason for the decline of this species within the local area. Targeted management regimes for the remaining specimen may result in the increasing of the local population throughout habitats created from revegetation works.

In relation to White Box Yellow Box Blakely's Red Gum Woodland EEC, it is considered that the proposal has adequately minimised the short-term impacts through avoidance, dedication to the conservation reserve network, revegetation works and progressive rehabilitation (i.e. preferred mitigation strategy). The MCP will not accelerate the local extinction of this EEC, particularly given the extent of dedication (i.e. 130 ha to local conservation reserve), proposed revegetation (*ie* 144 ha) and rehabilitation works for the 64.68 ha loss (*ie* proposed to offset/revegetate/rehabilitate at least 4 times the quantity lost through mining activities).

If Grey-crowned Babbler's cannot recolonise restored habitat in the OC3 area, then the loss of the local population would further the species towards extinction (although not necessarily 'accelerate' given that the impact is one-off short term impact, and that habitats would be restored).

"Whether or not the proposal will adversely affect critical habitat."

The proposed mine would not adversely affect any declared critical habitat.

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MOO O O T ST 1

F O F U U T O O SS SSM T

1

ompliance

u ust 2006

Ta le 1.1 ompliance of the Flora Fauna and uatic colo ssessment eport ith the irector eneral s e uirements dated 16th March 2006 here the relate to assessment of flora fauna and a uatic ecolo .

irector eneral s e uire ents	Location
eneral e uire ents	
etailed assessment of the ke issues specified elo hich includes	
description of the e istin en ironment	hapters 6 7
assessment of the potential impacts of the pro ect	hapter 8
description of the measures that ould e implemented to a oid minimise miti ate offset mana e and or monitor the impacts of the pro ect.	hapter 9
onsider the enefits and impacts of the pro ect as a hole	hapter 10
e ssues	
Flora and Fauna impacts on critical ha itats	hapter 10
threatened species populations ecolo ical communities	hapter 8.3
nati e e etation	hapter 8.2
ad acent ational ark estate	hapter 8.6
comprehensi e offset strate must e included as part of the miti ation measures for the pro ect to ensure there is no net loss of flora and fauna alues in the area in the medium to lon term.	hapter 9
umulati e mpacts potential cumulati e impacts on flora and fauna that ma arise from the com ined operation of the mine to ether ith the Ulan oal Mine and ilpin on oal Mine.	hapter 8 10
eferences	**a ter 11**
The n ironmental ssessment must take into account appropriate State o ernment technical and polic uidelines.	efer to Ta le 1.2 elo
onsultation	
urin the preparation of the n ironmental ssessment ou must consult ith the rele ant local and State o ernment authorities ser ice pro iders communit roups affected lando ners and an affected ommon ealth o ernment authorities. n particular ou must consult ith - epartment of n ironment onser ation - ommunit onsultati e ommittee - Ulan omunit	onsultation undertaken.

Ta le 1. ompliance of the Flora Fauna and uatic colo ssessment eport ith the draft uidelines for Threatened Species ssessment 2005 .

The uidelines identif important factors and or heads of consideration that must e considered proponents and consultants hen assessin potential impacts on threatened species populations or ecolo ical communities or their ha itats for de elopment applications assessed under art 3 of the *Environmental Planning and Assessment Act 1979*.

uidelines	Location
Factors to onsider	
ll de elopment applications must include a statement as to hether or not threatened species are likel to occur in the stud area.	Te t Ta les 4.1 6.2 hapter 7.3
The stud area should e tend as far as is necessar to take all potential direct and indirect impacts into account.	hapters 1 2.3
f there is a likelihood of threatened species ein present the de elopment application must e accompanied a threatened species assessment.	hapter 8
Ste s in t e ssess ent rocess	
Ste 1 reli inar ssess ent	
rimaril a desktop assessment ith some preliminar site inspections.	hapters 3.1 3.2 4.1 5.2 5.3
preliminar assessment should include	
• a description of dominant e etation t pes	hapter 3.2
• a description of ha itat features	hapter 4.3.1 6.2
• a list of threatened species kno n or likel to occur ithin the stud area	ppendices 2 5
• an assessment of hich of the threatened species are likel to e affected the proposal.	Te t Ta les 4.1 6.2
Ste Field Sur e and ssess ent	
Field sur e s should e conducted suita l ualified and e perienced in esti ators.	See end of this appendi .
ntensit and e tent of sur e must encompass the eo raphic e tent of the de elopment and sample the full ran e of en ironments that occur.	hapters 3.3 4.2 5.4 and ppendi 6
Sur e s should conform to accepted methods and e fle i le to account for species and or features not detected durin preliminar assessment.	hapters 3.3 4.2 5.4
Sur e s to e undertaken durin optimal climatic and seasonal conditions considerin issues such as mi rator species and a aila ilit of ha itat features and resources.	hapters 3.3.4 4.2 and ppendi 6
onsideration must e i en to the presence of ha itat for threatened species in the sur e area.	ppendices 2 5 Te t Ta le 4.1
Ste 3 aluation of acts	
dentif impacts in terms of ma nitude and e tent of impacts and also si nificance.	hapter 8
Ste oid itigate and t en ffset	
escri e and ustif measures to miti ate ad erse impacts. onsideration to e i en to measures to a oid or minimise the impacts.	hapter 9.2
here measures to a oid and miti ate are not possi le or not sufficient then offset strate ies need to e considered.	hapter 9.2
The e tent to hich measures a oid miti ate or offset impacts upon threatened species must reflect the conser ation alue and formal status of the feature species or ha itat.	hapter 9.2

Ta le 1. cont ompliance of the Flora Fauna and uatic colo ssessment eport ith the draft uidelines for Threatened Species ssessment 2005 .

uidelines	Location
Ste e t res olds	
The de elopment application needs a ustification of the preferred option ased on the four ke thresholds listed in the uidelines.	hapter 10.3
endi 1 Structure and content of t e re ort	
efinitions	**a ter 1**
planation of technical terms used throu hout the report.	hapter 1
ntroduction	**a ter**
uthor of the stud and ho it as commission	hapter 2.1
description of the proposal	hapter 2.2
The re ional conte t location eolo soils landforms climate distur ance histor and other rele ant information relatin to stratification re uirements	hapter 2.3
onstraints or limitations to the stud .	hapter 2.4
et ods	**a ters 3**
ata sources and ho data as handled	hapters 3.1 3.4 4.1 4.3 5.2
Methods used to determine stratification units ho the units ere sampled and information relatin to spatial distri ution and si e of strata	hapter 3.2
escription of each stratification unit	hapter 6.2
a itat assessment of each unit includin distur ance eeds and suita ilit as ha itat for species populations and ecolo ical communities of conser ation si nificance.	hapter 6.2
Sur e techni ues and intensit of samplin in each strata	hapter 3.3.2 4.2.3
T pe and num er of traps la out aits num er of sur e ni hts per techni ue	ppendi 6
Samplin dates times and eather conditions	hapters 3.3.4 4.2.4 5.4.2
ocation and la out of stratification units uadrats samplin sites e etation t pes and rele ant species distri ution	Fi ures 3.1 4.1 4.2 4.3 5.1. 4.4 6.1
ata anal sis methods includin criteria used to cate orise areas of hi h iodi ersit .	hapters 3.4.5 4.3.3
esults	**a ters**
ists of all plants and animal species recorded	ppendices 4 7 8
ist of all threatened species populations ecolo ical communities recorded kno n or likel to occur	hapter 6.3
Summaries of data includin hich species found at hich sites strata or ha itat t pes and hich methods	ppendicis 4 6 8
Maps of sur e method locations	Fi ures 4.1 4.2 4.3 5.1
Maps of en ironmental features e etation t pes and ha itat t pes	Fi ures 3.1 3.3 4.4
esults of modellin or statistical anal sis of data	hapter 3.4 and ppendi 8
Maps sho in location of threatened species records or e tents	Fi ures 3.5 4.4

Ta le 1. cont ompliance of the Flora Fauna and uatic colo ssessment eport ith the draft uidelines for Threatened Species ssessment 2005 .

uidelines	**Location**
Maps of areas of hi h iodi ersit or other special si nificance	Fi ure 9.1
a data sheets should e included in an appendi .	ppendi 6
act aluation	**a ter**
escri e the conte t and intensit of impacts.	hapter 8
itigation	**a ter**
Measures to a oid impacts	hapter 9.2.5
Miti ation measures amelioration and off set strate ies.	hapter 9.2
onclusion	**a ter 1**
Summar of information collected includin statements on the likel presence a sence of threatened iodi ersit and eneral ha itat alue of the stud area	hapter 10.1
nterpretation of results of the stud includin statements as to ke thresholds	hapter 10.3
imitations and further issues that ma need to e addressed.	o further issues than those listed in hapter 2.4
eferences	**a ter 11**
ite all pu lications used.	hapter 11
endices	**endices 1**
ollates detailed information in the ack of the report and allo s the main od of the report to e concise.	
To include	
• ra field data sheets	ppendi 6
• ualifications of all people in ol ed in the samplin and preparation of the report	See end of this appendi
• certification of the report the in esti ator	See end of this appendi
• issue num er and names of issuin odies of an licenses permits or authorities under hich the field ork as carried out.	See end of this appendi

Ta le 1.3 ro ect Team e perience ualifications and licenses

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MOOLARBEN COAL PROJECT – STAGE 1

FLORA, FAUNA AND AQUATIC ECOLOGY ASSESSMENT

APPENDIX 2

Flora literature review including information on threatened species

May 2006

. in i tearns ngineers 3

Flora sur e s and impact assessment ere completed in 1983 to support an S assessin the impacts of an e pansion to the e istin Ulan coal mine. Se en e etation t pes ere identified durin that sur e ith a summar of these pro ided in a e A2. .

a e A2. Vegetation o unities o t e an en ut and surrounding en irons 3

T		
1	Woodland (Ridgetops)	Canopy dominated by Narrow leaved Ironbark (*Eucalyptus crebra*) Blue leaved Stringybark (*E. agglomerata*) Dwyer s Redgum (*E. dwyeri*) Caleys Ironbark (*E. caleyi*) Brown Stringybark (*E. eugenoides*) and Black Cypress Pine (*Callitris endlicheri*) Understorey consisting of *Melaleuca uncinata, Hakea dactyloides, Acacia brownei, Grevillea sericea, G. floribunda, Persoonia linearis, Oxylobium ilicifolium, Cassinia laevis.*
2	Woodland pen Forest (Talus Slopes)	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Forest Redgum (*E. tereticornis*) Dwyer s Redgum (*E. dwyeri*) Brown Stringybark (*E. eugenoides*) and Blakely s Redgum (*E. blakelyii*) Understorey consisting of *Casuarina littoralis, Acacia linearifolia, M. uncinata, Hakea dactyloides, C. endlicherii, Persoonia linearis, Cassinia laevis.*
3	Cleared (Throughout area mainly valley floor)	Canopy dominated by scattered Rough barked Apple (*A. floribunda*) Understorey consisting of *Acacia linearifolia, Cassinia laevis* and groundcover native grasses (e g *Stipa, Danthonia*)
4	Cleared (Valley floor)	Canopy dominated by ellow Box (*E. melliodora*) and Rough barked Apple (*A. floribunda*) Understorey consisting of *Acacia linearifolia, Cassinia laevis* and grasses
5	pen Woodland (Talus Slopes Partly Cleared)	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Brown Stringybark (*E. eugenoides*) ellow Box (*E. melliodora*) and Rough barked Apple (*Angophora floribunda*) Understorey consisting of *Acacia linearifolia, Cassinia laevis* and grasses
6	pen Woodland (Talus Slopes Partly Cleared)	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Dwyer s Redgum (*E. dwyeri*) and Blakely s Redgum (*E. blakelyi*) Understorey consisting of *Casuarina littoralis, Acacia linearifolia, A. polybotrya, C. endlicherii.*
	pen Woodland (Valley Floor)	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Inland Scribbly Gum (*E. rossii*) ellow Box (*E. melliodora*) and Blakely s Redgum (*E. blakelyi*) Understorey consisting of *C. littoralis* and *A. linearifolia.*

These studies ere completed durin the earl sta es of the enacted ct ith flora and fauna impact assessments relatin to the schedules of the *ational Par s and ildli e Act 197* . t that time none of the species or communities found ithin the sur e ed area as listed as threatened.

o e er su se uent to these studies there ha e een man chan es to the le islation and threatened species listin s. comparison of the results from this 1983 stud ith recent listin s indicate the presence of at least one threatened ecolo ical communit this ein hite o ello o lakel s ed um oodland i.e. communities 3 4 5 and possi l 7 .

1. S ( )

ecent mappin and round sur e the S has esta lished oul urn i er ational ark to contain at least 14 e etation communities. **Ta le .** identifies those e etation communities located ithin the ad oinin oul urn i er ational ark.

Ta le . egetation o unities of t e oul urn i er ational ar ( )

T		
1	Ironbark pen Forest on Sandstone	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Blue leaved Ironbark (*E. nubila*) Broad leaved Ironbark (*E. fibrosa*) Stringybark (*E. sparsifolia*) and Black Cypress Pine (*C. endlicheri*) with a shrubby understorey Sheoak (*Allocasuarina gymnanthera*) dominates the shrub stratum ccurs on ridgetop plateaus with shallow to skeletal soils
2	Sheltered pen Forest Complex	Canopy dominated by Grey Gum (*E. punctata*) with canopy associates of varying abundance including Redgum (*E. blakelyi, E. tereticornis*) and Stringybark (*E. sparsifolia / E. agglomerata*) Shrub stratum well developed Located on protected slopes and gullies and is widespread
3	Exposed pen Woodland	pen woodland canopy dominated by Narrow leaved Ironbark (*E. crebra*) Caley s Ironbark (*E. caleyi*) Broad leaved Ironbark (*E. fibrosa*) and Black Cypress Pine (*Callitris endlicheri*) with a shrubby understorey Canopy associates of varying abundance include Bloodwood (*Corymbia amphistomatica*) Inland Scribbly Gum (*E. rossii*) and Grey Gum (*E. punctata*)
4	Narrow leaved Ironbark pen Forest	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) and Rough barked Apple (*A. floribunda*) with canopy associate including Grey Gum (*E. punctata*) Shrub stratum poorly developed Grassy herb rich groundcover dominates understorey
5	Slaty Gum pen Forest	Canopy dominated by Slaty Gum (*E. dawsonii*) and Grey Box (E *moluccana*) Canopy associates include Narrow leaved Ironbark (*E. crebra*) Broad leaved Ironbark (*E. fibrosa*) Brown Stringybark (*E. eugenoides*) and Black Cypress Pine (*C. endlicheri*) Limited occurrence on Narrabeen clays
6	pen Forest on Pilliga Sandstone	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Broad leaved Ironbark (*E. fibrosa*) and Brown Bloodwood (*C. trachyphloia*) Shrub stratum well developed ccurs on ridgetops and plateaus
	Apple Alluvial pen Forest	Canopy dominated by Rough barked Apple (*A. floribunda*) with canopy associates of varying abundance including Narrow leaved Ironbark (*E. crebra*) Box s (*E. melliodora, E. albens*) and Redgum (*E. blakelyi, E. tereticornis*) Inland Scribbly Gum (*E. rossii*) and Grey Gum (*E. punctata*) occur in sandier soils with a more pronounced shrub stratum Found on broad depressions stream banks and sandy alluvial deposits
8	Munghorn Sheltered pen Forest	Canopy dominated by Grey Gum (*E. punctata*) Blue leaved Stringybark (*E. agglomerata*) Stringybark (*E. sparsifolia*) and Black Cypress Pine (*C. endlicheri*) Shrub stratum well developed Located on sheltered slopes and gullies.
9	Low pen Forest Scrub Complex	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Broad leaved Ironbark (*E. fibrosa*) Stringybark (*E. sparsifolia*) and Bloodwood (*C. amphistomatica*) Shrub stratum well developed including *Hakea, Callitris Melaleuca* and *Allocasuarina* ccurs on ridgetops and plateaus in the Wollar Creek catchment
10	Scribbly Gum Woodland (Valley Floor)	Canopy dominated by Inland Scribbly Gum (*E. rossii*) in association with Ironbarks and Bloodwoods Shrub stratum well developed ccurs on broad sandy flats in the Wilpin ong area
11	White and Grey Box Woodlands	Canopy dominated by Box (*E. albens* and *E. moluccana*) Canopy associates include ellow Box (*E. melliodora*) Blakely s Redgum (*E. blakelyi*) and Fu y Box (*E. canonica*) Understorey grassy except for some basalt areas where White Cypress (*C. glaucophylla*) may occur Located on basalt caps and basalt derived alluvial flats
12	Callitris Alluvial pen Forest	Canopy dominated by Black Cypress Pine (*C. endlicheri*) on deep alluvial sands Canopy associates include Grey Gum (*E. punctata*) and Rough barked Apple (*A. floribunda*) Understorey consisting of *Acacia linearifolia* and grasses
13	Dry Rainforest in Sandstone Gorges	Canopy dominated by Figs (*Ficus* sp) and Grey Myrtle (*Backhousia mytifolia*) Emergent canopy includes Grey Gum (*E. punctata*) and Brown Stringybark (*E. eugenoides*) Shrub stratum well sparse Located on protected south facing gullies along creek lines
14	River ak Riparian Forest	Canopy dominated by River ak (*Casuarina cunninghamiana*) on sandy alluvial soils Shrub stratum generally absent

ommunities 7 and 11 ma e classified as elon in to the hite o ello o lakel s ed um oodland as the oth contain one or more of the characteristic canop dominant and a rass her aceous understore .

oul urn i er ational ark also contains ha itat for threatened species ith man onl recentl ein listed on the schedules of the TS ct. **Ta le .3** identifies those species found ithin the national park oundaries.

Ta le .3 T reatened S ecies of oul urn i er ational ar

N	N	L		N R
		T	E B	
	Homoranthus darwiniodes	V	V	15 km East
	Kennedia retrorsa	V	V	60km East
	Ozothamnus tessellata	V	V	30 km East
	Cynanchum elegans	E		60km East
	Acacia dangariensis	V		60km East
	Senecio linearifolius var. dangariensis	E		60km East
	Lasiopetalum longistamineum	V	V	60km East
Tiger rchid	*Cymbidium canaliculatum*	EP		50km East

The nearest threatened species record located ithin oul urn i er ational ark to the stud area is *omorant s dar iniodes* hich occurs on the ees inch Soil andscape at ees inch. This species is found on rock sandstone outcrops and has een recorded as far est as u o arden 2002 . *ennedia retrorsa nanc m elegans Acacia dangariensis* and *enecio lineari oli s var dangariensis* occur at Mt an ar hich is located at the eastern mar in of oul urn i er ational ark some 60km from the stud area. These species are associated ith asaltic influenced soils.

ot amn s tessellata is a shru that is found on talus slopes sometimes in association ith Slat um forests. *m idi m canalic lat m* is listed as an endan ered population ithin the unter alle and oul urn i er catchments. The localit of the nearest record to the stud area is at ulls amp roadside rest stop east of Merri a here it is found in a mature hite o *E cal t s al ens* . This species is kno n to occur in o t pe eucal pt oodlands at a densit of appro imatel 1 plant per 30km^2 S Scientific ommittee 2005 .

1.3 esource Strategies ( )

n S as prepared for the proposed ilpin on oal ro ect hich is located ad acent to the eastern oundar of the stud area. The flora stud supportin this S identified a num er of e etation communities as sho n in **Ta le . .**

Ta le . egetation o unities it in t e il in ong oal ro ect ( )

T		
1	ellow Box Blakely s Redgum Woodlands	Canopy dominated by ellow Box (*E. melliodora*) and Blakely s Redgum (*E. blakelyi*) Canopy associates of varying abundance including Rough barked Apple (*A. floribunda*) and or Grey Box (*E. moluccana*) Blakely s Redgum (*E. blakelyi*) dominates wetter creeklines with Rough barked Apple (*A. floribunda*) occurring on the periphery
2	Coast Grey Box Woodlands	Canopy dominated by Grey Box (*E. moluccana*) Canopy associates include Narrow leaved Ironbark (*E. crebra*) Rough barked Apple (*A. floribunda*) and Black Cypress Pine (*C. endlicheri*) ccurs upslope of community 1 in drainage lines and gentle slopes of valleys
3	Rough barked Apple Woodland	Canopy dominated by Rough barked Apple (*A. floribunda*) with canopy associates including Narrow leaved Ironbark (*E. crebra*) and Black Cypress Pine (*C. endlicheri*) ccurs on slopes rises and hills of the valley floor
4	Narrow leaved Ironbark Forest	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) and Black Cypress Pine (*C.*

T		
		endlicheri) Canopy associates include Rough barked Apple (*A. floribunda*) Red Stringybark (*E. macrorhyncha*) and Caley s Ironbark (*E. caleyi*) ccurs on gravely soils of the lower slopes
5a	Grassy White Box Woodlands	Canopy dominated by White Box (*E. albens*) Canopy associates include Grey Box (*E. moluccana*) and Black Cypress pine (*C. endlicheri*) Permian clay hills north facing colluvial footslopes of sandstone ranges
5b	Shrubby White Box Woodlands	Canopy dominated by White Box (*E. albens*) Canopy associates include Grey Box (*E. moluccana*) Narrow leaved Ironbark (*E. crebra*) Rough barked Apple (*A. floribunda*) and Black Cypress pine (*C. endlicheri*) East south and west facing lower and mid slopes of sandstone ranges dry elevated flats on sandstone ranges
6	Sandstone Range Shrubby Woodlands	Canopy dominated by Narrow leaved Ironbark (*E. crebra*) Blue leaved Stringybark (*E. agglomerata*) Broad leaved Ironbark (*E. fibrosa*) Stringybark (*E. sparsifolia*) Grey Gum (*E. punctata*) Slaty Gum (*E. dawsonii*) and Black Cypress Pine (*C. endlicheri* ccurs on the upper slopes and ridges
	Cleared Agricultural Land	N A ccurs on the Permian soils of the valley floor
8	Secondary Shrubland	*Acacia ixiophylla A. implexa, A. linearifolia Bursaria spinosa Cassinia quinquefaria* Recently cleared lands of the sandstone range footslopes

hile 403 flora species ere found ithin the ilpin on stud area none ere listed as threatened esource Strate ies 2005 . o e er t o re ionall si nificant species ere recorded durin the sur e these ein *oronia ang stise ala* and *onocar s longi oli s*. oth are listed as rare nationall in *are or reatened A stralian Plants* OT ri s and ei h 1996 . either species as recorded ithin the area to e distur ed the ilpin on mine ith their occurrence restricted to the upper slopes of the Sandstone an e Scru oodlands e etation communit .

n addition one potential ne species of ello uttons *r soce al m* sp. as recorded in Sandstone an e Scru oodlands e etation communit in the south est of the ilpin on pro ect area. Similarl it is reported that this species of uncertain ta onomic identit ill not e ad ersel impacted the ilpin on mine.

1. nternational n iron ental onsultants t Li ited ( )

Trans rid proposes to install a ne 330k po er line from ollar to ellin ton there re uirin an S to e prepared to assess the impact. Species mpact Statement S S prepared um erland colo supported the S to address a ariet of threatened species and endan ered ecolo ical communit issues.

portion of this transmission line tra erses the stud area alon ilpin on reek here it crosses o er to the Ulan airstrip and Ulan illa e. **Ta le .** identifies the e etation communities mapped ithin the stud area.

Ta le . egetation o unities of t e ollar to ellington 33 trans ission line ( )

T		
1	Black Cypress Pine White Box	Canopy dominated by Black Cypress Pine (*C. endlicheri*) and White Box (*E. albens*) Canopy associates include Tumbledown Redgum (*E. dealbata*) Understorey sparsely shrubby with *Hibbertia obtusifolia* and *Cassinia* sp ccurs on granite derived soils
2	White Box Inland Grey Box	Canopy dominated by Box (*E. albens* and *E. microcarpa*) Canopy associates include Blakely s Redgum (*E. blakelyi*) and Rough barked Apple (*A. floribunda*) Understorey grassy with shrubs less than 5 cover
3	Black Cypress Pine Tumbledown Redgum	Canopy dominated by Black Cypress Pine (*C. endlicheri*) Box and Tumbledown Redgum (*E. dealbata*) Understorey shrubby with grasses such as *Aristida* spp common throughout Located on granitic hilltops
4	Black Cypress Pine Broad leaved Ironbark	Canopy dominated by Black Cypress Pine (*C. endlicheri*) and Broad leaved Ironbark (*E. fibrosa*) ther canopy associates include Inland Scribbly Gum (*E. rossii*) Dwyer s Redgum

	T	
		(*E. dwyeri*) Narrow leaved Ironbark (*E. crebra*) and Blue leaved Stringybark (*E. agglomerata*) and with a shrubby understorey containing Sheoak (*A. gymnanthera*) ccurs on ridgetop plateaus with shallow to skeletal soils
5	River Redgum Riparian Forest	Canopy largely absent ccurs along creeklines

etailed sur e s also identified the presence of the threatened arro lea ed oodenia *oodenia mac arronii* a small annual her found mostl in moist draina e lines on cla s and shale deri ed allu iums. Other species considered potentiall occurrin ithin the transmission easement that ere assessed in the S S include the apertee Strin ark *E cal t s cannonii ot rioc loa ilo a icant e m setos m* and *ieria o cordata*.

T T FL F T UL ST T

isted elo in **Ta le .** are the threatened flora species endan ered populations and endan ered ecolo ical communities of the Ulan localit accordin to the ildlife tlas ata ase 2006 rotected Matters eport 2006 rele ant local literature S 2000 inhill Stearns n ineers 1983 esource Strate ies 2005 2005 and field sur e .

Ta le . T reatened Flora S ecies s and s of t e Ulan Localit ( )

		L O		A
Acacia dangariensis Vulnerable (TSC Act)	Small tree to 10 m high bark at first smooth and grey later fissured and blackish at base Leaves with petiole 0 4 5 cm long with 1 prominent gland glabrous to very sparsely haired Leaf glands present pinnae 2 6 pairs 3 8 cm long pinnules 14 30 pairs linear mostly 4 9 mm long glabrous Flowers in terminal or auxiliary panicles bright yellow Pods mostly straight flat and straight sided	Basaltic soils of the study area are restricted to isolated outcrops on ridges and plateaus and mostly disturbed by agriculture Nearest occurrence 60 km to the east on a basaltic outcrop near the Sandy ollow village (i e Mt Dangar)	Briggs and Leigh (1995) classified with a risk code of 2RC t meaning that it has a range of less than 100 km is not conserved and is threatened Records from Mt Dangar are within Goulburn River NP	This species has limited potential to occur within the study area
Boronia ruppii Endangered (TSC Act) Endangered (EPBC Act)	Shrub 0 4 2 m high branchlets stellate pubescent Leaves 1 foliolate or 3 foliolate leaflets elliptic to broad elliptic or spathulate 4 18 mm long 3 8 mm wide apex obtuse or retuse margins entire and recurved to flat concolorous both surfaces glabrous to sparsely stellate hairy petiole 1 3 mm long Inflorescences axillary 1 3 flowered pedicels 3 8 mm long Calyx stellate tomentose Petals 5 9 mm long valvate pale to bright pink stellate tomentose persistent in fruit	Nearest occurrence north of the Ulan coal mine within the study area The record is dated 1998 and is consistent with an identification using arden (1992) owever *Boronia ruppii* has been separated into two species these being the nominate species at Woods Reef and *Boronia rubiginosa* No plant material matching the description of *B. ruppii* in the study area Rather *B. rubiginosa* has been identified within the study area	Confined to Woods Reef on serpentinite in the North West Slopes botanical subdivision	There is no occurrence of suitable habitat within the study area It is considered that this species will not occur within the study area
Bothriochloa biloba Bi lobed Bluegrass Vulnerable (EPBC Act)	Bilobed Bluegrass (*B. biloba*) is an erect or decumbent caespitose perennial to 1 metre high with culms branching from nodes situated on the main growth axis This species flowers mostly in summer within woodlands on poorer soils	This species occurs on moderately fertile soils particularly in areas of limited gra ing The nearest occurrence is km to the east in the Wilpin ong Coal Pro ect area	The ma ority of known populations occur north from NSW central western districts with occurrences in the Denman locality representing	This species has limited potential to occur within the study area

		L O		A
	throughout a distribution that extends north from the NSW Central Coast to ueensland including the ad acent northern tablelands western slopes and plains The ma ority of confirmed specimens have come from roadsides travelling stock routes and paddocks The species appears to be more prevalent in conservatively or rotationally gra ed DEC (2004) purports that the absence of gra ing may preferentially benefit the growth of competitive perennial grasses thereby exclude *B. biloba*		one of the few populations located east of the Great Dividing Range Until recently Bilobed Bluegrass (*B. biloba*) was listed as vulnerable on the TSC Act owever in 2005 this species was removed from the schedules of the TSC Act	
Cymbidium canaliculatum Tiger rchid Endangered Population (TSC Act)	Epiphyte with linear leaves 10 50 cm long 1 5 4 cm wide succulent rigid deeply V shaped in cross section not shiny Flower 15 58 cm long 12 60 flowered suberect to pendent basal pedicel plus ovary 23 35 mm long Sepals and lateral petals very variable in colour usually olive green mottled with purple Sepals 11 25 mm long 4 5 10 mm wide Labellum 9 15 mm long with 2 parallel keels from the base to the base of the midlobe not viscid white to cream with red or purple markings (arden 1993)	The unter River population associated with White Box (*Eucalyptus albens*) usually occurring singly or as single clumps typically between two and six m above the ground Less common hosts include Slaty Gum (*E. dawsonii*) Narrow leaved Ironbark (*E. crebra*) Grey Box (*E. moluccana*) Rough barked Apple (*Angophora floribunda*) Cooba (*Acacia salicina*) (NSW Scientific Committee 2005) Database records identify the nearest occurrence of this species to be 0 km east of the study area near Sandy ollow	This species is listed as an Endangered Populations on the TSC Act for the unter and Goulburn River catchments	ost trees are common throughout the valley floor of the study area Potential exists for this species to occur within the study area
Cynanchum elegans Endangered (TSC Act)	Climber or twiner with stems to ca 1 m long Broad ovate to ovate leaves with lamina 1 5 5 5 cm long 15 25 mm wide apex short acuminate base truncate to scarcely cordate mostly glabrous 2 basal glands present petiole 5 25 mm long Few white flowers are borne in clusters or umbels on branched peduncles during summer	Database records identify the nearest occurrence of this species to be 60 km to the east at Mt Dangar a basaltic outcrop near the Sandy ollow village Basaltic soils of the study area are restricted to isolated outcrops on ridges and plateaus and are mostly disturbed by agriculture There is limited potential for this species to occur within the study area	This species is listed as Endangered on the TSC Act It is classified with a risk code of 3EC i meaning that it has a range of less than 100 km is conserved (Goulburn River NP) and is inadequately protected (Briggs and Leigh 1995)	This species has limited potential to occur within the study area
Dicanthium setosum	Erect perennial to 1 m high Leaves 2 3 5 mm wide with sheath glabrous except at the nodes	Database records identify the nearest occurrence of this species to be 12 km to the	This species is listed as Vulnerable on the TSC Act and	This species has limited potential to occur within the

		L O		A
Vulnerable (TSC Act) Endangered (EPBC Act)	Flower stalks number 1 3 to 8 cm long and appear in summer Lowest pairs of spikelets male oints and pedicels ca 2 mm long ciliate with hairs increasing upwards to 2 mm long Sessile spikelets 5 6 mm long callus obtuse often densely bearded with hairs to 1 mm long (arden 1993)	south of the study area in Cooyal Creek catchment Records indicate habitat to be associated with carboniferous derived quaternary alluviums	EPBC Act Its prescribed distribution is from the Dubbo district (Central Western Slopes) to the northern tablelands and ad oining slopes This species also occurs in ueensland and Western Australia	study area
Digitaria porrecta Endangered (TSC Act) Endangered (EPBC Act)	Spreading or erect greyish pubescent perennial to 0 6 m high swollen at the base culms and sheaths hairy especially near the nodes becoming glabrous upwards Leaves 2 3 mm wide with agged margins Racemes stiffly spreading at maturity the lower in a whorl of 4 to 6 and to 30 cm long bare at their bases for 4 11 cm mostly unilaterally branched the branches 3 12 cm long bearing 3 13 paired or solitary spikelets Flowers in summer	Database records identify the nearest occurrence of this species to be 80 km to the north This species grows on better soils that are of limited occurrence in the study area	This species is listed as Endangered on the TSC Act It is classified with a risk code of 3E meaning that it has a range of less than 100 km and is endangered (Briggs and Leigh 1995)	There is a low potential for this species to occur within the study area
Diuris tricolor Double tailed Donkey rchid Vulnerable (TSC Act) Vulnerable (EPBC Act)	Double tailed Donkey rchid *D. tricolor* previously referred to as *Diuris sheaffiana* is a spring flowering yellow orchid to 50cm with red to purple markings and long green to brown lateral sepals Flowers appear in early ctober and can last for a week before initiating the formation a fruit capsule Fruit are a dehiscent dry capsule borne on the plant during summer	Database records identify the nearest occurrence of this species to be 12 km to the south of the study area in Cooyal Creek catchment Records indicate habitat to be associated with carboniferous derived quaternary alluviums	This species is listed as Vulnerable on the TSC Act And EPBC Act	Given the occurrence of this species near coalmines in the Muswellbrook locality it is considered that this species is likely to occur within the study area
Eucalyptus cannonii Cannon s Stringybark Vulnerable (TSC Act) Vulnerable (EPBC Act)	Tree to 15 m high bark persistent throughout grey to red brown stringy uvenile leaves dis unct broad lanceolate glossy green hispid Adult leaves dis unct lanceolate 10 19 cm long 1 5 2 5 cm wide green dull to semi glossy concolorous Flowers anuary April	Database records indicate populations distributed to the south of the study area with the nearest herbarium lodged record approximately 15km to the south Throughout its distribution The Capertee Stringybark *E. cannonii* is locally frequent but restricted in	This species is listed as Vulnerable on the TSC Act And EPBC Act Conserved in Avisford Nature Reserve Winburndale NR Wollemi NP and Gardens of Stone NP	Given the presence of this species to the east in the Wilpin ong Coal mine area it is considered that there is a high chance of it occurring within the study area

		L O		A
		sclerophyll woodland on shallow soil on rises Prior to this study the Capertee Stringybark (*E. cannonii*) has been recorded approximately 5km to the E near the Wollar Mudgee Road (RS 2005)	Considered adequately conserved (unter and White 1999)	
Homoranthus darwiniodes Vulnerable (TSC Act)	Spreading shrub usually 1 1 5 m high glabrous Leaves linear terete 2 5 mm long in some populations 6 11 mm long in others up to ca 1 mm wide Flowers pendent on speciali ed 2 flowered shoots each flower enclosed by 2 tardily shed bracteoles Flowers in spring	Database records identify the nearest occurrence of this species to be within 5 km to the west within the Ulan coal mine precinct This species is restricted to skeletal sands of the Narrabeen geological formation from the Dubbo Goulburn River NP area	This species is listed as Vulnerable on the TSC Act It is classified with a risk code of 3VC a meaning that it has a range greater than 100 km is conserved (Goulburn River NP) and is adequately conserved (Briggs and Leigh 1995)	This species has potential to occur within the study area particularly throughout the northern parts of EL 6288
Goodenia macbarronii Narrow leaved Goodenia Vulnerable (TSC Act) Vulnerable (EPBC Act)	Narrow leaved Goodenia *G. macbarronii* is a small annual sometimes perennial herb growing to 30cm (max 40cm) with a short tap root and developed secondary root system The thick narrow obovate to linear oblanceolate leaved generally range from 5 11cm and are generally erect from a basal rosette (arden 1992 IEC 2005) Flowering generally occurs from December to April with occasional spot flowering evident in large populations after substantial periods of rainfall	Prior to this study the local recorded distribution of this species shows isolated occurrences north of the Ulan coal mine (DEC 2005) and a single location 4km to the WNW of the Ulan township (IEC 2005) At Wybong approximately 0km east of the study area is the most easterly known population consisting of at least 5000 throughout drainage lines and open paddocks	This species is listed as Vulnerable on the TSC Act And EPBC Act	igh potential exists for the presence of this species within the study area
Kennedia retrosa Vulnerable (TSC Act) Vulnerable (EPBC Act)	Climbing herb stems pubescent with rusty or white hairs Leaves 3 foliolate leaflets broad elliptic to obovate or circular 3 13 cm long 3 10 cm wide upper surface pubescent lower surface paler rusty to whitish pubescent stipules ovate ca 5 mm long Flowers pink purple to scarlet pod compressed 6 cm long densely hairy seeds ca 4 ovoid Flowers in spring	Database records identify the nearest occurrence of this species to be 60 km to the east at Mt Dangar a basaltic outcrop near the Sandy ollow village Basaltic soils of the study area are restricted to isolated outcrops on ridges and plateaus and mostly disturbed by agriculture	This species is listed as Vulnerable on the TSC Act It is classified with a risk code of 2VC a meaning that it has a range of less than 100 km is conserved (Goulburn River NP) and is adequately protected (Briggs and Leigh 1995)	This species has limited potential to occur within the study area
Leucochrysum albicans var.	The oary Sunray *Leucochrysum albicans* var	No known local populations Nearest records	This species is listed as	This species has limited

		L O		A
tricolor oary Sunray Endangered (EPBC Act)	*tricolor* is an erect perennial woolly herb with woody rootstock growing to 45 cm high Leaves linear to narrow oblong 2 5 10 cm long 0 5 1 5 mm wide crowded around base of stems and are woolly Flowers spring to summer	from the Mudgee district abitat is generally associated with sandy soils derived from granitic sources	Endangered on the EPBC Act No listing under the TSC Act	potential to occur within the study area
Ozothamnus tesselatus Vulnerable (TSC Act) Vulnerable (EPBC Act)	Dense shrub to 1 m high branches woolly Leaves spreading oblong 4 5 mm long 1 mm wide apex reflexed base decurrent on stem for 4 5 mm margins revolute lamina discolorous upper surface green and shining viscid glandular punctate lower surface white woolly eads in dense hemispherical corymbs heads globose Flowers in spring	Database records identify the nearest occurrence of this species to be 15 km to the east near Wollar on talus slopes	This species is listed as Vulnerable on the TSC Act It is classified with a risk code of 2VC meaning that it has a range of less than 100 km and is conserved (Goulburn River NP) (Briggs and Leigh 1995)	This species has potential to occur within the study area particularly on claystone talus slopes
Philotheca ericifolia Vulnerable (TSC Act) Vulnerable (EPBC Act)	Shrub 1 2 m high spreading stems sparsely glandular warty finely pubescent Leaves needle like 4 8 mm long ca 0 5 mm wide narrow grooved above sparsely glandular warty glabrous or sparsely and finely pubescent petiole short stipules small black Flowers 1 6 in sessile clusters pedicels 2 5 mm long minutely bracteolate at base Petals elliptic ca 9 mm long possibly pink glandular warty slightly white tomentose inside and on outside except for thick glandular midrib	Database records identify the nearest occurrence of this species to be 20 km south of the study area	This species is listed as Vulnerable on the TSC Act It is classified with a risk code of 3RC meaning that it has a range of greater than 100 km and is conserved (Goulburn River NP) (Briggs and Leigh 1995)	This species has potential to occur within the study area particularly in dry sclerophyll forest and heath on damp sandy flats and gullies
Senecio linearifolius var. dangariensis Endangered (TSC Act)	Many branched shrub to 120 cm high Leaves strongly glaucous lanceolate to elliptic mostly 5 10cm long 10 40mm wide Flowers arranged in a corymbose head heads many narrow campanulate Flowers spring to summer	Database records identify the nearest occurrence of this species to be 60 km to the east at Mt Dangar a basaltic outcrop near the Sandy ollow village Basaltic soils of the study area are restricted to isolated outcrops on ridges and plateaus and mostly disturbed by agriculture	This species is listed as Endangered on the TSC Act	This species has limited potential to occur within the study area
Austral Toadflax	Erect perennial herb to 40 cm high pale green to	Database records identify the nearest	This species is listed as	This species has potential to

		L O		A
(*Thesium australe*) Vulnerable (TSC Act) Vulnerable (EPBC Act)	yellow green glabrous stems 1 several little branched wiry striate Leaves linear usually 1 4 cm long 0 5 1 5 mm wide apex acute midrib decurrent sessile lowest leaves scale like Flowers solitary axillary green yellow peduncle 1 3 mm long subtended by leaf with 2 opposite bracteoles pedicel very short Spring to summer flowering	occurrence of this species to be 15 km to the east in Goulburn River NP	Vulnerable on the TSC Act It is classified with a risk code of 3VCi meaning that it has a range greater 100 km and is inadequately conserved (Briggs and Leigh 1995)	occur within the study area particularly in areas where the groundcoverstartum is dominated by angaroo Grass (*Themeda australis*)

t should e noted that hite o ello o lakel s ed um oodland includes the common ealth listed rass hite o oodland ithin its definition. Further hite o ello o lakel s ed um oodland is also ein considered the n ironment ustralia for listin as an i.e. ello o ed um oodlands under the ct.

