Appendix 3.2 Biodiversity Assessment Marilba Hills

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POWER FOR PORTFOLIOS

Biodiversity Assessment

MARILBA HILLS PRECINCT WIND FARM

JULY 2009

nghenvironmental

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Contents

1 INTRODUCTION 1

1.1 ABOUT THIS REPORT 1

1.2 KEY ISSUES IN THE ASSESSMENT 1

2 ASSESSMENT APPROACH 3

2.1 TERMINOLOGY 3

2.1.1 Subject site and study area 3

2.1.2 Development envelope 3

2.2 DESKTOP RESEARCH AND CONSULTATIONS 3

2.3 FIELDWORK 3

2.4 ANALYSIS, ASSESSMENT AND REPORT COMPILATION 4

3 DESCRIPTION OF THE PROPOSAL 5

3.1 SITE DESCRIPTION 5

3.2 PROPOSED WORKS 5

3.3 GENERAL ENVIRONMENTAL IMPACTS 8

3.3.1 Wind farm installation impacts 8

3.3.2 Wind farm operation impacts 9

3.3.3 Wind farm decommissioning impacts 9

4 REGIONAL CONTEXT 10

4.1 REGION SCALE 10

4.1.1 Regionalisations 10

4.1.2 Vegetation 13

4.1.3 Fauna 13

4.1.4 Conservation and environmental management 14

4.2 DISTRICT SCALE 14

4.2.1 District habitat features 14

4.2.2 Conservation reserves 15

4.2.3 Corridors 16

4.3 THREATENED SPECIES AND COMMUNITIES 17

4.3.1 Threatened Species Conservation Act 1995 17

4.3.2 Environment Protection and Biodiversity Conservation Act 1999 17

5 FLORA AND ECOLOGICAL COMMUNITIES 18
5.1 METHODS 18
5.1.1 Preliminary assessments 18
5.1.2 Field survey and mapping 18
5.1.3 Survey limitations 21
5.2 SURVEY AND ASSESSMENT RESULTS 28
5.2.1 Vegetation communities 28
5.2.2 Species recorded at the subject site 33
5.2.3 Disturbance and weeds 33
5.3 SPECIES AND COMMUNITIES OF CONSERVATION SIGNIFICANCE 39
5.3.1 Online database searches 39
5.3.2 Ecological communities 39
5.3.3 Species of conservation significance 45
6 FAUNA 48
6.1 METHODS 48
6.1.1 Preliminary assessments 48
6.1.2 Field survey 48
6.1.3 Mapping 52
6.1.4 Threatened and significant species 52
6.1.5 Survey limitations 52
6.2 ASSESSMENT AND SURVEY RESULTS 53
6.2.1 Fauna habitats in the study area 54
6.2.2 Species recorded at the site 57
6.2.3 Profile of potential bird usage 60
6.3 SPECIES OF CONSERVATION SIGNIFICANCE 68
6.3.1 Online database searches 68
6.3.2 Threatened species evaluation and risk assessment 68
7 BIODIVERSITY CONSTRAINTS ANALYSIS 70
7.1 APPROACH AND METHODS 70
7.2 APPLICATION TO THE PROPOSAL 70
7.2.1 Constraining values 70
7.2.2 Constraint classes 71
7.2.3 Biodiversity constraint mapping 71
7.3 PLANNING AND MODIFYING THE PROPOSAL 72
8 IMPACT ASSESSMENT AND MITIGATION 78
8.1 CONSTRUCTION IMPACTS 78
8.1.1 Flora and ecological communities 78
8.1.2 Fauna 83
8.1.3 Cumulative impacts 85
8.1.4 Offsetting 85
8.1.5 Impact avoidance and mitigation 86

8.2 OPERATIONAL IMPACTS 88
8.2.1 Flora and ecological communities 88
8.2.2 Fauna 89
8.2.3 Cumulative impacts 106
8.2.4 Impact avoidance and mitigation 108
8.3 DECOMMISSIONING IMPACTS 110
9 CONCLUSION 112
9.1 CONSTRUCTION 112
9.2 OPERATION 112
9.3 IMPACT AVOIDANCE AND MITIGATION 113
10 ASSESSMENT PERSONNEL 114
11 REFERENCES 115

APPENDICES

APPENDIX A FLORA SURVEY RESULTS

A1. COMPOSITE SPECIES LISTS FOR EACH VEGETATION TYPE A-2
A2. REPRESENTATIVE QUADRAT RESULTS FOR VEGETATION TYPES AND TYPE VARIANTS A-7
A3. VEGETATION SURVEY SITES LOCATIONS, METHODS AND RESULTS SUMMARY A-14
A4. YASS DAISY (*AMMOBIUM CRASPEDIOIDES*) RECORDS A-17

APPENDIX B FAUNA SURVEY RESULTS

B1. FAUNA SPECIES LIST B-1
B2. FAUNA SURVEY DATA SUMMARY B-3
APPENDIX C THREATENED SPECIES EVALUATION C-1
C1. THREATENED FLORA AND ECOLOGICAL COMMUNITIES C-2
C2. THREATENED FAUNA C-9
APPENDIX D BIRD AND BAT IMPACT RISK ASSESSMENT D-1
D1. THREATENED SPECIES RISK POTENTIAL MATRIX D-1
D2. VULNERABLE BIRD GROUP RISK ASSESSMENT D-4
APPENDIX E ASSESSMENT OF SIGNIFICANCE (NSW) E-1
APPENDIX F ASSESSMENT OF SIGNIFICANCE (COMMONWEALTH) F-1
APPENDIX G MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT G-1
APPENDIX H BOX-GUM WOODLAND EEC DETERMINATION H-1
APPENDIX I YASS DAISY PROFILE I-1

APPENDIX J PHOTOGRAPHS OF THE SITE……J-1

APPENDIX K WINDFARM RISKS TO BIRDS AND BATS……K-1

MAPS

Map Set 1 – Flora and fauna survey sites 23

Map Set 2 – Ecological communities, vegetation condition and significant flora features 34

Map Set 3 – Fauna habitat and significant fauna features 63

Map Set 4 – Biodiversity constraints and project modifications 73

FIGURES

Figure 3.1 Location of the subject site 6

Figure 3.2 Wind farm development envelope and indicative locations of wind farm infrastructure 7

Figure 4.1 Yass Landscape Unit profile 12

Figure 8.1 Operating and proposed wind farms in the region 106

TABLES

Table 3-1 Wind farm infrastructure components and scale of impact 9

Table 5-1 Summary of vegetation types, survey effort and results 32

Table 5-2 Conservation status of vegetation types at the subject site 40

Table 6-1 Summary of fauna survey effort 50

Table 6-2 Weather conditions during September 2008 survey 53

Table 6-3 Microbat call detection results 59

Table 7-1 'Traffic light' constraint classes and recommended planning responses 70

Table 7-2 Key biodiversity constraints within the development envelope 71

Table 8-1 Impact areas per vegetation community 79

Table 8-2 Maximum impact areas on Box Gum Woodland EEC[1] vegetation based on condition class and constraint level 81

Table 8-3 Overall impact risk for vulnerable bird groups (bladestrike and habitat impacts) 91

Table 8-4 Impact potential for microbat species 104

1 INTRODUCTION

1.1 ABOUT THIS REPORT

This Biodiversity Assessment examines biodiversity values and likely impacts associated with a proposed wind farm in the Marilba Hills area west of Yass on the Southern Tablelands, New South Wales. The assessment has been undertaken by **ngh**environmental to support the Environmental Assessment (EA) report prepared on behalf of the proponent Epuron Pty Ltd.

The Biodiversity Assessment:

- provides a summary description of the proposed works;
- outlines the regional context of the study area in terms of biodiversity values;
- identifies, describes and maps the biodiversity values of the subject site;
- classifies and maps the constraints to development associated with biodiversity values;
- identifies species and communities of conservation significance which are present or have potential to be present at the subject site;
- identifies and assesses the significance of the potential impacts and risks associated with the proposed works in relation to biodiversity values;
- specifically assesses the risks from bladestrike and habitat impacts to bird and micro bat species, in conjunction with the bird and bat impact risk assessment (Appendix D) and specialist reports attached to the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009); and
- provides a series of recommended mitigation measures designed to reduce risks and minimise the impacts of the development on flora, fauna and ecological communities.

This Biodiversity Assessment is one of three assessments being undertaken concurrently as part of an overarching wind farm proposal encompassing sites located west of Yass at Carroll's Ridge, Marilba Hills and Coppabella Hills.

The Biodiversity Assessment is intended to meet the assessment requirements under Part 3A of the *Environmental Planning and Assessment Act 1979,* the *Threatened Species Conservation Act 1995* and the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999.*

Further background information relating to the site and the proposal is contained in the Environmental Assessment report prepared for the wind farm proposal (**ngh**environmental 2009).

1.2 KEY ISSUES IN THE ASSESSMENT

Significant biodiversity values at the subject site include:

- stands of the Box Gum Woodland Endangered Ecological Community (EEC), in a range of condition classes
- colonies of the threatened Yass Daisy and potential habitat for a further four threatened flora species
- the potential presence of 25 threatened or migratory fauna species, including 1 waterbird, 2 raptors, 11 woodland birds and 3 microbat species

- 3 threatened woodland bird species were recorded at the subject site during the survey – Superb Parrot, Diamond Firetail and Speckled Warbler
- one threatened microbat – the Eastern Bentwing Bat – was recorded at the site. A further two threatened species – the Large-footed Myotis and Yellow-bellied Sheathtail-bat – were possible call records. Further assessment is to be undertaken in relation to microbat species.