3 T T U T S SS T S

3.1 eneral Landsca e aracteristics

The e etation of the stud area is classifia le in eneral terms landscape position and eolo . erial photo raph interpretation to ether ith topo raphical o erla s has identified three distinct landscapes ithin the stud area these ein

- The alle floor and riparian corridors
- Midslopes and
- id etops and plateaus.

Mapped eolo ical influences hich also affect the nature of the e etation include the follo in formations

- uaternar llu ial deri ed from Tertiar Triassic ermian and ar oniferous formations
- Tertiar asalts
- Triassic arra een on lomerates
- urassic Sandstones
- ermian on lomerates and oal Measures and
- ar oniferous ranites and uart Mono ites.

Si road e etation communities ere conse uentl identified ithin the stud area. reliminar field reco nisance and detailed sur e permitted the description of these communities and contained plant associations. The follo in is a eneral description of the stud areas e etation landscape position and eolo .

1 1 egetation o t e alle loor and i arian orridors

oodland and open forest e etation throu hout the predominantl cleared alle s are enerall restricted to remnants located alon creek lines and road corridors. Some areas of remnant e etation also e ist as isolated patches ithin the a ricultural landscape. Man of these remnant oodlands and forests are floristicall aria le due to eolo ical and soil moisture influence ith some ein characterised ello o *E melliodora* and lakel s ed um *E la el i* . oodlands dominated ou h arked pple *Ango ora lori nda* are commonl found alon the creek lines often in association ith ello o *E melliodora* and lakel s ed um *E la el i* . The ad oinin sand terraces of the ermian eolo ical formation also host monot pic communities dominated ou h arked pple *A lori nda* . More cla e soils support re o *E mol ccana* dominated communities.

ocated upslope of the outcroppin coal measures is a la er of tuffaceous cla stone that supports oodlands dominated a ariet of eucal pts includin ron arks re o *E mol ccana* and Slat o *E da sonii* . This e etation communit supports a rass understore ith a sparse ut di erse shru mid stratum. mmediatel upslope of this e etation near the footslope of the ad oinin plateaus and their midslopes are iron ark forests dominated a com ination of arro lea ed ron ark *E cre ra* and road lea ed ron ark *E i rosa* . lack press ine *endlic erii* is e uall as common and occasionall forms a co dominant canop species. Other canop species ma include Mu a ron ark *E sidero lon* ed

Strin ark *E macror nc a* arro lea ed Strin ark *E s arsi olia* and re um *E nctata* ith their presence dependant on topo raphic position and soil t pe.

The alle floor enerall contain road e etation t pes associated ith the follo in map units

- 10 istur ed e etation
- 30 o oodlands
- 40 Ta leland ed um oodlands and
- 60 llu ial pple Forests

lso sporadicall occurrin throu hout this landscape are Sedimentar Scri l um oodlands road e etation ommunit 50 . This e etation is restricted to con lomerate outcrops referred to as hard caps hich are associated ith tertiar channels and e hi it transitional ualities ith the ad oinin e etation units.

1 egetation o t e idslo es

The ma orit of the midslopes throu hout the localit are e etated due to the unsuita ilit of these landscapes for a riculture i.e. poor fertilit and steepness . ermian con lomerates and cla stones are common throu hout the lo er and central midslopes ith the upperslopes often characterised Triassic sandstones. ariet of communities occur throu hout this landscape ith some ein dominated hite o *E al ens* hile others ein dominated ron ark Strin ark re um *E nctata* and lack press ine *endlic erii* .

Soils deri ed from con lomerates are enerall characterised ron arks such as arro lea ed ron ark *E cre ra* and road lea ed ron ark *E i rosa* . re um *E nctata* and lue lea ed Strin ark *E agglomerata* also occur in association ith these canop dominants particularl in sheltered locations elo rock outcrops and south to northeast facin slopes. rimar creek lines are predominantl characterised arro lea ed ron ark *E cre ra* and lack press ine *endlic erii* .

Mid slopes ith soils deri ed from ermian cla stones are enerall steep and are relati el fertile hen compared ith the ad oinin sandstone con lomerate deri ed soils. This supports a e etation association dominated hite o *E al ens* particularl on estern to south est facin slopes. The shru understore is predominantl characterised species of the pacridaceae famil i.e. scleroph llous prickl species . The roundco ers are e uall as sparse and consist of rasses and her s.

The midslopes landscape enerall contains road e etation t pes associated ith the follo in map units

- 10 istur ed e etation
- 20 Sedimentar ron ark Forest
- 30 o oodlands i.e. Shru hite o oodlands
- 50 Sedimentar Scri l um oodlands

1 egetation o t e idgelines and Platea s

The ma orit of the rid elines throu hout the localit are e etated due to the poor soil fertilit of the underl in Triassic eolo ical formation arra een Sandstones . rincipall t o communities occur throu hout this landscape these ein Scri l um *E rossii* oodlands and road lea ed ron ark *E i rosa* forests. Shale enriched sand soils are enerall characterised ron arks such as arro lea ed ron ark *E cre ra* and road lea ed ron ark *E i rosa*. re um *E nctata* and Strin ark *E s arsi olia* also occur in association ith these species. The predominantl shru understore of this road e etation class is mostl dominated prickl scleroph llous species such as *Acrotric e rigida* lack press ine *endlic eri* also occurs as an associate canop species ith the ron ark dominated e etation or as canop dominant here the sand soils are shallo to skeletal.

Sandier infertile soils enerall support oodland e etation dominated Scri l um *E rossii* and arro lea ed ron ark *E cre ra* particularl in the northern parts of the stud area. ock outcrops throu hout these landscapes support localised occurrences of mallee dominated er s ed um *E d eri* and arious heath species. reek lines ithin these landscapes are enerall characterised Scri l um *E rossii* and arramatta ed um *E arramattensis* ssp. *arramattensis* particularl in the first order ephemeral draina e lines. Semi permanent creeklines are enerall supporti e of Scri l um *E rossii* ou h arked pple *A lori nda* and lakel s ed um *E la el i*. ock outcrops upslope of these creek lines often support associations containin lue lea ed Strin ark *E agglomerata*.

asalt deri ed soils are also dominated hite o *E al ens* enerall as is also found on asalt deri ed soils hich is comparati el of reater rass and her di ersit to those oodlands formed on tuffaceous cla stones. The understore of hite o *E al ens* oodlands on asalt caps is enerall rass ith fe shru s in contrast ith those oodlands and forests of the cla stone midslopes hich are enerall shru ith limited rass and her co er.

The midslopes landscape enerall contains road e etation t pes associated ith the follo in mapped units

- 20 Sedimentar ron ark Forest
- 30 o oodlands i.e. rass hite o oodlands on asalt caps and
- 50 Sedimentar Scri l um oodlands.

lso sporadicall occurrin throu hout this landscape is o oodlands road e etation ommunit 30 . This e etation is restricted to asalt outcrops that ield distur ed hite o *E al ens* open oodlands rasslands and shru lands.

3. road egetation o unities

The road e etation map codes used in this stud are pro ided in **Ta le .** to ether ith a eneral summar of landscape eolo ical characteristics.

Ta le . Su ar of road egetation o unities

B		
Disturbed Vegetation	10	Mostly cleared grasslands and regenerating shrublands of the Permian geological formation Also included are roadside environments and claystone mines
Sedimentary Ironbark Forest	20	Forests and woodlands dominated by Ironbarks and Black Cypress Pine on sandstone and conglomerate geological formations (predominantly Narrabeen sandstones)
Box Woodlands	30	Forests and woodlands dominated by Box eucalypts of the Permian (claystone derived soils) and Carboniferous geological formations
Tableland Redgum Woodlands	40	Forests and woodlands dominated by Redgum on alluvial deposits derived from basalt and or claystone formations
Sedimentary Scribbly Gum Woodlands	50	Woodlands dominated by Inland Scribbly Gum and Black Cypress Pine on sandstone and conglomerate geological formations (predominantly Narrabeen sandstones)
Alluvial Apple Forests	60	Woodlands dominated by Rough barked Apple on uaternary geological formations

3.3 egetation ssociations

etailed s stematic field sur e s and data anal sis resulted in the identification of 30 e etation map units i.e. e etation associations ithin the si road e etation communities. **Ta le .** summarises the mapped e tent of e etation associations ithin the de elopment application area.

Ta le . egetation ssociations and t eir aerial co erage it in t e area

TSU	Vegetation Association	Code	Area (ha)
10	Unimproved Ungra ed	10	228 543
	Unimproved Gra ed	11	259 929
	Improved Cropped	12	5 241
	Sifton Bush	13	59 5526
	Mudgee Wattle	16	2 225
	Narrow leaved Wattle	1	8 25665
	Roadside Vegetation	18	21 8044
	Claystone Mine	19	98664
20	Broad leaved Ironbark Grey Gum	20	182 2 6
	Ironbark Grey Gum Stringybark	21	286 936
	Ironbark Black Cypress Pine	22	9 40433
	Black Cypress Pine	23	16 0886
	Narrow leaved Ironbark Red Stringybark	24	11 6262
	Ironbark Slaty Gum	25	59 982
30	ellow Box Red Stringybark Blakely s Redgum	30	36 119
	White Box Narrow leaved Ironbark	31	8 9 02
	Grey Box Narrow leaved Ironbark Blakely s Redgum	33	46 9444
	Grey Box Ironbark Slaty Gum	34	15 143
	Grey Box Ironbark	35	35 61
	Grassy White Box	36	6 331
	Shrubby White Box	3	1 29
	Slaty Gum	39	8 9 4 5
40	Blakely s Redgum	40	130 49
	Tumbledown Redgum	41	13 2299
50	Inland Scribbly Gum Rough barked Apple	50	118 855
	Inland Scribbly Gum Blue leaved Stringybark	51	46 3 0
	Inland Scribbly Gum Black Cypress Pine	52	8 1451
	Inland Scribbly Gum Stringybark Ironbark	53	243 0
	Inland Scribbly Gum Ironbark	54	489 904
60	ellow Box Rough barked Apple	60	28 192
	Rough barked Apple	61	59 9655
	Rough barked Apple Ironbark	62	0 398
	Rough barked Apple Grey Box	63	1 11653

3. o arison of Sur e esults it Local Studies

1 egetation escri tions

The e etation associations descri ed in this report are the ase unit for anal sin the e tent of impact and hence miti ation re uirements for this de elopment. n understandin of the local conte t is re uired to impro e the anal sis of immediate and cumulati e iodi ersit losses resultin from direct and indirect impacts. ccordin l the e etation associations identified ithin the stud area ha e een compared ith e etation mappin from rele ant flora studies of the local area.

Ta le . o arison of egetation association codes it a ing fro ot er local studies

A		L [1]	
		Vegetation Code	Comments
Unimproved Ungra ed Grasslands	10	03 RS0	Compared codes broadly describe 10
Unimproved Gra ed Grasslands	11	03 RS0	Compared codes broadly describe 11
Improved Cropped Grasslands	12	RS0	Compared code broadly describes 12
Sifton Bush Shrubland	13	03 RS08	Compared codes broadly describe 13
Banksia Shrubland	15		No similar vegetation codes
Mudgee Wattle Shrubland	16	RS08	RS08 broadly describes 16
Narrow leaved Wattle Shrubland	1		No similar vegetation codes
Roadside Vegetation	18		No similar vegetation codes
Claystone Minesties	19		No similar vegetation codes
Broad leaved Ironbark pen Forest	20	01 NPWS01 RS06 IEC04	Compared codes broadly describe 20
Broad leaved Ironbark Stringybark Grey Gum pen Forest	21	02 NPWS08 RS06 IEC04	Compared codes broadly describe 21
Broad leaved Ironbark Black Cypress Pine Woodland	22	01 NPWS01 RS06 IEC04	Compared codes broadly describe 22
Black Cypress Pine Forest	23	01 NPWS01 RS06 IEC04	Compared codes broadly describe 23
Narrow leaved Ironbark Red Stringybark Forest	24	01 02 NPWS01 RS04 RS06 IEC04	Compared codes broadly describe 24
ellow Box Red Stringybark Blakely s Redgum pen Forest	30	0 NPWS11 RS01	Similarities between all vegetation descriptions
White Box Ironbark pen Forest	31		No similar vegetation codes
Grey Box Narrow leaved Ironbark Blakely s Redgum Forest	33	IEC02	IEC02 describes the presence of Inland Grey Box (*E. microcarpa*) which is not present in 33 therwise similar
Grey Box Ironbark Slaty Gum pen Forest	34	NPWS05	Close similarities between descriptions
Grey Box Ironbark pen Forest	35	NPWS05	Difference being absence of Slaty Gum
Grassy White Box Woodlands	36	NPWS11 RS05a RS05b	Similarities between descriptions
Shrubby White Box pen Forests	3	NPWS11 RS05a RS05b	Similarities between descriptions
Green leaf White Box pen Woodlands	38		No similar vegetation codes
Slaty Gum Woodlands	39	NPWS05	Difference being dominance of Slaty Gum and absence of associates described in NPWS05
Blakely s Redgum pen Forest	40		No similar vegetation codes
Tumbledown Redgum Woodland	41	IEC03	Similarities between descriptions
Inland Scribbly Gum Rough barked Apple pen Forests	50	NPWS12	Similarities between descriptions
Inland Scribbly Gum Blue leaved Stringybark pen Forests	51		No similar vegetation codes
Inland Scribbly Gum Black Cypress Pine Woodlands	52		No similar vegetation codes
Inland Scribbly Gum Stringybark Ironbark Woodlands	53		No similar vegetation codes
Inland Scribbly Gum Ironbark Woodlands	54	NPWS10	Similarities between descriptions
Cyperoid erbland	59		No similar vegetation codes

[1] inhill Engineers (1983) NPWS NPWS (2000) RS Resources Strategies (2005) IEC International Environmental Consultants (2005)

A		L [1]	
		Vegetation Code	Comments
ellow Box Rough barked Apple pen Forests	60	04 NPWS0	Similarities between descriptions
Rough barked Apple pen Forests	61	RS03	Compared code broadly describes 51
Rough barked Apple Ironbark pen Forests	62	05 NPWS04 RS03	Compared codes broadly describe 52
Rough barked Apple Grey Box pen Forests	63	RS02	Similarities between descriptions

This comparati e anal sis enerall indicates the usa e of roader e etation definitions pre ious in esti ators to descri e local e etation. n particular pre ious in esti ators ha e onl roadl descri ed and mapped the associations contained ithin the Sedimentar Scri l um oodlands and Sedimentar ron ark Forests road e etation communities. o e er in man cases there are similarities in descriptions for the o oodlands and iparian oodlands et een this stud and those of pre ious in esti ators.

egetation a ing

T o of the four local studies ha e coincidin e etation maps ith the area mapped in this stud these ein

- inhill Stearns n ineers 1983 Ulan oal Mines Sta e 2 ollier e elopment and pansion n ironmental mpact Statement and

- nternational n ironmental onsultants t imited 2005 ollar to ellin ton 330k Transmission ine n ironmental mpact Statement.

in ill Stearns ngineers (1 3)

This e etation map preceded a series of open cut operations ithin the Ulan coal mine precinct there identif in some areas of nati e e etation that no lon er e ist. o e er a comparison et een the t o e etation maps ased on e istin e etation co er indicates past mappin for the arra een sandstone e etation t pes i.e. oodland id etops and midslope ermian con lomerates i.e. oodland Open oodland Talus slopes to e consistent at the road e etation description le el. re ious mappin at course scale as appropriate i en the focus of impacts ein on open cut areas throu hout predominantl cleared alle floor.

Mapped occurrences of o oodlands ere also sho n in the 1983 mappin ith the most si nificant mapped e etation t pes ein

- Open oodland alle Floor dominated lakel s ed um *E la el i* ello o *E melliodora* nland Scri l um *E rossii* and arro lea ed ron ark *E cre ra* and

- Open oodland Talus Slopes artl leared dominated ello o *E melliodora* Strin ark *E e genoides* ou h arked pple *A lori nda* and arro lea ed ron ark *E cre ra* .

ain similarities e ist et een the mapped e tant of o oodlands ithin these t o e etation maps.

nternational n iron ental onsultants ( )

The e etation map presented in the S for the ollar ellin ton 330k po er line differs su stantiall to the e etation mapped in this stud . Onl one similarit e ists et een the t o e etation maps this ein the occurrence of Sedimentar ron ark Forests at the eastern oundar of the stud area. 2005 identified the presence of a lack press ine road lea ed ron ark e etation communit o er an area that as mapped as road lea ed ron ark Strin ark re um road lea ed ron ark lack press ine and nland Scri l um Strin ark ron ark. The inconsistencies are identified in **Ta le .1** .

Ta le .1 nconsistencies in egetation a ing et een ( ) and t is stud

IEC (2005)	This Study
Black Cypress Pine Tumbledown Redgum	Broad leaved Ironbark Stringybark Grey Gum Inland Scribbly Gum Ironbark ellow Box Red Stringybark Blakely s Redgum
Black Cypress Pine White Box	Inland Scribbly Gum Ironbark Rough barked Apple Banksia Woodland Grey Box Ironbark Grey Box Ironbark Slaty Gum Blakely s Redgum Grey Box Narrow leaved Ironbark Blakely s Redgum ellow Box White Box Blakely s Redgum
White Box Inland Grey Box	Grey Box Narrow leaved Ironbark Blakely s Redgum
Riparian Woodland	Blakely s Redgum
ellow Box White Box	Grey Box Narrow leaved Ironbark Blakely s Redgum

Su stantial differences e ist et een these t o e etation maps there limitin the alue of the 2005 mappin for this pro ect. ccordin l the spatial datasets i.e. e etation mappin presented in 2005 has een disre arded ith onl point data alues i.e. uadrat records considered useful information for the compilation of this assessment.

3. o oodlands ot ncluded in t e classification

Four e etation associations contained ithin the o oodlands road e etation communit are not considered to form part of the o um oodland definitio these ein

- 34 re o Slat um ron ark Forest
- 35 re o ron ark
- 37 Shru hite o oodland and
- 39 Slat um Open Forest.

re o Slat u ron ar Forest i3

The final determination for hite o ello o lakel s ed um oodland S 2002 identifies

> *oodlands incl ding arro leaved iron ar* *E cre ra* *lat m* *E da sonii* *and re o* *E mol ccana* *and intergrades it ite o* *E al ens* *or e am le in t e erri a latea o l rn iver ational Par and estern ollemi ational Par are also incl ded*

The identification uidelines for o um oodlands are specific in its interpretation of this e etation ariant for the oul urn i er catchment. The uidelines interpret the statement *oodlands* ***including*** *arro leaved iron ar E cre ra lat m E da sonii and re o E mol ccana* as oodlands that must either currentl or pre iousl ha e contained one or more of the characteristic dominants i.e. hite o and or ello o and or lakel s ed um for it to e considered o um oodland.

e etation association 34 is formed on infertile soils deri ed from the ermian lla arra eolo ical formation there su stantiall limitin the potential occurrence the characteristic o um oodland dominants. n the stud area hite o *E al ens* onl occurs ith arro lea ed iron ark *E cre ra* Slat um *E da sonii* and re o *E mol ccana* in areas ere eathered asalts ha e influenced the soils hich is restricted to the isolated an isolated stand in the Murra am a reek catchment. This stand is located outside the su ect site and ill not e impacted the proposed mine.

The localised presence of Slat um *E da sonii* is likel to e attri uted to the tuffaceous cla stone outcrop i.e. situated immediatel a o e the coal seam hich t picall forms soils of lo fertilit . isuall this e etation association is structurall similar to the o um oodland communit . o e er floristicall this e etation association does not currentl and has ne er contained one or more of the dominants hite o and or ello o and or lakel s ed um ith the a sence of these dominants attri uted to the infertile soils rather than past clearin e ents.

n the case of e etation association 34 the pre ailin infertile soils are formed tuffaceous cla stones i.e. deri ed from olcanic ash and eathered material from upslope sedimentar con lomerates. n contrast the soils of the similar e etation association 31 i.e. hite o ron ark is comparati el more fertilit irtue of influences from upslope asalt outcrops. The presence of hite o *E al ens* and a rassier understore in e etation association 31 is e plaina le the eathered asaltic influence hich is a sent from the catchment containin e etation association 34.

S ru ite o en Forest (i n) 3

The identification uidelines for o um oodlands are specific in its interpretation of shru oodlands containin one or more of the o um oodland dominants. ccordin to the uidelines

> *s r oodlands ic generall occ r in er or midslo e sit ations on s allo er soils are not art o t e EE c oodlands are more revalent on illsides o t e ort estern lo es ande ar and rigalo elt o t ioregions ere s r oodlands dominated ite o ello o or la el s ed m intergrades it t e o m oodland t e more s r ree sections o t e comm nit s o ld e regarded as o m oodland* .

e etation association i n 37 occurs on steep tuffaceous cla stone soils of the ermian lla arra eolo ical formation. The landscape containin this e etation association is steep and rock midslopes and upperslopes and is characterised non pioneer shru s such as one pots *Acrotric e rigida* each eath *issant e strigosa* and lack press ine *endlic erii* . The rass her aceous roundco er stratum is sparse rarel e ceedin 20 co er there not i in a rass appearance.

1 Plant ecies o egional igni icance

The flora sur e identified t o species of re ional si nificance these ein

- *oronia r iginosa* and
- *Pse dant s divaricatissim s*

discussion of this species is as follo s

Boronia rubiginosa

Shru 0.4 2 m hi h ranchlets stellate pu escent. ea es pinnate ith 3 7 leaflets rachis 4 20 mm lon in ed leaflets narro elliptic to road elliptic or spathulate 4 30 mm lon 3 12 mm ide ape o tuse or retuse mar ins entire and recur ed flat la rous to sparsel stellate hair lo er surface prominentl paler petiole 1 12 mm lon . nflorescences a illar 1 3 flo ered pedicels 3 15 mm lon . al la rous to stellate tomentose. etals 6 10 mm lon al ate pale to ri ht pink stellate tomentose to la rescent persistent in fruit. occi la rous or densel hirsute. Flo ers ul o .

onser ation Status
re iousl included in *oronia r ii* hich is restricted to the oods eef serpentine in the S otanical su di ision of S. fter the reclassification of the species *oronia r iginosa* is descri ed as ha in a restricted distri ution ithin the S dne asin iore ion in particular the S otanical su di isions T S. This species is classified ith a risk code of 2 a meanin that it is rare has a ran e of less than 100 km and is ade uatel conser ed oul urn i er ri s and ei h 1995 .

earest Occurrence
ro s in dr scleroph ll forest on skeletal sandstone deri ed soils chiefl in the S dne re ion from ees inch in the north to errima in the south. ithin the stud area a sin le specimen of *oronia r iginosa* as o ser ed alon side a track opposite the entrance to the Ulan oal mine.

Pseudanthus divaricatissimus
More or less prostrate shru ith stems to 20 cm lon la rous to minutel sca rous. ea es scattered o ate to o lon mostl 2 4 mm lon 1.5 2 mm ide ape o tuse and often recur ed. Male flo ers on peduncle ca 1 mm lon inner perianth se ments lar er than the outer ones stamens 6 inner 3 distinctl lon er than the outer ones. Female perianth se ments ca 2 mm lon acute reddish.

onser ation Status
The distri ution of *Pse dant s divaricatissim s* is restricted to the S otanical su di isions S T T S ith specimens also kno n to occur in ictoria. This species is classified ith a risk code of 3 a meanin that it is rare has a ran e of reater than 100 km and is ade uatel represented in the reser e net ork ri s and ei h 1995 .

earest Occurrence
ro s in dr scleroph ll forest on skeletal sandstone deri ed soils i.e. rock sites on hi her land from the arrum un les and oul urn i er south to den and ictoria. ithin the stud area this species as o ser ed in heath oodlands a o e the proposed under round mine near oul urn i er. This species is approachin its northern limit of distri ution ithin the stud area.

Plant ecies o ocal nterest

num er of flora species o ser ed durin the sur e period are of local interest for reasons such as distri utional limits ran e e tensions or are simpl uncommon. These species are discussed as follo s.

olden ust attle *Acacia acinacea*
ro s in oodland chiefl on sand south from the il andra district ithin the S otanical su di isions T ST S S S S . The records collected from the stud area are at the north eastern limit of distri ution for this species lantnet 2005 . This species as recorded in re o ron ark Slat um Open Forest near proposed open cut 1.

roo ing attle *Acacia di ormis*
ro s in dr scleroph ll forest oodland and mallee often in red sand soils ut also in cla soils south from the inna a district est from near len lice ithin the S otanical su di isions T S S S S S . The records collected from the stud area represent the north eastern limit of distri ution for this species lantnet 2005 . This species as recorded in re o arro lea ed ron ark lakel s ed um oodland near the upper reaches of Murra am a reek.

allee attle *Acacia montana*
ommonl in mallee in sand red earths in estern districts also in hea cla soils scattered occurrences est from arro itch ithin the S otanical su di isions T T S S S S S also recorded near len lice . The records collected from the stud area represent the eastern limit of

distri ution for this species lantnet 2005 . This species as recorded near ands on ock and the entrance to a oons oad.

l lea ed attle *Acacia s lata*
ro s in dr scleroph ll forest and oodland in cla s loams and sand soils often in skeletal soils in hill areas or alon streams chiefl from arialda in the north upper unter alle in the east and u o district to the est ithin the S otanical su di isions S S also recorded for the apertee alle T . The records collected from the stud area are representati e of a population near its eastern limit of distri ution lantnet 2005 . This species as recorded from an unnamed creek east of Murra am a reek near its confluence ith ilpin on reek.

Sea eler *A i m rostrat m var rostrat m*
ro s on ed es of saltmarsh and coastal cliffs or near ri ers or rackish ater est to enman ithin the S su di isions S S . The records collected from the stud area represent the most estern e tent of this species distri ution lantnet 2005 . This species as recorded in lo er reaches of Murra am a reek.

or scre rass *A strosti a setacea*
idespread and uncommon rass ithin the S otanical su di isions T T ST S S S S S . The records collected from the stud area confirm the presence of this species ithin the S otanical su di ision lantnet 2005 . This species as recorded in Slat um oodland.

ello acint orc id *i odi m amiltonian m*
ro s in dr scleroph ll forest dominated ucal ptus and or allitris usuall on acidic sand soils chiefl on estern Slopes est to arkes district ithin the S otanical su di isions T T ST S S S S. The sin le record from the stud area is the first collection from the S dne asin iore ion lantnet 2005 . This species as recorded in nland Scri l um ed Strin ark ron ark oodland.

ed String ar rid *E cal t s macror nc a cannonii*
ocall fre uent ut restricted in scleroph ll oodland on shallo soil on rises lstone to upper ol an alle ithin the S otanical su di isions T S. The h rid is formed ith the apertee Strin ark *E cannonii* ith h rids distin uished in the field on the asis of fruit diameter lack of prominence of the medial rim and reduced an ularit of uds 2003 . umerous records of this h rid occur throu hout the stud area particularl upslope of the coal seam outcrop and near asalt outcrops.

Leucopogon biflorus
ro s in scleroph ll oodland on skeletal sand soils and on rock outcrops north from undedoo ithin the S otanical su di isions T ST S S S S . ecords ithin the stud area represent the south eastern limit of distri ution for the northern meta population lantnet 2005 . This species is restricted to a sand draina e line terrace in the central eastern part of the stud area.

ooll atrus *omandra le coce ala* ssp. *le coce ala*
hiefl occurs chiefl on the estern Slopes of the reat i idin an e in .S. . here is ro s in dr scleroph ll forest on rock slopes and sand soils ithin the S otanical su di isions S S S SF . This species is approachin its eastern distri utional limits ithin the stud area ith fe records from the S dne asin iore ion lantnet 2005 . umerous records of this species ere recorded throu hout the sand flats of ilpin on reek.

esert e aliu *P e ali m gland los m* ssp. *ang sti oli m*
ro s alon stream flats and scleroph ll oodland on sandstone in ollemi . . ithin the S otanical su di ision of S. This su species is approachin its northern distri utional limit ithin the stud area ith the ma orit of records from ollemi lantnet 2005 .

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AUGUST 2006

Unimproved Ungrazed Grassland

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	(Cug a Rn Pi)10
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi) Carboniferous Ulan uart Mon onites (Cug) uaternary (a)
Total Area:	634 ha (EL 6288) 228 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		#	Area (ha)	Survey extant for association within EL6288 (%)
Systematic Survey (Quadrats):		1	0 040	0 006
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	10		
Opportunistic Observations:		44	0 104	0 016
Total Species Observations:		54	0 144	0 023

Description

This vegetation association represents the cleared forest and woodland communities (i e Sedimentary Ironbark Forests Box Woodlands Apple Forests) of low soil fertility of the study area s footslopes Native grasses characteristic of gra ed and ungra ed landscapes such as Wire Grasses (*Aristida vagans*) Redleg Grass (*Bothriochloa macra*) Native Sorghum (*Sarga leioclada*) occur together amongst scattered shrub and tree regrowth Native herbs and orchids also occur frequently throughout this landscape Exotic grasses and herbs are restricted to widely naturalised species such as Catsear (*Hypochaeris radicata*) and airfoot Clover (*Trifolium arvense*) This landscape represents the early stages of natural regeneration where rare pioneer may also appear

Structure		Max	Min	Floristics: *Genus species*	Common Name
Trees	eight	12 m	10 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	5	0	*Eucalyptus moluccana*	Grey Box
Shrubs	eight	1 m	0 m	*Calytrix tetragona*	Common Fringe myrtle
	Cover	5	0	*Styphelia triflora*	Five Corners
				Allocasuarina gymnanthera	Sheoak
				Cassina arcuata	Sifton Bush
				Kunzea 'Mt Kaptiar'	
Herbs	eight	1 m	0 m	*Acetosella vulgaris*	Sheep Sorrel
	Cover	25	20	*Conyza sumatriensis*	Fleabane
				Hypochaeris radicata	Catsear
				Calotis lappulacea	
				Trifolium arvense	airfoot Clover
Grasses				*Aristida vagans*	Threeawn Speargrass
				Imperata cylindrica	Blady Grass
				Sporobolus creber	Rats Tail Grass
Orchids				*Diuris goonooensis*	Western Donkey rchid
Vines				*Absent*	
Mistletoe				*Amyema miquelii*	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species	N A
Species of Significance	*Diuris tricolor* (Vulnerable TSC Act and EPBC Act)
	Goodenia macbarronii (Vulnerable - TSC Act and EPBC Act)

Unimproved Grazed Grassland

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	(Pi Rn u a)11
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi) urassic (u) uaternary (a)
Total Area:	1849 ha (EL 6288) 260 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		1	0 040	0 002
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	19		
Opportunistic Observations:		34	0 200	0 011
Total Observations:		53	0 240	0 013

Description

Cleared forests and woodland communities (i e Sedimentary Ironbark Forests Box Woodlands Apple Forests) on soils of limited fertility Native and exotic grasses and herbs tolerant of gra ing such as Wire Grasses (*Aristida vagans*) Speargrass (*Austrostipa scabra*) Rats Tail (*Sporobolus creber*) and Redleg Grass (*Bothriochloa macra*) are common amongst scattered remnant shrubs and trees Exotic species common to this vegetation type include thistles Sheep Sorrel and Clover The increased presence of exotic species when compared with Unimproved Ungra ed Grassland association is explained by the presence of seed vectors (sheep) increased vehicle activity and supplementary feeding activities

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	12 m	10 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	5	0	*Eucalyptus albens*	Grey Box
Shrubs	eight	4 m	1 m	*Cassina arcuata*	*Sifton Bush*
	Cover	5	0	*Acacia spectablis*	Mudgee Wattle
Herbs	eight	1 m	0 m	*Erodium crinitum*	Blue Storksbill
	Cover	80	50	*Medicago arabica*	Spiny Burr
				Rumex brownii	Swamp Dock
				Trifolium arvense	airfoot Clover
Grasses				*Sporobolus creber*	Slender Rat s Tail Grass
				Hordeum leporinum	Barley Grass
				Bromus hordeaceus	Praire Grass
				Bothriochloa macra	Redleg Grass
				Vulpia spp.	
				Aristida vagans	Three awned Speargrass
Orchids				*Diuris goonooensis*	Western Donkey rchid
Vines				*Absent*	
Mistletoe				*Amyema miquelii*	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species: *Anthoxanthum odoratnm, Bromus hordeaceus, Eleusine indica, Erodium crinitum, Hordeum hystrix, Medicago arabica, Spergularia marina*

Species of Significance: N A

Improved/Cropped Grassland

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	Pi12
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	10 6 ha (EL 6288) 5 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		1	0 040	0 004
Seasonal Observations	Summer:	14		
	Autumn:	0		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		4	0 024	0 002
Total Observations:		18	0 064	0 006

Description

Cleared forests and woodland communities (i e Box Woodlands Apple Forests) of elevated soil fertility Native grasses and herbs have largely been displaced by agricultural practices including ploughing and direct seeding of exotic pasture species Native grasses such as Wire Grass (*Aristida vagans*) are uncommon relative to exotic seeded species such as Ryegrass (*Lolium* spp) Clover (*Trifolium* spp) Medic (*Medicago* spp) and Fescue (*Vulpia* spp) Weedy exotics include Sheep Sorrel (*Acetosella vulgare*) and Praire Grass (*Briza minor*) This association occurs predominantly along the lower slopes of the valley floor near creeklines and their ad oining alluvial terraces

Structure		**Max**	**Min**	**Floristics** **Genus species**	**Common Name**
Trees	eight	18 m	14 m	*Eucalyptus albens*	White Box
	Cover	1	0	*Eucalyptus blakelyi*	Blakely s Redgum
				Angophora floribunda	Rough barked Apple
				Eucalyptus moluccana	Grey Box
Shrubs	eight	5 m	1 m	*Callitris endlicheri*	Black Cypress Pine
	Cover	1	0	*Cassinia quinquefaria*	
				Acacia linearifolia	A Wattle
				Bursaria spinosa	Native Blackthorn
				Exocarpos cupressiformis	Bush Cherry
				Podolobium ilicifolium	Prickly Shaggy Pea
Herbs	eight	0 6 m	0 m	*Trifolium subterraneum*	Subterraneum Clover
	Cover	80	60	*Erodium crinitum*	Blue Storksbill
				Medicago arabica	Spiny Burr
				Trifolium arvense	airs foot Clover
				Catharmus lanatus	Saffron Thistle
Grasses				*Hordeum leporinum*	Fescue
				Bromus cartharticus	Prairie Grass
				Dactylis glomerata	Cocksfoot
				Lolium rigidum	Ryegrass
				Vulpia muralis	Barley Grass

Indicator Species	N A
Species of Significance	N A

Sifton Bush Shrubland

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	(Pi Rn u a)13
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi) urassic (u) uaternary (a)
Total Area:	101 ha (EL 6288) 60 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling	**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):	1	0 040	0 040
Seasonal Observations Summer:	0		
Autumn:	0		
Winter:	0		
Spring:	25		
Opportunistic Observations:	20	0 102	0 101
Total Observations:	45	0 142	0 140

Description

Dominated principally by Sifton Bush (*Cassinia arcuata*) this vegetation association is the product of natural regeneration near vegetation lands within ungra ed cleared areas The age of the regeneration is uncertain however given the variety of native species observed it is considered that ma ority of Sifton Bush Shrublands present at least 5 10 years of natural regeneration This vegetation principally occurs throughout the cleared midslopes of the valley floor (i e Permian) with isolated occurrences on the ad oining plateaus in association with basalt

Structure		**Max**	**Min**	**Floristics** **Genus species**	**Common Name**
Trees	eight	14 m	10 m	*Angophora floribunda*	Rough barked Apple
	Cover	1	0	*Eucalyptus crebra*	Narrow leaved Ironbark
Shrubs	eight	5 m	1 m	*Cassinia arcuata*	Sifton Bush
	Cover	60	20	*Callitris endlicheri*	Black Cypress Pine
				Acacia spectablis	Mudgee Wattle
Herbs	eight	1 m	0 m	*Gahnia aspera*	Rough Saw sedge
	Cover	45	20	*Goodenia hederacea*	Forest Goodenia
				Lomandra multiflora ssp. multiflora	Mat Rush
Grasses				*Eragrostis leptostachya*	Paddock Lovegrass
				Aristida vagans	Three awned Speargrass
				Arundinella nepalensis	Reed Grass
Orchids				*Thelymitra pauciflora*	Sun rchid
				Microtis parvifolia	Leek rchid
				Pterostylis bicolor	
Vines				*Absent*	
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				N A	
Species of Significance				N A	

Mudgee Wattle Shrubland

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	Pi16
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	2 ha (EL 6288) 3 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		1	0 040	0 150
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	30		
Opportunistic Observations:			0 043	0 161
Total Observations:		3	0 083	0 311

Description

Mudgee Wattle regrowth occurs as scattered patches throughout the study area on well drained sandy soils underlain by heavier gravely loams where cultural practices are supportive of natural regeneration ther species observed in this environment include pioneers such as Varnish Wattle (*Acacia verniciflua*) and Sifton Bush (*Cassinia arcuata*) with the latter species dominating within areas of limited sand cover and impeded drainage A variety of grass and herb species also occur throughout the sparse groundcover stratum

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	10 m	8 m	*Eucalyptus fibrosa*	Broad leaved Ironbark
	Cover	5	0	*Eucalyptus crebra*	Narrow leaved Ironbark
Shrubs	eight	4 m	0 m	*Acacia spectablis*	Mudgee Wattle
	Cover	25	20	*Acacia verniciflua*	Varnish Wattle
				Bursaria spinosa	Native Blackthorn
				Cassinia arcuata	Sifton Bush
Herbs	eight	1 m	0 m	*Glycine clandestina*	Glycine
	Cover	20	10	*Glycine tabacina*	
				Hypochaeris glabrata	Catsear
Grasses				*Austrostipa densiflora*	Spear Grass
				Austrodanthonia eriantha	Wallaby Grass
				Austrostipa scabra	Slender Speargrass
Orchids				*Absent*	
Vines				*Absent*	
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Acacia spectablis, Austrodanthonia eriantha*	
Species of Significance				N A	

Narrow-leaved Wattle Shrubland

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	Pi1
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	16 ha (EL 6288) 8 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		1	0 040	0 246
Seasonal Observations	Summer:	15		
	Autumn:	0		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		0	0 000	0 000
Total Observations:		15	0 040	0 246

Description

Narrow leaved Wattle (*Acacia linearifolia*) forms thick tall shrublands in moderately protected sites particularly at the interface between cleared vegetated lands along creeklines and footslopes of steep gullies The diversity and cover of other native and exotic species is limited by the extent of previous disturbances and the canopy dominant erbs with broad leaves and gra ing sensitive grasses occur in the understorey Grey Mistletoe (*Amyema quandang* spp *quandang*) is common throughout this vegetation association which is supportive of seasonal fauna activity particularly honeyeaters

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	10 m	8 m	*Angophora floribunda*	Rough barked Apple
	Cover	10	0		
Shrubs	eight	10 m	1 m	*Acacia linearifolia*	Narrow leaved Wattle
	Cover	30	10	*Cassinia arcuata*	Sifton Bush
				Leucopogon muticus	
Herbs	eight	1 m	0 m	*Calotis cuneifolia*	Purple Burr daisy
	Cover	20	10	*Glycine tabacina*	
				Hypochaeris glabrata	Catsear
Grasses				*Aristida vagans*	Three awn Speargrass
				Austrodanthonia spp.	Wallaby Grass
				Austrostipa scabra	Slender Speargrass
Orchids				*Absent*	
Vines				*Absent*	
Mistletoe				*Amyema quandang var. quandang*	Grey Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				N A	
Species of Significance				N A	

Vegetation of Roadside Environments

Broad Vegetation Community: Disturbed Vegetation
Vegetation Codes: (Pi Rn a)18
Geology: Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi) uaternary (a)
Total Area: 60 ha (EL 6288) 22 ha (DA Boundary)
Legislative Status: Unprotected vegetation community association

Sampling		#	Area (ha)	Survey extant for association within EL6288 (%)
Systematic Survey (Quadrats):		0	0 000	0 000
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		31	0 232	0 386
Total Observations:		31	0 232	0 386

Description

The roadside environment permits the formation of a variable vegetation assemblage consisting of remnant trees and pioneer species (i e species capable of colonising disturbed environments) verall the vegetation is defined as an open woodland formation consisting of Wattles as the principal understorey component and cosmopolitan grasses suited to variable soil moisture and fertility Commonly occurring trees include Narrow leaved Ironbark (*Eucalyptus crebra*) and Grey Box (*Eucalyptus moluccana*) with shrubs such as Mudgee Wattle (*Acacia spectablis*) and Sifton Bush (*Cassinia arcuata*) Grasses such as Three awned Speargrass (*Aristida vagans*) and Ryegrass (*Lolium* spp) dominate the groundcover stratum with less disturbed areas supporting angaroo Grass (*Themeda australis*) and a variety of herbs characteristic of ad oining vegetation communities

Structure		Max	Min	Floristics: *Genus species*	Common Name
Trees	eight	16 m	10 m	*Eucalyptus moluccana*	Grey Box
	Cover	15	0	*Eucalyptus blakelyi*	Blakely s Redgum
				Eucalyptus crebra	Narrow leaved Ironbark
Shrubs	eight	8 m	1 m	*Acacia spectablis*	Mudgee Wattle
	Cover	25	0	*Bursaria spinosa*	Native Blackthorn
				Cassinia arcuata	Sifton Bush
				Acacia linearifolia	Narrow leaved Wattle
Herbs	eight	1 m	0 m	*Glycine clandestina*	Glycine
	Cover	60	30	*Glycine tabacina*	
				Hypochaeris glabrata	Catsear
				Bulbine bulbosa	
Grasses				*Austrostipa scabra*	Spear Grass
				Aristida vagans	Wallaby Grass
				Lolium spp.	Ryegrass
Orchids				*Diuris goonooensis*	Western Donkey rchid
				Diuris sulphurea	Tiger rchid
Mistletoe				*Amyema miquelii*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Characteristic Species				N A	
Species of Significance				N A	

Vegetation of Disturbed Claystone Quarries

Broad Vegetation Community:	Disturbed Vegetation
Vegetation Codes:	Pi19
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	30 ha (EL 6288) 8 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		0	0 000	0 000
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		1	0 132	0 440
Total Observations:		1	0 132	0 440

Description

This map unit represents a chronically disturbed landscape resultant from past claystone mining The ma ority of past mining practices have not engaged in mine site rehabilitation leaving many voids without vegetation cover Most regrowth is natural and occurs on the periphery of the mined areas with the remainder shown as white on the aerial photography Given the disturbed nature of this landscape many different species of eucalypts and pioneer shrubs (i e wattles) occur within this landscape with limited groundcover species

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	16 m	8 m	*Angophora floribunda*	Rough barked Apple
	Cover	5	5	*Eucalyptus dawsonii*	Slaty Gum
				Eucalyptus fibrosa	Broad leaved Ironbark
				Eucalyptus macrorhyncha	Red Stringybark
				Eucalyptus sideroxylon	Mugga Ironbark
				Eucalyptus albens	White Box
Shrubs	eight	2 m	0 m	*Bursaria spinosa*	Native Blackthorn
	Cover	20	5	*Acacia hakeoides*	
				Acacia gunnii	
				Cassinia arcuata	Sifton Bush
				Acacia linearifolia	Narrow leaved Wattle
Herbs	eight	1 m	0 m	*Hypochaeris radicata*	Catsear
	Cover	60	40	*Calotis cuneifolia*	Purple Burr daisy
Grasses				*Austrostipa scabra*	Speargrass
				Austrodanthonia spp.	Wallaby Grass
				Austrostipa densiflora	Speargrass
Orchids				*Absent*	
Vines				*Absent*	
Mistletoe				*Amyema quandang var. quandang*	Grey Mistletoe
				Amyema miquelii	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				N A	
Species of Significance				N A	

Broad-leaved Ironbark/ Grey Gum Open Forest

Broad Vegetation Community:	Sedimentary Ironbark Forests
Vegetation Codes:	(Pi Rn)20
Geology:	Permian Illawarra Coal Measures (Pi) Triassic Narrabeen Group (Rn)
Total Area:	653 ha (EL 6288) 182 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		12	0 480	0 0 4
Seasonal Observations	Summer:	146		
	Autumn:	25		
	Winter:	44		
	Spring:	5		
Opportunistic Observations:		25	0 08	0 013
Total Observations:		29	0 56	0 08

Description

This open forest vegetation association is predominantly characterised by Broad leaved Ironbark (*Eucalyptus fibrosa*) on elevated flat to gently undulating sedimentary geologies throughout the ridgelines and plateaus of the central and southern parts of the study area Grey Gum (*Eucalyptus punctata*) forms a localised canopy associate in the deeper soils of minor creeklines The underlaying Narrabeen sandstone geology is low in nutrients thus limiting the understorey to sclerophyllous shrubs and woody herbs Few grasses occur within this vegetation association with the cosmopolitan Three awned Speargrass (*Aristida vagans*) being the most common *Phyllanthus occidentalis* is a common woody herb growing in association with *Pomax umbellata* and *Porantha corymbosa*

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	20 m	12 m	*Eucalyptus fibrosa*	Broad leaved Ironbark
	Cover	45	30	*Eucalyptus punctata*	Grey Gum
				Eucalyptus agglomerata	Blue leaved Stringybark
				Eucalyptus crebra	Narrow leaved Ironbark
Shrubs	eight	12 m	1 m	*Leucopogon muticus*	Blunt Beard heath
	Cover	40	5	*Acrotriche rigida*	oneypots
				Persoonia linearis	Narrow leaved Geebung
				Callitris endlicheri	Black Cypress Pine
				Acacia linearifolia	Narrow leaved Wattle
Herbs	eight	1 m	0 m	*Pomax umbellata*	
	Cover	30	5	*Phyllanthus occidentalis*	
				Goodenia hederacea	Forest Goodenia
Grasses				*Aristida vagans*	Threeawn Speargrass
				Austrostipa densiflora	Spear Grass
				Tetrarrhena juncea	Rock Grass
Orchids				*Caladenia caerulea*	Blue Caladenia
				Glossodia major	Waxlip rchid
Vines				*Absent*	
Mistletoe				*Amyema quandang var. quandang*	uandang
				Amyema miquelii	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Phebalium glandulosum ssp. angustifolium, Pomaderris elliptica var. elliptica*

Species of Significance N A

Ironbark/ Grey Gum/ Stringybark Open Forest

Broad Vegetation Community:	Sedimentary Ironbark Forests
Vegetation Codes:	Pi21
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	1061 ha (EL 6288) 28 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		12	0 480	0 045
Seasonal Observations	Summer:	86		
	Autumn:	0		
	Winter:	88		
	Spring:	13		
Opportunistic Observations:		23	0 106	0 010
Total Observations:		334	0 586	0 055

Description

This association occurs on protected slopes of improved soil moisture and depth near the uncture between the Narrabeen and Permian geological formations An increased abundance of canopy species such as Blue leaved Ironbark (*Eucalyptus agglomerata*) and Grey Gum (*Eucalyptus punctata*) in association with Broad leaved Ironbark (*Eucalyptus fibrosa*) separates this association from the ridgetop vegetation dominated by Broad leaved Ironbark (*E. fibrosa*) and Black Cypress Pine (*Callitris endlicherii*) Characteristic shrubs and herbs include oneypots (*Acrotriche rigida*) Geebung (*Persoonia linearis*) *Pomax umbellata* Forest Goodenia (*Goodenia hederacea*) with the dominant Three awned Speargrass (*Aristida vagans*)

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	22 m	10 m	*Eucalyptus punctata*	Grey Gum
	Cover	60	25	*Eucalyptus fibrosa*	Broad leaved Ironbark
				Eucalyptus crebra	Narrow leaved Ironbark
				Eucalyptus sparsifolia	Narrow leaved Stringybark
Shrubs	eight	14 m	0 5 m	*Acrotriche rigida*	oneypots
	Cover	40	10	*Callitris endlicheri*	Black Cypress Pine
				Persoonia linearis	Narrow leaved Geebung
				Lissanthe strigosa	Peach eath
Herbs	eight	1 m	0 m	*Goodenia hederacea*	Forest Goodenia
	Cover	15	5	*Pomax umbellata*	
				Lepidosperma laterale	Broad Sword sedge
Grasses				*Microlaena stipoides*	Weeping Grass
				Aristida vagans	Threeawn Speargrass
				Dichelacne micrantha	Weeping Grass
Orchids				*Acianthus fornicatus*	Pixie Caps
				Glossodia major	Waxlip rchid
Vines					
Mistletoe				*Amyema quandang var. quandang*	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Billardiera scandens, Entolasia marginata, Goodenia heterophylla*

Species of Significance N A

Ironbark/ Black Cypress Pine Woodlands

Broad Vegetation Community:	Sedimentary Ironbark Forests
Vegetation Codes:	(Pi Rn)22
Geology:	Permian Illawarra Coal Measures (Pi) Triassic Narrabeen Group (Rn)
Total Area:	225 ha (EL 6288) 9 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		5	0 200	0 089
Seasonal Observations	Summer:	23		
	Autumn:	0		
	Winter:	58		
	Spring:	46		
Opportunistic Observations:		14	0 081	0 036
Total Observations:		141	0 281	0 125

Description

Located on dry shallow sandy soils of the Narrabeen geological formation is a vegetation association dominated by Black Cypress Pine (*Callitris endlicherii*) together with Broad leaved Ironbark (*Eucalyptus fibrosa*) ther commonly observed canopy associates include Dwyer s Redgum (*Eucalyptus dwyeri*) and Narrow leaved Ironbark (*Eucalyptus crebra*) Red Stringybark (*Eucalyptus macrorhyncha*) is often restricted to slightly sheltered habitats Sheoak (*Allocasuarina gymnanthera*) is common throughout together with various epacrids such as oneypots (*Acrotriche rigida*) Blunt Beard heath (*Leucopogon muticus*) and Urn eath (*Melichrus urceolatus*) The coverage of grasses and herbs is limited by the low soil fertility and moisture levels

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	18 m	10 m	*Eucalyptus fibrosa*	Broad leaved Ironbark
	Cover	40	20	*Eucalyptus dwyeri*	Dwyer s Redgum
				Eucalyptus crebra	Narrow leaved Ironbark
Shrubs	eight	10 m	0 5 m	*Callitris endlicheri*	Black Cypress Pine
	Cover	45	15	*Leucopogon muticus*	Blunt Beard heath
				Acrotriche rigida	oneypots
				Calytrix tetragona	Common Fringe myrtle
Herbs	eight	0 5 m	0 m	*Pomax umbellata*	
	Cover	15	5	*Goodenia hederacea*	Forest Goodenia
				Lomandra glauca	Pale Mat rush
Grasses				*Aristida vagans*	Threeawn Speargrass
				Joycea pallida	Silver top Wallaby Grass
				Poa sieberiana	Tussock Grass
Orchids				*Caladenia caerulea*	Blue Caladenia
				Diuris goonooensis	Western Donkey rchid
Vines				*Absent*	
Mistletoe				*Absent*	
Ferns				*Absent*	

Indicator Species *Ozothamnus diosmifolia, Prostanthera howelliae*

Species of Significance N A

Black Cypress Pine Forests and Woodlands

Broad Vegetation Community:	Sedimentary Ironbark Forests
Vegetation Codes:	(Pi Rn)23
Geology:	Permian Illawarra Coal Measures (Pi) Triassic Narrabeen Group (Rn)
Total Area:	13 ha (EL 6288) 16 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		2	0 080	0 058
Seasonal Observations	Summer:	32		
	Autumn:	20		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		42	0 266	0 193
Total Observations:		94	0 346	0 251

Description

Black Cypress Pine Forests are predominantly restricted to dry sandy and or skeletal soils A variety of sub associate canopy species exist throughout this vegetation type with the ma ority capable of withstanding harsh soil conditions Shrub species include those that are typical of landscapes characterised by dry conditions such as Box leaved Wattle (*Acacia buxifolia*) *Babingtonia cunninghamii* and Sifton Bush (*Cassinia arcuata*) Grasses and herbs characteristic of shallow sandy soils dominate and include Short haired Plumed Grass (*Dichelacne micrantha*) and Speargrass (*Austrostipa scabra*) Rock Fern (*Cheilanthes sieberi* ssp *sieberi*) is also common

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	16 m	10 m	*Angophora floribunda*	Rough barked Apple
	Cover	10	5	*Eucalyptus crebra*	Narrow leaved Ironbark
Shrubs	eight	14 m	1 m	*Callitris endlicheri*	Black Cypress Pine
	Cover	30	20	*Cassinia arcuata*	Sifton Bush
				Acacia leucolobia	Box Wattle
				Babingtonia cunninghamii	
Herbs	eight	1 m	0 m	*Goodenia hederacea*	Forest Goodenia
	Cover	10	0	*Lepidosperma laterale*	Broad Sword sedge
				Einadia polygonoides	Fishweed
Grasses				*Austrostipa scabra*	Slender Speargrass
				Dichelacne micrantha	Short haired Plummed Grass
				Microlaena stipoides	Weeping Grass
Orchids				*Caladenia spp.*	
				Glossodia major	Waxlip
Vines				*Absent*	
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				N A	
Species of Significance				N A	

Narrow-leaved Ironbark/ Red Stringybark Open Forest

Broad Vegetation Community:	Sedimentary Ironbark Forests
Vegetation Codes:	Pi24
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	38 ha (EL 6288) 12 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		4	0 160	0 424
Seasonal Observations	Summer:	4		
	Autumn:	0		
	Winter:	0		
	Spring:	1		
Opportunistic Observations:		82	0 399	1 058
Total Observations:		200	0 559	1 482

Description

This vegetation association is restricted to the lower midslopes located immediately above the tuffaceous claystone outcrops The canopy is dominated mostly by Narrow leaved Ironbark (*Eucalyptus crebra*) and Red Stringybark (*Eucalyptus macrorhyncha*) on the dry upper slopes with soils characterised by tuffaceous claystones The lower slopes are characterised by increased densities of Black Cypress Pine (*Callitris endlicherii*) Increased grass content in the understorey stratum coincides with woody shrubs and herbs of comparatively improved soil fertility Spring flowering ground orchids are common within this vegetation association

Structure				**Floristics**	
		Max	**Min**	***Genus species***	**Common Name**
Trees	eight	20 m	12 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	35	20	*Eucalyptus macrorhyncha*	Red Stringybark
				Angophora floribunda	Rough barked Apple
				Eucalyptus fibrosa	Broad leaved Ironbark
Shrubs	eight	4 m	0 m	*Cassinia arcuata*	Sifton Bush
	Cover	25	15	*Lissanthe strigosa*	Peach eath
				Acrotriche rigida	oneypots
				Cassinia cunninghamiana	
Herbs	eight	1 m	0 m	*Goodenia hederacea*	Forest Goodenia
	Cover	30	5	*Astroloma humifusum*	Native Cranberry
				Lomandra multiflora ssp. multiflora	Mat Rush
Grasses				*Aristida vagans*	Threeawn Speargrass
				Dichelacne micrantha	Weeping Grass
				Austrostipa scabra	Slender Speargrass
Orchids				*Caladenia gracilis*	Musky Caladenia
				Thelymitra pauciflora	Sun rchid
Vines				*Cassytha pubescens*	
Mistletoe				*Amyema miquelii*	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species	*Cassytha pubescens, Hovea apiculatum*
Species of Significance	N A

Yellow Box/ Red Stringybark/ Blakely's Redgum Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Pi Rn a Tb)30
Geology:	Permian Illawarra Coal Measures (Pi) Triassic Narrabeen Group (Rn) uaternary (a)
Total Area:	61 ha (EL 6288) 3 ha (DA Boundary)
Legislative Status:	Listed Endangered Ecological Community (White Box ellow Box Blakely s Redgum Woodland)

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):			0 280	0 460
Seasonal Observations	Summer:	138		
	Autumn:	10		
	Winter:	0		
	Spring:	34		
Opportunistic Observations:		32	0 163	0 26
Total Observations:		311	0 443	0 2

Description

The canopy dominant ellow Box (*Eucalyptus melliodora*) occurs in association with Red Stringybark (*Eucalyptus macrorhyncha*) and Narrow leaved Ironbark (*Eucalyptus crebra*) as isolated vegetation remnants mostly on west facing Permian claystone slopes below weathered Tertiary basalts Blakely s Redgum (*Eucalyptus blakelyi*) and White Box (*Eucalyptus albens*) occur as sub associates in areas of elevated soil moisture A diverse shrub layer of limited coverage combined with a rich diversity of grasses and herbs typify this vegetation association Clearing for agriculture has substantially reduced the extent of this vegetation due to the desired fertility levels derived from the weathered basalts

Structure		**Max**	**Min**	**Floristics** ***Genus species***	**Common Name**
Trees	eight	20 m	10 m	*Eucalyptus melliodora*	ellow Box
	Cover	40	25	*Eucalyptus macrorhyncha*	Red Stringybark
				Eucalyptus blakelyi	Blakely s Redgum
				Eucalyptus macrorhyncha X	Red Stringybark
Shrubs	eight	2 m	0 5 m	*Acrotriche rigida*	oneypots
	Cover	30	5	*Cassinia arcuata*	Sifton Bush
				Cassinia quinquefaria	
				Lissanthe strigosa	Peach eath
Herbs	eight	0 8 m	0 m	*Hydrocotyle laxiflora*	Stinking Pennywort
	Cover	60	20	*Dianella revoluta*	Flax Lily
				Glycine clandestina	Glycine
				Rumex brownii	Swamp Dock
Grasses				*Dichelacne micrantha*	Weeping Grass
				Aristida vagans	Threeawn Speargrass
				Austrodanthonia racemosa	Wallaby Grass
				Themeda australis	angaroo Grass
Orchids				*Caladenia fuscata*	Finger rchid
				Glossodia major	Waxlip rchid
Vines				*Clematis glycinoides*	
Mistletoe				*Amyema miquelii*	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Eucalyptus melliodora, Convovulus erubescens, Geranium retrorsum, Vittadinia sulcata*

Species of Significance N A

White Box/ Narrow-leaved Ironbark Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Pi Rn)31
Geology:	Permian Illawarra Coal Measures (Pi) Triassic Narrabeen Group (Rn)
Total Area:	31 ha (EL 6288) 9 ha (DA Boundary)
Legislative Status:	Listed Endangered Ecological Community (White Box ellow Box Blakely s Redgum Woodland)

Sampling		#	Area (ha)	Survey extant for association within EL6288 (%)
Systematic Survey (Quadrats):		1	0 040	0 131
Seasonal Observations	Summer:	3		
	Autumn:	0		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		16	0 0 9	0 258
Total Observations:		53	0 119	0 389

Description

This vegetation association is restricted to the lower Permian midslopes directly below areas heavily influenced by claystone outcrops resulting in improved localised soil fertility In some cases soil fertility boosted by weathered basalts however in contrast to ellow Box Red Stringybark Blakely s Redgum Woodland the absence of ellow Box (*Eucalyptus melliodora*) is explained by the poorer drainage associated with the prevailing gentler slopes The main canopy species are White Box (*Eucalyptus albens*) and Narrow leaved Ironbark (*Eucalyptus crebra*) with Slaty Gum (*Eucalyptus dawsonii*) forming a minor associate in areas influenced by weathered basalts While the understorey is relatively shrubby it is considered that the groundcover layer is relatively diverse in herbs and grasses indicating the influence of disturbances

Structure		**Max**	**Min**	**Floristics** ***Genus species***	**Common Name**
Trees	eight	18 m	16 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	30	20	*Eucalyptus albens*	White Box
				Eucalyptus dawsonii	Slaty Gum
Shrubs	eight	2 m	0 5 m	*Acacia linearifolia*	A Wattle
	Cover	30	5	*Acacia decora*	Western Golden Wattle
				Dodonea viscosa ssp. cuneata	op Bush
				Lissanthe strigosa	Peach eath
				Allocasuarina leuhamanii	Bulloake
Herbs	eight	0 6 m	0 m	*Calotis cuneifolia*	Purple Burr Daisy
	Cover	20	10	*Calotis lappulacea*	ellow Burr daisy
				Dichondra repens	idney Weed
Grasses				*Austrodanthonia laevis*	Wallaby Grass
				Aristida vagans	Three awned Speagrass
				Austrostipa scabra	
Orchids				*Absent*	
Vines				*Absent*	
Mistletoe				*Amyema cambagii*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Amyema cambagei*	
Species of Significance				N A	

Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Pi a)33
Geology:	Permian Illawarra Coal Measures (Pi) uaternary (a)
Total Area:	180 ha (EL 6288) 4 ha (DA Boundary)
Legislative Status:	Listed Endangered Ecological Community (White Box ellow Box Blakely s Redgum Woodland)

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		8	0 320	0 1 8
Seasonal Observations	Summer:	63		
	Autumn:	32		
	Winter:	0		
	Spring:	149		
Opportunistic Observations:		86	0 285	0 159
Total Observations:		330	0 605	0 33

Description

Grey Box Narrow leaved Ironbark Blakely s Redgum is associated with the oldest conglomerate strata of the Permian geological formation (i e Marrangaroo Conglomerates) which lies ad acent to Blakely s Redgum dominated vegetation of alluvial deposits and poor drainage The clayey soils favour an association between Grey Box (*Eucalyptus moluccana*) and Blakely s Redgum (*Eucalyptus blakelyi*) with Narrow leaved Ironbark (*Eucalyptus crebra*) Black Cypress Pine (*Callitris endlicherii*) and various op Bushes (*Dodonaea* spp) and Wattles (*Acacia* spp) found mostly in elevated sandier parts of this association The understorey is predominantly grassy with non woody herbs also of high abundance

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	22 m	8 m	*Eucalyptus blakelyi*	Blakely s Redgum
	Cover	35	25	*Eucalyptus moluccana*	Grey Box
				Eucalyptus crebra	Narrow leaved Ironbark
				Eucalyptus sideroxylon	Mugga Ironbark
Shrubs	eight	10 m	0 5 m	*Cassinia arcuata*	Sifton Bush
	Cover	35	10	*Lissanthe strigosa*	Peach eath
				Styphelia triflora	Five Corners
				Acrotriche rigida	oneypots
				Acacia decora	Western Wattle
Herbs	eight	1 m	0 m	*Calotis cuneifolia*	Purple Burr Daisy
	Cover	30	20	*Astroloma humifusum*	Native Cranberry
				Gahnia aspera	Rough Saw sedge
Grasses				*Aristida vagans*	Threeawn Speargrass
				Austrostipa scabra	Slender Speargrass
				Arundinella nepalensis	Reedgrass
Orchids				*Caladenia fuscata*	Finger rchid
				Diuris goonooensis	Western Donkey rchid
Vines				*Absent*	
Mistletoe				*Amyema miquelii*	Box Mistletoe
				Amyema quandang var. quandang	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Acacia polybotrya, Enneapogon gracilis, Eucalyptus goniocalyx, Acacia decora*	
Species of Significance				*Leucochrysum albicans var. tricolor* (Endangered EPBC Act)	

Grey Box/ Ironbark/ Slaty Gum Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	Pi34
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	16 ha (EL 6288) 15 ha (DA Boundary)
Legislative Status:	Unprotected undescribed vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		9	0 360	2 191
Seasonal Observations	Summer:	86		
	Autumn:	23		
	Winter:	0		
	Spring:	49		
Opportunistic Observations:		18	0 115	0 698
Total Observations:		246	0 4 5	2 890

Description

This vegetation association is locally restricted to gently sloping weathered tuffaceous claystone and coal seam outcrops with substantial influence from upslope weathered conglomerates (i e increased sand content) The absence of basalt caps has limited the extent of soil fertility thereby excluding species of more fertile landscapes such as White Box (*Eucalyptus albens*) and ellow Box (*Eucalyptus melliodora*) The canopy is dominated by Narrow leaved Ironbark (*Eucalyptus crebra*) and Blue leaved Ironbark (*Eucalyptus nubila*) with Slaty Gum (*Eucalyptus dawsonii*) locally frequent on claystone outcrops and Grey Box (*Eucalyptus moluccana*) in moister open depressions The understorey is diverse with wattles and other woody shrubs characteristic of the ad oining conglomerate ridges A sparse but diverse groundcover also characterises this vegetation

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	22 m	12 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	45	30	*Eucalyptus sideroxylon*	Mugga Ironbark
				Eucalyptus dawsonii	Slaty Gum
				Eucalyptus moluccana	Grey Box
Shrubs	eight	10 m	0 5 m	*Cassinia arcuata*	Sifton Bush
	Cover	25	5	*Lissanthe strigosa*	Peach eath
				Acrotriche rigida	oneypots
				Callitris endlicheri	Black Cypress Pine
				Acacia hakeoides	akea Wattle
Herbs	eight	1 m	0 m	*Astroloma humifusum*	Native Cranberry
	Cover	25	10	*Lomandra filiformis ssp. filiformis*	Mat Rush
				Goodenia hederacea	Forest Goodenia
Grasses				*Aristida vagans*	Threeawn Speargrass
				Austrostipa scabra	Slender Speargrass
				Joycea pallia	Silver top Wallaby Grass
Orchids				*Caladenia gracilis*	
				Diuris goonooensis	Western Donkey rchid
Vines				*Cassytha glabrella*	Devils Twine
Mistletoe				*Amyema miquelii*	Box Mistletoe
				Amyema quandang var. quandang	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Aristida calycina, Austrodanthonia richardsonii, Acacia hakeoides*	
Species of Significance				N A	

Grey Box/ Ironbark Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Pi Rn u)35
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi) urassic (u)
Total Area:	214 ha (EL 6288) 36 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling	**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):	4	0 160	0 0 5
Seasonal Observations Summer:	24		
Autumn:	88		
Winter:	0		
Spring:	0		
Opportunistic Observations:	6	0 045	0 021
Total Observations:	118	0 205	0 096

Description

Located further downslope of Grey Box Ironbark Slaty Gum Forest is vegetation dominated by Grey Box (*Eucalyptus moluccana*) and Narrow leaved Ironbark (*Eucalyptus crebra*) The absence of Slaty Box (*Eucalyptus dawsonii*) symbolises a subtle change in soil conditions thereby reduced shrub diversity (i e fewer wattles) and dominance of Sifton Bush (*Cassinia arcuata*) The groundcover stratum is less specious with grasses and herbs forming a limited cover of ground vegetation The presence of Rough barked Apple (*Angophora floribunda*) is indicative of a transition with vegetation of alluvial landscapes

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	18 m	8 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	25	15	*Eucalyptus moluccana*	Grey Box
				Angophora floribunda	Rough barked Apple
				Eucalyptus sideroxylon	Mugga Ironbark
Shrubs	eight	4 m	0 5 m	*Cassinia arcuata*	Sifton Bush
	Cover	30	5	*Lissanthe strigosa*	Peach eath
				Allocasuarina luehmannii	Bulloak
				Daviesia genistifolia	Broom Bitter Pea
Herbs	eight	1 m	0 5 m	*Calotis cuneifolia*	Purple Burr Daisy
	Cover	20	5	*Goodenia hederacea*	Forest Goodenia
				Stackhousia viminea	Slender Stackhousia
Grasses				*Aristida vagans*	Threeawn Speargrass
				Austrostipa scabra	Slender Speargrass
				Microlaena stipoides	Weeping Grass
Orchids				*Eriochilus cucullatus*	
Vines				*Absent*	
Mistletoe				*Amyema miquelii*	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				N A	
Species of Significance				*Microseris lanceolata* (declining woodland species)	

Grassy White Box Woodland

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Tb Pi)36
Geology:	Tertiary Basalt (Tb) Permian Illawarra Coal Measures (Pi)
Total Area:	99 ha (EL 6288) 8 ha (DA Boundary)
Legislative Status:	Listed Endangered Ecological Community (White Box ellow Box Blakely s Redgum Woodland)

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		4	0 160	0 161
Seasonal Observations	Summer:	0		
	Autumn:	44		
	Winter:	6		
	Spring:	4		
Opportunistic Observations:		1	0 103	0 104
Total Observations:		184	0 263	0 265

Description

White Box (*E. albens*) of woodland to open woodland structure on Tertiary basalts is the characteristic canopy dominant of this vegetation association Minor associates such as urra ong (*Brachychiton populneus*) and Rough barked Apple (*Angophora floribunda*) also occur The understorey is predominantly grassy with numerous herbaceous species occurring in rocky crevices and beneath the scattered tree canopy Past clearing is responsible for the predominantly open woodland structure Grasses dominating this vegetation association include angaroo Grass (*Themeda australis*) Wallaby Grass (*Austrodanthonia* spp) Three awned Speargrass (*Aridtida vagans*) and slender Speargrass (*Austrostipa scabra*) with the latter two species indicative of gra ed conditions A diverse herb flora is also characteristic of this vegetation association including idney Weed (*Dichondra repens*) Geranium (*Geranium solanderi*) and Australe Bugle (*Ajuga australis*)

Structure				**Floristics**	
		Max	**Min**	***Genus species***	**Common Name**
Trees	eight	14 m	8 m	*Eucalyptus albens*	White Box
	Cover	10	5	*Brachychiton populneus*	urra ong
Shrubs	eight	8 m	0 5 m	*Indigofera adesmiifolia*	
	Cover	20	0	*Callitris endlicheri*	Black Cypress Pine
				Cassinia quinquefaria	
				Santalum lanceolatum	Sandalwood
Herbs	eight	0 3 m	0 m	*Dichondra repens*	idney Weed
	Cover	60	40	*Ajuga australis*	Australe Bugle
				Geranium solanderi	Native Geranium
				Wahlenbergia communis	Tufted Bluebell
				Veronica plebia	Trailling Speedwell
Grasses				*Austrodanthonia pilosa*	Wallaby Grass
				Aristida vagans	Threeawn Speargrass
				Themeda australis	angaroo Grass
				Bothriochloa macra	Redleg Grass
				Dichelacne micrantha	Weeping Grass
				Sarga leioclada	Wild Sorghum
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
				Pleurosorus rutifolius	
Indicator Species				*Pleurosorus rutifolius, Acaena ovina, Brachychiton populneus, Swainsona galegifolia*	
Species of Significance				N A	

Shrubby White Box Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Rn Pi)3
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	204 ha (EL 6288) 1 8 ha (DA Boundary)
Legislative Status:	Unprotected vegetation association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		12	0 480	0 236
Seasonal Observations	Summer:	161		
	Autumn:	69		
	Winter:	6		
	Spring:	85		
Opportunistic Observations:			0 045	0 022
Total Observations:		389	0 525	0 258

Description

White Box (*Eucalyptus albens*) occurring on steep midslopes characterised by tuffaceous claystones of the Permian geological formation are generally shrubby with limited groundcover forbs and grasses Typically this vegetation association is dominated by White Box (*E. albens*) with minor associates including Narrow leaved Ironbark (*Eucalyptus crebra*) on the lower slopes Broad leaved Ironbark (*Eucalyptus fibrosa*) on the upper slopes and Red Stringybark (*Eucalyptus macrorhyncha*) Shrubs are common with the dominants being non pioneer species such as oneypots (*Acrotriche rigida*) and Peach eath (*Lissanthe strigosa*) Grasses and herbs form a sparse groundcover stratum that is not indicative of grassy woodland Mistletoes including Box Mistletoe (*Amyema miquelii*) on White Box (*E. albens*) and Grey Mistletoe (*A. quandang* var quandang) on Narrow leaved Wattle (*A. linearifolia*) are common on the lower slopes

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	18 m	14 m	*Eucalyptus albens*	White Box
	Cover	35	25	*Eucalyptus crebra*	Narrow leaved Ironbark
				Angophora floribunda	Rough barked Apple
Shrubs	eight	10 m	0 5 m	*Acrotriche rigida*	oneypots
	Cover	40	10	*Lissanthe strigosa*	Peach eath
				Cassinia arcuata	Sifton Bush
				Cassinia quinquefaria	
Herbs	eight	1 m	0 m	*Calotis cuneifolia*	Purple Burr Daisy
	Cover	30	5	*Hydrocotyle laxiflora*	Stinking Pennywort
				Dichondra repens	idney Weed
				Goodenia hederacea	Forest Goodenia
Grasses				*Aristida vagans*	Threeawn Speargrass
				Austrostipa scabra	Slender Speargrass
				Dichelacne micrantha	Weeping Grass
				Austrodanthonia spp.	Wallaby Grass
				Clematis glycinoides	
Mistletoe				*Amyema miquelii*	Box Mistletoe
				Amyema quandang var. quandang	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species	*Acacia penninervis, Panicum decompositum, Thysanotus tuberosus, Vittadinia dissecta*
Species of Significance	N A

Slaty Gum Woodlands

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	Pi39
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	20 ha (EL 6288) 9 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		3	0 120	0 615
Seasonal Observations	Summer:	0		
	Autumn:	10		
	Winter:	29		
	Spring:	30		
Opportunistic Observations:		14	0 044	0 223
Total Observations:		83	0 164	0 838

Description

Slaty Gum (*Eucalyptus dawsonii*) dominated vegetation is highly restricted in the study area to areas of iron rich soils derived from oolitic rocks of the Permian geological formation (i e formation of ironstone nodules under anaerobic conditions and cemented by sand and clay material) This vegetation is generally situated near the uncture of Permian and uaternary geological formations throughout the cleared valley floor istorical clearing events have predominantly avoided this vegetation due to the low soil fertility and soil toxicity (i e iron and aluminium content) The shrub understorey is sparse and dominated by Wattles and Sifton Bush The grasses and herb cover is limited but locally diverse with the ma ority of these species in this association reflective of the harsh soil conditions

Structure				**Floristics**	
		Max	**Min**	***Genus species***	**Common Name**
Trees	eight	20 m	14 m	*Eucalyptus dawsonii*	Slaty Gum
	Cover	25	10	*Angophora floribunda*	Rough barked Apple
				Eucalyptus crebra	Narrow leaved Ironbark
				Eucalyptus moluccana	Grey Box
Shrubs	eight	10 m	1 m	*Acrotriche rigida*	oneypots
	Cover	20	0	*Acacia linearifolia*	A Wattle
				Acacia hakeoides	A Wattle
				Callitris endlicheri	Black Cypress Pine
Herbs	eight	1 m	0 m	*Gahnia aspera*	Rough Saw sedge
	Cover	15	0	*Einadia trigonos*	Fishweed
				Goodenia hederacea	Forest Goodenia
Grasses				*Austrostipa scabra*	Slender Speargrass
				Aristida vagans	Threeawn Speargrass
				Arundinella nepalensis	Reedgrass
Orchids				*Glossodia major*	Waxlip rchid
				Diuris goonooensis	Western Donkey rchid
Vines				*Absent*	
Mistletoe				*Amyema quandang var. quandang*	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Enchylaena tomentosa*	
Species of Significance				N A	

Blakely's Redgum Woodland

Broad Vegetation Community:	Tablelands Redgum Woodlands
Vegetation Codes:	(Cug Pi a)40
Geology:	Permian Illawarra Coal Measures (Pi) Carboniferous Ulan uart Mon onites (Cug)
Total Area:	324 ha (EL 6288) 131 ha (DA Boundary)
Legislative Status:	Listed Endangered Ecological Community (White Box ellow Box Blakely s Redgum Woodland)

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		14	0 560	0 1 3
Seasonal Observations	Summer:	153		
	Autumn:	85		
	Winter:	38		
	Spring:	215		
Opportunistic Observations:		90	0 426	0 131
Total Observations:		581	0 986	0 304

Description

This vegetation association is widely distributed throughout the study area where it is predominantly found along drainage lines Near pure stands of Blakely s Redgum (*Eucalyptus blakelyi*) are found on the Permian derived soil types with associate canopy species Scribbly Gum (*Eucalyptus rossii*) and Blue leaved Stringybark (*Eucalyptus agglomerata*) restricted to creek lines derived from Narrabeen sandstones Rough barked Apple (*Angophora floribunda*) Pink Lace (*Melaleuca thymifolia*) and Reedgrass (*Arundinella nepalensis*) are also typical of this association The understorey is specious with a high number of native herbs and grasses This vegetation represents core habitat for the threatened Narrow leaved Goodenia (*Goodenia macbarronii*)

Structure		**Max**	**Min**	***Genus species*** (**Floristics**)	**Common Name**
Trees	eight	20 m	12 m	*Eucalyptus blakelyi*	Blakely s Redgum
	Cover	35	25	*Angophora floribunda*	Rough barked Apple
				Eucalyptus crebra	Narrow leaved Ironbark
				Eucalyptus rossii	Inland Scribbly Gum
Shrubs	eight	10 m	0 5 m	*Cassinia arcuata*	Sifton Bush
	Cover	35	15	*Brachyloma daphnoides*	Beard eath
				Acacia linearifolia	A Wattle
				Styphelia triflora	Five Corners
Herbs	eight	1 m	0 m	*Hydrocotyle laxiflora*	Stinking Pennywort
	Cover	40	15	*Goodenia macbarronii*	Narrow leaved Goodenia
				Hypochaeris radicata	Catsear
Grasses				*Aristida vagans*	Threeawn Speargrass
				Arundinella nepalensis	Reedgrass
				Themeda australis	angaroo Grass
Orchids				*Glossodia major*	Waxlip rchid
				Thelymitra pauciflora	Sun rchid
Vines				*Cassytha glabrella*	Devils Twine
Mistletoe				*Amyema miquelii*	Box Mistletoe
				Amyema quandang var. quandang	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species: *Bracteantha viscosa, Bulbine bulbosa, Desmodium brachypodium, Diuris sulphurea, Eriochloa pseudoacrotricha, Microseris lanceolata, Swainsona monticola, S. reticulata*

Species of Significance: *Goodenia macbarronii (Vulnerable - TSC Act and EPBC Act)*

Tumbledown Redgum Woodland

Broad Vegetation Community:	Tablelands Redgum Woodlands
Vegetation Codes:	(Pi Rn)41
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	18 ha (EL 6288) 13 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		1	0 040	0 220
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	21		
Opportunistic Observations:			0 039	0 21
Total Observations:		28	0 0 9	0 438

Description

This woodland vegetation is restricted to soils derived from the oldest conglomerate strata of the Permian geological formation (i e Marrangaroo Conglomerates) which lies directly ad acent the Carboniferous geological formation Tumbledown Redgum (*Eucalyptus dealbata*) a common western slopes species of igneous rock forms a low woodland association with Black Cypress Pine (*Callitris endlicherii*) The understorey is shrubby and mostly dominated by sclerophyllous species such as *Kunzea* spp and *Calytrix tetragona* *Acacia triptera* a species of restricted distribution within the study area is a characteristic dominant of the shrub strata