Potential risks to these biodiversity values associated with the wind farm project include:

- bladestrike and habitat impacts to birds, particularly vulnerable groups such as raptors, waterbirds, migratory species and threatened woodland species
- bladestrike, pulmonary barotrauma and habitat impacts to microbats, particularly threatened and migratory species such as the Eastern Bentwing Bat
- loss and fragmentation of Box Gum Woodland Endangered Ecological Community, and associated threatened Yass Daisy and woodland bird habitats.

The Biodiversity Assessment examines the scale, nature and significance of the risks, and concludes that the proposal would not be likely to have a significant impact on these values. A combination of avoidance, mitigation and impact offsetting would be used to ensure that the proposal meets the objective of improving or maintaining environmental outcomes.

2 ASSESSMENT APPROACH

2.1 TERMINOLOGY

2.1.1 Subject site and study area

The 'subject site' refers to all areas directly affected by the proposal. 'Direct impacts' are those that directly affect flora and fauna values, and may include trampling, pollution, vegetation clearing and soil disturbance. The term 'study area' includes the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area extends as far as is necessary to take all potential impacts into account. The use of these terms is consistent with the threatened species assessment guidelines issued by the NSW Department of Environment and Climate Change (DECC 2007b).

2.1.2 Development envelope

For a range of practical and commercial reasons, the proposed locations of the wind turbines, powerlines and access roads were not able to be precisely defined at the time of the biodiversity assessment.

The assessment has therefore been broadened to cover all parts of the site which have potential to carry this infrastructure. This 'development envelope' encompasses ridge and upper slope areas which are potentially suitable for turbine development, powerline access corridors 100 metres wide, proposed new turbine road access route corridors 50 metres wide and existing road access corridors 20 metres wide. The development envelope for the proposed Marilba Hills Precinct Wind Farm is 4140 hectares in area, and is shown on Figure 3.2.

Where relevant, the biodiversity assessment covers the range of possible impacts within the development envelope, including worst case impact scenarios. This approach is an effective precautionary response to the uncertainty regarding the positioning of wind farm infrastructure. The development envelope approach also allows finescale development planning and siting decisions to be informed by the findings of the assessment.

2.2 DESKTOP RESEARCH AND CONSULTATIONS

Information was sourced on threatened species, populations, and communities having potential to be present at the subject site and in the wider study area. Current reference books, research papers, conference papers, wind farm assessments and web search tools, databases and publications were sourced, focusing on relevant species and the study area. Several experts with local and specialist knowledge have been contacted in relation to threatened flora and fauna in the Yass district for earlier studies (**ngh**environmental 2006), and these consultations are equally relevant to the current proposal. These references are cited in relevant sections of the Biodiversity Assessment. In addition, government representatives and landholders provided relevant local information.

2.3 FIELDWORK

Site fieldwork was carried out on 16-19 September 2008, and 7 November 2008. A reconnaissance visit was undertaken on 1-3 September to obtain site information necessary to plan and design the field survey, including broad distribution of vegetation types, key physical features, potential threatened species habitats and access arrangements. Fieldwork sought to describe and measure key biodiversity attributes, assess the presence and condition of significant values and determine the nature and extent of impacts likely to result from the proposal. Field activities included general broadscale surveys as well as targeted surveys for threatened species and

communities known to be present, or with potential to be present at the site. Specific methodologies are described in relevant sections of the assessment.

2.4 ANALYSIS, ASSESSMENT AND REPORT COMPILATION

Data collected during fieldwork was analysed to determine threatened species habitat suitability, representation of vegetation types and the significance of biodiversity values present at the proposal site. Dedicated assessments of impact significance are presented for threatened species and communities, consistent with State and Commonwealth legislative requirements. In view of the potential for wind farms to impact on bird populations, a specific risk assessment for birds has also been undertaken, focusing on significant and vulnerable species. Potential impacts to microchiropteran bats are also given specific attention. A series of recommended mitigation measures to avoid and reduce impacts to flora and fauna at the site has been developed, based on identified values and potential impacts.

3 DESCRIPTION OF THE PROPOSAL

3.1 SITE DESCRIPTION

The Marilba Hills Precinct Wind Farm proposal site is located on private farmland north and south of the Hume Highway, near Conroys Gap, approximately 17 kilometres west of Yass, and 6 kilometres southeast of the village of Binalong in New South Wales (Figure 3.1). The site extends along a number of north-south oriented ridgelines over a distance of 9 kilometres in a north-south direction and eight kilometres east-west.

The wider study area is characterised by undulating to hilly terrain, mostly on volcanic geology. The proposed wind farm site is situated in the upper catchment of Jugiong Creek, which drains to the Murrumbidgee River and the Murray River.

The subject site lies within the Yass Valley Council Local Government Area, and is currently used for commercial agriculture (sheep and cattle grazing). The 15 turbine Conroys Gap Wind Farm site approved in May 2007 is located immediately south of the Marilba Hills Precinct.

3.2 PROPOSED WORKS

The proposal would involve the construction, operation and eventual decommissioning of:

- up to 66 wind turbines, each approximately 5 metres in diameter at the base, with three blades up to 56 metres long mounted on a tubular steel tower up to 100 metres high [with an overall maximum tip height of 150m;
- 33kV reticulation cabling and powerlines between wind turbines, between the turbine clusters and the Marilba Hills substation, and between this substation and the Carroll's Ridge substation;
- a substation located adjacent to the existing 132 kV transmission system;
- access tracks to the turbines for construction, operation and maintenance;
- onsite control room and maintenance facilities.

The wind farm would have a generating capacity of around 165 megawatts and an operational life of up to 30 years.

Figure 3.2 shows the location of the wind farm proposal elements and the survey area. For referencing purposes in this assessment, each of the seven discrete turbine clusters have been numbered from 1 to 7, ordered west to east.

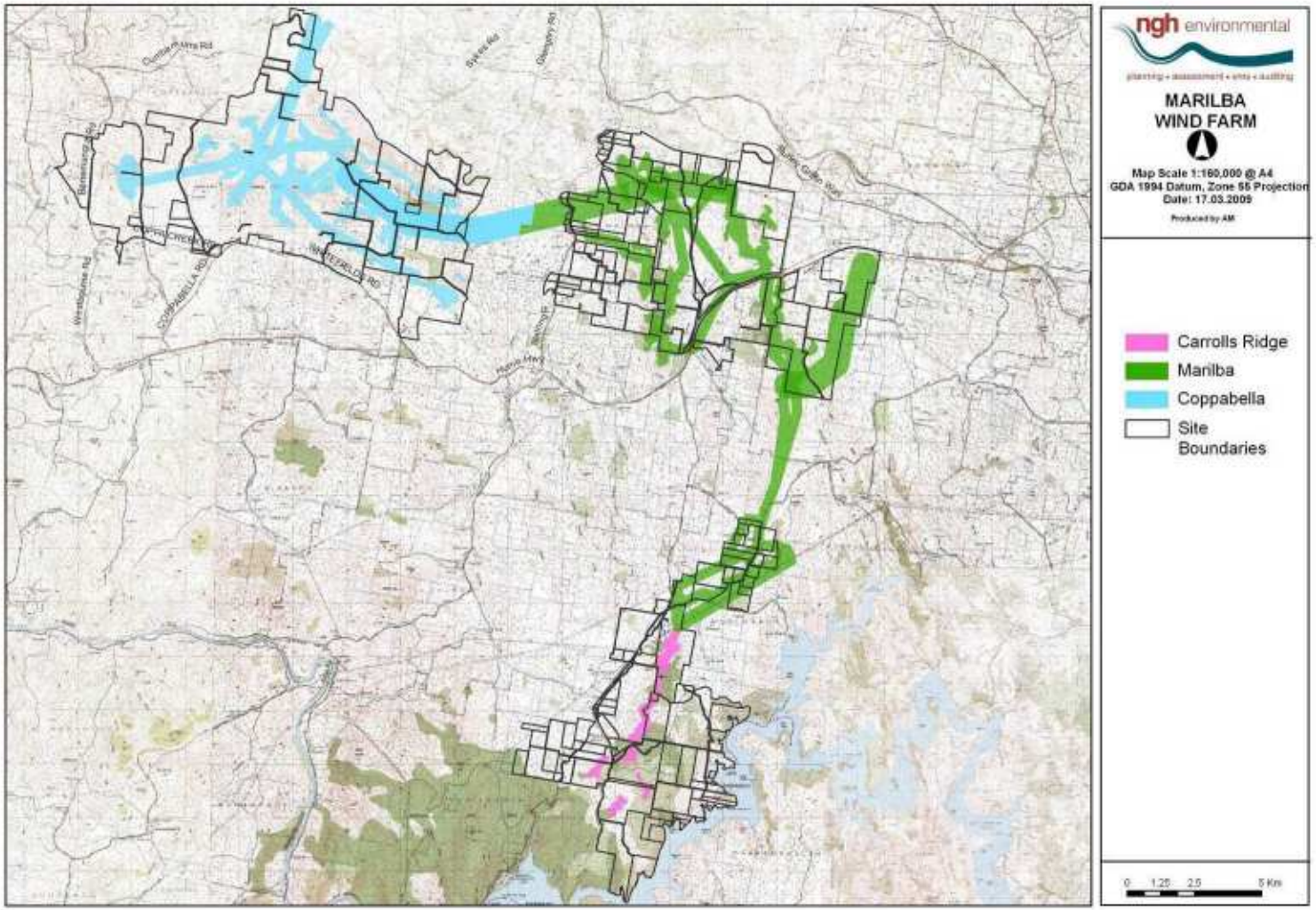


Figure 3.1 Location of the subject site

Development envelopes and site boundaries of the Marilba Hill Preceint (green), showing nearby Coppabella Hills Precinct (top left in blue) and Carrolls Ridge (pink).