Structure		**Max**	**Min**	**Floristics** ***Genus species***	**Common Name**
Trees	eight	10 m	6 m	*Eucalyptus dealbata*	Tumbledown Redgum
	Cover	20	15		
Shrubs	eight	4 m	0 5 m	*Callitris endlicheri*	Black Cypress Pine
	Cover	30	20	*Leucopogon virgatus*	Beard eath
				Babingtonia cunninghamii	
				Calytrix tetragona	Common Fringe myrtle
Herbs	eight	0 5 m	0 m	*Drosera auriculata*	Sundew
	Cover	20	5	*Gonocarpus elatus*	Raspwort
				Gonocarpus tetragynus	Raspwort
Grasses				*Austrodanthonia spp.*	Wallaby Grass
Orchids				*Thelymitra pauciflora*	Sun rchid
				Glossodia major	Waxlip rchid
Vines				*Absent*	
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Eucalyptus dealbata, Acacia triptera*	
Species of Significance				*N/A*	

Inland Scribbly Gum/ Rough-barked Apple Open Forest

Broad Vegetation Community:	Sedimentary Scribbly Gum Woodlands
Vegetation Codes:	(Pi Rn)50
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	232 ha (EL 6288) 119 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling	**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):	3	0 120	0 052
Seasonal Observations Summer:	29		
Autumn:	41		
Winter:	0		
Spring:	35		
Opportunistic Observations:	51	0 221	0 095
Total Observations:	156	0 341	0 14

Description

Scribbly Gum Rough barked Apple vegetation occurs in narrow upland drainage lines often flanked by rocky outcrops with instream conditions primarily ephemeral and sandy The dominant tree species occurs in association with Narrow leaved Ironbark (*Eucalyptus crebra*) on northerly slopes and Blakely s Redgum (*Eucalyptus blakelyi*) at the outcrop of minor clay lens within drainage lines The understorey is predominantly shrubby and is diverse particularly with species belonging to the Epacridaceae and Myrtaceae families The groundcover stratum is generally sparse and characterised mostly by herbs with few grasses

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	16 m	8 m	*Angophora floribunda*	Rough barked Apple
	Cover	20	10	*Eucalyptus rossii*	Inland Scribbly Gum
				Eucalyptus crebra	Narrow leaved Ironbark
				Eucalyptus blakleyi	Blakely s Redgum
Shrubs	eight	8 m	0 5 m	*Leucopogon muticus*	Blunt Beard heath
	Cover	35	15	*Persoonia linearis*	Narrow leaved Geebung
				Callitris endlicheri	Black Cypress Pine
				Brachyloma daphnoides	Beard eath
Herbs	eight	0 5 m	0 m	*Platysace ericoides*	
	Cover	15	10	*Pomax umbellata*	
				Poranthera microphylla	Milk Maids
Grasses				*Austrodanthonia spp.*	Wallaby Grass
				Entolasia stricta	Wiry Panic
				Microlaena stipoides	Weeping Grass
Orchids				*Caladenia fuscata*	Finger rchid
				Pterostylis concinna	Trim Greenhood
Vines				*Clematis glycinoides*	
Mistletoe				*Amyema quandang var. quandang*	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Hibbertia monogyna, Pellaea falcata, Pterostylis concinna, Rubus parvifolius*

Species of Significance *Goodenia macbarronii (Vulnerable - TSC Act and EPBC Act)*

Inland Scribbly Gum/ Blue-leaved Stringybark Open Forests

Broad Vegetation Community:	Sedimentary Scribbly Gum Woodlands
Vegetation Codes:	(Pi Rn)51
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	60 ha (EL 6288) 46 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		2	0 080	0 134
Seasonal Observations	Summer:	0		
	Autumn:	1		
	Winter:	0		
	Spring:	0		
Opportunistic Observations:		0	0 000	0 000
Total Observations:		1	0 080	0 134

Description

This vegetation association is spatially represented by a narrow band below cliff lines and rocky outcrops that flank drainage lines dominated by Inland Scribbly Gum Rough barked Apple Forests The dominant canopy species Blue leaved Stringybark (*Eucalyptus agglomerata*) occurs on sheltered moist soils of predominantly southerly aspect The shrubby understorey is relatively dense with sclerophyllous shrubs such as Blunt Beard eath (*Leucopogon muticus*) Five Corners (*Styphelia triflora*) and Native Fuschia (*Correa reflexa*) Grasses and herbs are limited

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	18 m	10 m	*Angophora floribunda*	Rough barked Apple
	Cover	40	20	*Eucalyptus rossii*	Inland Scribbly Gum
				Eucalyptus agglomerata	Blue leaved Stringybark
Shrubs	eight	10 m	1 m	*Acacia linearifolia*	A Wattle
	Cover	30	10	*Leucopogon muticus*	Blunt Beard heath
				Persoonia linearis	Narrow leaved Geebung
				Styphelia triflora	Five Corners
Herbs	eight	0 5 m	0 m	*Isotoma axillaris*	Showy Isotoma
	Cover	15	5	*Phyllanthus occidentalis*	
				Veronica plebia	Trailling Speedwell
Grasses				*Poa unknown*	Tussock Grass
				Poa sieberiana	Snow Grass
				Austrodanthonia spp.	Wallaby Grass
Orchids				*Dendrobium linguiforme*	Rock Lily
Vines				*Absent*	
Mistletoe				*Amyema quandang var. quandang*	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Dendrobium linguiforme, Epacris reclinata, Goodenia decurrens, Pelargonium australe*

Species of Significance N A

Inland Scribbly Gum/ Black Cypress Pine Woodlands

Broad Vegetation Community:	Sedimentary Scribbly Gum Woodlands
Vegetation Codes:	(Pi Rn)52
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	3 6 ha (EL 6288) 8 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		9	0 360	0 096
Seasonal Observations	Summer:	99		
	Autumn:	59		
	Winter:	25		
	Spring:	62		
Opportunistic Observations:		38	0 209	0 055
Total Observations:		283	0 569	0 151

Description

This vegetation association is dominated principally by Black Cypress Pine (*Callitris endlicherii*) together with various eucalypt associates including Narrow leaved Ironbark (*Eucalyptus crebra*) Inland Scribbly Gum (*Eucalyptus rossii*) and Dwyer s Redgum (*Eucalyptus dwyeri*) The shrubby understorey is characterised by sclerophyllous species including Blunt Beard eath (*Leucopogon muticus*) Five Corners (*Styphelia triflora*) Beard eath (*Brachyloma daphnoides*) and Common Fringe myrtle (*Calytrix tetragona*) The groundcover stratum is predominantly woody herbs and few grasses

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	18 m	12 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	20	5	*Eucalyptus dwyeri*	Dwyer s Redgum
				Eucalyptus fibrosa	Broad leaved Ironbark
				Eucalyptus rossii	Inland Scribbly Gum
Shrubs	eight	12 m	1 m	*Callitris endlicheri*	Black Cypress Pine
	Cover	50	30	*Allocasuarina gymnanthera*	Sheoak
				Brachyloma daphnoides	Beard eath
				Leucopogon muticus	Blunt Beard heath
Herbs	eight	0 4 m	0 m	*Goodenia hederacea*	Forest Goodenia
	Cover	30	5	*Pomax umbellata*	
				Dianella revoluta	Flax Lily
Grasses				*Aristida vagans*	Threeawn Speargrass
				Echinopogon intermedius	A edgehog Grass
				Arundinella nepalensis	Reedgrass
Orchids				*Glossodia major*	Waxlip rchid
				Caladenia caerulea	Blue Caladenia
Vines				*Cassytha glabrella*	Devils Twine
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Acacia serratifolia, Boronia bipinnata, Cheiranthera cyanea, Glossogyne tannensis, Jacksonia scoparia, Themeda avenacea*	
Species of Significance				*Goodenia macbarronii (Vulnerable - TSC Act and EPBC Act)*	

Inland Scribbly Gum/ Stringybark/ Ironbark Woodland

Broad Vegetation Community:	Sedimentary Scribbly Gum Woodlands
Vegetation Codes:	(Pi Rn)53
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	819 ha (EL 6288) 243 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		4	0 160	0 020
Seasonal Observations	Summer:	42		
	Autumn:	33		
	Winter:	0		
	Spring:	62		
Opportunistic Observations:			0 052	0 006
Total Observations:		144	0 212	0 026

Description

This diverse vegetation association occurs down slope of minor rocky outcrops on relatively deep sandy soils with northerly aspect The Red Stringybark (*Eucalyptus macrorhyncha*) is a minor associate to the Ironbarks (*Eucalyptus fibrosa* and *Eucalyptus crebra*) and Inland Scribbly Gum (*Eucalyptus rossii*) The sclerophyllous shrubby groundcover understorey is predominantly void of grasses and soft herbaceous species Understorey dominants include Black Cypress Pine (*Callitris endlicherii*) Box Wattle (*Acacia buxifolia*) Blunt Beard eath (*Leucopogon muticus*)

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	20 m	10 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	30	10	*Eucalyptus rossii*	Inland Scribbly Gum
				Eucalyptus macrorhyncha X	Red Stringybark
				Angophora floribunda	Rough barked Apple
Shrubs	eight	16 m	0 5 m	*Grevillea sericea*	Grevillea
	Cover	20	5	*Acacia leucolobia*	Box Wattle
				Cassinia quinquefaria	
				Persoonia curviflora	Geebung
Herbs	eight	1 m	0 m	*Patersonia sericea*	
	Cover	10	0	*Phyllanthus occidentalis*	
				Lomandra confertifolia	Mat Rush
Grasses				*Aristida vagans*	Threeawn Speargrass
				Arundinella nepalensis	Reedgrass
				Austrodanthonia racemosa	Wallaby Grass
Orchids				*Dipodium hamiltonianum*	
				Glossodia major	Waxlip rchid
Vines				*Absent*	
Mistletoe				*Amyema quandang var. quandang*	uandang
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Acacia gunnii*	
Species of Significance				N A	

Inland Scribbly Gum/ Ironbark Woodland

Broad Vegetation Community:	Sedimentary Scribbly Gum Woodlands
Vegetation Codes:	(Pi Rn)54
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	628 ha (EL 6288) 490 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling	**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):	10	0 400	0 064
Seasonal Observations Summer:	146		
Autumn:	95		
Winter:	0		
Spring:	80		
Opportunistic Observations:	24	0 118	0 019
Total Observations:	345	0 518	0 082

Description

Located on the flatter plateaus on dry shallow sandy soils is a vegetation association dominated by Inland Scribbly Gum (*Eucalyptus rossii*) Ironbark (*Eucalyptus crebra* and *Eucalyptus fibrosa*) and Narrow leaved Stringybark (*Eucalyptus sparsifolia*) Sclerophyllous shrubs are common such as Blunt Beard eath (*Leucopogon muticus*) and Narrow leaved Geebung (*Persoonia linearis*) Sheoak (*Allocasuarina gymnanthera*) is common throughout this vegetation association Groundcovers are generally restricted to woody herbs such as Forest Goodenia (*Goodenia hederacea*) and Mat Rush (*Lomandra* spp) Localised occurrences of Parramatta Redgum (*Eucalyptus parramattensis* ssp *parramattensis*) are common throughout the moist clay enriched open depressions

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	16 m	10 m	*Eucalyptus crebra*	Narrow leaved Ironbark
	Cover	40	20	*Eucalyptus rossii*	Inland Scribbly Gum
				Eucalyptus dwyeri	Dwyer s Redgum
				Eucalyptus fibrosa	Broad leaved Ironbark
Shrubs	eight	6 m	0 5 m	*Leucopogon muticus*	Blunt Beard heath
	Cover	55	20	*Grevillea sericea*	Grevillea
				Allocasuarina gymnanthera	Sheoak
				Calytrix tetragona	Common Fringe myrtle
Herbs	eight	1 m	0 m	*Pomax umbellata*	
	Cover	20	5	*Goodenia hederacea*	Forest Goodenia
				Phyllanthus occidentalis	
Grasses				*Aristida vagans*	Threeawn Speargrass
				Arundinella nepalensis	Reedgrass
				Tetrarrhena juncea	Rock Grass
Orchids				*Glossodia major*	Waxlip rchid
				Microtis parviflora	Slender nion rchid
Vines				*Cassytha glabrella*	Devils Twine
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Boronia anethifolia, Goodenia paniculata, Hemigenia cuneifolia, Hovea rosmarinifolia, Isopogon petiolaris, Pseudanthus divaricatissimus, Scutellaria humilis*

Species of Significance *Pseudanthus divaricatissimus* (R TAP 3RCa)

Yellow Box/ Rough-barked Apple Open Forest

Broad Vegetation Community:	Box Woodlands
Vegetation Codes:	(Pi a)60
Geology:	Permian Illawarra Coal Measures (Pi) uaternary (a)
Total Area:	92 ha (EL 6288) 29 ha (DA Boundary)
Legislative Status:	Listed Endangered Ecological Community (White Box ellow Box Blakely s Redgum Woodland)

Sampling	**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):	1	0 040	0 043
Seasonal Observations Summer:	30		
Autumn:	0		
Winter:	0		
Spring:	0		
Opportunistic Observations:	18	0 040	0 044
Total Observations:	48	0 080	0 08

Description

This vegetation association is restricted to fertile drainage lines of the valley floor particularly at and down slope of the outcropping coal seam The vegetation is dominated by Rough barked Apple (*Angophora floribunda*) with ellow Box (*Eucalyptus melliodora*) forming a minor associate owever the relatively low abundance of ellow Box (*Eucalyptus melliodora*) may be a function of historical clearing events The sparse shrub understorey is characterised by Sifton Bush (*Cassinia arcuata*) and a predominantly grassy groundcover stratum dominated by Weeping Grass (*Microlaena stipoides*)

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	20 m	16 m	*Angophora floribunda*	Rough barked Apple
	Cover	30	20	*Eucalyptus blakelyi*	Blakely s Redgum
				Eucalyptus melliodora	ellow Box
Shrubs	eight	2 m	0 5 m	*Cassinia arcuata*	Sifton Bush
	Cover	10	0	*Brachyloma daphnoides*	Beard eath
				Cassinia cunninghamiana	
Herbs	eight	1 m	0 m	*Glycine tabacina*	
	Cover	50	30	*Hypochaeris radicata*	Catsear
				Petrorhagia nanteuilii	Prolific Pink
Grasses				*Themeda australis*	angaroo Grass
				Austrodanthonia induta	Wallaby Grass
				Austrodanthonia linkii var. fulva	Wallaby Grass
Orchids				*Diuris sulphurea*	Tiger rchid
Vines				*Absent*	
Mistletoe				*Absent*	
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				*Neptunia gracilis*	
Species of Significance				N A	

Rough-barked Apple Open Forest

Broad Vegetation Community:	Alluvial Apple Woodlands
Vegetation Codes:	Pi61
Geology:	Permian Illawarra Coal Measures (Pi)
Total Area:	195 ha (EL 6288) 60 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		6	0 240	0 123
Seasonal Observations	Summer:	82		
	Autumn:	59		
	Winter:	0		
	Spring:	62		
Opportunistic Observations:		19	0 111	0 05
Total Observations:		222	0 351	0 180

Description

This vegetation typically occurs on gravely sandy soils such those located within an unmapped tertiary channel near the mid reaches of Moolarben creek which comprising of course transported material Few other associates occur with the dominant Rough barked Apple (*Angophora floribunda*) The shrubby understorey is diverse with sclerophyllous species such as Native Cranberry (*Astroloma humifusum*) *Babingtonia cunninghamii* and *Daviesia acicularis* which occurs with a grassy groundcover stratum dominated by Slender Speargrass (*Austrostipa scabra*) Weeping Grass (*Microlaena stipoides*) and Reedgrass (*Arundinella nepalensis*)

Structure / Floristics

Structure		**Max**	**Min**	***Genus species***	**Common Name**
Trees	eight	18 m	12 m	*Angophora floribunda*	Rough barked Apple
	Cover	50	30	*Eucalyptus crebra*	Narrow leaved Ironbark
				Eucalyptus punctata	Grey Gum
				Eucalyptus macrorhyncha	Red Stringybark
Shrubs	eight	8 m	0 5 m	*Cassinia arcuata*	Sifton Bush
	Cover	0	5	*Callitris endlicheri*	Black Cypress Pine
				Babingtonia cunninghamii	
				Pultenaea microphylla	A Pea
Herbs	eight	1 m	0 m	*Astroloma humifusum*	Native Cranberry
	Cover	45	30	*Lomandra confertifolia*	Mat Rush
				Wahlenbergia communis	Tufted Bluebell
Grasses				*Aristida vagans*	Threeawn Speargrass
				Dichelacne micrantha	Short haired Plummed Grass
				Microlaena stipoides	Weeping Grass
Orchids				*Microtis parviflora*	Slender nion rchid
Vines				*Clematis glycinoides*	
Mistletoe				*Amyema quandang var. quandang*	uandang
				Amyema miquelii	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species *Hibbertia linearis*

Species of Significance N A

Rough-barked Apple/ Ironbark Open Forest

Broad Vegetation Community:	Alluvial Apple Woodlands
Vegetation Codes:	(Pi Rn)62
Geology:	Permian Illawarra Coal Measures (Pi) Triassic Narrabeen Group (Rn)
Total Area:	8 ha (EL 6288) 1 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		1	0 040	0 4 9
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	25		
Opportunistic Observations:		0	0 000	0 000
Total Observations:		25	0 040	0 4 9

Description

This vegetation association is of restricted occurrence within EL6288 with mapped occurrences confined to the southeastern corner of the study area ad acent to the margin of the Sydney Basin Bioregion Typically this vegetation association is situated on conglomerate derived soils consisting of large si ed gravely material and course sands immediately ad acent to quaternary sediments derived from Carboniferous parent material The tree and shrub canopy consists of a diverse range of Myrtaceous species characteristic of infertile dry soils Grasses and woody herbs form a sparse groundcover stratum This vegetation association which is formed on the Marrangaroo Conglomerates appears to contain core habitat for Cannon s Stringybark (*Eucalyptus cannonii*)

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	0 m	0 m	*Angophora floribunda*	Rough barked Apple
	Cover	0	0	*Eucalyptus crebra*	Narrow leaved Ironbark
				Eucalyptus rossii	Inland Scribbly Gum
				Eucalyptus macrorhyncha	Red Stringybark
Shrubs	eight	0 m	0 m	*Cassinia arcuata*	Sifton Bush
	Cover	0	0	*Callitris endlicheri*	Black Cypress Pine
				Babingtonia cunninghamii	
				Pultenaea microphylla	A Pea
Herbs	eight	0 m	0 m	*Astroloma humifusum*	Native Cranberry
	Cover	0	0	*Lomandra confertifolia*	Mat Rush
				Wahlenbergia communis	Tufted Bluebell
Grasses				*Aristida vagans*	Threeawn Speargrass
				Dichelacne micrantha	Weeping Grass
				Microlaena stipoides	Weeping Grass
Orchids				*Microtis parviflora*	Slender nion rchid
Vines				*Clematis glycinoides*	
Mistletoe				*Amyema quandang var. quandang*	uandang
				Amyema miquelii	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern

Indicator Species N A

Species of Significance *Eucalyptus cannonii* (Vulnerable TSC Act and EPBC Act)

Rough-barked Apple/ Grey Box Open Forest

Broad Vegetation Community:	Alluvial Apple Woodlands
Vegetation Codes:	(Pi Rn)63
Geology:	Triassic Narrabeen Group (Rn) Permian Illawarra Coal Measures (Pi)
Total Area:	6 ha (EL 6288) 1 ha (DA Boundary)
Legislative Status:	Unprotected vegetation community association

Sampling		**#**	**Area (ha)**	**Survey extant for association within EL6288 (%)**
Systematic Survey (Quadrats):		2	0 080	0 120
Seasonal Observations	Summer:	0		
	Autumn:	0		
	Winter:	0		
	Spring:	4		
Opportunistic Observations:		31	0 131	0 196
Total Observations:		8	0 211	0 316

Description

This vegetation association is found along well defined drainage corridor of Murragamba Creek and dominated by Grey Box (*Eucalyptus moluccana*) and Rough barked Apple (*Angophora floribunda*) Isolated occurrences occur in near the transition between Permian and Carboniferous geological formations in the mid reaches of Moolarben Creek and at the northern extremity of the study area Grasses are common and include a variety of native and exotic species together with herbs of moist environs

Structure		**Max**	**Min**	**Floristics** *Genus species*	**Common Name**
Trees	eight	18 m	14 m	*Angophora floribunda*	Rough barked Apple
	Cover	25	15	*Eucalyptus crebra*	Narrow leaved Ironbark
				Eucalyptus punctata	Grey Gum
				Eucalyptus macrorhyncha	Red Stringybark
Shrubs	eight	10 m	1 m	*Cassinia arcuata*	Sifton Bush
	Cover	35	5	*Callitris endlicheri*	Black Cypress Pine
				Babingtonia cunninghamii	
				Pultenaea microphylla	A Pea
Herbs	eight	1 m	0 m	*Astroloma humifusum*	Native Cranberry
	Cover	60	15	*Lomandra confertifolia*	Mat Rush
				Wahlenbergia communis	Tufted Bluebell
Grasses				*Aristida vagans*	Threeawn Speargrass
				Dichelacne micrantha	Weeping Grass
				Microlaena stipoides	Weeping Grass
Orchids				*Microtis parviflora*	Slender nion rchid
Vines				*Clematis glycinoides*	
Mistletoe				*Amyema quandang var. quandang*	uandang
				Amyema miquelii	Box Mistletoe
Ferns				*Cheilanthes sieberi ssp. sieberi*	Poison Rock Fern
Indicator Species				N A	
Species of Significance				*Apium prostratum* (range extension)	

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Flora list for the Stud rea

AUGUST 2006

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Adiantaceae	*Cheilanthes distans*	Y	U																					•														
	Cheilanthes sieberi ssp. sieberi	Y	U	•			•	•	•				•	•		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•	•		•
	Pellaea falcata	Y	U																										•									
Amaranthiaceae	*Alternanthera denticulata*	Y	U	•																																		
	Alternanthera pungens	N	U			•																																
	Schinus areira	N	U	•																																		
Anthericaceae	*Arthropodium species B*	Y	U																				•	•			•											
	Dichopogon fimbriatus	Y	U																		•				•		•									•		
	Laxmannia gracilis	Y	U										•	•	•			•		•	•	•	•				•		•		•					•		
	Thysanotus juncifolius	Y	U																																•	•		
	Thysanotus patersonii	Y	U											•	•				•				•				•				•							
Apiaceae	*Thysanotus tuberosus*	Y	U																						•													
	Tricoryne elatior	Y	U											•					•	•	•		•		•		•				•		•			•		•
	Actinotus helianthi	Y	P13										•																	•			•					
	Apium prostratum var. prostratum	Y	U																																			•
	Ciclospermum leptophyllum	N	U																								•											
	Daucus glochidiatus	Y	U			•															•				•													
	Eryngium rostratum	Y	U																•																			
	Hydrocotyle laxiflora	Y	U					•						•				•	•	•	•		•	•	•	•	•		•	•						•		•
	Hydrocotyle tripartita	Y	U																															•				
	Platysace ericoides	Y	U										•	•				•									•		•	•	•		•					
Araliaceae	*Astrotricha longifolia*	Y	U											•																								
Asphodelaceae	*Bulbine bulbosa*	Y	U																•					•														
Aspleniaceae	*Asplenium flabellifolium*	Y	U																•								•		•	•								
Aspleniaceae	*Pleurosorus rutifolius*	Y	U																					•														
Asteraceae	*Arctotheca calendula*	N	U			•																					•											
	Bidens pilosa	N	U																																			
	Brachyscome multifida	Y	U										•																									
	Bracteantha viscosa	Y	U																								•											
	Calocephalus citreus	Y	U																•								•											
	Calotis cuneifolia	Y	U				•	•	•				•	•		•		•	•	•	•		•		•	•	•				•				•	•		
	Calotis lappulacea	Y	U	•		•			•									•	•	•	•		•	•	•		•								•	•		
	Cassinia aculeata	Y	U										•	•																								
	Cassinia arcuata	Y	U				•	•	•				•	•	•	•		•	•	•	•	•	•	•	•	•	•		•		•		•		•	•		•
	Cassinia cunninghamiana	Y	U											•	•				•						•										•			•

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Asteraceae	*Cassinia quinquefaria*	Y	U										•	•	•				•					•	•	•	•		•		•		•			•		
	Catharmus lanatus	N	U	•	•	•													•					•			•					•						
	Chrysocephalum apiculatum	Y	U										•			•		•	•		•		•		•		•				•		•		•			
	Cirsium vulgare	N	U	•		•									•				•					•			•											•
	Conyza bonariensis	N	U																								•											
	Conyza sumatriensis	N	U	•				•																														
	Cotula australis	Y	U																								•											
	Cotula coronopifolia	N	U																																			•
	Cymbonotus lawsonianus	Y	U																					•	•				•									
	Dittrichia graveolens	N	U	•	•																											•						
	Euchiton gymnocephalus	Y	U																•																			
	Euchiton involucratum	Y	U																	•			•		•		•	•										•
	Gamochaeta americanum	N	U																								•											
	Glossogyne tannensis	Y	U																		•										•							
	Helichrysum collinum	Y	U																														•					
	Hypochaeris glabrata	N	U						•					•									•				•									•		
	Hypochaeris radicata	N	U	•		•	•	•											•		•		•		•	•	•	•		•	•			•	•	•		•
	Lactuca seriola	N	U																•					•														
	Leucochrysum albicans tricolor	Y	E																		•																	
	Microseris lanceolata	Y	U		•									•							•			•			•					•						•
	Minuria integerrima	Y	U																					•														
	Olearia elliptica	Y	U																						•													
	Ozothamnus diosmifolia	N	U												•																							
	Podolepis neglecta	Y	U																		•				•		•											
	Senecio bathurstianus	Y	U																								•											
	Senecio hispidulus	Y	U											•						•			•															
	Senecio prenanthoides	Y	U																•										•									
	Senecio quadridentatus	Y	U				•									•			•		•							•										
	Sigesbeckia orientalis ssp. orientalis	Y	U																					•														
	Sochus oleraceus	N	U																					•			•											
	Solenogyne bellioides	Y	U											•					•	•					•		•		•									
	Taraxacum officinale	N	U																					•	•		•											
	Tolpis umbellata	N	U																								•											
	Triptilodiscus pygmaeus	Y	U	•					•																											•		
	Vittadinia cuneata	Y	U																	•				•	•		•											

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
	Vittadinia dissecta	Y	U																						•													
	Vittadinia muelleri	Y	U	•															•	•	•										•							
	Vittadinia pustulata	Y	U											•											•													
	Vittadinia sulcata	Y	U																•																			
	Xanthium spinosum	N	U																																•			
Blechnaceae	*Doodia aspera*	Y	U																					•														
Boraginaceae	*Cynoglossum australe*	Y	U																•	•									•									
	Echium plantagineum	N	U																																•			
Brassicaceae	*Capsella bursa-parstoris*	N	U			•																																
	Lepidium africana	N	U			•																																
	Sisymbrium irio	Y	U																					•														
Cactacea	*Opuntia stricta*	N	U						•												•			•	•				•									
Campanulaceae	*Wahlenbergia communis*	Y	U		•	•			•				•	•	•				•	•	•		•	•	•		•		•	•		•	•		•	•		•
	Wahlenbergia luteola	Y	U																						•										•			
	Wahlenbergia stricta	Y	U																														•					
Caryophyllaceae	*Cerastium glomeratum*	N	U		•																						•					•						
	Petrorhagia nanteuilii	N	U																					•	•	•	•								•	•		
	Silene gallica	N	U																					•	•													
	Spergularia marina	N	U		•																											•						
	Stellaria pungens	Y	U											•					•								•		•	•						•		
	Stellaria sp. D	Y	U																					•	•				•									
Casuarinaceae	*Allocasuarina diminuta*	Y	U																														•					
	Allocasuarina gymnanthera	Y	U		•								•	•	•	•					•				•		•		•		•	•	•					
	Allocasuarina littoralis	Y	U																												•		•					
	Allocasuarina luehmannii	Y	U						•					•						•		•	•		•		•						•					
	Allocasuarina verticillata	Y	U		•																				•							•						
	Casuarina cunninghamiana	Y	P13																																			
Chenopodiaceae	*Chenopodium ambrosioides*	N	U	•																																		
	Einadia nutans	Y	U											•											•	•										•		
	Einadia polygonoides	Y	U													•		•					•		•					•								
	Einadia trigonos	Y	U											•				•	•					•	•	•	•											
	Enchylaena tomentosa	Y	U																							•												
	Maireana enchylaenoides	Y	U																•																			
	Maireana microphylla	Y	U																							•												
	Salsola kali	Y	U	•																																		

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Clusiaceae	*Hypericum gramineum*	Y	U				•	•						•				•	•	•	•				•	•	•		•				•	•		•		
	Hypericum perforatum	N	U			•													•		•			•														
Colchicaceae	*Wurmbea biglandulosa*	Y	U	•			•									•					•																	
Convolvulaceae	*Convovulus erubescens*	Y	U																•						•													
	Dichondra repens	Y	U											•				•	•	•	•	•	•	•	•	•	•		•							•		
Crassulaceae	*Crassula sieberiana*	Y	U											•					•					•					•	•								
	Cucumis myriocarpus	N	U	•																																		
Cupressaceae	*Callitris endlicheri*	Y	U		•		•		•				•	•	•	•		•	•		•	•	•	•	•	•	•	•	•		•	•	•			•		•
Cyperaceae	*Carex appressa*	Y	U																•				•				•							•				•
	Carex inversa	Y	U																•					•	•		•											
	Cladium procerum	Y	U																																•			
	Cyperus fulvus	Y	U																								•							•				
	Cyperus gracilis	Y	U																					•														
	Cyperus lucidus	Y	U																								•											
	Eleocharis gracilis	Y	U																															•				
	Eleocharis plana	Y	U	•																																		
	Eleocharis sphaceolata	Y	U	•																																		
	Fimbristylis dichotoma	Y	U																•	•			•		•											•		
	Gahnia aspera	Y	U				•						•	•	•			•	•	•	•	•	•	•	•	•	•				•		•			•		
	Lepidosperma laterale	Y	U						•				•	•	•	•			•			•			•	•					•		•			•		
	Lipocarpha microcephala	Y	U										•		•																							
	Scheonus apogon	Y	U																															•				
	Schoenoplectus mucronatus	Y	U	•																																		
	Schoenoplectus validus	Y	U																•																			
	Schoenus ericetorum	Y	U												•												•		•		•		•					
	Schoenus moorei	Y	U																															•				
Dennstaedtiaceae	*Pteridium esculentum*	Y	U																								•		•	•								
Dilleniaceae	*Hibbertia acicularis*	Y	U												•				•						•											•		
	Hibbertia circumdans	Y	U										•	•							•						•		•	•	•		•		•	•		
	Hibbertia linearis	Y	U																														•			•		
	Hibbertia monogyna	Y	U																										•									
	Hibbertia obtusifolia	Y	U										•	•	•			•	•		•		•		•	•	•				•					•		
	Hibbertia riparia	Y	U												•												•		•		•		•					
Droseraceae	*Drosera auriculata*	Y	U	•			•	•								•					•						•	•					•					
	Drosera burmannii	Y	U																															•				

Family	*Species*	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Epacridaceae	*Acrotriche rigida*	Y	U						•				•	•	•			•	•	•	•		•	•	•	•	•	•					•			•		•
	Astroloma humifusum	Y	U				•	•					•	•	•			•	•	•	•	•	•	•	•	•	•	•	•		•		•			•		
	Brachyloma daphnoides	Y	U										•		•	•					•				•		•		•		•		•		•	•		•
	Epacris reclinata	Y	U																											•								
	Leucopogon biflorus	Y	U																		•						•											
	Leucopogon microphyllus	Y	U											•	•														•		•		•					
	Leucopogon muticus	Y	U					•					•	•	•	•		•	•		•				•		•	•	•	•	•		•					
	Leucopogon virgatus	Y	U										•	•	•	•											•	•			•		•					
	Lissanthe strigosa	Y	U				•						•	•	•	•		•	•	•	•	•	•		•	•	•				•					•		
	Melichrus erubescens	Y	U										•	•	•	•		•	•								•				•		•					•
	Melichrus urceolatus	Y	U										•			•			•		•				•		•				•		•					
	Monotoca scoparia	Y	U										•														•		•	•	•		•			•		
	Styphelia triflora	Y	U	•									•	•	•			•	•		•				•		•		•	•	•		•			•		
Eriocaulaceae	*Eriocaulon scariosum*	Y	U																															•				
Euphorbiaceae	*Chamaesyce drummondii*	Y	U																•	•					•													
	Phyllanthus occidentalis	Y	U										•	•	•				•						•	•	•			•			•					
	Poranthera corymbosa	Y	U										•	•													•			•								
	Poranthera microphylla	Y	U										•	•		•			•						•		•		•				•			•		
	Pseudanthus divaricatissimus	Y	U										•																				•					
Fabaceae_Faboideae	*Aotus subglauca var. filiformis*	Y	U												•												•						•					
	Bossiaea buxifolia	Y	U			•	•												•		•				•	•	•									•		
	Bossiaea obcordata	Y	U										•		•												•				•		•					
	Bossiaea rhombifolia ssp. concolor	Y	U										•														•		•									
	Daviesia acicularis	N	U				•																				•									•		
	Daviesia genistifolia	Y	U																•	•	•	•	•		•		•									•		
	Daviesia latifolia	Y	U																										•									
	Daviesia ulicifolia	Y	U						•					•	•																•							
	Desmodium brachypodum	Y	U																					•	•		•											
	Desmodium variens	Y	U															•	•					•												•		
	Dillwynia elegans	Y	U										•		•												•				•							
	Glycine canescens	Y	U																						•		•											
	Glycine clandestina	Y	U				•		•				•	•				•	•	•	•		•	•	•	•	•			•						•		
	Glycine tabacina	Y	U						•					•					•	•	•		•	•	•		•								•	•		•
	Gompholobium huegelii	Y	U										•	•	•				•								•		•									
	Hardenbergia violacea	Y	U										•						•	•					•		•									•		

Family	*Species*	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Fabaceae_Faboideae	*Hovea heterophylla*	Y	U										•												•		•		•		•				•	•		
	Hovea lanceolata	Y	U										•																									
	Hovea rosmarinifolia	Y	U																														•					
	Indigofera adesmiifolia	Y	U																•					•	•											•		
	Indigofera australis	Y	U										•	•										•														
	Jacksonia scoparia	Y	U																												•							
	Kennedia rubicundra	Y	U																•																	•		
	Lotus australis	N	U																					•														
	Medicago arabica	N	U		•																											•						•
	Medicago polymorpha	N	U																																•			
	Mirbelia pungens	Y	U																														•					
	Oxylobium pulteneae	Y	U											•	•												•						•					
	Podolobium ilicifolium	Y	U										•	•											•	•				•								
	Pultenaea foliolosa	Y	U													•		•													•					•		
	Pultenaea microphylla	Y	U				•						•	•	•			•		•	•	•			•	•	•		•		•		•			•		
	Pultenaea spinosa	Y	U										•	•																								
	Swainsona galegifolia	Y	U																•					•														
	Swainsona monticola	Y	U																																			
	Swainsona reticulata	Y	U																•		•						•											
	Templetonia stenophylla	Y	U																•		•	•			•													
	Trifolium arvense	N	U		•														•					•	•		•					•			•			•
	Trifolium campestre	N	U		•																											•						
	Trifolium subterraneum	N	U			•																																
	Zornia dyctiocarpa	Y	U																		•						•								•			
Fabaceae_Mimosoideae	*Acacia deanii*	Y	U											•							•																	
	Acacia acinacea	Y	U											•				•																				
	Acacia ausfeldii	Y	U	•																																		
	Acacia brownii	Y	U			•							•	•	•	•									•		•						•					•
	Acacia dawsonii	Y	U																								•				•							
	Acacia decora	Y	U																•	•	•		•		•		•									•		
	Acacia difformis	Y	U															•			•																	
	Acacia doratoxylon	Y	U										•												•								•			•		•
	Acacia gladiiformis	Y	U										•		•												•		•		•		•					
	Acacia gunnii	Y	U									•																										
	Acacia hakeoides	Y	U											•					•	•	•		•			•	•				•							

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Fabaceae_Mimosoideae	*Acacia implexa*	Y	U						•					•				•	•		•		•	•	•	•	•									•		•
	Acacia lanigera	Y	U																		•						•				•							
	Acacia leucolobia	Y	U										•	•	•	•			•		•			•	•		•		•	•	•		•			•		
	Acacia linearifolia	Y	U		•								•	•	•			•	•	•				•	•	•	•		•	•	•	•	•			•		
	Acacia paradoxa	Y	U								•																											
	Acacia penninervis	Y	U																		•			•		•							•					
	Acacia polybotrya	Y	U													•					•						•											•
	Acacia sertiformis	Y	U												•										•		•				•		•					
	Acacia spectablis	Y	U						•					•						•	•						•				•							
	Acacia subulata	Y	U					•																														
	Acacia triptera	Y	U	•												•												•					•					
	Acacia verniciflua	Y	U					•	•									•	•	•	•		•		•													•
	Acacia vestita	Y	U																		•																	
	Neptunia gracilis	Y	U																																•			
Genticulaceae	*Centaurium erythraea*	N	U																								•											
	Centaurium tenuiflorum	N	U																								•									•		•
	Sebaea ovata	N	U																								•											
Geraniaceae	*Erodium crinitum*	Y	U	•	•																											•						
	Geranium retrorsum	Y	U																•																			
	Geranium solanderi	Y	U																•					•	•		•								•	•		
	Pelargonium australe	Y	U																											•								
Goodeniaceae	*Dampiera lanceolata var. lanceolata*	Y	U										•		•												•						•					
	Goodenia decurrens	Y	U																											•								
	Goodenia hederacea	Y	U				•						•	•	•	•		•	•		•	•	•	•	•	•	•		•	•	•		•			•		
	Goodenia heterophylla	Y	U										•	•																								
	Goodenia macbarronnii	Y	T		•								•			•			•	•			•			•	•	•	•		•	•		•				
	Goodenia paniculata	Y	U													•																	•					
	Goodenia pinnatifida	Y	U																•						•													
Haloragaceae	*Gonocarpus elatus*	Y	U										•	•													•	•	•	•			•					
	Gonocarpus tetragynus	Y	U										•	•					•		•				•		•	•			•					•		
	Haloragis heterophylla	Y	U	•			•	•													•						•							•				
	Myriophyllum gracile var. lineare	Y	U																															•				
Iridaceae	*Patersonia sericea*	Y	U										•	•	•	•					•				•		•		•		•		•			•		
	Sisyrinchium sp.A	N	U															•																				
Juncaceae	*Juncus articulatus*	N	U																															•				

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Juncaceae	*Juncus filicaulis*	Y	U															•					•				•				•							
	Juncus homalocaulis	Y	U																•				•				•											
	Juncus planifolius	Y	U																															•				•
	Juncus subsecundus	Y	U											•				•	•				•				•											•
	Luzula meridionalis	Y	U												•				•					•										•				
Lamiaceae	*Ajuga australis*	Y	U																•					•												•		
	Hemigenia cuneifolia	Y	U																														•					
	Marrubium vulgare	N	U																	•						•												
	Mentha diemenica	Y	U																•					•	•		•											
	Prostanthera howelliae	Y	U												•																							
	Prostanthera nivea	Y	U															•																				
	Scutellaria humilis	Y	U																														•					
	Teucrium corymbosum	Y	U																				•															
Lauraceae	*Cassytha glabrella*	Y	U												•			•									•				•		•					
	Cassytha melantha	Y	U																					•														
	Cassytha pubescens	Y	U																																			
Lentibulariaceae	*Utricularia dichotoma*	Y	U																															•				
Linaceae	*Linum marginale*	Y	U			•													•					•		•	•									•		
	Linum trigynum	N	U																								•											
Lobeliaceae	*Isotoma axillaris*	Y	U										•														•		•	•								
	Isotoma fluviatilis	Y	U																								•							•				
Loganiaceae	*Logania albiflora*	Y	U											•																								
Lomandraceae	*Lomandra confertifolia*	Y	U				•						•	•		•		•	•	•			•	•	•	•	•		•		•		•		•	•		•
	Lomandra filiformis ssp. coriacea	Y	U										•	•		•		•		•			•	•	•		•		•		•		•			•		
	Lomandra filiformis ssp. filiformis	Y	U										•	•	•	•		•	•		•		•	•	•	•	•		•				•			•		
	Lomandra glauca	Y	U										•	•	•				•		•	•			•	•	•		•		•		•			•		
	Lomandra leucocephala	Y	U	•																							•											
	Lomandra longifolia	Y	U											•													•		•									
	Lomandra multiflora ssp. multiflora	Y	U	•			•						•	•	•			•	•	•	•		•	•	•	•	•		•		•		•			•		•
Loranthaceae	*Amyema cambagei*	Y	U																	•																		
	Amyema miquelii	Y	U										•	•				•	•	•	•	•	•		•		•									•		
	Amyema miraculosum spp. boormanii	Y	U																•								•											
	Amyema quandang var. quandang	Y	U		•								•	•				•		•					•	•	•		•	•		•				•		
Malaceae	*Cotoneaster pannonsus*	N	U		•																											•						
Malvaceae	*Modiola caroliniana*	Y	U	•																																		