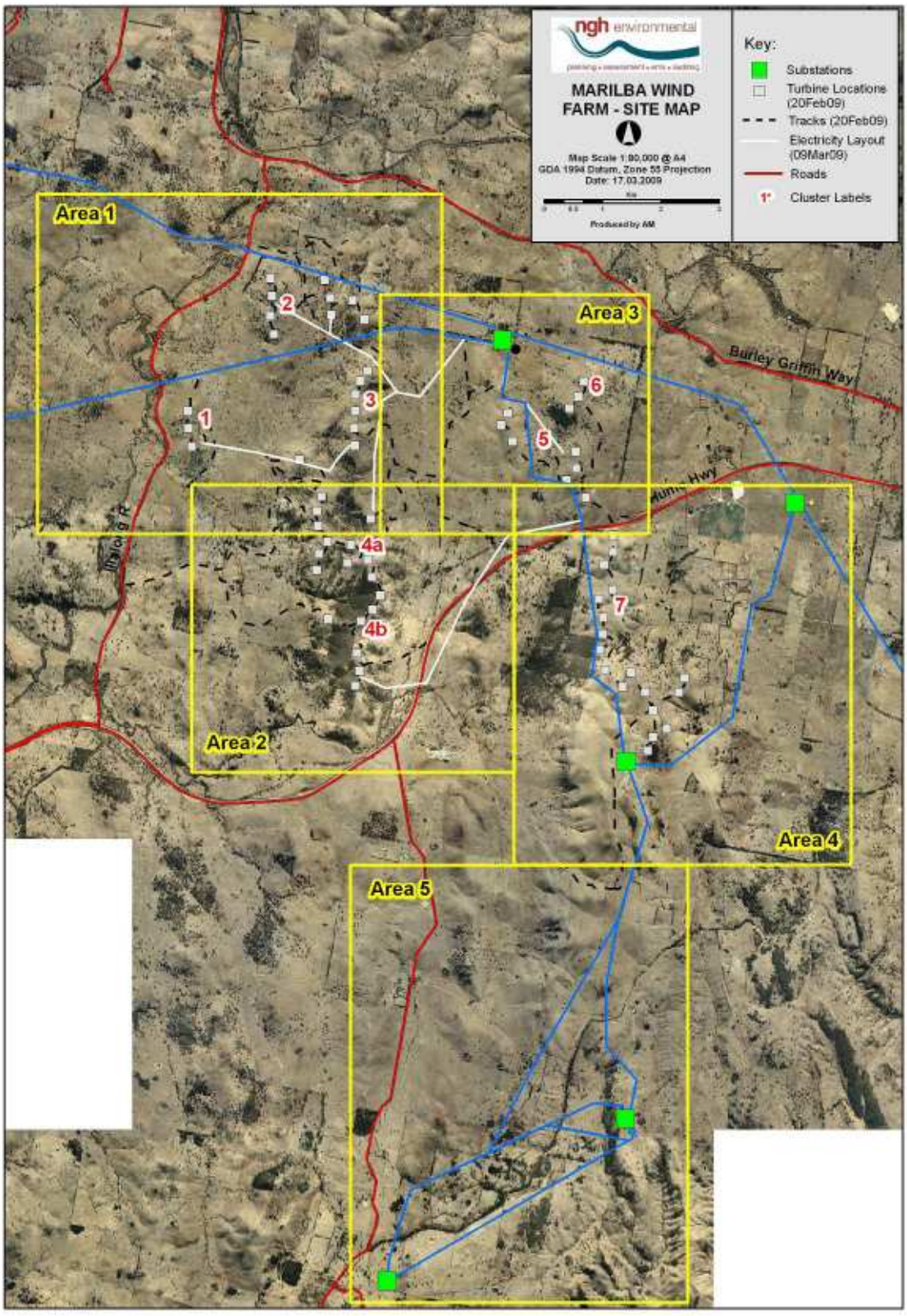


Figure 3.2 Wind farm development envelope and indicative locations of wind farm infrastructure

3.3 GENERAL ENVIRONMENTAL IMPACTS

3.3.1 Wind farm installation impacts

Vegetation clearing

Vegetation clearing would be required to construct the wind farm infrastructure – indicative land areas affected by the various elements of the proposal are provided in Table 3.1 below.

In general, underground cabling would be used to connect turbines on ridgelines, and overhead cabling would be used to transport power from clusters of turbines back to the substation. Cable trenches would, where possible, be dug within or adjacent to tracks to minimise ground disturbance. Trenches would be 1–1.5 metres deep and 0.5–1 metres wide.

The impacts on specific vegetation types, including Endangered Ecological Communities, are addressed in section 5 of the Biodiversity Assessment.

Because the turbine sites are largely situated on cleared farmland, it is assumed that clearing to provide materials and equipment laydown space would be minimal. Some branch lopping along access tracks and public roads is likely to be necessary to allow large vehicles to access the site. The significance of these losses in terms of conservation and fauna habitat values has been evaluated in sections 6 and 7 of this Biodiversity Assessment.

Water impacts

Increased sedimentation or nutrients that find their way to drainage lines can create ongoing offsite impacts. It has been assumed that large and heavy vehicles and turbine placement would not be required in close proximity to gullies and water bodies, with the exception of constructed dams located near proposed works. Some dams may need to be filled to reduce the attractiveness of the site to vulnerable bat and bird species. With this exception, water impacts are expected to be temporary, assuming the application of best practice construction and environmental protection methods.

Soils

The proposal would require upgrades to roads onsite and potentially to public roads accessing the site. This would involve some clearing as well as cut and fill and the laying of road base. Excavation would be required to establish turbine and power pole footings and to construct the substation and control buildings.

Construction facilities

A concrete batching plant and/or rock-breaking equipment would be established during the construction period to facilitate the construction of turbine footings, hard stand areas and roads. Water would be sourced offsite.

Indirect construction impacts

Noise, dust and vehicle emissions would be generated during installation activities. Appropriately managed, these impacts are expected to be temporary, confined to the 12-24 month construction period.

Table 3-1 Wind farm infrastructure components and scale of impact

This table calculates the uppermost areas of direct impact as a percentage of the development envelope (DE). Calculations are based on the indicative infrastructure layout provided by the Proponent.

Marilba Hills Precinct				
Infrastructure	**Width (m)**	**Length (m)**	**Area (ha)**	**Width (m)**
Turbine footing [a]	66.00	25.00	25.00	**4.13**
Crane hardstand [c]	66.00	22.00	40.00	**5.81**
Crane operation area (includes footing and hardstand) [c]	66.00	50.00	50.00	**16.50**
Tracks [a]	1.00	8.00	63834.46	**51.15**
Underground powerlines onsite [c]	1.00	2.00	18330.43	**3.67**
Overhead powerline cabling / easement [b]	1.00	20.00	40031.00	**80.06**
Overhead power pole footings [a]	400.31	1.00	1.00	**0.04**
Substation and control bldg [a]	5.00	150.00	85.00	**6.38**
Concrete batch plant [c]	1.00	75.00	100.00	**0.75**
Construction compound, staging and storage [c]	1.00	300.00	100.00	**3.00**
Development envelope (DE)				**4140.00**
Percentage of DE permanently removed				**1.81**
Breakdown by impact type:				
a Permanent habitat loss (includes all footings and tracks)				**74.93**
b Habitat modification (transmission easement maintenance)				**96.56**
c Temporary habitat loss (areas that can be rehabilitated post construction)				**19.79**

3.3.2 Wind farm operation impacts

The operation of the turbine would entail risks to local fauna, particularly birds and bats, in terms of collision, wind and air pressure impacts, habitat alienation, shadow flicker (when the sun is low on the horizon) and noise (including subaural or low frequency noise). Maintenance activities and vehicle access would have potential to impact soils and waterways, increase risks of weed introduction and spread and increase traffic hazards for fauna.

3.3.3 Wind farm decommissioning impacts

Decommissioning impacts are difficult to accurately determine, given that over the next 30 years, construction techniques and machinery are likely to change. In general, impacts are expected to include the following:

- removal of all above ground infrastructure, including limited excavation (concrete slabs and underground cabling would remain in situ);
- vegetation clearing/branch lopping may be required to enable access by large vehicles and for equipment/materials laydown.
- indirect construction impacts (noise, dust and vehicle emissions) confined to the decommissioning period.

4 REGIONAL CONTEXT

Regional context is important in the consideration of rarity and conservation significance, interactions between the subject site and surrounding habitats, and potential wind farm impacts which may have repercussions beyond the immediate study area.

A review of biodiversity features has been undertaken at two scales:

- region scale
  - using data compiled for established regionalisations (South-Eastern Highlands Bioregion, Southern Tablelands). Key regional attributes include the abundance, distribution and conservation status of communities and species and the presence of threats and disturbance regimes.
- district scale
  - examining an area around the proposal site over a radius of up to 30 kilometres. Species and habitat interactions within this area include foraging and breeding ranges, dispersal patterns and migration routes for fauna, and dispersal and genetic exchange opportunities for flora species.

4.1 REGION SCALE

4.1.1 Regionalisations

Interim Bioregionalisation of Australia (IBRA 5.1)

IBRA bioregions are a landscape-scale approach to land classification using a range of environmental data (Thackway and Cresswell, Environment Australia 2000). There are 17 bioregions across NSW. The study area is located close to the boundary between two IBRA bioregions; the South West Slopes Bioregion and the South Eastern Highlands Bioregion. Both bioregions capture a wide range of geophysical and biological variation.