Family	Species	Native Status		10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Malvaceae	*Sida corrugata*	Y	U																	•	•					•		•								•			
	Sida cunninghamii	Y	U																	•	•																		
Menyanthaceae	*Nymphoides geminata*	Y	U	•																																		
Moraceae	*Ficus rubiginosa*	Y	U											•																								
Myoporaceae	*Eremophila deblis*	Y	U																						•													
	Myoperum montanum	Y	U		•																											•						
Myrtaceae	*Angophora floribunda*	Y	U				•	•					•	•		•		•	•		•		•	•	•	•	•		•	•	•		•		•	•		•
	Babingtonia cunninghamii	Y	U			•	•						•	•		•		•			•				•		•	•	•		•		•			•		•
	Babingtonia densifolia	Y	U												•																•		•					
	Callistemon linearis	Y	U												•																						
	Calytrix tetragona	Y	U	•			•								•												•	•	•		•		•					
	Eucalyptus agglomerata	Y	U										•	•													•		•	•								
	Eucalyptus albens	Y	U																	•	•			•	•	•													
	Eucalyptus blakelyi	Y	U					•											•		•		•		•		•		•		•		•		•			•
	Eucalyptus cannonii	Y	T															•																				
	Eucalyptus crebra	Y	U										•	•	•	•		•	•	•	•		•		•	•	•		•		•		•					
	Eucalyptus dawsonii	Y	U											•				•		•		•	•			•										•		
	Eucalyptus dealbata	Y	U																									•											
	Eucalyptus dwyeri	Y	U										•		•														•		•		•					
	Eucalyptus fibrosa	Y	U						•				•	•	•			•		•					•								•					
	Eucalyptus goniocalyx	Y	U																	•																		
	Eucalyptus macrorhyncha	Y	U										•	•	•	•		•	•		•		•		•		•				•		•					
	Eucalyptus macrorhyncha X	Y	U											•		•			•		•		•															
	Eucalyptus melliodora	Y	U					•											•		•				•		•		•						•			•
	Eucalyptus moluccana	Y	U			•								•					•	•	•	•	•		•	•	•		•		•							•
	Eucalyptus parramattensis ssp. parramatten	Y	U										•	•		•											•		•		•		•					
	Eucalyptus punctata	Y	U										•	•											•				•									
	Eucalyptus rossii	Y	U										•	•	•												•		•	•	•		•					
	Eucalyptus sideroxylon	Y	U		•								•	•				•			•	•	•				•					•				•		
	Eucalyptus sparsifolia	Y	U										•	•												•					•		•					
	Kunzea 'Mt Kapitar'	Y	U	•									•	•				•					•								•							
	Kunzea parvifolia	Y	U	•				•	•						•	•							•				•		•				•			•		•
	Leptospermum arachnoides	Y	U																														•					
	Leptospermum continentale	Y	U	•																							•		•									
	Leptospermum parvifolia	Y	U										•			•											•				•		•					

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Myrtaceae	*Leptospermum polygalifolium*	Y	U					•																			•		•		•		•					
	Melaleuca erubescens	Y	U																														•					
	Melaleuca thymifolia	Y	U											•		•							•				•		•		•		•					
	Melaleuca uncinata	Y	U																			•																
	Micromyrtus sessilis	Y	U																														•					
Olacaceae	*Olax stricta*	Y	U										•																									
Orchidaceae	*Acianthus fornicatus*	Y	U											•	•																							
	Caladenia caerulea	Y	U										•	•	•												•		•		•		•					
	Caladenia catenata	Y	U																								•									•		
	Caladenia fuscata	Y	U												•				•		•						•		•		•							
	Caladenia gracilis	Y	U										•	•		•		•			•		•				•	•			•							
	Calochilus robertsonii	Y	U											•														•										
	Dendrobium linguiforme	Y	P13																											•								
	Dipodium hamiltonianum	Y	U																																			
	Diuris goonooensis	Y	U	•	•	•	•		•		•			•	•	•		•	•		•	•	•				•				•	•				•		
	Diuris sulphurea	Y	U		•	•								•					•					•			•					•						•
	Diuris tricolor	Y	T	•			•																															
	Eriochilus cucullatus	Y	U																		•		•															
	Glossodia major	Y	U			•					•		•	•	•	•			•		•					•	•	•			•		•					•
	Microtis parviflora	Y	U				•		•												•						•				•		•			•		
	Pterostylis bicolor	Y	U	•			•	•	•							•		•	•	•	•			•							•					•		
	Pterostylis concinna	Y	U																										•									
	Pterostylis mutica	Y	U								•																								•			
	Pterostylis nutans	Y	U																		•								•									
	Thelymitra malvina	Y	U	•					•																													
	Thelymitra pauciflora	Y	U	•			•														•		•				•	•	•		•					•		
Oxalidaceae	*Oxalis chnoodes*	Y	U																					•														
	Oxalis exilis	Y	U											•				•									•						•			•		
	Oxalis perennans	Y	U					•	•				•	•					•	•			•	•	•	•	•		•				•			•		
Philydraceae	*Philydrum lanuginosum*	Y	U																															•				
Phormiaceae	*Dianella caerulea*	Y	U																•							•	•						•					•
	Dianella longifolia	Y	U										•	•																•								
	Dianella revoluta	Y	U			•							•	•	•			•	•		•	•			•	•	•		•	•	•		•			•		
Pittosporaceae	*Bursaria spinosa*	Y	U											•																								
	Billardiera scandens	Y	U						•				•	•		•		•	•			•		•	•	•					•					•		

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Pittosporaceae	*Cheiranthera cyanea*	Y	U																						•						•							
Plantaginaceae	*Plantago debilis*	Y	U																•	•							•											
	Plantago gaudichaudii	Y	U																•					•												•		
	Plantago hispidulus	Y	U																						•													
	Plantago lanceolata	N	U																																•	•		•
	Plantago varia	N	U																•	•				•	•		•											•
Poaceae	*Aira elegantissima*	N	U													•			•								•								•			•
	Anthoxanthum odoratnm	N	U		•																											•						
	Aristida calycina	Y	U															•																				
	Aristida ramosa	Y	U										•	•				•		•							•						•					
	Aristida vagans	Y	U	•			•	•	•				•	•	•			•	•		•	•	•	•	•	•	•		•	•	•		•		•	•		•
	Arundinella nepalensis	Y	U				•	•								•				•	•	•	•		•	•	•				•		•	•		•		•
	Austrodanthonia caespitosa	Y	U																						•													•
	Austrodanthonia eriantha	Y	U						•																													
	Austrodanthonia fulvus	Y	U													•		•					•		•													
	Austrodanthonia laevis	Y	U																	•					•													
	Austrodanthonia linkii	Y	U											•					•		•		•		•				•									•
	Austrodanthonia linkii var. fulva	Y	U										•	•		•			•				•		•						•				•	•		
	Austrodanthonia pilosa	Y	U															•						•														
	Austrodanthonia racemosa	Y	U											•				•	•		•		•	•	•		•								•	•		
	Austrodanthonia richardsonii	Y	U																			•																
	Austrodanthonia setacea	Y	U																				•	•	•											•		
	Austrostipa densiflora	Y	U						•				•	•							•				•	•					•				•			•
	Austrostipa scabra	Y	U		•				•				•	•		•		•	•	•	•		•		•	•	•				•	•				•		•
	Austrostipa setacea	Y	U																							•												
	Austrostipa verticillata	Y	U	•																																		
	Bothriochloa decipiens	Y	U																•				•		•		•											•
	Bothriochloa macra	Y	U																	•			•	•														
	Briza minor	N	U	•																							•							•	•			•
	Bromus hordeaceus	N	U		•	•																										•						•
	Chloris gayana	N	U								•																											
	Chloris truncata	Y	U		•																•		•	•								•						
	Chloris ventricosa	Y	U																						•													
	Cymbopogon refractus	Y	U																				•	•		•	•											
	Cynodon dactylon	Y	U		•																						•					•		•				

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Poaceae	*Dicantheum sericeum*	Y	U	•																																		
	Dichelacne micrantha	Y	U										•	•		•		•	•				•	•	•	•	•				•		•			•		
	Dichelacne rara	Y	U																•																			
	Digitaria breviglumis	Y	U										•										•															
	Digitaria brownii	Y	U																	•	•						•											
	Digitaria divaricatissima	Y	U											•																								
	Digitaria violascens	N	U													•				•							•									•		
	Echinopogon cheelii	Y	U																																•	•		
	Echinopogon intermedius	Y	U					•						•		•		•			•		•		•		•		•	•	•		•		•	•		
	Eleusine indica	N	U		•																											•						
	Elymus scaber	Y	U																					•	•											•		
	Enneapogon gracilis	Y	U																	•	•																	
	Entolasia marginata	Y	U											•																								
	Entolasia stricta	Y	U																		•					•			•				•					
	Eragrostis brownii	Y	U																•				•	•			•							•				
	Eragrostis leptostachya	Y	U				•	•												•			•															
	Eriochloa pseudoacrotricha	Y	U																								•											
	Eulalia aurea	Y	U						•																		•				•					•		•
	Hordeum hystrix	N	U		•																											•						
	Hordeum leporinum	Y	U		•																			•								•						
	Imperata cylindrica	Y	U	•				•								•											•											
	Joycea pallida	Y	U											•	•	•		•				•	•		•	•									•	•		
	Lolium rigidum	N	U			•																			•													
	Microlaena stipoides	Y	U						•					•		•		•	•		•		•	•	•	•	•		•				•		•	•		•
	Panicum decompositum	Y	U																						•													
	Panicum effusum	Y	U													•								•			•											
	Panicum simile	Y	U																																			
	Paspalum dilatatum	N	U																								•											
	Phragmites australis	Y	U																																			•
	Poa labillardieri	Y	U						•																•		•											•
	Poa meionectes	Y	U																•																			
	Poa sieberiana	Y	U												•	•			•					•	•	•				•			•			•		
	Sarga leioclada	Y	U																					•														•
	Setaria pumila	N	U	•																																		
	Sporobolus creber	Y	U		•																						•					•						

Family	Species	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Poaceae	*Tetrarrhena juncea*	Y	U										•	•															•				•					
	Themeda australis	Y	U				•												•		•	•		•	•	•	•				•				•	•		•
	Themeda avenacea	Y	U																												•							
	Vulpia bromoides	N	U																												•							
	Vulpia muralis	N	U																		•																	
Polygonaceae	*Acetosella vulgaris*	N	U	•		•																					•								•			
	Persicaria decipiens	Y	U	•																																		
	Rumex brownii	Y	U		•	•													•	•				•	•	•	•		•			•			•	•		
	Rumex conglomeratus	N	U			•																																
	Rumex crispis	Y	U																																			•
Portulacaceae	*Portulaca oleracea*	Y	U			•																																
Primulaceae	*Anagallis arvensis*	N	U																						•		•											
Proteaceae	*Banksia marginata*	Y	U					•											•								•									•		
	Grevillea ramosissima	Y	U											•		•											•		•		•		•					
	Grevillea sericea	Y	U										•	•	•						•			•	•		•		•	•	•		•					
	Grevillea triternata	Y	U										•	•											•											•		
	Hakea dactyloides	Y	U										•		•												•						•					
	Isopogon dawsonii	Y	U										•														•		•	•			•					
	Isopogon petiolaris	Y	U																														•					
	Persoonia curvifolia	Y	U												•												•		•		•		•					
	Persoonia linearis	Y	U										•	•	•			•	•		•			•	•		•	•	•	•	•		•			•		
	Persoonia myrtiloides ssp. cunninghamii	Y	U																								•											
Psilotaceae	*Psilotum nudum*	Y	U																																	•		
Ranunculaceae	*Clematis glycinoides*	Y	U											•					•						•				•							•		
	Ranunculus inundatus	Y	U																																			•
Rhaminaceae	*Cryptandra amara var floribunda*	Y	U										•	•	•			•									•						•					
	Cryptandra spinescens	Y	U										•														•				•							
	Pomaderris elliptica var. elliptica	Y	U										•																									
	Pomaderris ferruginea	Y	U																								•											
	Pomaderris precaria	Y	U																						•													
Rosaceae	*Acaena ovina*	Y	U																•					•	•													
	Rosa rubiginosa	N	U																								•									•		
	Rubus discolor	N	U																																			•
	Rubus parvifolius	Y	U																•										•									
Rubiaceae	*Asperula conferta*	Y	U																•	•	•			•	•		•											

Family	*Species*	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Rubiaceae	*Gallium gaudichaudii*	Y	U																•						•													
	Gallium migrans	Y	U											•					•					•	•		•		•							•		
	Gallium propinquum	N	U																						•													
	Opercularia diphylla	Y	U						•				•	•					•				•		•		•											
	Opercularia hispida	Y	U															•		•	•				•						•					•		
	Pomax umbellata	Y	U										•	•	•			•			•				•	•	•	•	•	•	•		•			•		
Rutaceae	*Boronia anethifolia*	Y	U																														•					
	Boronia bipinnata	Y	U																														•					
	Boronia rubiginosa	Y	U	•																											•							
	Correa reflexa	Y	U										•	•					•											•								
	Phebalium glandulosum ssp. angustifolium	Y	U										•																									
	Phebalium squamulosum	Y	U										•	•	•			•	•						•	•	•											
	Philotheca salsolifolia	Y	U										•														•						•					
Salicaceae	*Salix babylonica*	N	U																																			
Santalaceae	*Choretrum pauciflorum*	Y	U																•														•					
	Exocarpos cupressiformis	Y	U										•	•	•								•		•													
	Exocarpos strictus	Y	U										•	•				•	•		•		•		•	•	•				•							
	Santalum lanceolatum	Y	U																					•		•												
Sapindaceae	*Dodonaea boroniifolia*	Y	U										•	•							•																	
	Dodonaea peduncularis	Y	U															•						•						•								
	Dodonaea sinuolata	Y	U															•			•					•												
	Dodonaea triangularis	Y	U						•				•	•											•													
	Dodonaea viscosa ssp. cuneata	Y	U										•	•				•		•					•													
	Dodonaea viscosa ssp. spathulata	Y	U										•	•					•	•	•				•													•
Scrophulariaceae	*Linaria pelisseriana*	N	U				•																															
	Parentucellia latifolia	N	U	•	•		•													•												•				•		
	Verbascum thapsus	N	U																																•			
	Veronica plebia	Y	U										•	•		•			•	•	•		•	•	•					•						•		
Solanaceae	*Solanum brownii*	Y	U																•					•	•				•	•								
	Solanum campanulatum	Y	U											•									•	•	•				•	•			•			•		
	Solanum cinereum	Y	U		•																				•							•						
	Solanum nigrum	N	U	•																																		
Stackhousiaceae	*Stackhousia monogyna*	Y	U																•					•	•											•		
	Stackhousia viminea	Y	U				•		•					•				•	•	•	•		•	•	•		•						•			•		
Sterculiaceae	*Brachychiton populneus*	Y	U										•										•	•	•													

Family	*Species*	Native	Status	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	30	31	33	34	35	36	37	39	40	41	50	51	52	53	54	59	60	61	62	63
Stylidiaceae	*Stylidium eglandulosum*	Y	U																						•													
Thymelaeaceae	*Pimelea curviflora ssp. sericea*	Y	U																•					•	•										•	•		
	Pimelea linifolia	Y	U										•			•												•			•							
Typhaceae	*Typha domingensis*	Y	U																•																			•
Urticaceae	*Urtica incisa*	Y	U																							•												
Verbenaceae	*Verbena bonariensis*	N	U			•																					•											
Violaceae	*Hymenanthera dentata*	Y	U																										•									
	Viola betonicifolia	Y	U																								•											
Viscaceae	*Notothixos cornifolius*	Y	U		•																											•						
anthorrhoeaceae	*Xanthorrhoea johnsonii*	Y	U										•						•								•		•				•			•		•
yridaceae	*Xyris complanta*	Y	U																															•				
amiaceae	*Macrozamia secunda*	Y	U										•	•	•			•	•		•				•		•		•		•		•					

MOOLARBEN COAL PROJECT – STAGE 1

FLORA, FAUNA & AQUATIC ECOLOGY ASSESSMENT

APPENDIX 5

Threatened fauna species known or potentially occurring

AUGUST 2006

APPENDIX 5

Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
BIRDS		
Malleefowl *Leipoa ocellata* E (TSC) V (EPBC)	Occurs in dry inland areas of southern Australia (western parts of NSW), ranging from the Pilliga Scrub, southwest to the Griffith and Wentworth districts (excluding the Southern Riverina) and through to the SA border (NPWS 1999). Mainly inhabits mallee woodland and dry scrub on well-drained, light sandy or loamy soils (NPWS 1999; Blakers *et al* 1984). Canopy usually dense but discontinuous. Shrub and groundcover usually varied containing food plants particularly acacia, cassia, bossiaea, beyeria. Usually abundant leaf litter, and some open ground for ease of movement (NPWS 1999). A sedentary territorial bird (Lindsey 1992; Blakers *et al* 1984; NPWS 1999). The male maintains a permanent home range centered on a large nesting mound used to incubate eggs (NPWS 1999). Nest mounds can be over 1m in height and 4m across (DEC 2004b). Malleefowl are mainly terrestrial, but will roost at night in low bushes (Lindsey 1992).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 1989), approximately 15km to the east of the EL area, near Wollar Creek. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Bionet record/s in region. NPWS (2003) intend to investigate a number of un-confirmed sightings in the area. Areas of potential habitat exist in the Goulburn River NP (NPWS 2003).
Australian Painted Snipe *Rostratula australis* E (TSC) V (EPBC)	Inhabits inland and coastal shallow freshwater wetlands, lakes, swamps and innundated grasslands of mainly southeastern mainland Australia (NPWS 1999; NSW Scientific Committee; DEH 2003). Occurs in both permanent and ephemeral wetlands, particularly where there is a cover of vegetation, including grasses, lignum and samphire (NPWS 1999). Nests in a scrape on the ground amongst tall vegetation such as grass tussocks or reeds (NPWS 1999; DEH 2003). Shelters by day in dense vegetation. Forages nocturnally for plant material and invertebrates on mud flats and in shallow water (NPWS 1999; DEH 2003). Recorded erratically and may be migratory, moving north in winter and south in summer (NPWS 1999; Blakers *et al* 1984; DEH 2003).	Moolarben Biota – not recorded. DEC Atlas – no records. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Bush Stone-curlew *Burhinus grallarius* E (TSC)	Distribution has contracted to isolated areas on the central and mid-north coast of NSW, and the western slopes and plains of the Great Dividing Range and the Riverina district of central NSW (NPWS 1999). Inhabits lightly timbered open forest and woodland areas with a grassy understorey (NPWS 1999; Blaker *et al* 1984). Preferred habitat usually has good visibility at ground level, with this structure being more important than floristics (DEC 2006). In western NSW this species is known to utilise Box-Ironbark forests and patches of she-oaks (DEC 2006). Will also use dry open grassland and cropland with cover nearby (NPWS 1999). Nests in a shallow scrape on the ground (Lindsey 1992), near dead timber, usually under trees in open woodland with a short grassy understorey (NPWS 1999). Grass height should be less than 15cm (DEC 2006). Nocturnal, especially active on moonlit nights (NPWS 1999). Pairs defend approx 10-25ha when breeding, but may forage over an area of 250-600ha (DEC 2006). Small flocks may roam over 100km^2 in the non-breeding season (Blakers *et al* 1984). At night, birds will travel up to 3km from a roost site to feeding grounds in open paddocks, wetlands, woodland remnants *etc* (DEC 2006).	Moolarben Biota – not recorded. Anecodotal landholder records (M Swords) – recently before or during heavy rain in summer in paddocks around house, and (Mayberry) – late 1940's on the landholding. DEC Atlas – no records.
Square-tailed Kite *Lophoictinia isura* V (TSC)	Has a widespread distribution aross virtually all of mainland Australia, excepting waterless desert (NPWS 1999). Typically inhabits tropical and temperate coastal forests and woodlands, and also inland along timbered watercourses (NPWS 1999). Appears to migrate seasonally, south in summer, north in winter (Blakers *et al* 1984). In NSW, it is often associated with forests dominated by *Eucalyptus longifloria*, *Corymbia maculata* or *E elata, E smithii*. Also sighted within forests containing other eucalypts, *Angophora* spp and *Callitris* spp with a shrubby understorey and Box-Ironbark woodland (NPWS 1999). Feeds on passerine birds, especially honeyeaters, nestling birds, rabbits, reptiles and carrion (NPWS 1999; Lindsey 1992). Nests is a substantial structure of sticks, usually constructed in a fork or on a large horizontal limb of *Angophora* spp or *Eucalyptus* spp approx 15-20m above the ground, along or near watercourses (Lindsey 1992; NPWS 1999).	Moolarben Biota - 1 record, from TSU 30 Box Woodlands, veg. assoc. Grassy White Box Woodland. DEC Atlas – 8 records (dates 1981-2002), scattered with no apparent pattern. Wilpinjong Coal Project EIS – 3 records all in Autumn. This species was observed flying over the edges of woodland, apparently hawking for insects in grassland. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Gang Gang Cockatoo *Callocephalon fimbriatum* V (TSC)	Inhabits tall montane forests and woodlands in summer, particularly heavily timbered mature wet scelerophyll forests. Also occurs in sub-alpine Snow Gum woodland and occasionally in temperate rainforests. Undertakes nomadic and seasonal movements, and in winter tends to occur at lower altitudes in drier, more open eucalypt forest and woodland, particularly Box-Ironbark associations, and in dry forest in coastal areas (NSW Scientific Committee). Feeds on green acacia seeds, eucalypt seeds, fruits and berries, including seeds, fruits and berries of introduced plant species (Lindsey 1992; Blakers *et al* 1984). Tends to exhaust one food supply before moving to another (Blakers *et al* 1984). Nests in hollows in large old trees, usually close to water. Shows strong nest site fidelity. Breeding occurs mainly in tall mature wet sclerophyll forests with a dense understorey (NSW Scientific Committee).	Moolarben Biota - 1 record, from veg. assoc. 52, which is dominated by Black Cypress Pine. DEC Atlas – no records.
Glossy Black Cockatoo *Calyptorhynchus lathami* V (TSC)	Inhabits drier eucalypt forest and woodland, characteristically on sites with low soil nutrient status (Blakers *et al* 1984; NPWS 1999; DEC 2004a). Prefers intact landscapes (NPWS 1999; DEC 2004a). Feeds almost exclusively on seeds of *Allocasuarina* spp - predominantly *A littoralis* and *A torulosa* (Lindsey 1992; Blakers *et al* 1984; NPWS 1999). Inland birds use a more diverse range of species, including *A cristata* (Blakers *et al* 1984). In the central west of NSW they also eat the seeds of Cypress Pine (DEC 2004a). Birds favour individual trees which produce seeds with high nutrient content, and may sample a few trees before selecting one to feed in (DEC 2004a). Lives in loose groups which occupy an area permanently (Blakers *et al* 1984) Nests in a large tree hollow (Lindsey 1992; NPWS 1999).	Moolarben Biota - 39 records, from most TSU's in the study area (mainly from veg. assocns with dominance of Black Cypress Pine), two main locations in the EL area - north of Wollar Road, and along a broad vegetated ridgeline in the central part of the EL area. DEC Atlas – 19 records (dates 2000-2004), scattered across the Gulgong 1:100 000 mapsheet. Wilpinjong Coal Project EIS – 2 records (possibly the same pair) both in woodland habitats in Autumn, one at western end of Wilpinjong study area close to Moolarben EL boundary, and the other at eastern end of Wilpinjong study area. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.
Swift Parrot *Lathamus discolor* E (TSC) E (EPBC)	Breeds only in Tasmania, (Lindsey 1992, Blakers *et al* 1984; NSW Scientific Committee). Occurs in forests and woodlands of NSW from May to August (NSW Scientific Committee). Forages in the upper tree canopy for nectar, pollen and lerps (Blakers *et al* 1984). Lives in small flocks which appear in areas where eucalypts are flowering in profusion (Blakers *et al* 1984). Dependent on flowering resources across a wide range of habitats in its wintering grounds of NSW (NSW Scientific Committee).	Moolarben Biota - not recorded. DEC Atlas – 1 record (dates 1984), approximately 5km to the southeast of the EL area, in Munghorn Gap Nature Reserve. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Turquoise Parrot *Neophema pulchella* V (TSC)	Inhabits open eucalypt woodland and forest, especially with a grassy understorey and rocky outcrops (Lindsey 1992). Prefers the edge of eucalypt woodland adjoining clearings and also timbered ridges and creeklines in farmland (Blakers *et al* 1984; NPWS 1999). Birds may move from eucalypt woodland to pasture after the breeding season in some places (Blakers *et al* 1984). Usual forests/woodlands have mixed assemblages of Cypress Pine *Callitris* sp and a variety of eucalypts including White Box, Yellow Box, Red Box, Blakely's Red Gum, Red Stringybark, Bimble Box or Mulga Ironbark (NPWS 1999). Usually occurs in small family groups, forages on the ground for seeds (native and introduced) (Lindsey 1992; Blakers *et al* 1984). Requires a reliable drinking supply (NPWS 1999). Nests may be located in hollows of small trees, in holes or stumps of dead eucalypts, fence posts or even logs lying on the ground (NPWS 1999). Suffered a major decline in numbers early this century (NPWS 1999; Lindsey 1992), possibly due to competition with livestock during drought and/or trapping (Blakers *et al* 1984). Appears now to have regained much of its former range (Blakers *et al* 1984; Lindsey 1992).	Moolarben Biota - not recorded. DEC Atlas – 19 records (dates 1971-2002), all to the east and southeast of the EL area, including a large proportion of records in Munghorn Gap Nature Reserve. Wilpinjong Coal Project EIS – 1 record in Autumn at the edge of woodland in the southern part of the Wilpinjong study area. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.
Superb Parrot *Polytelis swainsonii* V (TSC) V (EPBC)	The Superb Parrot predominantly inhabits woodland dominated by River Red Gum in the interior of NSW (Lindsey 1992; Blakers *et al* 1984). In the west of its range it is restricted to near watercourses due to the dry plains in between. In the east of its range it may range into lightly timbered areas between watercourses (Blakers *et al* 1984). Also occurs in box or mixed box woodlands, and White Cypress Pine woodlands (Lindsey 1992). Lives in small flocks foraging on the ground or in trees. Feeds on seeds, nectar, blossoms, fruits and insects, and also on spilled cereal grains (Lindsey 1992). Nests in a deep tree hollow, high in a large River Red Gum, near water (Lindsey 1992)	Moolarben Biota - not recorded. DEC Atlas – no records. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Powerful Owl *Ninox strenua* V (TSC)	Inhabits tall moist productive eucalypt forests of the eastern tableland edge, and the mosaic of wet and dry scelerophyll forests occurring on undulating, gentle terrain near the coast. Ideally with a tall shrub layer and/or abundant hollows supporting a high density of arboreal marsupials (DEC 2005a; Blakers *et al* 1984; Lindsey 1992). A nocturnal sedentary species which lives alone or in pairs, occupies permanent territories up to 1500 ha in size which contain several roost sites (Blakers *et al* 1984; Lindsey 1992; DEC 2005a). Roosts by day in dense foliage of mid-canopy trees (including *Allocasuarina* spp, rainforest species, Turpentine and eucalypts), often amongst groves of up to 2ha of similar-sized trees in the height range of 3-15m (DEC 2005a), in sheltered gullIles, often along streams and wide creek flats between ridges covered with eucalypt forest (DEC 2005a; Blakers *et al* 1984). Prefers to forage in moist unlogged forest in gully systems, but also forages in dry and regrowth forest. Preys on arboreal mammals (80% of diet), birds (18%) and insects and some terrestrial mammals (2%) (Blakers *et al* 1984). The Common Ringtail Possum is a primary prey species in lowland areas, and the Greater Glider in highland areas (DEC 2005a). Nests in a large tree-hollow (greater than 45cm wide and 100cm deep), usually high (at least 20m from the ground) in a very large eucalypt (with a DBH of at least 80cm) (Lindsey 1992; DEC 2005a). Nesting sites are typically in unlogged unburnt gullies and lower slopes, within 100m of streams, and surrounding by trees or tall shrubs (DEC 2005a).	Moolarben Biota - 3 records, 2 from veg. assocns with dominance of Ironbarks, 1 from disturbed roadside vegetation. No discernible pattern. DEC Atlas – 14 records (dates 1985-2002), all to the east and southeast of the EL area, including a large proportion of records in Munghorn Gap Nature Reserve. Bionet record/s in region.
Masked Owl *Tyto novaehollandiae* V (TSC)	Inhabits eucalypt forest and woodland from the coast to the western plains (DEC 2005a). It is most abundant within 300km of the coast (DEC 2005a; Blakers *et al* 1984). Optimal habitat includes a mosaic of sparse (grassy) and dense (shrubby) groundcover on gentle terrain (DEC 2005a). A sedentary species which occupies permanent territories 500-1000 ha in size (Blakers *et al* 1984). Nocturnal, roosts by day in hollows, in cover of dense vegetation in gullies or in caves (Blakers *et al* 1984; Lindsey 1992; DEC 2005a). Roosts at least 5m above the ground (DEC 2005a). Forages at forest edges or in partial clearing for small terrestrial mammals including rabbits, supplemented by some arboreal mammals, bats and birds (Blakers *et al* 1984; Lindsey 1992; DEC 2005a)). Nests in tree hollows greater than 40cm wide and greater than 100cm deep. No relationship with distance to streams. Entrances are at least 3m above the ground in trees with DBH of at least 90cm. Generally faithful to traditional hollows (DEC 2005a).	Moolarben Biota – not recorded. DEC Atlas – no records. Wilpinjong Coal Project EIS – 1 record in Spring, to the southwest of the Wilpinjong study area, in Munghorn Gap Nature Reserve. This individual responded to owl call playback, calling from a densely vegetated gully. Known to occur in the area (NPWS 2003). Wollar to Welligton transmission line EIS – recorded.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Barking Owl *Ninox connivens* V (TSC)	Lives in pairs in forests and woodlands typically dominated by eucalypts, often Red Gum species in temperate and semi-arid areas (Blakers *et al* 1984; NPWS 2003b). Has been recorded in remnant patches on farms and golf courses (NPWS 2003b). Usually roosts in or under dense foliage in large trees including rainforest species, *Casuarina* and *Allocasuarina* spp, eucalypts, *Angophora* spp or *Acacia* spp. Roost sites are often near watercourses or wetlands (NPWS 2003b). Forages from dusk to dawn (occasionally in daylight) for a variety of birds, mammals and insects (Blakers *et al* 1984; Lindsey 1992; NPWS 2003b). Most prey birds and mammals are hollow-dependent, prefers native arboreal mammals, but will also prey on rabbits (NPWS 2003b; Lindsey 1992). Nests in a large open hollow, often vertical or sloping, in large eucalypts or paperbarks. Nest entrances are usually 2-35m above the ground, with a diameter of 20-46cm and depth of 20-300cm (NPWS 2003b). Nests are usually near watercourses or wetlands (NPWS 2003b). Presumed to breed in traditional permanent territories ranging in size from 30ha up to 200ha in southern Qld (Blakers *et al* 1984; NSW Scientific Committee; NPWS 2003b). Forages over a larger area (Blakers *et al* 1984).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 2001), approximately 1-2km east of the EL area, in Goulburn River NP. Bionet record/s in region.
Gilbert's Whistler *Pachycephala inornata* V (TSC)	Usually occurs in mallee, but also taller dry eucalypt woodland, melaleuca thickets, lignum, and partly cleared country (Blakers *et al* 1984; Lindsey 1992). Lives in pairs that defend permanent territories (Lindsey 1992). Forages mainly on the ground for large insects such as caterpillas and beetles (Blakers *et al* 1984; Lindsey 1992). Nests approximately 2-3 metres from the ground in a cup of bark and dry grass in an upright fork, on a dead stump, or occasionally in the disused nest of another bird (Lindsey 1992).	Moolarben Biota - 2 records, 1 from TSU 10 Disturbed Vegetation – unimproved grassland, and 1 from TSU 50 Sedimentary Scribbly Gum Woodlands. DEC Atlas – no records.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Grey-crowned Babbler *Pomatostomus temporalis* V (TSC)	Inhabits forests and woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs and an intact groundcover of grasses and forbs (NSW Scientific Committee; Lindsey 1992). Also occurs in acacia scrub and farmland (Blakers *et al* 1984). Lives in sedentary communal groups of 2-13 birds which inhabit permanent territories of 12-20ha (Lindsey 1992; NSW Scientific Committee). Forages mostly on the ground amongst leaf litter for insects (Lindsey 1992; Blakers *et al* 1984), and also on the bark of trees (NSW Scientific Committee; Blakers *et al* 1984). Nests and breeds co-operatively, building a bulky dome of sticks and twigs placed conspicuously in a tree fork up to 12m above the ground (Lindsey 1992; NSW Scientific Committee).	Moolarben Biota - 6 records, mainly from TSU 30 Box Woodlands and TSU 10 Disturbed Vegetation. DEC Atlas – 1 record (date 1981), approximately 2-3km to the southeast of the EL area, in Munghorn Gap Nature Reserve. Bionet record/s in region.
Speckled Warbler *Pyrrholaemus sagittatus* V (TSC)	Inhabits woodland with a grassy understorey, often on rocky ridges or in gullies. Mainly recorded from the hills and tablelands of the Great Dividing Range (Blakers *et al* 1984; NSW Scientific Committee). A sedentary species, apparently social, with breeding territories approx 10 ha in size. Forages mainly on the ground for seeds and insects, seldom wandering far from the shelter of bushes and shrubs (Blakers *et al* 1984; Lindsey 1992). Preferred foraging habitat is areas with a combination of open grassy patches, leaf litter and shrub cover (NSW Scientific Committee). Nests on the ground in grass tussocks, dense litter and fallen branches (NSW Scientific Committee).	Moolarben Biota - 21 records, from most TSU's in the study area, but predominantly from TSU 30 Box Woodlands and ecotones between this and TSU 20 Sedimentary Ironbark Forest. DEC Atlas – 25 records (dates 1972-2003), scattered across the Gulgong 1:100 000 mapsheet. Wilpinjong Coal Project EIS – 2 records Spring and Autumn, both from the southeastern part of the Wilpinjong study area, one from scattered trees and one from shrubby regrowth. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Brown Treecreeper *Climacteris picumnus victoriae* V (TSC)	Inhabits a variety of drier vegetation types across eastern Australia, commonly eucalypt woodland, sometimes adjacent forest where there is dead timber (Lindsey 1992; Blakers *et al* 1984). Mainly occurs in the central-west of NSW. Prefers open woodland lacking a dense understorey (NSW Scientific Committee). A sedentary species that lives in small groups and occupies permanent home territories of about 5-10ha (Blakers *et al* 1984; Lindsey 1992). Forages on tree trunks and amongst leaf litter for insects, spending approx half of its time on the ground (NSW Scientific Committee; Blakers *et al* 1984). Nests in a tree-hollow (Lindsey 1992).	Moolarben Biota - 76 records, from all TSU's in the study area, but predominantly from TSU 30 Box Woodlands and TSU 10 Disturbed Vegetation. DEC Atlas – 45 records (dates 1971-2004), scattered across the Gulgong 1:100 000 mapsheet, but with most records in two general locations – The Munghorn Gap Nature Reserve southeast of the EL area; and rugged wooded country approx 5-6km northwest of the EL area. Wilpinjong Coal Project EIS – 22 records in Spring and Autumn, scattered across woodland areas within the Wilpinjong study area. Wollar to Welligton transmission line EIS – recorded. Bionet record in region.
Hooded Robin *Melanodryas cucullata cucullata* V (TSC)	Occurs throughout SE Australia, although mainly west of the Great Dividing Range, in a range of drier eucalypt woodlands, acacia shrublands and open forests, often in or near clearings (Blakers *et al* 1984; Lindsey 1992). Possibly seasonally migratory in some areas (Blakers *et al* 1984). Lives in small family groups within large home ranges (NSW Scientific Committee). Forages mainly on open ground by pouncing from a perch. Forages in areas with a mix of bare ground, ground cover and litter (Blakers *et al* 1984; NSW Scientific Committee). Nests in a cup of grass in a fork or small tree hollow usually within a few metres of the ground (Lindsey 1992).	Moolarben Biota - 26 records, from most TSU's, but with 22 records from TSU 10 Disturbed Vegetation, mostly from unimproved grasslands. DEC Atlas – 12 records (dates 1971-2004), all in the southern part of the EL area, and southeast of the EL area in Munghorn Gap Nature Reserve. Wilpinjong Coal Project EIS – 8 records in Spring and Autumn (mostly Autumn), mostly from the woodland/grassland interface in the southeastern part of Wilpinjong study area. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Black-chinned Honeyeater *Melithreptus gularis gularis* V (TSC)	Inhabits mainly eucalypt forest and woodland, paperbark woodland, acacia scrub and spinifex, particularly where there are patches of flowering shrubs, across northern and eastern Australia (Lindsey 1992; Blakers *et al* 1984). In NSW, it occurs generally inland of the Great Dividing Range, mainly in eucalypt woodlands containing Box-Ironbark associations and River Red Gum (Blakers *et al* 1984; NSW Scientific Committee). A sedentary species which lives in small groups which maintain permanent, extensive territories. It is an active bird, forever on the move, and forages high in the tree canopy (Lindsey 1992). Feeds on nectar, honeydew and insects (Blakers *et al* 1984). Occurs mainly in larger remnants, reportedly affected by competition for food and by nest predation in smaller remnants (NSW Scientific Committee).	Moolarben Biota - 8 records, mainly from TSU 30 Box Woodlands. DEC Atlas – 11 records (dates 1981-2003), scattered with no apparent pattern. Wilpinjong Coal Project EIS – 2 records both in Autumn, one at western end of Wilpinjong study area close to Moolarben EL boundary, and the other at eastern end of Wilpinjong study area. Bionet record/s in region.
Painted Honeyeater *Grantiella picta* V (TSC)	Inhabits forest and woodland thoughout most of eastern Australia, generally where there is an abundance of mistletoe (Blakers *et al* 1984; Lindsey 1992). Strongly migratory, breeding mainly in the interior southeast during spring and summer, and dispersing northward to spend the winter (Lindsey 1992). Unusual amongst honeyeaters in its almost complete dependence upon berries or drupes of mistletoes of the *Amyema* genus (Lindsey 1992). Locally nomadic, with movements reportedly governed by the flowering and fruiting of mistletoes (Lindsey 1992; Blakers *et al* 1984). Forages mainly in the upper canopy of trees. Nests in a frail dish suspended in the outer foliage of a bush or tree, from 3-10m above the ground (Lindsey 1992).	Moolarben Biota - 6 records, from most TSU's in the study area, including TSU 10 Disturbed Vegetation. DEC Atlas – 9 records (dates 1981-1999), all from Munghorn Gap Nature Reserve southeast of the EL area. Wilpinjong Coal Project EIS – 1 record in Spring at the southeastern extremity of the Wilpinjong study area, foraging in the upper canopy of ironbark trees. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.
Regent Honeyeater *Xanthomyza phrygia* E (TSC) E (EPBC)	Semi-nomadic, usually recorded on western slopes of the Great Dividing Range, in open eucalypt forest and woodland. Usually recorded in box-ironbark associations, also wet lowland coastal forests. Forages in the upper canopy of flowering eucalypts for nectar, fruits and insects (NPWS 1999; Lindsey 1992; Blakers *et al* 1984). Nectar taken from approximately 16 species of eucalypt (NPWS 1999). A noisy, aggressive and conspicuous species, gregarious when not breeding. Observed bathing in roadside puddles. Nests in the fork of a tree 1-20m above the ground (Lindsey 1992). Specific requirements in mature Ironbark and Red-Yellow Box communities (NPWS 2003).	Moolarben Biota - not recorded. DEC Atlas – 54 records (dates 1967-1999), with virtually all records from 5-8km to the southeast of the EL area, in Munghorn Gap Nature Reserve. Other records are scattered widely to the south and east. Wilpinjong Coal Project EIS – not recorded, but known to have occured in the study area and expected to occur. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Bionet record/s in region. Nomadic opportunist in the area (NPWS 2003).