Catchment Management Authority (CMA) regions and sub-regions

There are thirteen CMA regions in NSW, established by the State Government to manage natural resources on a catchment basis. The study area lies within the Murrumbidgee Catchment, which extends from the Great Dividing Range in the east to the confluence of the Murrumbidgee and Murray Rivers in the west near Balranald. The catchment contains a large variety of landforms and vegetation types, including alpine, montane, tableland and slopes and western plains environments. While many vegetation types in the far eastern parts of the catchment are well represented in conservation reserves, vegetation elsewhere in the region is poorly conserved (DECC 2008a). Box-Gum Woodland and Native Grassland in particular have been extensively cleared and degraded.

CMA sub-regions are based on a simplified overlay of CMA region boundaries with the draft sub-IBRA (V6) boundaries under the IBRA framework (DECC 2008a). The study area is located close to the boundary between two sub-regions; Upper Slopes to the west and Murrumbateman to the east. Upper Slopes sub-region features include Ordovician to Devonian geology, large areas of intrusive granites, steep, hilly and undulating ranges, texture contrast loams and clays grading from red subsoils on upper slopes to yellow subsoils on lower slopes, and shallow stony soils on steep slopes. Vegetation is generally open forests and woodlands (Morgan 2001 in NPWS 2003).

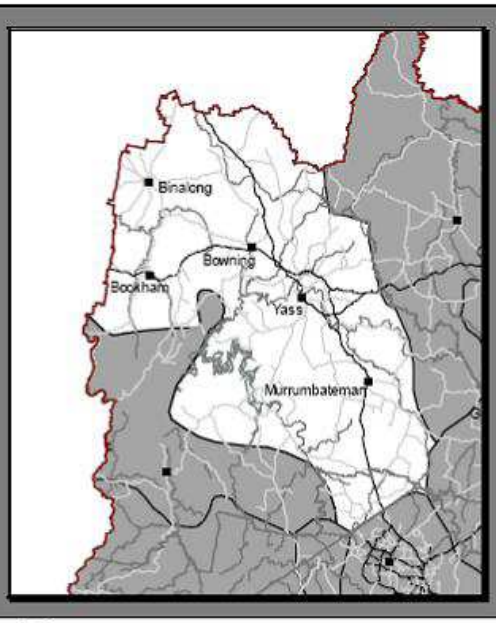
The Murrumbateman sub-region features fine-grained Palaeozoic sedimentary and metasedimentary rocks, with minor areas of coarse acid volcanics, undulating plateaus with rounded hills and peaks, entrenched meandering

streams with chain of ponds tributaries. Soils include mottled yellow and brown texture contrast soils with strongly bleached topsoils, dark organic loams and clay loams on valley floors and saline patches. Vegetation is typically box gum woodland on lower slopes, and red stringybark, bundy and white gum on ridges (Morgan 2001 in NPWS 2003).

Threatened species, populations and communities known or predicted to occur within the Bondo, Upper Slopes and Murrumbateman sub-regions of the Murrumbidgee CMA region are listed in Appendix C.

Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands

The proposal site also occurs within the Southern Tablelands region, which has been defined by the NSW and ACT Governments for the purposes of biodiversity protection and conservation planning (Fallding 2002). Within this region, the proposal site lies in the Yass Landscape Unit. Key features of the Unit are summarised in the extract in Figure 4.1. The Yass Unit is characterised by undulating country largely carrying box gum woodlands. The major land uses are cropping, grazing, rural subdivisions and urban uses, with two major transport links and water-based recreation on Lake Burrinjuck (Fallding 2002).



1. Yass Landscape Unit

Planning and management guidelines

These guidelines summarise important biodiversity information for land within this landscape unit.

The information can be used to assist in:

- **Deciding where and how to develop land**
- **Assessing development proposals**
- **Guiding management of land**

Note: Information for each unit will be updated over time

Description	Land uses
Undulating country fringed to the east by the low Mundoonan Range and in the south-west by the Murrumbidgee valley, including the Burrinjuck Reservoir. Largely occupied by extensive Box-Gum Woodlands, areas of Grassland-Woodland Mosaic and areas of Grasslands, the unit is fringed to the east and south-west by Dry Forest on the low ranges. Riparian Forests of River Red Gum and River Oak occur along the Murrumbidgee River.	Cropping, grazing, a town and several small villages, rural subdivisions, two major transport links, lake-based recreation, one medium-sized and one very small nature reserve (Mundoonan NR, Hatton's Corner NR).
Vegetation status	**Endemic features**
Dry Forests on the fringing hills remain relatively intact in the east, though are largely cleared and fragmented in the south-west. The Box-Gum Woodlands have been severely cleared or modified throughout. The Grasslands are extremely highly cleared, modified and fragmented. The Riparian Forests are similarly fragmented. Burrinjuck Dam has replaced a large area of vegetation. There are: • Several samples of Box-Gum Woodlands and Grasslands of considerable diversity, including Nanima, Coolalie, Eedy's New and Wargeila TSRs, a reserve at Yass Gorge, and Bookham and Bowning Cemeteries.	This unit contains: • The region's core nesting habitat for Superb Parrot • The region's only population of Grey-crowned Babbler • Records of vagrant Major Mitchell's Cockatoos • Records of Striped Legless Lizard and Pink-tailed Worm-lizard • The centre of distribution of Yass Daisy • A minor karst landscape within Hatton's Corner NR.
Known threatened and important species and endangered ecological communities	**Planning and management issues**
Plants: Yass Daisy, Silky Swainson-pea, Tarengo Leek Orchid (an introduced population), Australian Anchor-plant **Mammals:** Koala, Eastern Pygmy-possum, Spotted-tailed Quoll, Eastern Quoll (an old record), Eastern Bent-wing Bat, Little Pied Bat **Birds:** Blue-billed Duck, Freckled Duck, Square-tailed Kite, Australasian Bustard (an old record), Major Mitchell's Cockatoo (vagrants), Superb Parrot, Powerful Owl, Grass Owl (a vagrant), Brown Treecreeper, Grey-crowned Babbler, Hooded Robin, Speckled Warbler, Regent Honeyeater, Diamond Firetail **Reptiles and frogs:** Striped Legless Lizard, Pink-tailed Worm Lizard, Booroolong Frog **Invertebrates:** Golden Sun Moth **Vegetation communities:** Natural Temperate Grassland, White Box - Yellow Box - Blakely's Red Gum Woodland	In this unit there are: • Small areas secure within nature reserves • Major pressures from rural subdivisions around Yass and Murrumbateman • Substantial areas developed as vineyards • Major areas showing signs of former severe clearing • Substantial areas of dryland salinity • Minor areas of tree dieback • Minor infestations of Chilean Needle-grass in low areas Consists primarily of planning setting D (See Part 5 of report).

Figure 4.1 Yass Landscape Unit profile

4.1.2 Vegetation

A diverse range of vegetation communities occur across the South West Slopes and South Eastern Highlands Bioregions, varying according to topography, soils and micro-climate.

The hill country in the east of the South West Slopes bioregion typically carries Red Stringybark (*Eucalyptus macrorhyncha*) and other species on higher slopes, with White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*Eucalyptus blakelyi*) woodland occupying the lower slopes. River Red Gum (*Eucalyptus camaldulensis*) lines the larger central and western streams (NPWS 2003). There are 36 threatened flora species listed in the schedules of the TSC Act in the bioregion. Of these, 13 are endangered, 22 are listed as vulnerable and one species, *Euphrasia arguta*, is considered extinct in the bioregion (NPWS 2003).

The Southeastern Highlands has a diverse range of vegetation communities, including Yellow Box (*Eucalyptus melliodora*), Red Box (*Eucalyptus polyanthemos*) and Blakely's Red Gum (*Eucalyptus blakelyi*), with areas of white box (Eucalyptus albens) occupying lower areas. Red Stringybark (*Eucalyptus macrorhyncha*), Broad-leaved Peppermint (*Eucalyptus dives*) and White Gum (*Eucalyptus rossii*) associations dominate hills in the west of the bioregion. There are 88 species listed in the schedules of the TSC Act in the bioregion; 36 are listed as endangered, 50 are listed as vulnerable, and 2 species, *Stemmacantha australis* and *Galium australe*, are considered extinct (NPWS 2003).

In both bioregions, the box gum woodlands and natural temperate grasslands have been heavily cleared and fragmented by agricultural activities, and are listed as Endangered Ecological Communities.

Of the remnant vegetation that remains in the Southern Tablelands region (Fallding 2002), 1% is grassland, 3% is grassland-woodland mosaic, 9% is Box-Gum Woodland, 21% is dry forest, 12 % is wet forest and 0.5% is riparian forest. Box gum woodlands occupied around 23% of the region prior to European settlement. 9% of the region currently carries this community, in varying condition. Over 1200 flora species occur in the Southern Tablelands region.

4.1.3 Fauna

Sixty-seven threatened fauna species are found in the South Western Slopes Bioregion; 13 are listed as endangered and 54 are listed as vulnerable (NPWS 2003). Widespread vegetation clearing has caused a decline in woodland-dependent bird, reptile and insect populations.

Eighty-eight threatened fauna species occur in the South Eastern Highlands; 25 are listed as endangered and 63 are listed as vulnerable. Woodland bird species such as the endangered Regent Honeyeater (*Anthochaera phrygia*) have noticeably declined (Australian Terrestrial Biodiversity Assessment 2002 in NPWS 2003) as a result of landscape fragmentation. A decline in groundfeeding insectivores was recently observed in the bioregion (Australian Terrestrial Biodiversity Assessment 2002 in NPWS 2003). Protection and enhancement of woodland fragments is necessary to prevent continued loss of woodland birds. Some bird species such as the Noisy Miner (*Manorina melanocephala*), Australian Magpie (*Gymnorhina tibicen*) and Grey Butcherbird (*Cracticus torquatus*) have substantially increased, consistent with the effects of long term fragmentation (NPWS 2003).