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Diamond Firetail *Stagonopleura guttata* V (TSC)	Inhabits eucalypt woodland, forests and mallee where there is a grassy understorey, including agricultural land, mainly inland of the Great Dividing Range (Lindsey 1992; Blakers *et al* 1984; NSW Scientific Committee). Generally sedentary, lives in pairs or small groups, consolidating into flocks during winter (Lindsey 1992; Blakers *et al* 1984; NSW Scientific Committee). Forages on the ground for grass seeds, other plant material and insects (NSW Scientific Committee; Lindsey 1992; Blakers *et al* 1984). Nests in a bulky flask-shaped structure with a side entrance approached by a woven tunnel, usually placed in dense foliage in a bush or mistletoe clump, several metres from the ground (Lindsey 1992).	Moolarben Biota - 52 records, from all TSU's in the study area, but with a very strong preference for TSU 10 Disturbed Vegetation – unimproved grasslands, and for TSU 30 Box Woodlands. DEC Atlas – 17 records (dates 1971-2002), scattered through areas in the eastern part of the EL area and to the east, including a high proportion of records to the southeast in Munghorn Gap Nature Reserve. Wilpinjong Coal Project EIS – 15 records, abundant in Autumn, less common in Spring, mainly observed on the cleared edges of woodland, at locations scattered across the Wilpinjong study area. Wollar to Welligton transmission line EIS – recorded.
REPTILES		
Pink-tailed Legless Lizard *Aprasia parapulchella* V (TSC) V (EPBC)	Inhabits open areas with predominantly native grass understorey and rock outcrops or scattered partially buried rocks. Usually found under rocks on well drained soil (Swan 1990). Type specimens were found under weathered granite rocks on a grazed, grassy riverside slope, at Coppins Crossing, Molonglo River, ACT. Species is also known from near Tarcutta and Bathurst, NSW. Northern limit of distribution is reportedly around Bathurst (Cogger 1996; Swan 1990).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 2000) approximately 14km to the east of the EL area, near Wollar Creek. Bionet record/s in region.
Little Whip Snake *Suta flagellum* V (TSC)	Found mainly in eucalypt woodland and associated grasslands, especially on stony hills where it shelters under rocks and logs (Cogger 1996). Occurs mainly in Victoria, extending into southeastern NSW and SA (Cogger 1996). Secretive and nocturnal, feeds on small skinks and frogs (Cogger 1996).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 2000), approximately 3-5km southwest of the EL area, on the Worobil Ridge formation. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Broad-headed Snake *Hoplocephalus bungaroides* E (TSC) V (EPBC)	Restricted to sandstone ranges within the Sydney basin, and areas within a radius of approximately 200km of Sydney (NPWS 1999; DEH 2006). Distribution appears to be in four key areas, the Blue Mountains, Southern Sydney, an area NW of the Cumberland Plain, and the Nowra hinterland (NPWS 1999). Prefers habitats centered on the Triassic sandstone of the Sydney basin. Sites are typified by exposed sandstone outcrops and benching in areas of open woodland and/or heath (NPWS 1999). Refuge sites are predominantly west to north west in aspect, never east (NPWS 1999; DEH 2006). Some individuals near Bathurst occur in forest growing on shale or conglomerate slopes and bluffs (DEH 2006). The Broad-headed Snake shelters in tree-hollows during summer (preferring large trees, dead trees and trees with multiple hollows – DEH 2006), and beneath close-fitting exfoliating sheets of sandstone rock during the cooler months (NPWS 1999; Cogger 1995). A nocturrnal species which preys mainly on lizards and geckoes (NPWS 1999; Cogger 1995). Snakes are more common away from the disturbance of access routes (DEH 2006). Canopy tree species at known sites include Yellow Bloodwood *Corymbia eximia*, Red Bloodwood *Corymbia gummifera*, Silver-top Ash *Eucalyptus sieberi*, Grey Gum *Eucalyptus punctata* and Sydney Peppermint *Eucalyptus piperita* (NPWS 1999). Snakes occupy discrete home ranges. Adults show strong site fidelity, and juveniles do not disperse long distances (DEH 2006).	Moolarben Biota – not recorded. DEC Atlas – no records. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Thought to occur in Goulburn River NP (NPWS 2003).
AMPHIBIANS		
Giant Barred Frog *Mixophyes iteratus* E (TSC) E (EPBC)	Associated with permanent flowing creeklines, from shallow rocky rainforest streams to slow moving rivers in lowland open forest. Is not known to utilise still water (NSW Scientific Committee). Does not appear to be restricted to particular vegetation forms, although apparently prefers rainforest and wet sclerophyll forest (NSW Scientific Committee; Cogger 1996; Robinson 1998). Will also use cleared land (NSW Scientific Committee).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 2002), approximately 4km east of the EL area, close to Wilpinjong Creek. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
MAMMALS		
Spotted-tailed Quoll *Dasyurus maculatus* V (TSC) V (EPBC)	Variety of habitats including sclerophyll forest and woodlands, coastal heathlands and rainforest (NPWS 1999; Edgar & Belcher 1995). Occasionally sighted in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999). Usually nocturnal, partly arboreal (Edgar & Belcher 1995; NPWS 1999). Apparently defines its territory with 'latrines' (Edgar & Belcher 1995). Requires suitable den sites (*eg* hollow logs, tree-hollows, rock crevices or caves), an abundance of food (small terrestrial birds and mammals, up to the size of small wallabies), and relatively large areas of intact vegetation for foraging (NPWS 1999; Edgar & Belcher 1995). Uses numerous den sites within its home range, which is estimated to be between 800ha and 20km^2 (NPWS 1999). A highly mobile species recorded travelling several kilometres overnight (NPWS 1999).	Moolarben Biota – not recorded. DEC Atlas – no records. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area.
Koala *Phascolarctos cinereus* V (TSC)	In NSW the Koala occurs mainly on the north coast and central coast, extending west of the Great Dividing Range along inland rivers (NPWS 1999). Koalas inhabit eucalypt forest and woodland, and are influenced in distribution by size and species of tree present, soil nutrients, climate, rainfall, and size and disturbance history of habitat patches (NPWS 1999). Although solitary in appearance, Koalas live in complex groups with individuals having overlapping territories (NPWS 1999). Koalas are relatively sedentary, and spend the majority of their time resting in the forks of trees (NPWS 1999; Martin & Handasyde 1995). Koalas are generally most active at dusk (NPWS 1999). Koalas feed almost exclusively on the leaves of a wide range of eucalypts, although within any one area Koalas will prefer only a small number of species (NPWS 1999; Martin & Handasyde 1995).	Moolarben Biota - not recorded. DEC Atlas – 8 records (dates 1957-2002), scattered locations. The only record within the last 20 years is located greater than 10km to the southwest of the EL area. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Squirrel Glider *Petaurus norfolcensis* V (TSC)	Inhabits dry sclerophyll forest and woodland with an abundant supply of hollow-bearing trees and a mix of eucalypts, acacias and banksias (NPWS 1999). Within a suitable vegetation community, at least one flora species should flower heavily during winter, and one or more eucalypts should be smooth-barked (NPWS 1999). Potential habitat in NSW includes Box-Ironbark forests and woodlands in the west, River Red Gum Forests of the Murray Valley and eucalypt forests in the northeast (NPWS 1999). The Squirrel Glider is nocturnal, shelters in leaf-lined tree hollows, and feeds primarily on nectar, pollen, flowers, acacia gum and insects (NPWS 1999; Suckling 1995). Squirrel Gliders can glide for up to 50m, and occupy home ranges estimated as between 0.65 and 8.55ha (NPWS 1999).	Moolarben Biota - 1 record, from TSU 60 Alluvial Apple Forests. DEC Atlas – 1 record (date 2000), approximately 2km to the east of the EL area, in rugged country draining to Wilpinjong Creek. Wilpinjong Coal Project EIS – 1 record in Spring in the southern part of the Wilpinjong study area, adjacent to Munghorn Gap Nature Reserve. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.
Brush-tailed Rock Wallaby *Petrogale penicillata* E (TSC) V (EPBC)	Inhabits rocky areas in a wide range of vegetation types. Strong preference to sites with a northerly aspect (Eldridge & Close 1995). Three habitat categories have been identified for this species (DEC 2005b; NSW Scientific Committee): • loose piles of large boulders containing a maze of subterranean holes and passageways; • cliffs with many mid-level ledges and with some caves and/or ledges covered by overhangs. Cliff height is usually over 15m; • isolated rock stacks, usually sheer-sided and often girdled with fallen boulders. Vegetation is also of importance, as a source of food, and in some areas, shelter (*eg* spreading fig trees). Core habitat appears to be areas of rainforest or wet sclerophyll forest in association with complex cliffs and rock outcrops (DEC 2005b). Lives in small family groups which maintain permanent territories in loose colonies. Colonies do not appear to move (DEC 2005b). Feeds on a wide range of grasses and plant material (including fruits, roots, bark, seeds, lichen), and also on termite mounds, cowpat, bone, rotten log (DEC 2005b).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 1999), approximately 15km to the east of the EL area, near Wollar Creek. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Bionet record/s in region. Gouburn River NP plays a major regional and national role in the conservation of this species (NPWS 2003).

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Large-eared Pied Bat *Chalinolobus dwyeri* V (TSC) V (EPBC)	Inhabits dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range, from Queensland to Bungonia. Has also been recorded occasionally in sub-alpine woodlands above 1500m, and at the edge of rainforest and moist eucalypt forest (Hoye & Dwyer 1995). First recorded in a dis-used mine tunnel near Copeton, NSW in early 1960's. Probably forages for insects below the forest canopy (Hoye & Dwyer 1995). Roosts by day in tree-hollows, caves and dis-used mine-tunnels (DEC NRMAS-7 2004; Hoye & Dwyer 1995). In caves it often selects positions close to the entrance in the 'twilight zone'. Appears to hibernate during winter (Hoye & Dwyer 1995).	Moolarben Biota - 9 records, mainly from TSU 10 Disturbed Vegetation – unimproved grasslands, and from veg. assoc. 40 Blakely's Red Gum Woodland. DEC Atlas – 8 records (dates 1968-2002), all to the east of the EL area, most to the northeast within Goulburn River NP. Wilpinjong Coal Project EIS – 67 echolocation calls recorded in total, all from extensive tracts of vegetation, in the southeast corner of the study area, on the fringe of Munghorn Gap Nature Reserve. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.
Little Pied Bat *Chalinolobus pictatus* V (TSC)	Inhabits dry areas of southern Qld, NSW and SA. Very little is known about this species (Richards 1995c). It roosts in in tree-hollows, dry caves and mine shafts, but has also been recorded in an abandoned house (DEC NRMAS-7 2004; Richards 1995c). Capable of dealing with aridity and heat, provided water is available with flight range (Richards 1995c).	Moolarben Biota - 3 records, from TSU 10 Disturbed Vegetation, and from veg. assoc. 40 Blakely's Red Gum Woodland. DEC Atlas – no records.
Eastern False Pipistrelle *Falsistrellus tasmaniensis* V (TSC)	Thought to forage above the forest canopy, in open woodland or over water. Occurs along the Great Dividing Range of SE Australia, and east to the coast. Is more common at cooler elevations (Phillips 1995). Has been recorded roosting in tree hollows (Phillips 1995). Occasionally found in caves (DEC NRMAS-7 2004). Apparently hibernates during winter, and may sexually segregate for part of the year (Phillips 1995).	Moolarben Biota - not recorded. DEC Atlas – 1 record (date 2000), approximately 12km to the east of the EL area, near Wollar Creek. Wilpinjong Coal Project EIS – 8 echolocation calls recorded in total, thought to prefer more extensive and less disturbed vegetation remnants. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Eastern Freetail Bat *Mormopterus norfolkensis* V (TSC)	Usually recorded in dry eucalypt forest and woodland east of the Great Dividing Range, but has also been recorded in rainforest and wet sclerophyll forest (Allison & Hoye 1995). Apparently solitary. Predominantly tree-dwelling, but has been recorded roosting in the roof of a hut (Allison & Hoye 1995).	Moolarben Biota – not recorded. DEC Atlas – no records. Wilpinjong Coal Project EIS – 59 echolocation calls recorded in total. Wollar to Welligton transmission line EIS – recorded.
Eastern Bent-wing Bat *Miniopterus schreibersii oceanenis* V (TSC)	Typically inhabits well-timbered valleys where it forages above the tree canopy (Dwyer 1995b). Roosts in caves, old mines, stormwater channels and comparable structures (DEC NRMAS-7 2004; Dwyer 1995b). In SE Australia it seeks cold roosts through winter to allow hibernation. Depends upon specific mass nursery sites in Spring to rear its young (Dwyer 1995b), thus prone to mass damage from catastrophic events (DEC NRMAS-7 2004).	Moolarben Biota - 5 records, mainly from veg. assoc. 40 Blakely's Red Gum Woodland, and from veg. assoc. 52, which is dominated by Black Cypress Pine. DEC Atlas – 2 records (dates 1968-2000), one south of the EL area and one northeast of the EL area. Wilpinjong Coal Project EIS – 707 echolocation calls recorded in total, from a wide variety of habitats. Wollar to Welligton transmission line EIS – recorded. Bionet record/s in region.
Little Bent-wing Bat *Miniopterus australis* V (TSC)	Forages beneath the tree canopy of well-timbered habitats including rainforest, *Melaleuca* swamps and dry sclerophyll forests (Dwyer 1995a). Roosts in caves and old mines, depends upon specific nursery sites to rear its young (Dwyer 1995a), thus prone to mass damage from catastrophic events (DEC NRMAS-7 2004).	Moolarben Biota – not recorded. DEC Atlas – no records. Wilpinjong Coal Project EIS – 220 echolocation calls recorded in total, all in conjunction with Eastern Bent-wing Bat (detailed below) and from a wide variety of habitats.
Greater Long-eared Bat *Nyctophilus timoriensis* V (TSC) V (EPBC)	Little is known regarding this species. It reportedly occurs in a variety of habitats, including tall forests, woodland and mallee (Parnaby 2005). Roosts in tree hollows and under loose bark (Parnaby 2005).	Moolarben Biota - 1 record, from veg. assoc. 40 Blakely's Red Gum Woodland. DEC Atlas – 6 records (dates 2000-2002), all except one to the east of the EL area in Goulburn River NP. EPBC Protected Matters Search – species or species habitat may occur within the EL and/or surrounding area. Bionet record/s in region.

APPENDIX 5 cont Threatened fauna species known or potentially occurring in the study area, their habits and habitat requirements.

Species	Habits/Requirements	Records in the study area and region
Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris* V (TSC)	Occurs throughout eastern and northern Australia, foraging above the canopy in eucalypt forests, and closer to the ground in mallee or open country (Richards 1995a). Usually solitary, occasionally occurring in colonies of less than 10 individuals (Richards 1995a). Roosts in tree hollows (Richards 1995a), occasionally in caves (DEC NRMAS-7 2004), and has been found in the abandoned nests of Sugar Gliders (Richards 1995a). Possibly migratory in southern Australia (Richards 1995a).	Moolarben Biota - 2 records, 1 from TSU 30 Box Woodlands and 1 from veg. assoc. 40 Blakely's Red Gum Woodland. DEC Atlas – no records. Wilpinjong Coal Project EIS – 96 echolocation calls recorded in total, widespread across the study area. Wollar to Welligton transmission line EIS – recorded.
Eastern Cave Bat *Vespadelus troughtoni* V (TSC)	Inhabits drier forest and tropical woodlands along the east coast of Australia, from the coast to Great Dividing Range to the semi-arid zone (Strahan 1995). Roosts in caves, including sandstone overhangs, mine tunnels and occasionally in buildings, usually in well-lit areas (Strahan 1995; DEC NRMAS-7 2004). Little else is known regarding this species (Strahan 1995).	Moolarben Biota – not recorded. DEC Atlas – no records. Wollar to Welligton transmission line EIS – recorded.

MOOLARBEN COAL PROJECT – STAGE 1

FLORA, FAUNA & AQUATIC ECOLOGY ASSESSMENT

APPENDIX 6

Fauna survey details

AUGUST 2006

APPENDIX 6

1 SURVEY METHODS, SEASONS AND EFFORT

Table 1.1 Targeted bird survey methods, seasons and effort.

Method	Season	Effort
Quantitative bird searches conducted at flora quadrat sites. Birds detected visually and aurally. Surveys timed for 20 minutes per 4 ha area, if new species found within last 10mins then survey continues, up to 1 hour.	Summer '04 Autumn '05 Winter '05 Early Spring '05 Late Spring '05	6:50 person hours 8:35 person hours 28 surveys; 18:20 person hours 9 surveys; 14:10 person hours 3 surveys, 4:00 person hours
Non-quantitative targeted bird surveys	Winter '05 Early Spring '05 Late Spring '05 Late Spring '05	6 surveys; 12:50 person hours Search at selected water body – 1 site, 0:10 hours Driving to known areas of Mistletoe in search of Painted Honeyeaters. Search at selected water body - 1 site, 0:10 hours
Call playback for the Powerful Owl, Masked Owl and Barking Owl. Method involved 3-5 minutes of call playback, with a brief silence of 3 mins between calls where multiple calls played, followed by 10-15 minutes of listening, then at least 10 mins spotlighting.	Summer '04 Autumn '05 Winter '05 Early Spring '05 Late Spring '05	2:30 hours of survey with 2 observers 23 surveys 8 consecutive nights at each of 2 sites 3 surveys, 1 of 6 consecutive nights and 2 of 8 consecutive nights 8 consecutive nights at 1 site; Masked Owl only - 1 night at each of 15 sites

Table 1.2 Targeted herpetological survey methods, seasons and effort.

Method	Season	Effort
Quantitative herpetological hand searches at each trapping site. Timed for 30 mins per 4 ha area.	Summer '04 Autumn '05 Winter '05 Early Spring '05 Late Spring '05	1:20 person hours 4:45 person hours 2 sites; 1 person hour 8 person hours 2 sites, 2:00 person hours
Pitfall trapping at 14 sites. Method - 30m of drift fence with 4 deep buckets (40cm and 25cm diameter) spaced at 10m intervals.	Summer '04 Autumn '05 Early Spring '05 Late Spring '05	12 bucket nights 8 trapline nights (32 bucket nights) 4 surveys, 20 trapline nights (80 bucket nights) 7 sites, 54 trapline nights (216 bucket nights)
Opportunistic road frog surveys conducted at night after heavy rain. Method - driving a car along a specific route with 2 persons, identifying each frog observed, either through capture or aurally.	Summer '04	1:45 survey hours with 2 observers
Call Playback – Green & Golden Bell Frog *Litoria aurea*	Late Spring '05	1 site 0:20 hours

Table 1.3 Targeted mammal survey methods, seasons and effort.

Method	Season	Effort
Trapping - Elliot Type A – 25 Elliot Type A traps were set in a grid pattern (as illustrated below) over an area of 1 ha at each trapping site. 20 traps set on the ground and 5 in trees. Baited with honey/rolled oats/peanut butter with vanilla	Summer '04 Autumn '05 Early Spring '05	320 ground trap nights and 80 tree trap nights 547 trap nights 517 trap nights
Trapping – Elliot Type A – set in trees	Early Spring '05	28 trap nights, targeting areas with flowering White Box
Trapping – Elliot Type B – 3 Elliot Type B traps were set at each trapping site, near areas of thicker groundcover to target bandicoots. Baited with honey/rolled oats/peanut butter with vanilla	Summer '04 Autumn '05 Winter '05	51 trap nights 167 trap nights 220 trap nights (2 lines X 10 traps) set in areas with flowering White Box
Trapping – Elliot Type B – set in trees	Early Spring '05 Late Spring '05	3 sites, 72 trap nights, targeting areas with flowering White Box 3 sites, 126 trap nights
Trapping – Elliot Type E – 6 Elliot Type E traps were set at some trapping sites in flowering shrubs to target Pygmy Possums. Baited with honey/rolled oats/peanut butter with vanilla	Summer '04	60 trap nights
Trapping – Cage Traps – 2 cage traps were set near each trapping site, near tracks or Quoll den habitat, to target carnivores. Baited with chicken necks	Summer '04 Autumn '05 Early Spring '05	38 trap nights 32 trap nights 49 trap nights
Hair Tubes set in lines approx 2.3km long, with approx 30 tubes at 80m intervals. 12 regular tubes baited with honey/rolled oats/peanut butter,12 regular tubes baited with dry dog food ('Good O's'), 6 flexiglass tubes (refer to Murray 2005) baited with whole cans of sardines.	Autumn '05 Winter 0'5	370 tube nights 3 lines
Harp traps were set opportunistically along dirt tracks through forest or woodland for a variable number of nights (but at least 2 nights).	Summer '04 Autumn '05 Late Spring '05	11 trap nights 16 trap nights 12 sites, 24 trap nights
Anabat II Bat Detectors Generally, 2-4 detectors were used at each spotlighting site – one was set stationary at the spotlight transect starting point, and the other was used as a roaming survey and taken along the spotlight transect	Summer '04 Autumn '05 Early Spring '05 Late Spring '05	6:35 hours at dusk 30:30 hours at dusk; 34:15 hours all night (3 nights) 5:55 hours – roaming only 114:31 hours

Table 1.4 Non-specific survey methods, seasons and effort.

Method	Season	Effort
Spotlighting surveys were conducted for approx 1 hour sessions with 2 persons and 2 spotlights.	Summer '04 Autumn '05 Early Spring '05 Late Spring '05	8:30 person hours 20:10 person hours 7 surveys, 18:10 person hours, targeting areas of flowering White Box 6 sites, 12:40 person hours
Dedicated scat searches, timed for 15 mins per 1 ha area.	Autumn '05 Winter '05 Early Spring '05	1:45 person hours 19 surveys; 4:45 person hours 2 person hours
Opportunistic records of all species were maintained whilst travelling around the site, and whilst conducting other surveys. The majority of bird species records were obtained in this manner.	Summer '04 Autumn '05 Winter '05	15 person hours 9 days 10 days (approx 1/3 of this time spent amongst flowering White Box)

2 SURVEYS WITHIN EACH TERRESTRIAL STRATIFICATION UNIT

Table 2.1 Details of fauna surveys within TSU 10 – Disturbed Vegetation.

Method	Season	Veg Assocns	Summary of Effort
Quantitative Bird	Autumn '05	10, 12	8 surveys
	Winter '05	10, 11, 18	14 surveys
	Early Spring '05	10, 11, 15	4 surveys
	Late Spring '05		1 survey
Non-quantitative Bird	Summer '04	10	1 survey at water body
	Autumn '05	10	1 survey at water body
Call Playback 1 night	Autumn '05	10, 12	5 nights.
Call Playback 2 consecutive nights	Late Spring '05	10, 11, 12, 13, 16, 17, 18, 19, 70	35? survey sets targeting Masked Owl
Call Playback 4 consecutive nights	Autumn '05	10, 11, 12, 13	4 survey sets.
	Winter '05	10, 11,	2 survey sets.
Call Playback 8 consecutive nights	Autumn '05	10, 11, 13	3 survey sets.
	Winter	11, 12, 13, 18, 19	7 survey sets.
	Early Spring '05	10, 11, 12, 16, 18	6 survey sets.
	Late Spring '05	11	1 survey set.
Quantitative Herpetological	Late Spring '05	12	1 survey
Pitfall Trapping	Early Spring '05	15	30m trapline
Elliot Trapping	Early Spring '05	10	Elliot Type A ground
Hair Tubes	Autumn '05	12	short transect
	Early Spring '05	11, 15	3 survey sets/nights?,
Harp Trap	Late Spring '05	11	2 sites
Anabat	Autumn '05	10, 12, 13	8 survey sets/nights?,
Spotlighting	Summer '04	10	1 survey night.
	Autumn '05	10, 12	5 survey nights.
	Early Spring '05	10, 11, 15	3 survey nights.
	Late Spring '05	18	1 survey night.
Scats, tracks, traces	Winter '05	11	1 site

Table 2.2 Details of fauna surveys within TSU 20 – Sedimentary Ironbark Forests.

Method	Season	Veg Assocns	Summary of Effort
Quantitative Bird	Autumn ‘05	23	1 survey
	Winter ‘05	20, 21, 22	6 surveys
Quantitative Herpetological	Summer ‘04	23	1 survey
	Early Spring ‘05	21, 24	2 surveys
	Late Spring ‘05	21, 23	2 surveys
Pitfall Trapping	Early Spring ‘05	20, 21	2 30m traplines
	Late Spring ‘05	21	1 30m trapline
Elliot Trapping	Summer ‘04	21, 23	2 surveys with Elliot B tree-mounted
	Summer ‘04	21, 23	2 surveys with Elliot A ground
	Autumn ‘05	23	1 survey with Elliot A ground
	Early Spring ‘05	23	1 survey with Elliot A ground
	Early Spring ‘05	20	1 survey with Elliot B tree-mounted
	Late Spring ‘05	23	2 surveys with Elliot B tree-mounted
Cage Traps	Summer ‘04	21, 23	2 surveys
	Autumn ‘05	20	1 survey
	Early Spring ‘05	23	1 survey
Harp Trap	Summer ‘04	21, 23	2 sites
	Autumn ‘05	20	1 site
Anabat	Early Spring ‘05	23	1 survey night
	Late Spring ‘05	21	1 survey night
Spotlighting	Early Spring ‘05	23	1 survey night
	Late Spring ‘05	21	2 surveys nights
Scats, tracks, traces	Summer ‘04	23	1 survey
	Winter ‘05	20	1 survey
	Early Spring ‘05	24	1 survey

Table 2.3 Details of fauna surveys within TSU 30 – Box Woodlands.

Method	Season	Veg Assocns	Summary of Effort
Quantitative Bird	Summer ‘04	34	2 surveys
	Autumn ’05	30, 33, 36, 37	5 surveys
	Winter ‘05	30, 31, 33, 35, 36, 37, 39	25 surveys
	Early Spring ‘05	31, 35, 37	3 surveys
	Late Spring ‘05	33	1 survey
Call Playback 1 night	Summer ‘04	34	1 survey
	Autumn ‘05	33	1 survey
Call Playback 2 consecutive nights	Late Spring ‘05	33	1 survey set targeting Masked Owl
Quantitative Herpetological	Summer ‘04	34	2 surveys
	Autumn ‘05	35, 37	2 surveys
	Winter ‘05	36	2 surveys
Pitfall Trapping	Late Spring ‘05	30, 33, 34	3 30m traplines
Elliot Trapping	Summer ‘04	33	1 survey with Elliot B tree-mounted
	Summer ‘04	33	1 survey with Elliot A ground
	Autumn ‘05	30, 31	2 surveys with Elliot B tree-mounted
	Autumn ‘05	30	1 survey with Elliot A ground
	Winter ‘05	36, 37	2 surveys with Elliot B tree-mounted
	Early Spring ‘05	30	1 survey with Elliot B tree-mounted
	Late Spring ‘05	33	1 surrvey with Elliot B tree-mounted
Cage Traps	Summer ‘04	33	1 survey
	Autumn ‘05	30, 33	2 survey
Hair Tubes	Autumn ‘05	33, 35	2 short transects
Harp Trap	Summer ‘04	34	1 site
	Autumn ‘05	33, 35	2 sites
	Late Spring ‘05	30, 31, 35	3 sites
Anabat	Summer ‘04	34	2 survey nights
	Autumn ‘05	30, 33	3 survey nights
	Late Spring ‘05	31, 33	2 survey nights
Spotlighting	Summer ‘04	34	1 survey night
	Autumn ‘05	36	1 survey night
	Early Spring ‘05	37	1 survey night
	Late Spring ‘05	31, 33	2 survey night
Scats, tracks, traces	Autumn ‘05	35	1 search
	Winter ’05	30, 36, 39	3 searches

Table 2.4 Details of fauna surveys within TSU 40 – Tablelands Red Gum Woodlands.

Method	Season	Veg Assocns	Summary of Effort
Quantitative Bird	Winter '05	40	2 surveys
	Early Spring '05	40	2 surveys
Non-quantitative Bird	Early Spring '05	40	1 survey at water body
	Late Spring '05	40	1 survey at water body
Call Playback 1 night	Summer '04	40	1 survey
	Autumn '05	40	1 survey
Call Playback 2 consecutive nights	Late Spring '05	40	1 survey set targeting Masked Owl
Call Playback 8 consecutive nights	Early Spring '05	40	1 survey set
Pitfall Trapping	Summer '04	40	1 30m trapline
	Late Spring '05	40	1 30m trapline
Elliot Trapping	Autumn '05	40	1 survey with Elliot A ground
	Autumn '05	40	1 survey with Elliot B tree-mounted
Cage Traps	Autumn '05	40	1 survey
Harp Trap	Autumn '05	40	1 site
Anabat	Summer '04	40	2 survey nights
	Autumn '05	40	4 survey nights
Spotlighting	Summer '04	40	1 survey night
	Autumn '05	40	1 survey night
Scats, tracks, traces	Winter '05	40	1 search

Table 2.5 Details of fauna surveys within TSU 50 – Sedimentary Scribbly Gum Woodlands.

Method	Season	Veg Assocns	Summary of Effort
Quantitative Bird	Summer '04	53, 54	2 surveys
	Autumn '05	51, 54	3 surveys
	Winter '05	54	1 survey
	Early Spring '05	52, 53	3 surveys
	Late Spring '05	52	1 survey
Call Playback 1 night	Summer '04	52	1 survey
	Autumn '05	50, 54	3 surveys
Quantitative Herpetological	Summer '04	54	1 survey
	Autumn '05	51, 53, 54	5 surveys
	Early Spring '05	50, 52, 53	5 surveys
Pitfall Trapping	Late Spring '05	52	1
Elliot Trapping	Summer '04	52, 54	2 surveys with Elliot B tree-mounted
	Summer '04	52, 54	2 surveys with Elliot A ground
	Autumn '05	50	1 survey with Elliot B tree-mounted
	Autumn '05	50, 54	1 survey with Elliot A ground
	Early Spring '05	50, 52	2 surveys with Elliot B tree-mounted
Cage Traps	Summer '04	52, 54	2 surveys
	Autumn '05	52, 54	3 surveys
	Early Spring '05	50, 52, 53	3 surveys
Harp Trap	Summer '04	52	1 site
	Autumn '05	54	2 sites
Anabat	Summer '04	52, 54	3 survey nights
	Autumn '05	50, 54	4 survey nights
	Early Spring '05	50	1 survey nights
Spotlighting	Summer '04	52	1 survey night
	Autumn '05	54	1 survey night
	Early Spring '05	50	2 survey night
Scats, tracks, traces	Autumn '05	51, 53, 54	3 searches
	Early Spring '05	52	1 search

Table 2.6 Details of fauna surveys within TSU 60 – Alluvial Apple Forests.

Method	Season	Veg Assocns	Summary of Effort
Quantitative Bird	Winter '05	61, 64	4 surveys
Call Playback 1 night	Autumn '05	61	1 survey
Pitfall Trapping	Autumn '05	64	1 30m trapline
	Early Spring '05	61	1 30m trapline
	Late Spring '05	61	1 30m trapline
Elliot Trapping	Autumn '05	61, 64	2 surveys with Elliot B tree-mounted
	Autumn '05	61	1 survey with Elliot A ground
	Late Spring '05	61	1 survey with Elliot B tree-mounted
Cage Traps	Autumn '05	61	1 survey
Harp Trap	Autumn '05	61	1 site
	Late Spring '05	63	3 sites
Anabat	Autumn '05	61	1 survey night
	Late Spring '05	61	1 survey night
Spotlighting	Autumn '05	61	1 survey night
	Late Spring '05	61	1 survey night

3 WEATHER CONDITIONS

Table 3.1 Survey seasons, dates and weather conditions.

Date	Day	Evening
Summer 2004		
Sun 5/12/04	Fine, approx 30°C	Cloudy, approx 20°C
Mon 6/12/04	Cloudy periods with light rain, approx 25°C	Cloudy, approx 20-25°C
Tues 7/12/04	Cloudy periods, approx 25°C, sunny periods up to approx 30°C	Thunderstorm approx 18°C
Wed 8/12/04	Heavy rain, approx 25°C, sunny periods up to 30°C	Thunderstorm with local lightening, approx 18°C
Thurs 9/12/04	Mostly fine, humid, 15-30°C	Mostly clear, 24°C
Fri 10/12/04	Morning shower and drizzle approx 18°C	20-25°C
Sat 11/12/04	Mostly fine 18-25°C	N/a
Autumn 2005		
30/3/05-8/4/05	Weather conditions during the day were good for surveying, with temperatures mostly 20-25°C and an occasional day in the high 20's. Most days were still or with a light breeze.	Evenings were generally warm (15-20°C), dropping to around 15°C overnight, with the occasional cool night (13-17°C), dropping to 5-10°C. No rain except for a very few patches of fine drizzle. No moon during the nocturnal surveys.
Winter 2005		
28/6/05	Overcast, light rain, 8-15°C, light to strong wind	Cloudy, moderate rainfall, 5-10°C, moderate to strong wind
29/6/05	Overcast, heavy rain, 10°C, moderate to strong wind	Cloudy, moderate to heavy rain, 5-10°C, moderate to strong wind
4/7/05	Fine, 10-17°C	Fine, temps down to 4°C
5/7/05	Some cloud (up to 30% cover), 10-17°C	Fine, temps down to 5°C
6/7/05	Fine, temps up to 18°C	Fine, temps down to 5°C
7/7/05	Overcast, light rain, temps up to 18°C	Cloudy, 13°C
8/7/05	Mostly cloudy (30-100% cover), 5-13°C	Overcast, 10°C, light breeze
9/7/05	Overcast, light to heavy showers, 5-10°C	Overcast, light showers, 5°C, strong wind
10/7/05	Cloudy (approx 70% cover), 10°C, cool moderate southerly wind	Overcast, 7°C, light wind
Early Spring 2005		
5/9/05	Overcast, light rain, 20-25°C	Clearing, 5-10°C
6/9/05	Fine, 15-20°C	Fine, 7°C
7/9/05	Fine, 20°C	Fine, slight wind, 6°C
8/9/05	overnight slight frost, fine, 26°C, slight wind	-
9/9/05	overnight slight frost, fine, 25°C, slight wind	-
10/9/05	Cloudy (30-100% cover), light drizzle, 20°C, slight wind	Overcast, light rain, 17°C, strong wind
11/9/05	Overcast, light drizzle, 15°C, light to moderate windy gusts	Overcast, constant moderate drizzle
12/9/05	Cloudy (30-80% cover), 8-15°C, light showers, moderate windy gusts	Cloudy (30-100% cover), light to moderate rain, 8°C, gentle to strong wind
13/9/05	Cloudy (30-80% cover), 15°C, light to moderate wind	-
14/9/05	Cloudy (0-50% cover), 15°C, moderate windy gusts	5°C
15/9/05	Cloudy (0-50% cover), 17°C, moderate gusts, strong at times	-
16/9/05	Overcast, constant moderate to heavy rain, 11°C, light wind	Overcast, heavy rain, 5-10°C, moderate winds
17/9/05	Overcast, light showers, 10°C, moderate wind	-

Table 3.1 cont Survey seasons, dates and weather conditions.

Date	Day	Evening
Late Spring 2005 4/11/05-18/11/05	Weather conditions varied during this period, with some days reaching 30°C and other cooler days only 15°C. Heavy rain preceded the survey making the region very green. Some heavy rain also occurred during the surveys, which encouraged frogs to call.	Overnight temperatures varied from 10-15°C. Moon was out for some nights, but on most nights the moon was hidden by cloud

4 KEYING CHARACTERS FOR ANABAT CALLS

Table 4.1 Keying characters for Anabat calls of the bats of Moolarben.

Note: species are listed that have not been found on the site but are included because these were the characters used to distinguish these species from others that were found

Species	Calls on site?	Expected or Known Characteristic freq		Tail	IDing Notes	Pulse Shape	RA *	Trends/Notes
		Min	Max					
Tadarida australis	Yes	10	15			flat	4	
Saccolaimus flaviventris	No	17.5	22.5		harmonics	curved or flat	1	Only one call with nice curved pulses at 19-20, looks like S. flaviventris, although only 2 pulses recorded
Chalinolobus dwyeri	Yes	21.5	25.5	Up	Pulses alternate	Curved	2	Low pulse 22-24, high pulse 26-28
Chalinolobus gouldii	Yes	25	34	Down or none	Pulses alternate, low pulse sometimes flat in cruise mode	Curved	5	
Mormopterus sp4	Yes	24	30			flat	4	quite a range- from 24-30
Mormopterus sp2	No	28.5	31			flat	0	Calls around 30 could all be Mormopterus sp3 or sp4, and no Mormopterus sp2 were captured, so there is no proof of their presence
Scotorepens balstoni	Yes	28	34	Down or none or occasionally up	flat cruise pulse at 28	Curved	2	mostly at 32, no tail
Mormopterus sp3	Yes	31	36			flat	2	
Scoteanax rueppellii	No	32	36.5	mostly none, occ short down	knee>37, pre-characteristic drop >3	curved	0	No calls in range with large pre-characteristic section drop, suggesting calls in this range likely to be S. balstoni or S. orion
Scotorepens orion	Yes	34.5	37.5	mostly none, sometimes down	knee>38	curved	2	
Falsistrellus tasmaniensis	No	35.5	39	not up. none or down	often steep, pree-characteristic often long	curved	0	Calls in this range appeared to be the shape of S. orion
Scotorepens greyii	No	35	40	up, sometimes down or absent	sometimes flatter	curved	0	No calls in high 30's and most calls 35-37 likely to be S. orion
Vespadelus darlingtoni	No	40	44	absent or up	characteristic freq often long	curved	0	Some low Vespadelus calls could theoretically be this species but no V darlingtoni were captured, so have to call them V.vulturnus, since none were below the known range of V. vulturnus from the western slopes.

Table 4.1 cont Keying characters for Anabat calls of the bats of Moolarben.

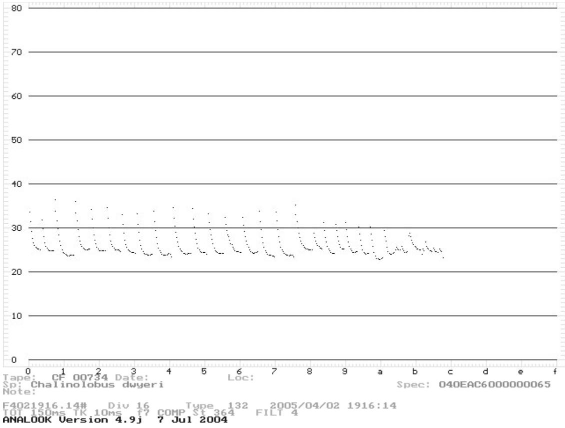
Species	Calls on site?	Expected or Known Characteristic freq		Tail	IDing Notes	Pulse Shape	RA *	Trends/Notes
		Min	Max					
Chalinolobus pictatus	Yes	42	44		pulses alternate	curved	1	Best call low pulse 39 high pulse 41, questionable calls 42-44 could be V. vulturnus
Vespadelus regulus	No	43.5	46	ussually up		curved	0	Some low Vespadelus calls could theoretically be this species but no V regulus were captured, so have to call them V.vulturnus, since none were below the known range of V. vulturnus from the western slopes.
Miniopterus schreibersii	Yes	43	48	down	characteristic section may be long, pulse shape and gap ussually variable	curved	1	Best call at 44, other questionable calls 46-48 could be C. morio
Vespadelus vulturnus	Yes	42.5	50	up		curved	5	mostly from 44-48
Chalinolobus morio	Yes	46.5	53	down	pulse shape (or sometimes frequency) alternates	curved	3	
Vespadelus troughtoni	No	49	53.5	up		curved	0	No vespadelus calls over 50
Rhinolophus megaphyllus	Yes	66	70			flat	1	
		Range of start and end frequency	**Notes**					
		end	**start**					
Nyctophilus sp	Yes	31-47	60-80			vertical	5	
Myotis macropus	No	35-40	70-80	Good calls have kink at 47-50, and sometimes at 35. Pulse interval <75, initial slope >400	near vertical	0		No calls with kink at 47-50 and none with initial slop >400 or pulse interval <75, so most all vertical calls seem to be Nyctophilus

RA *
Relative Abundance Score

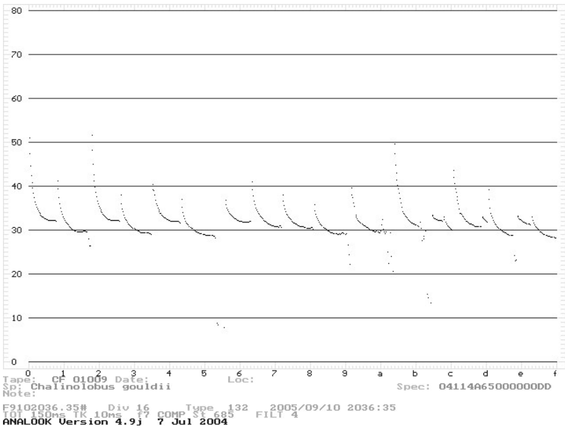
0=Species appears not to occur at the site, or no convincing calls found
1= One or two confidently identified calls of this species
2= Species found rarely at a few sites
3= Species found occaioanlly at many locations
4= Species widespread and fairly common
5= Species highly abundant and widepread, most anabat calls recorded during the project were one of these species

5 ANABAT FILES

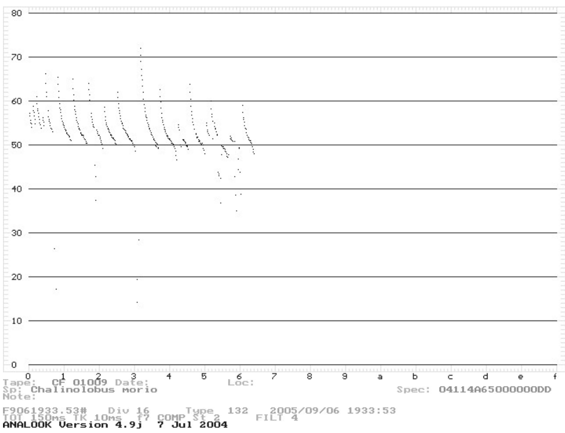
Chalinolobus dwyeri



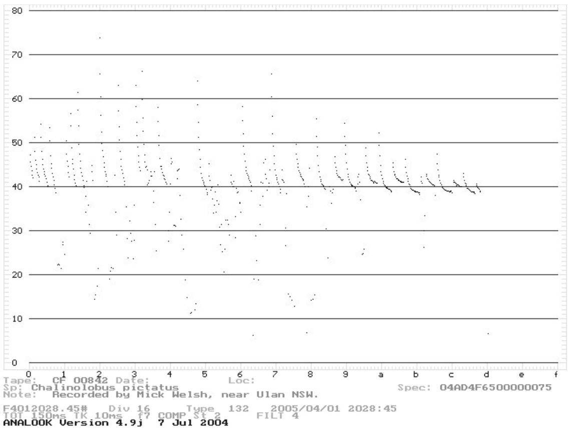
Chalinolobus gouldii



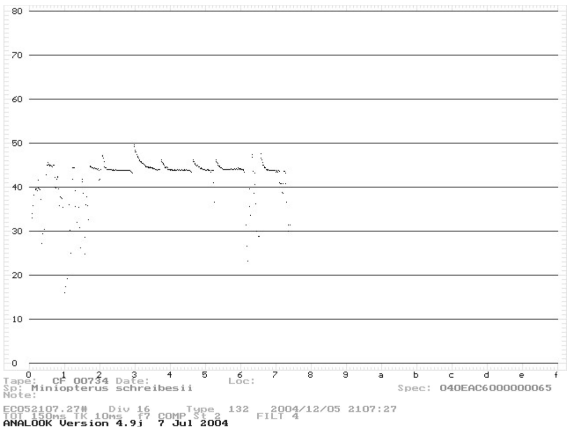
Chalinolobus morio



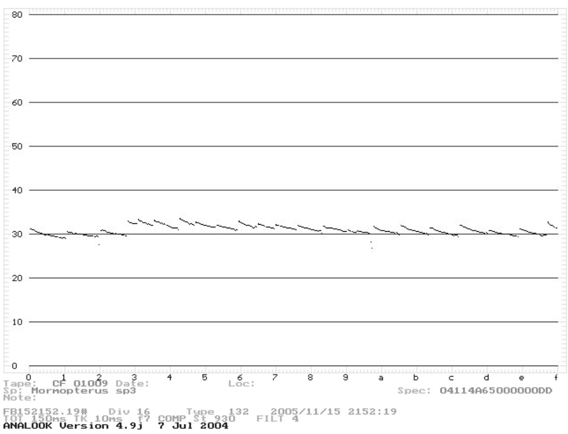
Chalinolobus pictatus

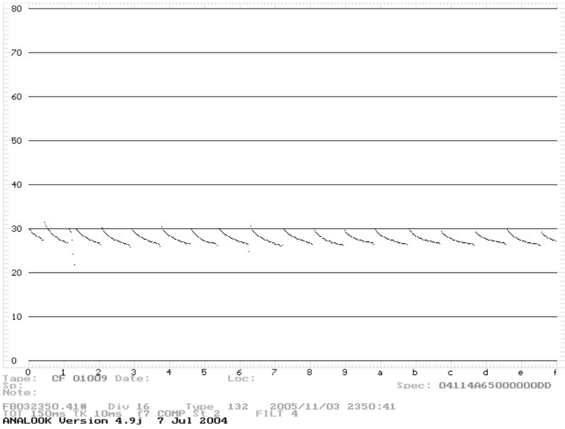


Miniopterus schreibersii

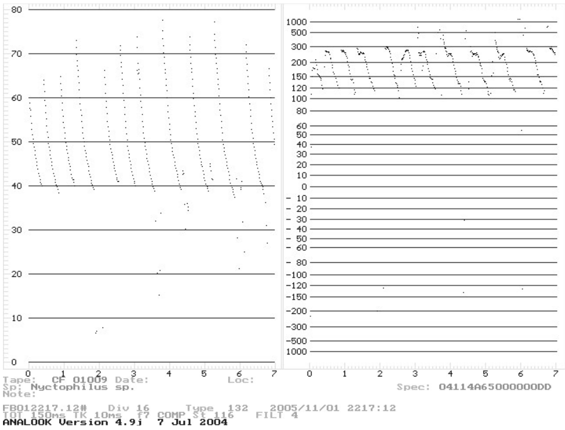


Mormopterus sp 3

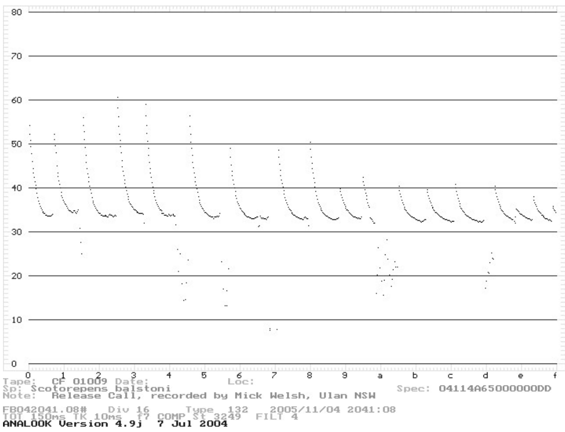




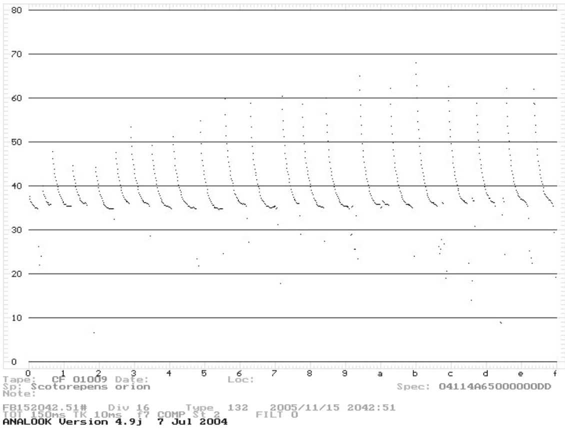
Nyctophilus sp



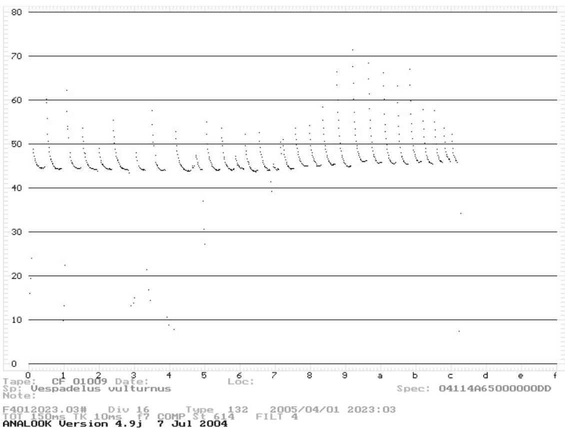
Scotorepens balstoni



Scotorepens orion



Vespadelus vulturnus



6 FIELD HABITAT ASSESSMENT SHEETS

Copies of raw field habitat assessment sheets for each of 17 specific fauna habitat survey sites.

MOOLARBEN COAL PROJECT – STAGE 1

FLORA, FAUNA & AQUATIC ECOLOGY ASSESSMENT

APPENDIX 7

Inventory of fauna species recorded

AUGUST 2006

APPENDIX 7

Table 7.1 Inventory of fauna species recorded

KEY

Status

*	Introduced species
M	Migratory species listed under the Commonwealth EPBC Act
E (TSC)	Endangered species listed on the NSW TSC Act
V (TSC)	Vulnerable species listed on the NSW TSC Act
E (EPBC)	Endangered species listed on the Commonwealth EPBC Act
V (EPBC)	Vulnerable species listed on the Commonwealth EPBC Act

Season/Survey Period

S	Summer ‘04
A	Autumn ‘05
W	Winter ’05 first part of survey
LW	Winter ’05 second part of survey, after break due to wet weather
ES	Early Spring ‘05
LS	Late Spring ‘05

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	MAMMALS							
	Tachyglossidae							
	Short-beaked Echidna	*Tachyglossus aculeatus*	S	A	W		ES	LS
	Dasyuridae							
	Yellow-footed Antechinus	*Antechinus flavipes*	S	A			ES	LS
	Common Dunnart	*Sminthopsis murina*					ES	
	Vombatidae							
	Common Wombat	*Vombatus ursinus*	S	A	W		ES	LS
	Petauridae							
	Sugar Glider	*Petaurus breviceps*	S	A			ES	LS
	Squirrel Glider	*Petaurus norfolcensis*					ES	
	Pseudocheiridae							
	Common Ringtail Possum	*Pseudocheirus peregrinus*	S	A	W		ES	LS
	Acrobatidae							
	Feathertail Glider	*Acrobates pygmaeus*					ES	LS
	Phalangeridae							
	Common Brushtail Possum	*Trichosurus vulpecula*	S	A	W		ES	LS
	Macropodidae							
	Eastern Grey Kangaroo	*Macropus giganteus*	S	A	W	LW	ES	LS
	Common Wallaroo	*Macropus robustus*	S	A	W	LW	ES	LS
	Red-necked Wallaby	*Macropus rufogriseus*	S	A	W	LW	ES	LS
	Swamp Wallaby	*Wallabia bicolor*	S	A			ES	LS

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Pteropodidae							
	Little Red Flying-fox	*Pteropus scapulatus*		S?				
	Emballonuridae							
V (TSC)	Yellow-bellied Sheath-tail Bat	*Saccolaimus flaviventris*		S?				
	Vespertilioidae							
V (TSC & EPBC)	Large-eared Pied Bat	*Chalinolobus dwyeri*						LS
	Gould's Wattled Bat	*Chalinolobus gouldii*	S					LS
	Chocolate Wattled Bat	*Chalinolobus morio*		A				LS
V (TSC)	Common Bent-wing Bat	*Miniopterus schreibersii*	S?					
	Lesser Long-eared Bat	*Nyctophilus geoffroyi*	S	A				LS
	Gould's Long-eared Bat	*Nyctophilus gouldi*		A				LS
V (TSC & EPBC)	Greater Long-eared Bat	*Nyctophilus timoriensis*		A				
	Eastern Broad-nosed Bat	*Scotorepens orion*	S					LS
	Inland Broad-nosed Bat	*Scotorepens balstoni*	S					LS
	Little Forest Bat	*Vespadelus vulturnus*	S	A				LS
	Molossidae							
	Inland Freetail Bat	*Mormopterus sp. 3*						LS
	Southern Freetail Bat	*Mormopterus sp. 4 (planiceps)*	S					LS
	White-striped Freetail Bat	*Tadarida (Nyctinomus) australis*	S	A			ES	LS
	Muridae							
	House Mouse	*Mus musculus*		A			ES	LS
	Canidae							
	Dog (Feral)	*Canis familiaris*		A			ES	
*	Fox	*Vulpes vulpes*	S	A	W		ES	LS
	Felidae							
*	Feral Cat	*Felis catus*		A			ES	LS
	Leporidae							
*	Rabbit	*Oryctolagus cuniculus*	S	A	W	LW	ES	LS
*	Brown Hare	*Lepus capensis*	S					
	Suidae							
*	Pig	*Sus scrofa*	S	A	W		ES	LS
	Bovidae							
*	Goat	*Capra hircus*		A	W			
	Cervidae							
*	Fallow Deer	*Dama dama*			W			
	BIRDS							
	Megapodiidae							
	Dromaiidae							
	Emu	*Dromaius novaehollandiae*	S	A	W	LW	ES	LS
	Phasianidae							
	Stubble Quail	*Coturnix pectoralis*		A				
	Brown Quail	*Coturnix ypsilophora*		A			ES	

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Turnicidae							
	Painted Button-quail	*Turnix varia*					ES	
	Pelecanidae							
	Australian Pelican	*Pelecanus conspicillatus*	S		W			LS
	Anhingidae							
	Darter	*Anhinga melanogaster*			W		ES	LS
	Phalacrocoracidae							
	Pied Cormorant	*Phalacrocorax varius*	S	A				
	Little Pied Cormorant	*Phalacrocorax melanoleucos*	S	A			ES	
	Great Cormorant	*Phalacrocorax carbo*		A			ES	
	Little Black Cormorant	*Phalacrocorax sulcirostris*	S					
	Podicipedidae							
	Australasian Grebe	*Tachybaptus novaehollandiae*	S	A	W		ES	
	Anatidae							
	Black Swan	*Cygnus atratus*		A			ES	LS
	Pacific Black Duck	*Anas superciliosa*	S	A	W		ES	LS
	Grey Teal	*Anas gracilis*		A			ES	
	Hardhead	*Aythya australis*	S				ES	LS
	Australian Wood Duck	*Chenonetta jubata*	S	A	W	LW	ES	LS
	Rallidae							
	Dusky Moorhen	*Gallinula tenebrosa*					ES	
	Purple Swamphen	*Porphyrio porphyrio*						
	Eurasian Coot	*Fulica atra*	S	A	W		ES	LS
	Ardeidae							
	Cattle Egret	*Ardea ibis*						LS
	White-necked Heron	*Ardea pacifica*		A			ES	LS
	White-faced Heron	*Egretta novaehollandiae*	S	A	W		ES	LS
	Threskiornidae							
	Straw-necked Ibis	*Threskiornis spinicollis*		A				
	Charadriidae							
	Masked Lapwing	*Vanellus miles*	S	A	W	LW	ES	LS
	Recurvirostridae							
	Black-fronted Dotterel	*Elseyornis melanops*	S		W		ES	LS
	Black-winged Stilt	*Himantopus himantopus*						
	Accipitridae							
	Black-shouldered Kite	*Elanus axillaris*		A	W		ES	LS
V (TSC)	Square-tailed Kite	*Lophoictinia isura*			W			
	Whistling Kite	*Haliastur sphenurus*				LW	ES	LS
	Wedge-tailed Eagle	*Aquila audax*	S	A		LW	ES	LS
	Little Eagle	*Hieraaetus morphnoides*						
	Brown Goshawk	*Accipiter fasciatus*			W		ES	LS
	Collared Sparrowhawk	*Accipiter cirrhocephalus*						LS
	Spotted Harrier	*Circus assimilis*		A				
	Falconidae							
	Peregrine Falcon	*Falco peregrinus*	S	A				LS
	Australian Hobby	*Falco longipennis*	S	A	W			

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Falconidae cont							
	Brown Falcon	*Falco berigora*	S	A			ES	LS
	Nankeen Kestrel	*Falco cenchroides*	S	A	W	LW	ES	LS
	Columbidae							
	Peaceful Dove	*Geopelia striata*	S			LW	ES	LS
	Bar-shouldered Dove	*Geopelia humeralis*					ES	
	Common Bronzewing	*Phaps chalcoptera*	S	A	W	LW	ES	LS
	Brush Bronzewing	*Phaps elegans*						
	Crested Pigeon	*Ocyphaps lophotes*	S	A	W	LW	ES	LS
	Wonga Pigeon	*Leucosarcia melanoleuca*	S					
	Cacatuidae							
V (TSC)	Glossy Black-Cockatoo	*Calyptorhynchus lathami*	S	A	W	LW	ES	LS
	Yellow-tailed Black Cockatoo	*Calyptorhynchus funereus*	S	A	W	LW		
V (TSC)	Gang-Gang Cockatoo	*Callocephalon fimbriatum*						
	Galah	*Eolophus roseicpilla*	S	A	W	LW	ES	LS
	Little Corella	*Cacatua sanguinea*						
	Sulphur-crested Cockatoo	*Cacatua galerita*	S	A	W	LW	ES	LS
	Psittacidae							
	Musk Lorikeet	*Glossopsitta concinna*	S			LW	ES	
	Little Lorikeet	*Glossopsitta pusilla*	S			LW	ES	
	Australian King Parrot	*Alisterus scapularis*	S	A	W	LW	ES	LS
	Crimson Rosella	*Platycercus elegans*						
	Eastern Rosella	*Platycercus eximius*	S	A	W	LW	ES	LS
	Red-rumped Parrot	*Psephotus haematonotus*	S	A	W	LW	ES	LS
	Cuculidae							
	Pallid Cuckoo	*Cuculus pallidus*	S				ES	LS
	Brush Cuckoo	*Cuculus variolosus*				LW	ES	LS
	Fan-tailed Cuckoo	*Cuculus flabelliformis*	S	A		LW	ES	LS
	Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*						LS
	Common Koel	*Eudynamys scopopacea*						LS
	Channel-billed Cuckoo	*Scthrops novaehollandiae*	S					LS
	Centropodidae							
	Strigidae							
V (TSC)	Powerful Owl	*Ninox strenua*		A	W *		ES	
	Southern Boobook	*Ninox novaeseelandiae*	S	A	W		ES	LS
	Tytonidae							
	Barn Owl	*Tyto alba*	S	A				
	Podargidae							
	Tawny Frogmouth	*Podargus strigoides*		A	W		ES	LS
	Caprimulgidae							
	White-throated Nightjar	*Eurostopodus mysticalis*						LS
	Aegothelidae		S					
	Australian Owlet-nightjar	*Aegotheles cristatus*		A	W		ES	LS
	Apodidae							
M	White-throated Needletail	*Hirundapus caudacutus*	S					

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Alcedinidae							
	Laughing Kookaburra	*Dacelo naxaeguineae*	S	A	W	LW	ES	LS
	Sacred Kingfisher	*Todiramphus sanctus*	S					LS
	Meropidae							
M	Rainbow Bee-eater	*Merops ornatus*	S					LS
	Coraciidae							
	Dollarbird	*Eurystomus orientalis*	S					LS
	Menuridae							
	Superb Lyrebird	*Menura novaehollandiae*	S	A	W	LW	ES	
	Neosittidae							
	Varied Sittella	*Daphoenositta chrysoptera*	S	A	W		ES	
	Climacteridae							
	White-throated Treecreeper	*Cormobates leucophaeus*	S	A	W	LW	ES	LS
V (TSC)	Brown Treecreeper	*Climacteris picumnus*	S	A	W	LW	ES	LS
	Maluridae							
	Superb Fairy-wren	*Malurus cyaneus*	S	A	W	LW	ES	LS
	Variegated Fairy-wren	*Malurus lamberti*	S				ES	LS
	Red-backed Fairy-wren	*Malurus melanocephalus*	S?					
	Pardalotidae							
	Spotted Pardalote	*Pardalotus punctatus*	S	A	W	LW	ES	LS
	Striated Pardalote	*Pardalotus striatus*	S	A	W	LW	ES	LS
	Rockwarbler	*Origma solitaria*	S	A	W	LW	ES	LS
	White-browed Scrubwren	*Sericornis frontalis*	S	A	W	LW	ES	LS
	Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*				LW	ES	
V (TSC)	Speckled Warbler	*Chthinicola sagittata*	S	A	W	LW	ES	LS
	Weebill	*Smicrornis brevirostris*	S	A	W	LW	ES	LS
	White-throated Gerygone	*Gerygone olivacea*			W		ES	LS
	Western Gerygone	*Gerygone fusca*	S	A			ES	LS
	Brown Thornbill	*Acanthiza pusilla*	S	A	W	LW	ES	LS
	Yellow Thornbill	*Acanthiza nana*		A	W		ES	
	Striated Thornbill	*Acanthiza lineata*		A	W	LW	ES	LS
	Buff-rumped Thornbill	*Acanthiza reguloides*	S	A	W	LW	ES	
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	S	A	W	LW	ES	LS
	Southern Whiteface	*Apehelocephala leucopsis*	S	A	W		ES	LS
	Meliphagidae							
	Red Wattlebird	*Anthochaera carunculata*	S	A	W	LW	ES	LS
	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	S		W	LW	ES	LS
	Striped Honeyeater	*Plectorhyncha lanceolata*			W	LW		LS
	Noisy Friarbird	*Philemon corniculatus*	S	A	W	LW	ES	LS
	Little Friarbird	*Philemon citreogularis*						LS
	Blue-faced Honeyeater	*Entomyzon cyanotis*	S	A	W			LS
	Noisy Miner	*Manorina melanocephala*	S	A	W	LW	ES	LS
	Yellow-faced Honeyeater	*Lichenostomus chrysops*	S	A	W	LW	ES	LS
	White-eared Honeyeater	*Lichenostomus leucotis*	S	A	W	LW	ES	
	Yellow-tufted Honeyeater	*Lichenostomus melanops*	S	A	W	LW	ES	LS
	Singing Honeyeater	*Lichenostonus virescens*						
	Fuscous Honeyeater	*Lichenostomus fuscus*	S	A	W	LW	ES	LS
	White-plumed Honeyeater	*Lichenostomus pencillatus*	S	A	W	LW	ES	LS

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Meliphagidae cont							
V (TSC)	Black-chinned Honeyeater	*Melithreptus gularis*	S?		W	LW	ES	
	Brown-headed Honeyeater	*Melithreptus brevirostris*	S?	A	W	LW	ES	
	White-naped Honeyeater	*Melithreptus lunatus*		A	W	LW		LS
	Brown Honeyeater	*Lichmera indistincta*		A				
	New Holland Honeyeater	*Phylidonryis novaehollandiae*				LW	ES	
	Painted Honeyeater	*Grantiella picta*						LS
	Eastern Spinebill	*Acanthorhynchus tenuirostris*	S	A	W	LW	ES	
	Scarlet Honeyeater	*Myzomela sanguinolenta*	S					
	White-fronted Chat	*Epthianura albifrons*					ES	
	Orthonychidae							
	Eastern Whipbird	*Psophodes olivaceus*					ES	
	Cinclosomatidae							
	Spotted Quail-thrush	*Cinclosoma punctatum*		A	W	LW	ES	LS
	Pomatostomidae							
V (TSC)	Grey-crowned Babbler	*Pomatostomus temporalis*	S	A		LW		
	White-browed Babbler	*Pomatostomus superciliosus*	S	A	W	LW	ES	LS
	Petroicidae							
	Red-capped Robin	*Petroica goodenovii*		A	W	LW	ES	
	Scarlet Robin	*Petroica multicolor*			W	LW		
V (TSC)	Hooded Robin	*Melanodryas cucullata*	S	A	W **	LW	ES	LS
	Eastern Yellow Robin	*Eopsaltria australis*	S	A	W	LW	ES	LS
	Jacky Winter	*Microeca fascinans*		A	W	LW	ES	LS
	Pachycephalidae							
	Crested Shrike-tit	*Falcunculus frontatus*	S	A	W	LW		
	Grey Shrike-thrush	*Colluricincla harmonica*	S	A	W	LW	ES	LS
	Golden Whistler	*Pachycephala pectoralis*	S	A	W	LW	ES	
V (TSC)	Gilbert's Whistler	*Pachycephala inornata*	S					
	Rufous Whistler	*Pachycephala rufiventris*	S	A	W		ES	LS
	Dicruridae							
	Grey Fantail	*Rhipidura fuliginosa*	S	A	W		ES	LS
M	Rufous Fantail	*Rhipidura rufifrons*		A				
	Willie Wagtail	*Rhipidura leucophrys*	S	A	W	LW	ES	LS
M	Satin Flycatcher	*Myiagra cyanoleuca*		A				
	Restless Flycatcher	*Myiagra inquieta*	S	A	W	LW	ES	LS
	Magpie Lark	*Grallina cyanoleuca*		A	W	LW	ES	LS
	Oriolidae							
	Olive-backed Oriole	*Oriolus sagittatus*		A		LW	ES	LS
	Ptilonorhynchidae							
	Campephagidae							
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	S	A		LW	ES	LS
	White-bellied Cuckoo-shrike	*Coracina papuensis*			W	LW	ES	LS
	Cicadabird	*Coracina tenuirostris*						LS
	White-winged Triller	*Lalage sueurii*	S					LS
	Varied Triller	*Lalage leucomela*	S					

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Artamidae							
	Masked Woodswallow	*Artamus personatus*	S					
	White-browed Woodswallow	*Artamus superciliosus*	S					
	Black-faced Woodswallow	*Artamus cinereus*	S					
	Dusky Woodswallow	*Artamus cyanopterus*	S	A		LW	ES	LS
	Grey Butcherbird	*Cracticus torquatus*	S	A	W	LW	ES	LS
	Pied Butcherbird	*Cracticus nigrogularis*	S	A	W	LW	ES	LS
	Australian Magpie	*Gymnorhina tibicen*	S	A	W	LW	ES	LS
	Pied Currawong	*Strepera graculina*	S	A	W	LW	ES	LS
	Corvidae							
	Australian Raven	*Corvus coronoides*	S	A	W	LW	ES	LS
	Corcoracidae							
	White-winged Chough	*Corcorax melanorhamphos*	S	A	W	LW	ES	LS
	Hirundinidae							
	White-backed Swallow	*Cheramoeca leucosternus*	S	A			ES	
	Welcome Swallow	*Hirundo neoxena*	S	A	W	LW	ES	LS
	Tree Martin	*Hirundo nigricans*	S					LS
	Fairy Martin	*Hirundo ariel*	S				ES	LS
	Motacillidae							
	Richard's Pipit	*Anthus naovaeseelandiae*	S		W	LW	ES	LS
	Sylviidae							
	Rufous Songlark	*Cincloramphus mathewsi*	S		W			LS
	Brown Songlark	*Cincloramphus cruralis*	S					
	Clamorous Reed-warbler	*Acrocephalus stentoreus*						LS
	Passeridae							
*	House Sparrow	*Passer domesticus*	S	A	W			
	Ploceidae							
	Double-barred Finch	*Taeniopygia bichenovii*		A	W	LW	ES	LS
	Red-browed Finch	*Neochmia temporalis*	S	A		LW	ES	LS
V (TSC)	Diamond Firetail	*Stagonopleura guttata*	S	A	W	LW	ES	LS
	Dicaeidae							
	Mistletoebird	*Dicaeum hirundinaceum*	S		W	LW	ES	LS
	Zosteropidae							
	Silvereye	*Zosterops lateralis*			W		ES	LS
	Muscicapidae							
	Bassian (Ground) Thrush	*Zoothera lunulata*	S	A				
*	Common Blackbird	*Turdus merula*	S					
	Sturnidae							
*	Common Starling	*Sturnus vulgaris*	S	A	W	LW	ES	LS
	REPTILES							
	Chelidae							
	Eastern Long-necked Turtle	*Chelodina longicollis*	S	A			ES	LS

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Gekkonidae							
	Wood Gecko	*Diplodactylus vittatus*		A			ES	LS
	Lesueur's Velvet Gecko	*Oedura lesueurii*		A			ES	LS
	Southern Leaf-tailed Gecko	*Phyllurus platurus*		A				
	Thick-tailed Gecko	*Underwoodisaurus milii*		A			ES	
	Pygopodidae							
	Burton's Snake-lizard	*Lialis burtonis*	S					
	Common Scaly-foot	*Pygopus lepidopodus*	S					
	Agamidae							
	Nobbi	*Amphibolurus nobbi*	S	A	W	LW	ES	
	Eastern Bearded Dragon	*Pogona barbata*	S				ES	LS
	Mountain Dragon	*Tympanocryptis diemensis*		A				LS
	Varanidae							
	Lace Monitor	*Varanus varius*	S	A			ES	LS
	Scincidae							
	Two-clawed Worm Skink	*Anomalopus leukartii*	S	A	W		ES	LS
	Littrer Skink	*Carlia foliorum*						LS
	Southern Rainbow Skink	*Carlia tetradactyla*	S					LS
	Striped Skink	*Ctenotus robustus*						
	Copper-tailed Skink	*Ctenotus taeniolatus*	S	A	W		ES	
	Cunningham's Skink	*Egernia cunninghami*	S					
	White's Skink	*Egernia whitii*		A			ES	LS
	Yellow-bellied Skink	*Eulamprus tenuis*	S					LS
	Grass Skink	*Lampropholis delicata*		A				
	South-eastern Slider	*Lerista bouganvilli*		A			ES	LS
	Boulenger's Skink	*Morethia boulengeri*	S	A	W	LW	ES	LS
	Eastern Blue-tongued Lizard	*Tiliqua scincoides*	S					
	Shingle-back	*Trachydosaurus rugosus*	S					LS
	Typhlopidae							
	Blind Snake	*Ramphotyphlops nigrescens*					ES	LS
	Blind Snake	*Ramphotyphlops proximus*						LS
	Elapidae							
	Yellow-faced Whip Snake	*Demansia psammophis*			W			LS
	Red-naped Snake	*Furina diadema*			W		ES	
	Red-bellied Black Snake	*Pseudechis porphyriacus*	S	A			ES	
	Eastern Brown Snake	*Pseudonaja textilis*						LS
	Dwyer's Black-headed Snake	*Suta dwyeri*		A			ES	
	Bandy Bandy	*Vermicella annulata*						LS *(anecdotal)
	AMPHIBIANS							
	Myobatrachidae							
	Common Eastern Froglet	*Crinia signifera*		A	W	LW	ES	LS
	Eastern Banjo Frog	*Limnodynastes dumerilii dumerilii*	S	A			ES	LS
	Ornate Burrowing Frog	*Limnodynastes ornatus*	S					

Table 7.1 cont Inventory of fauna species recorded

Status	Common Name	Scientific Name	S	A	W	LW	ES	LS
	Myobatrachidae cont							
	Striped Marsh Frog	*Limnodynastes peronii*	S		W			
	Spotted Grass Frog	*Limnodynastes tasmaniensis*	S				ES	LS
	Northern Banjo Frog	*Limnodynastes terraereginae*	S				ES	LS
	Painted Burrowing Frog	*Neobatrachus sudelli*		A	W		ES	LS
	Brown Toadlet	*Pseudophryne bibronii*	S	A		LW	ES	LS
	Smooth Toadlet	*Uperoleia laevigata*	S	A			ES	LS
	Tyler's Toadlet	*Uperoleia tyleri*	S					
	Hylidae							
	Green Tree Frog	*Litoria caerulea*	S					LS
	Eastern Dwarf Tree Frog	*Litoria fallax*	S				ES	LS
	Broad-palmed Frog	*Litoria latopalmata*	S					LS
	Leseur's Tree Frog	*Litoria lesueuri*						LS
	Peron's Tree Frog	*Litoria peronii*	S	A			ES	LS
	Bleating Tree Frog	*Litoria dentata*						
	Verreaux's Tree Frog	*Litoria verreauxii*			W		ES	LS
	FISH							
	Short-finned Eel	*Anguilla australis*					ES	

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Appendix 8 Table 8.4 Page 1 Macroinvertebrate Fauna SIGNAL Scores

					Sp 05	Sp 05	Sp 05	Su 06	Sp04	Au 05	Sp 05	Su 06	Sp04	Au 05	Sp 05	Sp 05	Sp04	Au 05	Sp 05	Sp04	Au 05	Sp 05	Sp 05	Su 06	Individual SIGNAL Scores**	
Class	Sub-Order				20/09/05	22/09/05	27/09/05	17/01/06	14/12/04	19/05/05	21/09/05	18/01/06	14/12/04	19/05/05	21/09/05	27/09/05	14/12/04	18/05/05	20/09/05	14/12/04	18/05/05	20/09/05	27/09/05	17/01/06		
		Family	Sub-Family	Common nam	BC1	BC2	ECX2	ECX2	GR1	GR1	GR1	GR2	GR3	GR3	GR3	LC2	MC1	MC1	MC1	MC2	MC2	MC3	MC4	MC6	HU97	SIGNAL-2
Insecta		Dytiscidae		Diving Beetles	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Insecta		Elmidae		Riffle Beetles									8												8	7
Insecta		Gyrinidae		Whirligig Beetles					5	5			5		5										5	4
Insecta		Haliplidae		Crawling Water Beetles		2			2	2	2	2	2	2	2											2
Insecta		Hydraenidae		Minute Rove Beetles	5		5												5						5	3
Insecta		Hydrochidae		Scavenger Water Beetles				4																	4	4
Insecta		Hydrophilidae			4	4		4	4	4		4	4	4	4	4		4	4	4	4				4	2
Insecta		Scirtidae		Marsh Beetles	6		6	6							6	6				6	6	6		6	6	6
Insecta		Ceratopogonidae		Biting Midges		5	5			5							5	5	5				5		5	4
Insecta		Chaoboridae		Phantom Midges			2																			2
Insecta		Chironomidae	Chironominae	Bloodworms	3	3	3	3			3	3	3	3	3	3	3	3	3	3	3	3	3		3	3
Insecta		Chironomidae	Orthocladiina	Bloodworms							4				4											4
Insecta		Chironomidae	Tanypodinae	Bloodworms	4	4	4				4				4	4	4		4				4	4		4
Insecta		Culicidae		Mosquitoes	6					6						6			6	6	6	6			6	1
Insecta		Dixidae		Meniscus Midges																					7	7
Insecta		Psychodidae		Moth Flies																		3				3
Insecta		Simuliidae		Black Flies							5		5		5										5	5
Insecta		Stratiomyidae		Soldier Flies												3		3	3	3	3				3	2
Insecta		Tabanidae		March Flies											3							3				3
Insecta		Tipulidae		Crane Flies							5						5		5						5	5
Insecta		Baetidae		Mayflies	7	7			7	7	7	7	7	7	7	7	7	7					7	7	7	5
Insecta		Caenidae		Mayflies	5	5					5		5		5		5						5	5	5	4
Insecta		Leptophlebiidae		Mayflies		10				10			10		10										10	8
Insecta		Aphididae		Aphids	*													*		*						*
Insecta		Corixidae		Lesser Water Boatmen	3	3			3		3			3		3	3	3	3	3			3	3	3	2
Insecta		Gerridae		Water Striders	7	7			7				7		7										7	4
Insecta		Hydrometridae		Water Measurers									3							3						3
Insecta		Naucoridae		Creeping Water Bugs																						2
Insecta		Nepidae	'ater Scorpions/ Needle Bugs			3		3																		3
Insecta		Notonectidae		Backswimmers	6	6		6	6	6			6	6			6	6	6	6			6		6	1
Insecta		Pleidae		Pygmy Backswimmers																	2					2
Insecta		Veliidae		Small Water Striders	6	6							6							6					6	3
Insecta		Pyralidae		Moths					6				6									6			6	3
Insecta		Aeshnidae		Dragonflies		4			4			4					4	4		4	4		4			4
Insecta		Cordulephyidae		Dragonflies					5			5														5
Insecta		Gomphidae		Dragonflies		6			6	6			6	6	6										6	5
Insecta		Hemicorduliidae		Dragonflies		5	5	5	5		5	5	5	5			5	5	5	5	5		5			5
Insecta		Libellulidae		Dragonflies		4			4	4	4	4			4		4	4	4	4			4	4	4	4
Insecta		Synthemistidae		Dragonflies	5					5																5
Insecta		Telephlebiidae		Dragonflies					9																	9
Insecta		Coenagrionidae		Damselflies		2			2	2	2	2	2		2		2	2	2		2		2		2	2
Insecta		Lestidae		Damselflies	1		1									1				1						1
Insecta		Megapodagrionidae		Damselflies		6				6	6														6	5
Insecta		Synlestidae		Damselflies																						7
Insecta		Gripopterygidae		Stone Flies							9				9										9	8
Insecta		Calamoceratidae		Caddis Flies		9			9	9			9												9	7
Insecta		Ecnomidae		Caddis Flies	5									5											5	4
Insecta		Hydropsychidae		Caddis Flies									6												6	6
Insecta		Hydroptilidae		Caddis Flies		4			4	4	4		4	4	4	4		4					4	4	4	4
Insecta		Leptoceridae		Caddis Flies	7	7	7	7	7		7		7		7		7	7		7			7	7	7	6
Insecta		Philorheithridae		Caddis Flies					8		8		8													8
Arachnida	Hydracarina			Freshwater Mites	6		6				6				6		6	6	6	6			6			6
Collembola				Springtails	1										1					1		1				1
Crustacea	Cladocera			Water Fleas	*		*								*	*	*	*				*	*			*
Crustacea		Centropagidae		Copepods	*																					*
Crustacea		Cyclopidae		Copepods		*	*		*	*	*		*	*	*	*	*	*	*	*		*	*			*
Crustacea		Atyidae		Freshwater Shrimp		6			6	6	6		6	6	6									6	6	3
Crustacea		Palaemonidae		Freshwater Prawns																						4
Crustacea		Parastacidae		Yabbies																						4
Ostracoda				Seed Shrimps	*		*		*	*	*	*	*	*	*	*	*	*	*	*		*	*	*		*
Hirudinea		Glossiphoniidae		Leeches									3				3	3							3	1
Hirudinea		Richardsoniadidae		Leeches																						4
Oligochaeta				Freshwater Worms	2	2	2		2	2	2	2	2		2	2			2			2		2		2
Bivalvia		Sphaeriidae		Pea Shells		5			5	5	5	5	5	5	5									5	5	5
Gastropoda		Ancylidae		Freshwater Limpets	7		7															7			7	4
Gastropoda		Lymnaeidae		Freshwater Snails			4		4		4				4								4		4	1
Gastropoda		Physidae		Freshwater Snails					1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1
Gastropoda		Planorbidae		Freshwater Snails								5													5	2
Turbellaria		Dugesiidae		Flatworms		3	3	3	3	3	3	3		3	3		3		3					3	3	2
Notes:	* represents those taxa for which SIGNAL scores				**HU97 Scores used unless HU97 values are not available, then SIGNAL2 values used instead																					