54 mammal, 279 bird, 25 frog and 58 reptile species have been recorded in the Southern Tablelands region (Fallding 2002). The vegetation and fauna habitats over much of the region are heavily fragmented and dysfunctional. There are 54 fauna species listed as threatened in the region, including 17 mammals, 24 birds, 6 frogs and 5 reptiles. 13 fauna species have become extinct due to land use or habitat changes. There are 98 fauna species of regional conservation importance (Fallding 2002).

Waterbirds are likely to move between large waterbodies and wetland habitats at the region scale. Lake George (c. 70 kilometres south-east of the subject site), Lake Burley Griffin and associated wetlands (65 kilometres to

the south), Lake Burrinjuck (12 kilometres to the south) and major rivers in the region are likely to form part of the foraging range for several mobile waterbird species.

Seasonal wetland and swamp habitats have declined throughout the region due to increasing irrigation and water extraction from rivers, increased small dams and increased use of deep-rooted perennial pastures resulting in reduced runoff. Most wetland bird species in the region show signs of long-term decline (Reid *et al.* 2004).

4.1.4 Conservation and environmental management

About 726,530 hectares or 14.86 per cent of the South Eastern Highlands Bioregion is managed in conservation tenures. A large proportion of grassland and woodland remnants are on private lands (DEC 2005a).

The box gum woodlands and natural temperate grasslands in the Bioregion have been heavily cleared and fragmented by agricultural activities, are poorly represented in reserves and are listed as Endangered Ecological Communities. Lower elevation wetlands and riparian forests are also extensively depleted. Sites with high biodiversity value are rare, isolated and fragmented.

Key environmental management issues in the Yass Landscape Unit include dryland salinity, rural subdivision pressures around Yass and major areas showing signs of former severe clearing (Fallding 2002). The Unit consists primarily of areas likely to have limited conservation values. Roadside remnants are an important conservation resource (Fallding 2002).

The study area is located in the upper catchment of the Murrumbidgee River. It is estimated that over half of the catchment has been completely cleared of native vegetation. Some of the areas where native vegetation remains are in severely degraded condition (MCMA 2005).

4.2 DISTRICT SCALE

A district-scale review of habitats in the area was conducted with reference to aerial photography and topographic maps, vehicle-based survey results and contacts with local landholders and authorities. In particular, the locations of important wetland, woodland and forest habitat areas, and potential connectivity with the subject site were considered. The assessment was limited by air photograph quality, road access and the inability to ground-truth, but does give a broad indication of district-level habitat quality and the relative significance of habitat at the subject site.

For the purposes of this report, the district occupies an area surrounding the proposal site over a radius of 30 kilometres. Confirmed key conservation values include:

- the district forms part of the core breeding area for the Superb Parrot;
- the district is the centre of distribution for the threatened Yass Daisy;
- the district contains remnant box gum woodlands (EEC, CEEC).

4.2.1 District habitat features

Watercourses and wetlands

The permanent Illalong Creek and Jugiong Creek are located to the west of the subject site, each with sections carrying substantial tree cover. The subject site itself contains lower order drainage lines, generally with little natural vegetation cover.

The Yass River is a major watercourse running east-west and impounded by Burrinjuck Dam around 12 kilometres south of the site. The Yass River corridor and Lake Burrinjuck are likely to provide locally important habitat for waterbirds, with connectivity to the Murrumbidgee system and more significant wetlands below the

dam. The north-south oriented ridgelines and valleys provide intermittent connectivity between the subject site and Lake Burrinjuck.

Farmland surrounding the subject site is dotted with small farm dams, which provide ephemeral habitat for mobile waterbirds, but possibly at the expense of river flows and river-dependent species (Reid *et al*. 2005).

Grassland, woodland and forest remnants

No natural grassland areas were recorded at the subject site, or observed in surrounding areas during the survey. Natural grassland has been recorded at Hattons Corner Nature Reserve, near Yass.

The subject site is one of the most heavily cleared areas in the district, with the general loss of all indigenous eucalypts over large parts of the properties. Woodland remnants are largely restricted to areas with tree cover but depauperate or exotic understorey in farm paddocks. There are some highly restricted and fragmented examples of woodland understorey without tree cover in paddocks, and areas with tree cover and relatively intact understorey along watercourses (Illalong Creek, Jugiong Creek), roadsides (Black Range Road, Illalong Road, Hume Highway, Graces Flat Road) and in cemeteries (Bowning, Bookham, Galong) and Travelling Stock Reserves (such as Black Range Road to the east of the site).

Woodland remnants in the district, particularly those with tree cover, are used by a range of woodland bird species, including the threatened Superb Parrot and potentially several other threatened woodland bird species. Threatened and regionally significant plant species are also known to occur in woodland remnants in the district.

The subject site contains several small patches of remnant dry shrub forest dominated by Bundy (*Eucalyptus goniocalyx*). Remnant forest in the district is commonly associated with steep slopes and rock outcrops. In view of the general loss of native vegetation in the district, structurally and floristically intact forest remnants have at least regional conservation value. The closest large area of intact forest is Burrinjuck Nature Reserve, Burrinjuck Waters State Park and adjoining private land, which carry tableland dry sclerophyll and montane wet sclerophyll forest types.

4.2.2 Conservation reserves

The Yass Landscape Unit (Fallding 2002) contains one medium sized nature reserve (Mundoonen NR) and one very small nature reserve (Hattons Corner NR). The medium-sized Burrinjuck NR lies southwest of the unit. There are few large areas of remnant woodland or forest within 50 kilometres of the study area. Areas of montane and tableland forest are located to the south west, the closest being Burrinjuck Nature Reserve.

Burrinjuck Nature Reserve and Burrinjuck Waters State Park

Burrinjuck Nature Reserve occupies 5,250 hectares and is located 12 kilometres south-west of the study area. The reserve is contiguous with Burrinjuck Waters State Park, on the shores on Lake Burrinjuck, which has a strong recreational management focus. The dam was constructed in 1927, and raised in 1957, to supply water to the Murrumbidgee Irrigation Area. It impounds the Murrumbidgee River and the lower sections of the Yass and Goodradigbee Rivers. The area of stored water is 5,600 hectares and the shoreline is 645 kilometres in length (Yass Valley Council 2005).

Hattons Corner Nature Reserve

This small (4 hectare) karst reserve is located beside the Yass River, around three kilometres west of Yass, and fourteen kilometres east of the subject site. It is reserved principally for its geological values, but does contain an area of remnant grassland, and several ROTAP and regionally uncommon plant species (DEC 2005b).

Mundoonen Nature Reserve

Mundoonen Nature Reserve is located midway between Yass and Gunning, approximately 30 kilometres east of the study area. The reserve occupies 1,485 hectares, and together with adjoining private land forms part of a

3,000 hectare area of forests and woodland. Vegetation in the reserve is largely dry sclerophyll forest, with a small pocket of box gum woodland. Fauna of conservation significance recorded in the reserve include the Koala and Powerful Owl.

Wee Jasper Nature Reserve

Wee Jasper Nature Reserve is a 700 hectare reserve located around 30 kilometres south of the study area. Significant fauna recorded in the reserve includes the Regent Honeyeater, Gang-gang Cockatoo, White-throated Needle-tail and Eastern Bent-wing Bat.

Black Andrew Nature Reserve

This is a 1,559 hectare reserve located south of Burrinjuck, around 25 kilometres south-west of the study area. The reserve, with the Brindabella National Park and State Conservation Area, and reserves to the south, forms an almost continuous belt of forest extending to the Australian Alps. The reserve supports several dry and wet sclerophyll forest types. Disused mine shafts are used for roosting by dispersing juvenile bats, including the Eastern Bent-wing Bat. Other threatened fauna recorded in the reserve include the Yellow-bellied Glider, Powerful Owl, Barking Owl, Brown Treecreeper and the Booroolong Frog.

Brindabella National Park and State Conservation Area

The 18,472 ha National Park and recently declared 2,880 ha State Conservation Area adjoin the ACT boundary, around 40 kilometres south of the study area. The reserves carry tableland and montane forest and subalpine woodland communities. Threatened species recorded in the park include the Powerful Owl, Pink Robin, Brown Treecreeper, Gang-gang Cockatoo, Olive Whistler, Northern Corroboree Frog, Eastern Bent-wing Bat, Yellow-bellied Glider and Tiger Quoll.

Small reserves and woodland remnants

Small box gum woodland remnants are scattered throughout the Yass district, particularly along roadsides (including Black Range and Illlalong Roads), cemeteries (Bookham and Bowning Cemeteries) and Travelling Stock Reserves (Nanima, Bedulluck, Merryville, Coolalie, Eedy's, New and Wargeila TSRs) and a small reserve at Yass Gorge (Fallding 2002, Rainer Rehwinkel DECC pers. comm.). Lowland paddocks are also likely to carry remnant woodland; paddock tree density varies throughout the district and is generally low in the vicinity of the study area.

4.2.3 Corridors

Much of the sub-catchment has been cleared of woodland vegetation. Remaining remnants of substantial size (greater than 100-200 ha) are moderately rare in the landscape and linkages between these are limited to intermittent road-side and riparian corridors and smaller ‘stepping-stone’ woodland patches. Larger patches of remnant vegetation tend to occur on the steep slopes, with flats and ridges cleared for more intensive land use. The largest continuous area of forest and woodland vegetation within the district occurs to the south around Burrinjuck and Black Andrew Nature Reserve and within Bungongo, Wee Jasper, Red Hill and Bondo State Forests.

Large water bodies in the district include Lake Burrinjuck, Lake Bethungra and Lake George. The Murrumbidgee river system connects district wetland habitats including the Yass River and Lake Burrinjuck to wetlands on the slopes and inland of the Great Dividing Range. Nomadic and migratory water birds are likely to pass over the site when moving between large wetland systems.