Appendix 8 Table 8.3 Page 2 Aquatic Biota (Diversity) **Moolarben Combined Aquatic Species Survey Results - Spring 04, Autumn 05, Spring 05, Summer 2006**

Class	Sub-Order	Family	Sub-Family	Common Name	Sp04 ###### GR1	Sp04 ###### GR3	Sp04 ###### MC1	Sp04 ###### MC2	Sp04 ###### MG7	Sp04 ###### MG2	Sp04 ###### RC2	Sp04 ###### WC2	Au 05 ###### MC1	Au 05 ###### MC2	Au 05 ###### MG2	Au 05 ###### RC2	Au 05 ###### GR1	Au 05 ###### GR3	Au 05 ###### MG7	Sp 05 ###### BC1	Sp 05 ###### MC1	Sp 05 ###### MC3	Sp 05 ###### RC3	Sp 05 ###### GR1	Sp 05 ###### GR3	Sp 05 ###### REF1	Sp 05 ###### BC2	Sp 05 ###### MG2	Sp 05 ###### MC7	Sp 05 ###### ECX2	Sp 05 ###### LC2	Sp 05 ###### MC4	Sp 05 ###### WC1	Sp 05 ###### MG1	Sp 05 ###### WC4	Su 06 ###### MC7	Su 06 ###### RC2	Su 06 ###### WCX1	Su 06 ###### ECX2	Su 06 ###### MC6	Su 06 ###### MG1	Su 06 ###### WC4	Su 06 ###### GR2	Sp 2004 N=8	Au 2005 N=7	Sp 2005 N=16	Su 2006 N=8	Total Survey N=39	% Total Survey
Insecta		Dytiscidae		Diving Beetles	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	6	7	16	7	36	92
Insecta		Elmidae		Riffle Beetles		1																																							1				1	3
Insecta		Gyrinidae		Whirligig Beetles	1	1					1							1									1																					3	1	1		5	13
Insecta		Haliplidae		Crawling Water Beetles	1	1			1		1							1	1					1	1	1		1								1		1						1	4	2	5	2	13	33
Insecta		Hydraenidae		Minute Rove Beetles						1											1	1		1							1			1													1		5		6	15
Insecta		Hydrochidae		Scavenger Water Beetles					1																											1		1			1					1		1	2	4	10
Insecta		Hydrophilidae		Scavenger Water Beetles	1	1		1	1	1		1	1	1			1	1	1	1	1				1		1				1		1	1		1			1		1	1	1	6	5	7	5	23	59
Insecta		Scirtidae		Marsh Beetles				1				1		1						1		1	1		1	1			1	1	1									1	1	1			2	1	8	3	14	36
Insecta		Ceratopogonidae		Biting Midges			1						1		1	1	1		1		1		1			1	1		1	1		1	1	1		1	1	1			1			1	5	9	4	19	49
Insecta		Chaoboridae		Phantom Midges								1																			1															1		1		2	5
Insecta		Chironomidae	Chironomina	Bloodworms		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	7	6	16	6	35	90
Insecta		Chironomidae	Orthocladiin	Bloodworms																				1	1	1				1				1													5		5	13
Insecta		Chironomidae	Tanypodinae	Bloodworms			1		1											1	1	1		1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1			2	1	14	5	22	56
Insecta		Culicidae		Mosquitoes				1		1				1			1			1	1	1				1		1			1		1											1	1		2	2	7	2	13	33
Insecta		Dixidae		Meniscus Midges											1							1																								1	1		2	5
Insecta		Psychodidae		Moth Flies																			1																										1		1	3
Insecta		Simuliidae		Black Flies		1			1															1	1																						2		2		4	10
Insecta		Stratiomyidae		Soldier Flies				1					1	1							1										1															1	2	2		5	13
Insecta		Tabanidae		March Flies																			1			1																		1				2		2	5
Insecta		Tipulidae		Crane Flies			1									1			1		1			1				1	1							1								1	2	4		7	18
Insecta		Baetidae		Mayflies	1	1	1		1	1	1	1	1			1	1	1		1			1	1	1		1	1	1		1	1		1	1	1	1	1		1			1	7	4	11	5	27	69
Insecta		Caenidae		Mayflies		1	1				1					1				1				1	1		1		1			1						1			1				3	1	6	2	12	31
Insecta		Leptophlebiidae		Mayflies		1					1					1	1						1		1		1									1	1							2	2	3	2	9	23
Insecta		Aphididae		Aphids				1					1						1																										1	1		2	5
Insecta		Coroxidae		Lesser Water Boatmen	1		1	1	1	1	1	1	1		1	1		1	1	1	1		1	1			1	1			1	1	1	1		1	1	1		1	1			7	5	10	5	27	69
Insecta		Gerridae		Water Striders	1	1														1					1	1	1																		2		4		6	15
Insecta		Hydrometridae		Water Measurers		1		1			1																		1							1					1	1		3		1	3	7	18
Insecta		Naucoridae		Creeping Water Bugs					1																				1																1		1		2	5
Insecta		Nepidae		er Scorpions/ Needle Bugs																			1			1	1													1							3	1	4	10
Insecta		Notonectidae		Backswimmers	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1					1	1		1			1	1			1	1	1	1		1			8	5	7	5	25	64
Insecta		Pleidae		Pygmy Backswimmers						1				1																						1										1	1	1		3	8
Insecta		Veliidae		Small Water Striders		1		1		1	1	1								1							1							1			1				1	1		5		3	3	11	28
Insecta		Pyralidae		Moths	1	1			1												1												1		1						1		3		2	2	7	18
Insecta		Aeshnidae		Dragonflies	1		1	1			1	1	1	1	1	1			1								1	1				1	1		1	1					1	1	1	5	5	5	4	19	49
Insecta		Cordulephyidae		Dragonflies	1				1		1																										1	1						1	3			3	6	15
Insecta		Gomphidae		Dragonflies	1	1					1							1	1	1				1		1		1	1	1									1							3	3	5	1	12	31
Insecta		Hemicorduliidae		Dragonflies	1	1	1	1	1	1	1		1	1	1	1		1	1		1			1		1	1	1		1		1	1	1		1	1		1		1		1	7	6	9	5	27	69
Insecta		Libellulidae		Dragonflies	1		1	1	1		1		1		1	1	1		1		1			1	1	1	1		1			1				1				1	1		1	5	5	7	4	21	54
Insecta		Synthemistidae		Dragonflies													1			1															1											1	2		3	8
Insecta		Telephlebiidae		Dragonflies	1						1																											1							2			1	3	8
Insecta		Coenagrionidae		Damselflies	1	1	1		1		1		1	1	1		1		1		1			1	1	1	1	1	1			1	1	1	1	1	1	1			1		1	5	5	11	5	26	67
Insecta		Lestidae		Damselflies				1				1								1										1	1		1		1						1			2		5	1	8	21
Insecta		Megapodagrionidae		Damselflies												1	1						1			1																			2	2		4	10
Insecta		Synlestidae		Damselflies																																	1											1	1	3
Insecta		Gripopterygidae		Stone Flies																				1	1																							2		2	5
Insecta		Calamoceratidae		Caddis Flies	1	1										1	1									1										1							2	2	1	1	6	15
Insecta		Ecnomidae		Caddis Flies											1			1	1	1																	1	1							3	1	2	6	15
Insecta		Hydropsychidae		Caddis Flies		1																																								1				1	3
Insecta		Hydroptilidae		Caddis Flies	1	1			1		1		1			1	1	1	1				1	1	1		1		1		1	1			1	1				1	1		4	5	8	3	20	51
Insecta		Leptoceridae		Caddis Flies	1	1	1	1	1		1		1		1	1				1			1	1	1	1	1			1		1						1	1	1	1	1	1		6	3	8	6	23	59
Insecta		Philorheithridae		Caddis Flies	1	1					1						1						1	1														1							3	1	2	1	7	18
Arachnid	Hydracarina			Freshwater Mites			1	1		1			1							1	1			1	1	1			1	1		1		1		1					1	1		3	1	9	3	16	41
Collembola				Springtails				1								1				1		1			1			1								1								1	1	4	1	7	18
Crustace	Cladocera			Water Fleas			1		1	1		1	1		1				1	1		1			1			1	1	1	1	1	1	1	1	1	1									3	11	1	15	38
Crustacea		Centropagidae		Copepods																1													1													2		2	5
Crustacea		Cyclopidae		Copepods	1	1	1	1	1	1		1	1			1	1	1	1		1	1	1	1	1	1	1	1		1	1	1		1		1						1			5	12	2	19	49
Crustacea		Atyidae		Freshwater Shrimp	1	1			1		1				1	1	1	1	1				1	1	1		1	1	1						1	1	1	1		1				4	5	7	4	20	51
Crustacea		Palaemonidae		Freshwater Prawns					1																											1								1			1	2	5
Crustacea		Parastacidae		Yabbies						1																									1										1		1		2	5
Ostracoda				Seed Shrimps	1	1	1	1	1	1		1	1				1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1			1	1	1	1		4	15	6	25	64
Hirudinea		Glossiphoniidae		Leeches		1	1						1																														1			2	1		1	4	10
Hirudinea		Richardsoniadidae							1																																							1				1	3
Oligochaeta				Freshwater Worms	1	1						1			1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1		1		1	1	1	1	3	4	14	6	27	69
Bivalvia		Sphaeriidae		Pea Shells	1	1			1			1					1	1	1				1	1	1		1		1							1				1	1		1	4	3	5	4	16	41
Gastropoda		Ancylidae		Freshwater Limpets												1				1		1									1															1	3		4	10
Gastropoda		Lymnaeidae		Freshwater Snails	1				1									1				1	1	1				1	1		1	1	1	1	1	1					1		2	1	9	3	15	38
Gastropoda		Physidae		Freshwater Snails	1	1	1		1		1	1	1	1	1	1	1	1	1		1			1	1			1	1		1	1		1	1	1				1	1	1	1	6	7	9	5	27	69
Gastropoda		Planorbidae		Freshwater Snails																																								1				1	1	3
Turbellaria		Dugesiidae		Flatworms	1		1		1			1			1	1	1	1	1		1			1	1		1	1	1	1				1	1	1			1	1	1	1	1	4	5	9	6	24	62
Amphibia				Tadpoles	1	1				1	1										1			1		1	1		1			1	1	1	1											9		9	
Amphibia		Hylidae		Green Frogs																														1											1		1	
Amphibia		Myobatrachidae		Eastern Banjo Frog																							1																		1		1	
Osteichthyes		Anguillidae		Freshwater Eel																																		1		1			1				3	3	
Osteichthyes		Eleotridae		Gudgeon		1																					1																	1			1	1	2	
Osteichthyes		Eleotridae		Cox's Gudgeon																				1																		1			1		1	
Osteichthyes		Poeciliidae		Eastern Gambusia	1	1		1	1		1	1		1	1	1	1	1	1				1	1	1		1	1	1	1					1	1	1	1	1	1			1		6	8	6	20	
Osteichthyes		Retropinnidae		Australian Smelt														1								1																		1		1	1	1	3	
Reptilia		Chelidae		Long-Necked Turtle		1																																		1		1				1			2	3	
				Duck Weed										1																																1			1	
				Cumbungi	1	1	1	1	1			1	1	1	1	1	1	1	1		1	1		1	1		1	1	1	1	1	1			1	1	1		1	1		1	1		7	11	6	24	
				Slender Knotweed		1												1						1																					1	1		2	
				Common Reed	1	1	1		1							1	1	1		1			1	1				1						1								3	4	1	8	
				Potamageton		1																		1		1					1	1					1					1			4	2	6	
				Potamageton	1	1			1		1				1	1	1	1					1	1				1						1	1	1					1		4	3	4	11	
				Charophytes	1	1							1		1		1	1		1			1	1	1		1	1			1	1		1				1		1	1		1		4	9	4	17	
				Ferny Azolla					1											1										1						1								1	1	1	3	

Appendix 8 Table 8.3.1 Aquatic Biota (Taxonomy)
Moolarben Combined Aquatic Species Survey Results - Spring 04, Autumn 05, Spring 05, Summer 2006

Phylum	Class	Sub-Class	Order	Sub-Order	Family	Sub-Family	Genus/species	Common name
Arthropoda	Insecta		Coleoptera		Dytiscidae			Diving Beetles
Arthropoda	Insecta		Diptera		Chironomidae	Chironominae		Bloodworms
Arthropoda	Insecta		Ephemoptera		Baetidae			Mayflies
Arthropoda	Insecta		Hemiptera		Coroxidae			Lesser Water Boatmen
Arthropoda	Insecta		Odonata	Epiproctophora	Hemicorduliidae			Dragonflies
Annelida	Oligochaeta							Freshwater Worms
Mollusca	Gastropoda				Physidae		*Physa acuta*	Freshwater Snails
Arthropoda	Insecta		Odonata	Zygoptera	Coenagrionidae			Damselflies
Arthropoda	Insecta		Hemiptera		Notonectidae			Backswimmers
Arthropoda	Ostracoda							Seed Shrimps
Platyhelminthes	Turbellaria		Tricladida		Dugesiidae			Flatworms
Arthropoda	Insecta		Coleoptera		Hydrophilidae			Scavenger Water Beetles
Arthropoda	Insecta		Trichoptera		Leptoceridae			Caddis Flies
Arthropoda	Insecta		Diptera		Chironomidae	Tanypodinae		Bloodworms
Arthropoda	Insecta		Odonata	Epiproctophora	Libellulidae			Dragonflies
Arthropoda	Insecta		Trichoptera		Hydroptilidae			Caddis Flies
Arthropoda	Crustacea		Decapoda		Atyidae			Freshwater Shrimp
Arthropoda	Insecta		Diptera		Ceratopogonidae			Biting Midges
Arthropoda	Insecta		Odonata	Epiproctophora	Aeshnidae			Dragonflies
Arthropoda	Crustacea	Copepoda	Cyclopoida		Cyclopidae			Copepods
Arthropoda	Arachnida		Acarina	Hydracarina				Freshwater Mites
Mollusca	Bivalvia				Sphaeriidae			Pea Shells
Arthropoda	Crustacea	Branchiopoda	Diplostraca	Cladocera				Water Fleas
Mollusca	Gastropoda				Lymnaeidae			Freshwater Snails
Arthropoda	Insecta		Coleoptera		Scirtidae			Marsh Beetles
Arthropoda	Insecta		Coleoptera		Haliplidae			Crawling Water Beetles
Arthropoda	Insecta		Diptera		Culicidae			Mosquitoes
Arthropoda	Insecta		Ephemoptera		Caenidae			Mayflies
Arthropoda	Insecta		Odonata	Epiproctophora	Gomphidae			Dragonflies
Arthropoda	Insecta		Hemiptera		Veliidae			Small Water Striders
Arthropoda	Insecta		Ephemoptera		Leptophlebiidae			Mayflies
Arthropoda	Insecta		Odonata	Zygoptera	Lestidae			Damselflies
Arthropoda	Insecta		Diptera		Tipulidae			Crane Flies
Arthropoda	Insecta		Hemiptera		Hydrometridae			Water Measurers
Arthropoda	Insecta		Lepidoptera		Pyralidae			Moths
Arthropoda	Insecta		Trichoptera		Philorheithridae			Caddis Flies
Arthropoda	Collembola							Springtails
Arthropoda	Insecta		Coleoptera		Hydraenidae			Minute Rove Beetles
Arthropoda	Insecta		Hemiptera		Gerridae			Water Striders
Arthropoda	Insecta		Odonata	Epiproctophora	Cordulephyidae			Dragonflies
Arthropoda	Insecta		Trichoptera		Calamoceratidae			Caddis Flies
Arthropoda	Insecta		Trichoptera		Ecnomidae			Caddis Flies
Arthropoda	Insecta		Coleoptera		Gyrinidae			Whirligig Beetles
Arthropoda	Insecta		Diptera		Chironomidae	Orthocladiinae		Bloodworms
Arthropoda	Insecta		Diptera		Stratiomyidae			Soldier Flies
Arthropoda	Insecta		Coleoptera		Hydrochidae			Scavenger Water Beetles
Arthropoda	Insecta		Diptera		Simuliidae			Black Flies
Arthropoda	Insecta		Hemiptera		Nepidae			Water Scorpions/ Needle Bugs
Arthropoda	Insecta		Odonata	Zygoptera	Megapodagrionidae			Damselflies
Annelida	Hirudinea				Glossiphoniidae			Leeches
Mollusca	Gastropoda				Ancylidae			Freshwater Limpets
Arthropoda	Insecta		Hemiptera		Pleidae			Pygmy Backswimmers
Arthropoda	Insecta		Odonata	Epiproctophora	Synthemistidae			Dragonflies
Arthropoda	Insecta		Odonata	Epiproctophora	Telephlebiidae			Dragonflies
Arthropoda	Insecta		Diptera		Chaoboridae			Phantom Midges
Arthropoda	Insecta		Diptera		Dixidae			Meniscus Midges
Arthropoda	Insecta		Diptera		Tabanidae			March Flies
Arthropoda	Insecta		Hemiptera		Aphididae			Aphids
Arthropoda	Insecta		Hemiptera		Naucoridae			Creeping Water Bugs
Arthropoda	Insecta		Plecoptera		Gripopterygidae			Stone Flies
Arthropoda	Crustacea	Copepoda	Calanoida		Centropagidae			Copepods
Arthropoda	Crustacea		Decapoda		Palaemonidae			Freshwater Prawns
Arthropoda	Crustacea		Decapoda		Parastacidae		*Cherax destructor*	Yabbies
Arthropoda	Insecta		Coleoptera		Elmidae			Riffle Beetles
Arthropoda	Insecta		Diptera		Psychodidae			Moth Flies
Arthropoda	Insecta		Odonata	Zygoptera	Synlestidae			Damselflies
Arthropoda	Insecta		Trichoptera		Hydropsychidae			Caddis Flies
Annelida	Hirudinea				Richardsoniadidae			
Mollusca	Gastropoda				Planorbidae			Freshwater Snails
Chordata	Amphibia							Tadpoles
Chordata	Amphibia				Hylidae		*Litoria fallax/phyllochroa*	Green Frogs
Chordata	Amphibia				Myobatrachidae		*Limnodynastes dumerilii grayi*	Eastern Banjo Frog
Chordata	Osteichthyes				Anguillidae		*Anguilla reinhardtii*	Freshwater Eel
Chordata	Osteichthyes				Eleotridae			Gudgeon
Chordata	Osteichthyes				Eleotridae		*Gobiomorphus coxii*	Cox's Gudgeon
Chordata	Osteichthyes				Poeciliidae		*Gambusia holbrooki*	Eastern Gambusia
Chordata	Osteichthyes				Retropinnidae		*Retropinna semoni*	Australian Smelt
Chordata	Reptilia		Testudines		Chelidae		*Chelodina longicollis*	Long-Necked Turtle
Aquatic Plants							*Spirodela spp*	Duck Weed
							Typha spp	Cumbungi
							Persicaria spp (mainly P. decipens)	Slender Knotweed
							Phragmites australis	Common Reed
							Potamogeton spp	Potamageton
							Potamogeton spp(tricarinatus/ sulcatus)	Potamageton
							Chara spp	Charophytes
							Azolla pinnata	Ferny Azolla

Appendix 8 Table 8.2

Moolarben Water Quality Results: Spring 04, Autumn 05, Spring 05 & Summer 06

Sub-catchment	Creek	Site	Date	Time	Depth m	Temp °C	Cond μs/cm	Sal ppt	DO %Sat	DO mg/L	Acidity pH units	Turb NTU
Moolarben Creek (above Goulburn River confluence)												
	Lagoon Creek											
		LC2	27/09/05	14:01	0.05	23.20	2148	1.10	144.2	12.2	7.84	8.2
	Ryans Creek											
		RC1	20/09/05	09:59	0.20	12.69	183	0.08	43.3	4.6	6.66	214.5
		RC2	15/12/04	14:08	0.40	22.84	272	0.12	102.9	8.8	7.18	192.4
		RC2	15/12/04	14:08	0.40	22.97	272	0.12	101.1	8.7	7.16	196.2
		RC2	18/05/05	15:02	0.05	11.41	305	0.17	89.3	9.8	8.07	22.3
		RC2	18/05/05	15:02	0.30	11.15	307	0.17	88.7	9.8	8.03	23.6
		RC2	16/01/06	16:17	0.05	25.05	285	0.12	61.5	5.1	7.63	117.3
		RC2	16/01/06	16:18	0.25	24.99	292	0.13	60.6	5.0	7.53	130.1
		RC2	16/01/06	16:18	0.50	24.95	298	0.13	59.6	4.9	7.47	113.1
		RC3	20/09/05	15:41	0.15	11.86	261	0.12	115.1	12.5	8.02	130.0
	Moolarben Creek											
		MC1	14/12/04	09:38	0.30	22.34	3271	1.76	70.0	6.0	7.12	23.3
		MC1	18/05/05	08:33	0.05	8.88	3278	1.82	43.4	5.0	8.00	10.3
		MC1	20/09/05	08:34	0.15	10.98	3908	2.11	32.1	3.5	7.37	22.6
		MC2	14/12/04	11:09	0.10	19.88	2498	1.31	26.8	2.4	7.07	26.8
		MC2	14/12/04	11:12	0.30	19.64	2561	1.35	22.1	2.0	7.05	28.7
		MC2	14/12/04	11:13	0.60	19.58	2668	1.42	17.9	1.6	7.00	34.8
		MC2	14/12/04	11:13	1.00	19.40	2914	1.56	11.2	1.0	6.94	54.7
		MC2	14/12/04	11:14	1.30	17.79	5762	3.24	7.0	0.7	6.70	24.9
		MC2	14/12/04	11:14	1.50	17.00	6505	3.69	5.3	0.5	6.66	29.4
		MC2	18/05/05	10:01	0.10	9.86	6451	3.73	0.0	0.0	7.46	71.0
		MC2	18/05/05	10:02	0.40	9.86	6461	3.73	0.0	0.0	7.44	105.3
		MC2	18/05/05	10:02	0.80	9.85	6469	3.75	0.0	0.0	7.44	72.1
		MC2	18/05/05	10:03	1.00	9.87	6481	3.76	0.0	0.0	7.43	99.9
		MC3 u/s	20/09/05	13:46	0.05	15.30	4392	2.37	94.7	9.4	7.34	2.3
		MC3	20/09/05	13:42	0.05	16.95	4969	2.70	103.8	9.9	7.48	0.0
		MC3 d/s	20/09/05	13:33	0.05	14.35	6398	3.56	23.5	2.4	6.64	27.6
		MC4	27/09/05	15:29	0.05	20.40	3041	1.60	81.9	7.3	7.63	0.0
		MC4	27/09/05	15:29	0.40	18.60	3042	1.60	80.7	7.5	7.66	0.0
		MC6	17/01/06	11:15	0.05	26.72	888	0.43	72.3	5.8	8.19	11.6
		MC6	17/01/06	11:15	1.00	26.50	916	0.43	32.2	2.6	7.78	12.4
		MC6	17/01/06	11:16	2.00	25.31	926	0.45	2.6	0.2	7.53	13.9
		MC7	15/12/04	12:03	0.20	20.88	559	0.27	45.8	4.1	7.15	21.0
		MC7	15/12/04	12:04	0.70	20.46	559	0.25	45.1	4.1	7.14	46.7
		MC7	15/12/04	12:04	1.20	20.15	557	0.26	41.6	3.8	7.14	53.2
		MC7	19/05/05	15:22	0.10	10.81	725	0.38	47.0	5.2	7.72	32.9
		MC7	26/09/05	13:29	0.50	15.55	808	0.39	57.6	5.7	7.58	52.2
		MC7	16/01/06	14:57	0.05	26.79	555	0.25	69.2	5.5	7.48	385.5
		MC7	16/01/06	14:58	0.20	24.11	584	0.27	32.8	2.7	7.08	498.3
		MC7	16/01/06	14:58	0.50	22.91	521	0.24	15.9	1.4	7.03	600.0
Middle Goulburn River (Ulan Ck to Cassilus Rd crossing)												
	Goulburn River											
		GR1	14/12/04	17:32	0.40	24.81	520	0.24	89.8	7.4	7.29	48.2
		GR1	19/05/05	13:08	0.10	12.15	1008	0.54	84.5	9.1	8.01	10.9
		GR1	21/09/05	08:35	0.50	10.25	743	0.36	87.0	9.8	7.94	16.1
		GR2	18/01/06	09:10	0.05	22.89	819	0.39	24.2	2.1	8.00	15.4
		GR2	18/01/06	09:11	0.30	22.90	824	0.39	19.8	1.7	7.85	14.3

Lower Goulburn River (below Cassilus Rd to Wollar Ck)												
	Bobadeen Creek											
		BC1	20/09/05	10:40	0.10	16.32	680	0.33	82.2	8.0	7.40	553.9
		BC1	20/09/05	10:41	0.40	11.00	627	0.30	79.6	8.8	7.51	600.0
		BC1	20/09/05	10:41	0.80	10.85	470	0.22	64.1	7.1	7.49	600.0
		BC1	20/09/05	10:42	1.10	10.92	449	0.21	55.1	6.1	7.37	600.0
		BC1	20/09/05	11:57	0.10	12.95	704	0.34	77.7	8.2	7.38	570.0
		BC1	20/09/05	11:57	0.20	12.72	698	0.34	77.9	8.3	7.36	574.4
		BC1	20/09/05	12:00	0.05	22.60	688	0.33	84.3	7.3	7.17	515.0
		BC1	20/09/05	12:01	0.20	19.58	646	0.30	81.1	7.4	7.07	579.2
BC2 d/s pool1			21/09/05	16:53	0.20	16.67	310	0.14	113.7	11.1	7.41	2.0
BC2 d/s pool2			21/09/05	16:40	0.40	15.04	303	0.14	119.5	12.0	7.67	2.5
		BC2	22/09/05	09:09	0.30	10.04	290	0.14	95.9	10.8	7.94	11.8
	Goulburn River											
		GR3	14/12/04	14:49	0.30	25.88	457	0.20	102.9	8.4	7.66	34.4
		GR3	19/05/05	09:51	0.10	10.21	515	0.28	69.0	7.7	8.53	8.5
		GR3	21/09/05	14:07	0.40	15.84	698	0.33	113.7	11.3	8.12	41.6
		REF1 u/s	21/09/05	11:13	0.10	12.41	210	0.09	100.9	10.8	8.11	48.4
		REF1	21/09/05	10:35	0.50	11.49	182	0.08	65.6	7.2	7.59	20.5
		Minimum			0.05	8.88	182.00	0.08	0.00	0.00	6.64	0.00
		Maximum			2.00	26.79	6505.00	3.76	144.20	12.50	8.53	600.00
		Mean			0.36	17.11	1619.13	0.87	59.54	5.79	7.44	132.69
		SE of Mean			0.05	0.65	232.95	0.13	4.17	0.41	0.05	23.50
		Median			0.20	16.85	698.00	0.34	60.60	5.70	7.44	34.40

Appendix Table 8.1

Modified Riparian, Channel and Environment (RCE) Inventory (after Chessman et al 1997).

	Descriptor / Category	Value	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	Site Number and Designation		LCX1	LC1	LC2	RC1	RC2	RC3	MCX1	MCX2	MC1	MC2	MC3	MC4	MC5	MC6	MC7	SH0	SH1	OC1	BOX1	BOX2	BONX1	BONX2	BNX1	BNX2	GR1	GR2	BC1	BC2	SG0	SG1	GR3	REF1	GR4	GR5
	Category	**Value**							*	*										*	*		*		*						**	**			**	**
1	Land-use pattern beyond immediate riparian zone																																			
	Undisturbed native vegetation	4																										4		4			4	4		
	Mixed native vegetation and pasture/exotics	3				3	3		3							3					3		3				3									
	Mainly pasture, crops or pine plantation	2	2	2	2			2		2	2	2	2	2	2		2	2				2		2					2							
	Urban, some vegetation	1																	1																	
	Industrial, little vegetation	0																																		
2	Width of riparian strip-of woody vegetation																																			
	More than 30 m	4					4									4											4	4		4			4	4		
	Between 5 and 30 m	3				3		3						3							3		3													
	Less than 5 m	2							2		2	2	2				2	2	2										2							
	No woody vegetation	1	1	1	1					1												1		1												
	No Vegetation	0													0																					
3	Completeness of riparian strip of woody vegetation																																			
	Riparian strip without breaks in vegetation	4														4												4					4	4		
	Breaks at intervals of more than 50 m	3																									3									
	Breaks at intervals of 10-50 m	2				2	2	2					2	2																2						
	Breaks at intervals of less than 10 m	1	1						1	1	1	1					1	1	1		1	1	1	1												
	No riparian strip at all	0		0	0										0														0							
4	Vegetation of riparian zone within 10 m of channel																																			
	Native tree and shrub species	4														4												4		4				4		
	Mixed native and exotic trees and shrubs	3	3		3	3	3	3	3		3	3	3	3			3	1	1		3		3				3		3				3			
	Exotic trees and shrubs	2																																		
	Exotic grasses/weeds	1		1						1					1							2		2												
	No vegetation at all	0																																		
5	Stream bank structure																																			
	Banks fully stabilized by trees, shrubs, concrete	4																									4	4					4	4		
	Banks firm but held mainly by grass and herbs	3			3		3	3			3	3	3	3		3			3		3	3	3	3					3	3						
	Banks loose, partly held by sparse grass, rubble	2	2	2																																
	Banks unstable, mainly loose sand or soil	1							1	1					1		1																			
	Banks actively eroding	0				0												0																		
6	Bank undercutting																																			
	None, or restricted by tree roots or man-made	4														4																	4			
	Only on curves and at constrictions	3	3		3						3								3		3		3				3	3						3		
	Frequent along all parts of stream	2		2			2	2	2			2	2	2								2		2					2	2						
	Severe; bank collapses common	1				1				1					1		1	1																		
	Total bank collapse	0																																		
7	Channel form																																			
	Deep; width:depth ratio less than 8:1	4				4	4	4			4	4	4	4			4										4	4	4	4			4	4		
	Medium; width:depth ratio 8:1 to 15:1	3	3	3					3	3												3		3												
	Shallow; width:depth ratio greater than 15:1	2			2										2	2		2	2		2		2													
	Artificial; concrete or excavated channel< 8:1	1																																		
	Artificial; concrete or excavated channel > 8:1	0																																		
8	Riffle/pool sequence																																			
	Frequent alternation of riffles and pools	4												4													4	4	4	4			4			
	Long pools with infrequent short riffles	3			3													3	3																	
	Natural channel without riffle/pool sequence	2	2	2		2	2	2	2	2	2	2	2				2				2	2	2	2										2		
	Artificial channel; some riffle/pool sequence	1																																		
	Artificial channel; no riffle/pool sequence	0													0	0																				
9	Retention devices in stream																																			
	Many large boulders and/or debris dams	4														4												4						4		
	Rocks/logs present; limited damming effect	3																									3			3			3			
	Rocks/logs present but unstable; no damming	2							2					2				2				2		2												
	Stream or channel with few or no rocks/logs	1	1	1	1	1	1	1		1	1	1	1		1		1		1		1		1						1							
	Artificial channel; no retention devices	0																																		
10	Channel sediment accumulations																																			
	Little or no accumulation of loose sediments	4																																		
	Some gravel bars but little sand or silt	3				3																						3		3				3		
	Bars of sand and silt common	2		2			2		2					2		2	2		2			2		2			2		2				2			
	Braiding by loose sediment	1	1		1			1		1	1	1	1					1			1		1													
	Complete in-filled muddy channel	0													0																					
11	Stream bottom																																			
	Mainly clean stones with obvious interstices	4																																		
	Mainly stones with some cover of algae/silt	3				3		3						3													3	3					3	3		
	Bottom heavily silted but stable	2		2	2				2		2	2	2				2		2		2		2							2						
	Bottom mainly loose and mobile sandy sediment	1	1							1					1			1				1		1					1							
	Bottom mainly loose and mobile muddy sediment	0					0									0																				
12	Stream detritus																																			
	Mainly unsilted wood, bark, leaves	4																			4		4					4								
	Some wood, leaves, etc. with much fine detritus	3															3		3											3			3	3		
	Mainly fine detritus mixed with sediment	2		2	2	2	2				2			2		2						2		2			2									
	Little or no organic detritus, mainly sandy	1	1					1	1	1			1		1			1											1							
	No organic detritus, mainly mud	0										0																								
13	Aquatic vegetation																																			
	Little or no macrophyte or algal growth	4				4	4	4	4	4					4			4			4	4	4	4					4	4			4			
	Substantial algal growth; few macrophytes	3	3	3	3						3			3			3										3	3						3		
	Substantial macrophyte growth; little algal growth	2										2	2						2																	
	Substantial macrophyte and algal growth	1														1																				
	Total cover of macrophytes plus algae	0																																		
	RCE Score		24	23	26	31	32	31	28	20	29	25	27	35	14	33	27	21	26	0	32	27	32	27	0	0	41	48	29	42	0	0	46	45	0	0
	RCE %age		46	44	50	60	62	60	54	38	56	48	52	67	27	63	52	40	50	0	62	52	62	52	0	0	79	92	56	81	0	0	88	87	0	0

Notes:

* No stream structure at all; either ploughed under or too far up the catchment to have any structure

** Sites not inspected for this study

Appendix 8 Table 8.4 Page 2 Macroinvertebrate Fauna SIGNAL Scores																									
					Sp04	Au 05	Sp 05	Su 06	Sp 05	Su 06	Sp04	Au 05	Sp 05	Sp04	Au 05	Su 06	Sp 05	Sp 05	Sp 05	Sp04	Sp 05	Su 06	Su 06	Individual SIGNAL Scores**	
Class	Sub-Order				15/12/04	19/05/05	26/09/05	16/01/06	28/09/05	17/01/06	15/12/04	18/05/05	22/09/05	15/12/04	18/05/05	16/01/06	20/09/05	21/09/05	27/09/05	15/12/04	28/09/05	17/01/06	16/01/06		
		Family	Sub-Family	Common name	MC7	MC7	MC7	MC7	MG1	MG1	MG2	MG2	MG2	RC2	RC2	RC2	RC3	REF1	WC1	WC2	WC4	WC4	WCX1	HU97	SIGNAL-2
Insecta		Dytiscidae		Diving Beetles	2	2	2	2	2	2	2	2	2		2	2	2	2	2		2	2		2	2
Insecta		Elmidae		Riffle Beetles																				8	7
Insecta		Gyrinidae		Whirligig Beetles										5										5	4
Insecta		Haliplidae		Crawling Water Beetles	2									2		2	2				2				2
Insecta		Hydraenidae		Minute Rove Beetles							5						5		5					5	3
Insecta		Hydrochidae		Scavenger Water Beetles	4			4											4					4	4
Insecta		Hydrophilidae			4	4		4	4	4	4								4	4		4		4	2
Insecta		Scirtidae		Marsh Beetles			6			6							6	6		6				6	6
Insecta		Ceratopogonidae		Biting Midges		5	5	5	5	5		5			5	5	5	5	5				5	5	4
Insecta		Chaoboridae		Phantom Midges																2					2
Insecta		Chironomidae	Chironominae	Bloodworms	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3
Insecta		Chironomidae	Orthocladiinae	Bloodworms			4										4		4						4
Insecta		Chironomidae	Tanypodinae	Bloodworms	4	4	4	4	4	4			4			4	4	4	4				4		4
Insecta		Culicidae		Mosquitoes						6	6		6					6	6			6		6	1
Insecta		Dixidae		Meniscus Midges											7		7							7	7
Insecta		Psychodidae		Moth Flies																					3
Insecta		Simuliidae		Black Flies	5																			5	5
Insecta		Stratiomyidae		Soldier Flies																				3	2
Insecta		Tabanidae		March Flies																		3			3
Insecta		Tipulidae		Crane Flies		5	5	5					5		5									5	5
Insecta		Baetidae		Mayflies	7		7	7	7		7		7	7	7	7	7			7	7		7	7	5
Insecta		Caenidae		Mayflies			5							5	5	5								5	4
Insecta		Leptophlebiidae		Mayflies				10						10	10	10	10							10	8
Insecta		Aphididae		Aphids																					*
Insecta		Corixidae		Lesser Water Boatmen	3	3		3	3	3	3	3	3	3	3	3	3		3	3			3	3	2
Insecta		Gerridae		Water Striders														7						7	4
Insecta		Hydrometridae		Water Measurers				3		3			3	3								3			3
Insecta		Naucoridae		Creeping Water Bugs	2		2																		2
Insecta		Nepidae		Water Scorpions/ Needle Bugs													3	3							3
Insecta		Notonectidae		Backswimmers	6	6	6	6		6	6			6	6	6		6	6	6			6	6	1
Insecta		Pleidae		Pygmy Backswimmers					2		2														2
Insecta		Veliidae		Small Water Striders					6	6	6			6		6				6		6		6	3
Insecta		Pyralidae		Moths	6			6	6													6		6	3
Insecta		Aeshnidae		Dragonflies		4		4		4		4	4	4	4				4	4	4	4			4
Insecta		Cordulephyidae		Dragonflies	5			5						5		5									5
Insecta		Gomphidae		Dragonflies		6	6						6	6		6	6							6	5
Insecta		Hemicorduliidae		Dragonflies	5	5		5	5	5	5	5	5	5	5	5		5	5						5
Insecta		Libellulidae		Dragonflies	4	4	4	4		4		4		4	4			4						4	4
Insecta		Synthemistidae		Dragonflies					5																5
Insecta		Telephlebiidae		Dragonflies										9		9									9
Insecta		Coenagrionidae		Damselflies	2	2	2	2	2	2		2	2	2		2		2	2		2		2	2	2
Insecta		Lestidae		Damselflies						1									1	1	1				1
Insecta		Megapodagrionidae		Damselflies											6									6	5
Insecta		Synlestidae		Damselflies												7									7
Insecta		Gripopterygidae		Stone Flies																				9	8
Insecta		Calamoceratidae		Caddis Flies											9	9								9	7
Insecta		Ecnomidae		Caddis Flies		5		5				5				5								5	4
Insecta		Hydropsychidae		Caddis Flies																				6	6
Insecta		Hydroptilidae		Caddis Flies	4	4	4	4		4				4	4		4				4			4	4
Insecta		Leptoceridae		Caddis Flies	7					7		7		7	7	7	7	7				7	7	7	6
Insecta		Philorheithridae		Caddis Flies										8	8	8	8								8
Arachnida	Hydracarina			Freshwater Mites			6	6	6	6	6							6				6			6
Collembola				Springtails				1					1		1										1
Crustacea	Cladocera			Water Fleas	*	*	*	*	*		*	*	*						*	*	*				*
Crustacea		Centropagidae		Copepods															*						*
Crustacea		Cyclopidae		Copepods	*	*		*	*		*		*		*		*	*		*		*			*
Crustacea		Atyidae		Freshwater Shrimp	6	6	6	6				6	6	6	6	6	6				6		6	6	3
Crustacea		Palaemonidae		Freshwater Prawns	4			4																	4
Crustacea		Parastacidae		Yabbies					4		4														4
Ostracoda				Seed Shrimps	*	*	*	*	*	*	*		*			*	*	*	*	*	*	*			*
Hirudinea		Glossiphoniidae		Leeches						3														3	1
Hirudinea		Richardsoniadidae		Leeches	4																				4
Oligochaeta				Freshwater Worms		2	2	2	2	2		2	2		2		2	2		2	2	2	2		2
Bivalvia		Sphaeriidae		Pea Shells	5	5	5	5		5							5			5				5	5
Gastropoda		Ancylidae		Freshwater Limpets											7									7	4
Gastropoda		Lymnaeidae		Freshwater Snails	4	4	4	4	4							4	4		4		4	4		4	1
Gastropoda		Physidae		Freshwater Snails	1	1	1	1	1	1		1	1	1	1					1	1	1		1	1
Gastropoda		Planorbidae		Freshwater Snails																				5	2
Turbellaria		Dugesiidae		Flatworms	3	3	3	3	3	3		3	3		3					3	3	3		3	2
Notes:	* represents those taxa for which SIGNAL scores do not apply, or are not available																								