4.3 THREATENED SPECIES AND COMMUNITIES

4.3.1 Threatened Species Conservation Act 1995

The DECC Threatened Species web-based search tool was used to identify threatened species, populations and communities listed under the NSW *Threatened Species Conservation Act 1995* which are known or predicted to occur within the Bondo, Upper Slopes and Murrumbateman sub-regions of the Murrumbidgee CMA region. The likelihood of the presence of these species, populations and communities at the subject site is evaluated in Appendix C and summarised in sections 6 and 7.

4.3.2 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Matters of National Environmental Significance reporting tool was used to identify significant species, populations and communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* within a 50 kilometre radius of the development envelope. The likelihood of the presence of these species, populations and communities at the subject site is evaluated in Appendix C and summarised in sections 6 and 7. The full search report (biodiversity components) is provided in Appendix G.

5 FLORA AND ECOLOGICAL COMMUNITIES

5.1 METHODS

5.1.1 Preliminary assessments

The survey fieldwork was preceded by a desktop assessment to identify species and communities of conservation significance which may be present in the study area. Topographic maps, air photographs, previous research and surveys and records contained in national and state databases were consulted to identify known and potential values. Predictive vegetation mapping (Fallding 2002, Thomas *et al.* 2000) was used to assess the potential for the occurrence of threatened species and communities at the site. Key web-based databases used included the Commonwealth Protected Matters search tool using a 50 kilometre buffer, Bionet and the DECC Wildlife Atlas (based on the Murrumbidgee Catchment Management Area - Upper Slopes, Murrumbateman and Bondo sub-regions).

The Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands (Fallding 2002) was also consulted for threatened species and community records in the study area and analogous habitats within the region. Habitat potential for threatened species which have been recorded in the wider Southern Tablelands region was assessed using past records and known ecological relationships.

A preliminary scoping visit was undertaken on 1-3 September 2008 to obtain site information necessary to plan and design the field survey, including broad distribution of vegetation types, key physical features, potential threatened species habitats and access arrangements.

5.1.2 Field survey and mapping

The proposed turbine development zone and some sections of the grid connection powerline route were surveyed for flora values on 16-22 September 2008. Additional areas identified as having potential threatened species habitat were surveyed on 7 November 2008. Cluster 7 was surveyed in March 2007.

Additional survey work was undertaken on 10-11 March 2009 to assess proposed powerline routes between the Coppabella and Marilba substations, and Marilba and Carroll's Ridge substations. Woodland vegetation close to Black Range Road on the Carroll's Ridge – Marilba powerline route was assessed. The Coppabella – Marilba powerline sections were assessed as follows:

- Mylora property only at two points where the route intersects farm tracks,
- At Jugiong Creek/Illalong Road crossing point
- Myrana property, where tracks intersect the route, mostly in the eastern half of the property
- Weilora property, full distance of this property was walked, to a windbreak planting on the eastern side (on the adjoining property boundary)
- The final one kilometre section at the eastern end was not assessed
- The southern section of the route on the Ryalla property was driven, from where it crosses Graces Flat Road as far as the point where it begins its ascent of the ridge to the turbine cluster.

A total of 64 person hours was spent on the vegetation component of the survey.

Survey area

The development envelope survey area totals 4140 hectares and comprises:

- ridge crests and upper slopes of 7 discrete ridges where turbine clusters are proposed for construction. These turbine clusters are numbered 1 to 7, ordered from west to east;
- proposed powerline corridors between turbine ridges, where these intersected with access routes, or crossed areas of native vegetation (as determined from aerial photography).

The survey area is shown in Map Set 1. The area included all parts of the development envelope that would potentially be directly or indirectly affected by the proposal. In addition, the periphery of existing roads and tracks at the site which may be used during construction was examined for significant or sensitive vegetation features which may be impacted by increased traffic load or road improvement works.

Stratification

Following a preliminary scoping visit to the subject site and using aerial photographs, the survey area was stratified based on individual turbine clusters, vegetation type and vegetation condition. Within the development envelope, several representative survey sites were selected in each vegetation type which sampled the range of internal variation in each type.

The survey area was stratified into the following broad vegetation types:

- box gum woodland
    - overstorey including *Eucalyptus melliodora, E. albens, E. blakelyi*
- box gum woodland derived grassland
    - diverse secondary grassland likely to be derived from box gum woodland
- Long-leaved Box dry grass forest
    - overstorey dominated by *Eucalyptus goniocalyx*
- Brittle Gum – Broad-leaved Peppermint dry grass forest
    - overstorey dominated by *Eucalyptus dives* and *E. mannifera*
- native pasture
    - low diversity grassland derived from box gum woodland and dry grass forest, with a variable exotic component.

Survey methods

A three-tiered approach incorporating plot-based, traverse and general inspection methods was used to ensure that vegetation could be characterised in detail, while providing the areal coverage required for a project of this scale. Points at the centre of the survey sites are shown in Map Set 1, and the results summarised in Table 5.1 and Appendix A. The survey methods and outputs are intended to meet the requirements of the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DECC 2004).

Quadrats

In each vegetation type, a 0.04ha standard quadrat (generally 20 metres x 20 metres) was used to survey vegetation structure and floristics, and site physical values. Examples of representative quadrat data for a range of vegetation types are presented in Appendix A.

Random meanders

Formal random meanders (after Cropper 1993) within relatively homogeneous vegetation of up to 30 minutes duration and covering up to 1 hectare were undertaken at a number of sites in each vegetation type, recording floristics, with structural and physical data. This method complements the quadrat data by improving comprehensiveness in terms of species and variation within types, and improves opportunities for detecting significant or sparsely distributed plant species.

Inspections and targeted searches

In addition to the traverse and plot-based survey sites, the majority of the subject site was inspected on foot or by vehicle during the September survey to confirm vegetation types, map the distribution of Endangered Ecological Communities (EECs) and search for threatened species. EECs and areas of natural vegetation in better condition were given particular attention. Dedicated searches in specific habitat areas were undertaken for threatened species which were assessed as having at least a moderate potential to be present at the site (refer Appendix C). A return visit on 7 November targeted areas with greatest potential to support threatened species which may not have been detectable during the September survey.

Candidate areas of heavily disturbed habitats or areas carrying mainly exotic species, such as improved pasture and cultivated paddocks, were surveyed to record species composition. Because of their low likely conservation significance, not all of these highly modified areas were inspected in detail.

Understorey condition assessment

Vegetation surveyed using quadrat, random meander and inspection techniques was rated according to a five-point condition class scale, focusing on floristic integrity in the understorey:

Poor	groundlayer dominated by exotics
Poor-moderate	groundlayer dominated by one or two native grass species, very few native forbs
Moderate	groundlayer dominated by several native grasses, native forbs present but low diversity
Moderate-good	groundlayer dominated by several native grasses with a range of native forbs
Good	high groundlayer diversity, including significant forb species.

The understorey condition classes for each survey site are presented in Appendix A and shown in Map Set 2. These classes are most relevant for vegetation types with a grassy groundcover, such as box gum woodland.

Threatened species and communities

Threatened species and communities declared under the *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were specifically targeted in the assessment. Threatened species or communities recorded in the study area, or with potential to occur there, were identified using previous survey records and a DECC Wildlife Atlas search based on the Upper Slopes, Bondo and Murrumbateman sub-regions of the Murrumbidgee Catchment Management Area. The Commonwealth online Protected Matters search tool was used to identify flora and other values in the study area listed under the EPBC Act.

The identification of the White Box, Yellow Box, Blakely's Red Gum Woodland Endangered Ecological Community (EEC) ('box gum woodland') draws on the definition provided in the Final Determination and the DECC identification guidelines for the EEC (NPWS undated). Verbal advice was sought from DECC staff (A. Treweek, R. Rehwinkel) where matters of EEC definition were problematic. A precautionary approach has been adopted where distribution and habitat information is incomplete or uncertain.

General

The identification of specific vegetation types is based on the classification developed for the Southern Region Comprehensive Regional Assessment by Thomas *et al.* (2000), updated by Gellie (2005). Botanical nomenclature follows Harden (1990-2001), except where recent taxonomic changes have occurred. Noxious weeds identified are those declared for the Southern Slopes County Council control area under the *Noxious Weeds Act 1993*. Map references locating significant vegetation features, vegetation type boundaries and noxious weeds were obtained using a hand-held 12 channel GPS unit, and are based on the GDA (new) datum. The study area is covered by the Binalong and Bookham 1:25,000 topographic map sheets (AGD datum). GDA map references can be converted to AGD datum by subtracting 113 metres from the eastings and 184 metres from the northings.

5.1.3 Survey limitations

The development envelope survey area covers around 4140 hectares, dispersed over 7 ridgelines, and powerline corridors totalling 120 kilometres in length. The envelope includes substantial buffer areas to allow for the finescale planning and flexible siting of proposal elements. While attempts were made to survey the range of environmental variation at each cluster, not every part of each cluster was able to be surveyed in detail.

Closer attention was paid to areas supporting predominantly native box gum woodland understorey and remnant forest. These areas were subjected to targeted searches for threatened species, generally in representative areas rather than the full extent of such communities. Candidate areas of pasture dominated by exotics were surveyed to record general species composition.

Specific areas that would be affected by road construction, realignment, widening or other improvement works were not well defined at the time of survey and were not surveyed in detail. Observations of EEC presence along access tracks or road verges in the general vicinity of the site were recorded but searches for threatened flora species were not made in these areas because they were generally observed to be in poor condition with very little habitat potential.

The cluster 7 site was surveyed in autumn 2007, following a dry summer and an extended drought period. Similarly, the additional survey work on 10-11 March 2009 to assess proposed powerline routes between the Coppabella and Marilba substations, and Marilba and Carroll's Ridge substations was undertaken during very dry conditions. This is likely to have depressed the frequency and visibility of drought-sensitive species and summer-flowering species such as some grasses. Many spring flowering species, including a range of terrestrial orchids and grassland lilies and daisies may also have been unrecordable during the survey period. An inspection of this cluster undertaken in spring 2008 primarily to ascertain the distribution of the Yass Daisy at the site also provided an opportunity to supplement records with spring-flowering species.

Grass seed heads were still reasonably abundant despite the dry conditions during the March surveys, so it was generally possible to determine the nature of the understorey (whether predominantly native or exotic). However, some species are certain to have been overlooked, so the assessment of vegetation condition class could be out by one condition class. That is, areas assessed as poor-moderate condition could have been moderate in some areas, but insufficient native species were detectable to be able to make this distinction.

The vegetation survey for clusters 1-6 was undertaken in early spring, following good rains about a month previously. This is likely to have introduced a strong bias toward fast-growing annual and perennial species, particularly exotic weed and pasture species. This may have masked the 'normal' representation of native perennial grasses and forbs at the site. Most grasses were not identifiable with certainty at this time, other than by dried remains of the previous season's fruiting stems, so the proportion of the cover provided by the various grass species could not be estimated with accuracy. A brief return visit to cluster 4 in November 2008 allowed some grass species and their relative abundance to be identified at this site.

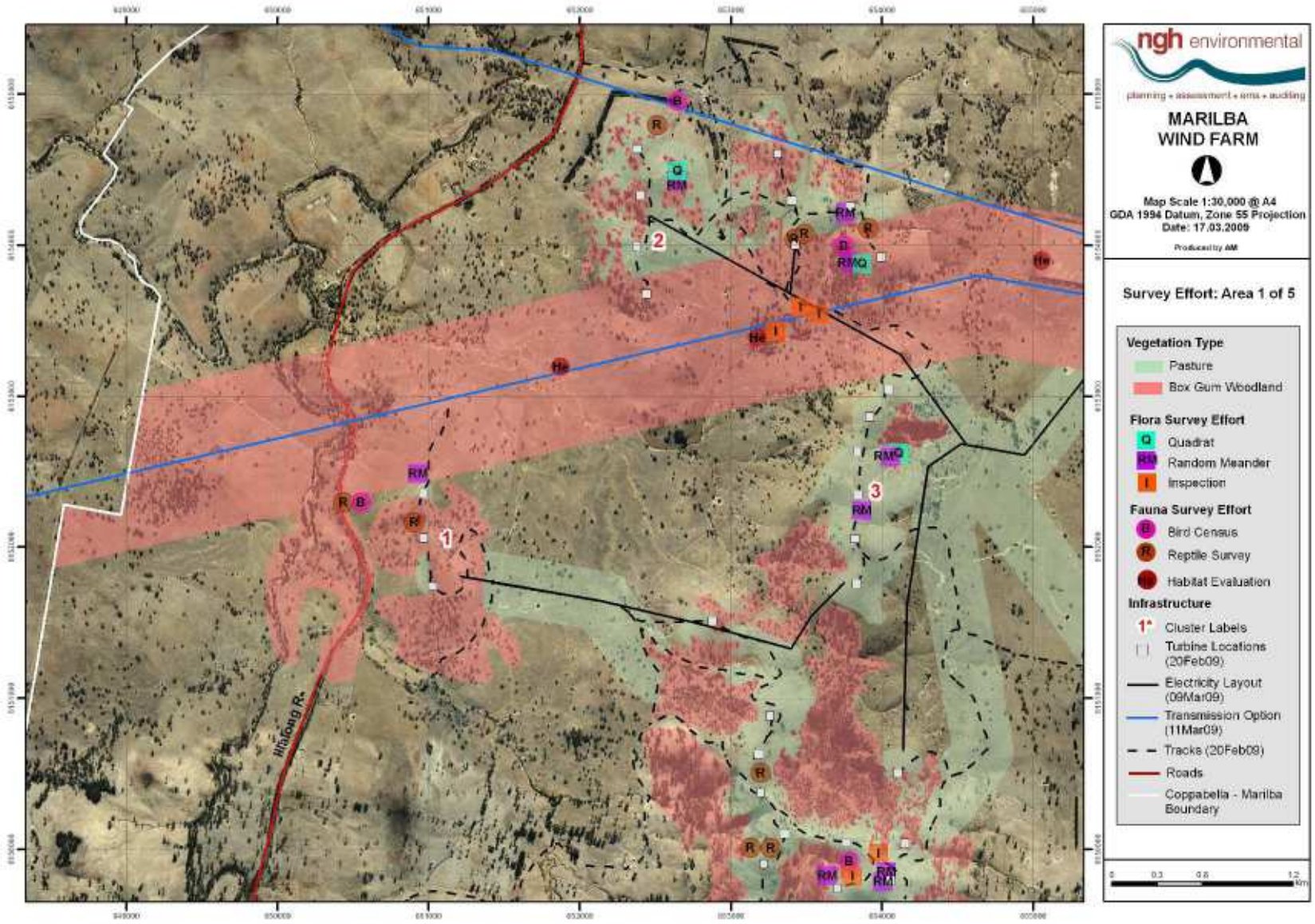
Some geophytic species (such as terrestrial orchids and lilies) which flower outside the survey periods will not have been recorded, and some species could be identified only to genus, due to lack of fertile material. Conversely, some species which are only apparent at the time of survey (e.g. *Wurmbea* spp) were abundant during the survey period but would not have been detected by a later survey. Ephemeral species which flower in response to irregular disturbance events such as fire will also have gone unrecorded. The probability of species of conservation significance having been omitted due to seasonal factors is further addressed in Appendix C.

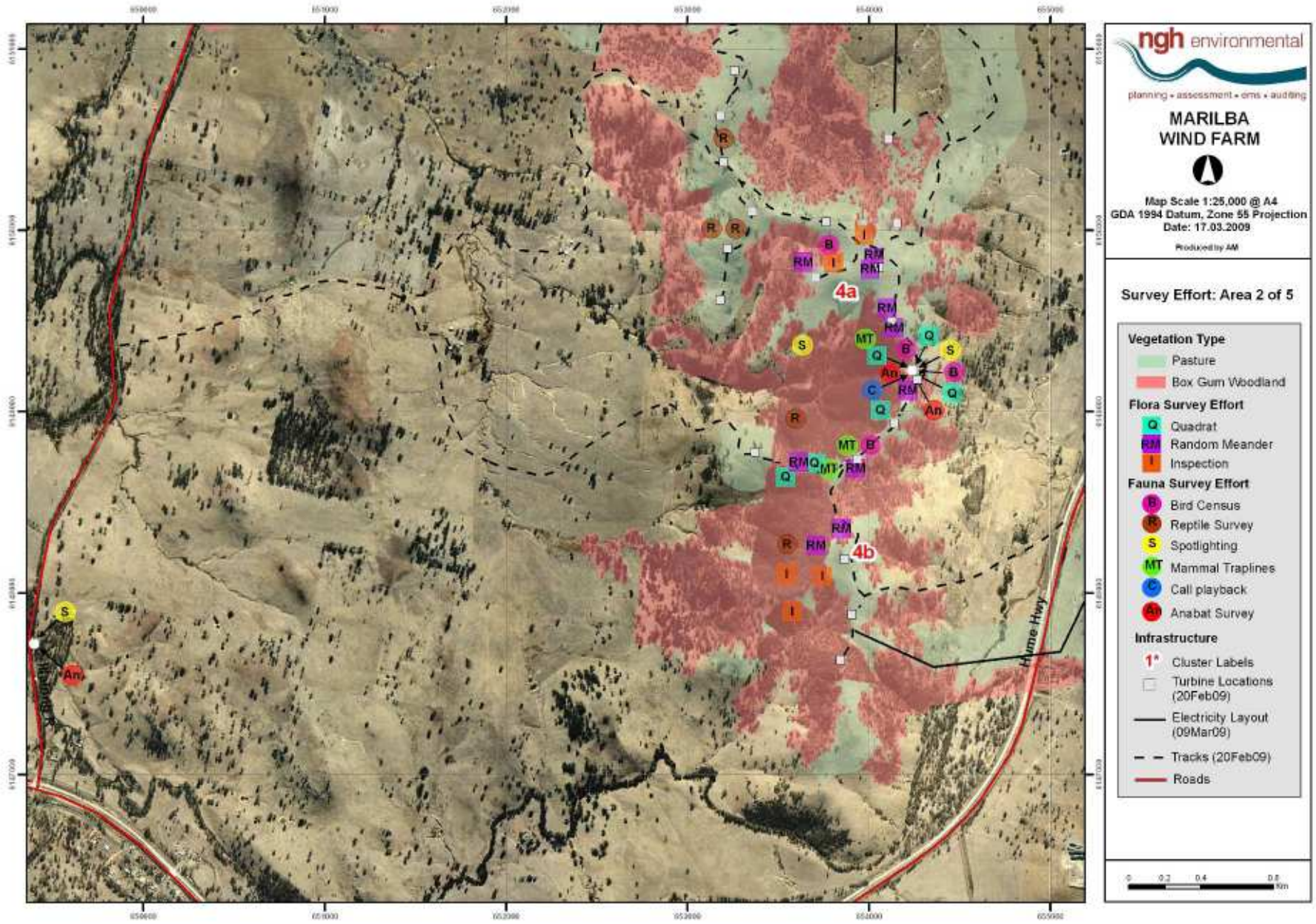
The survey of the powerline routes between substations undertaken in March 2009 was hampered by access problems due to fence and gate locations relative to the route. The proposed route was assessed at accessible locations (to which a vehicle could be driven) and some sections were walked if vehicle access was not feasible and vegetation appeared likely to be of conservation significance.

At the time of survey most of the subject site was being grazed by sheep or cattle, and this may have affected the recording of some taller or grazing-sensitive species, particularly grasses. However, the most heavily grazed areas were clearly largely composed of exotic plant species (either all exotic, or exotic forbs among native grasses), while the impact of current grazing on the steeper side slopes where the bulk of the native vegetation occurs appeared low at the time of the survey. Grazing impacts are therefore not likely to have significantly affected species detection.

In view of the known habitat requirements and distribution of threatened species which have been recorded in the region, and the degree of habitat degradation due to grazing over most of the site, it is considered unlikely that any threatened species will have been overlooked. Where some potential for unrecorded threatened species exists, this possibility is acknowledged and precautions incorporated into the impact assessment and mitigation measures.

Map Set 1 – Flora and fauna survey sites (5 maps in total)

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MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 2 of 5
Vegetation Type
Pasture
Box Gum Woodland
Flora Survey Effort
Q Quadrat
RM Random Meander
I Inspection
Fauna Survey Effort
B Bird Census
R Reptile Survey
S Spotlighting
MT Mammal Traplines
C Call playback
An Anabat Survey
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
4a
4b
Hume Hwy
Wollondilly R
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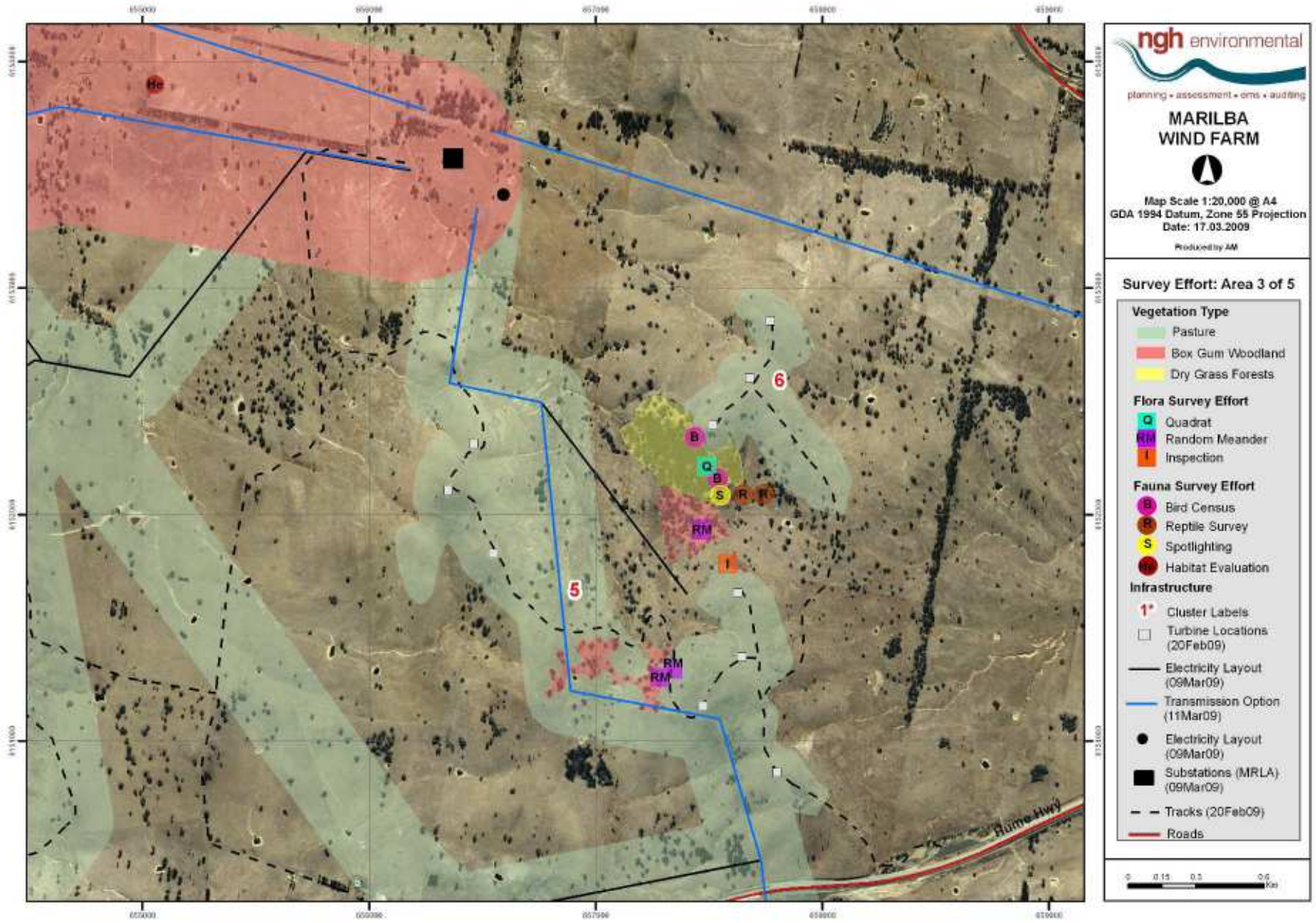
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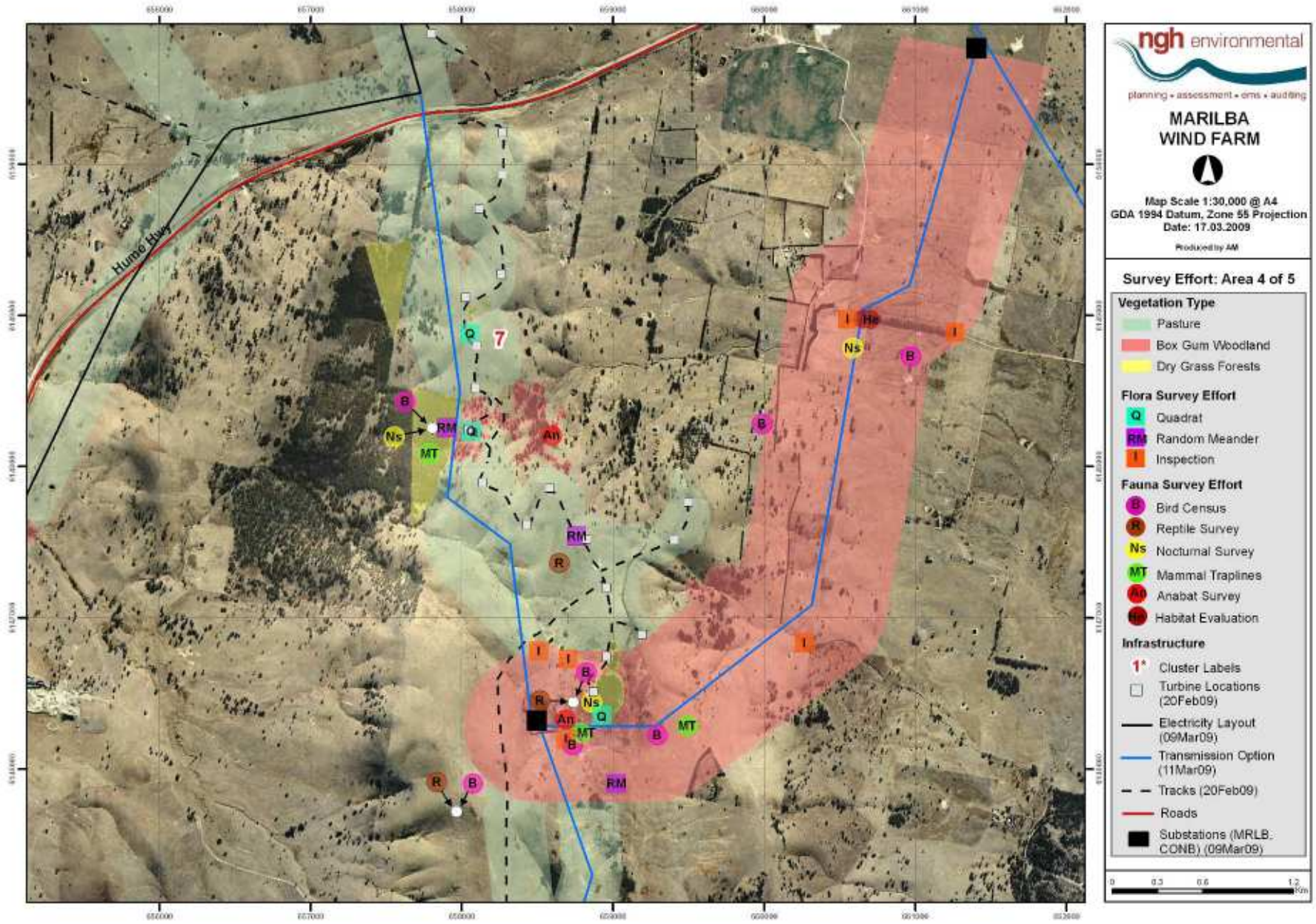
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 3 of 5
Vegetation Type
Pasture
Box Gum Woodland
Dry Grass Forests
Flora Survey Effort
Quadrat
Random Meander
Inspection
Fauna Survey Effort
Bird Census
Reptile Survey
Spotlighting
Habitat Evaluation
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
Hume Hwy
5
6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MARILBA
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Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 4 of 5
Vegetation Type
Pasture
Box Gum Woodland
Dry Grass Forests
Flora Survey Effort
Quadrat
Random Meander
Inspection
Fauna Survey Effort
Bird Census
Reptile Survey
Nocturnal Survey
Mammal Traplines
Anabat Survey
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Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substations (MRLB, CONB) (09Mar09)
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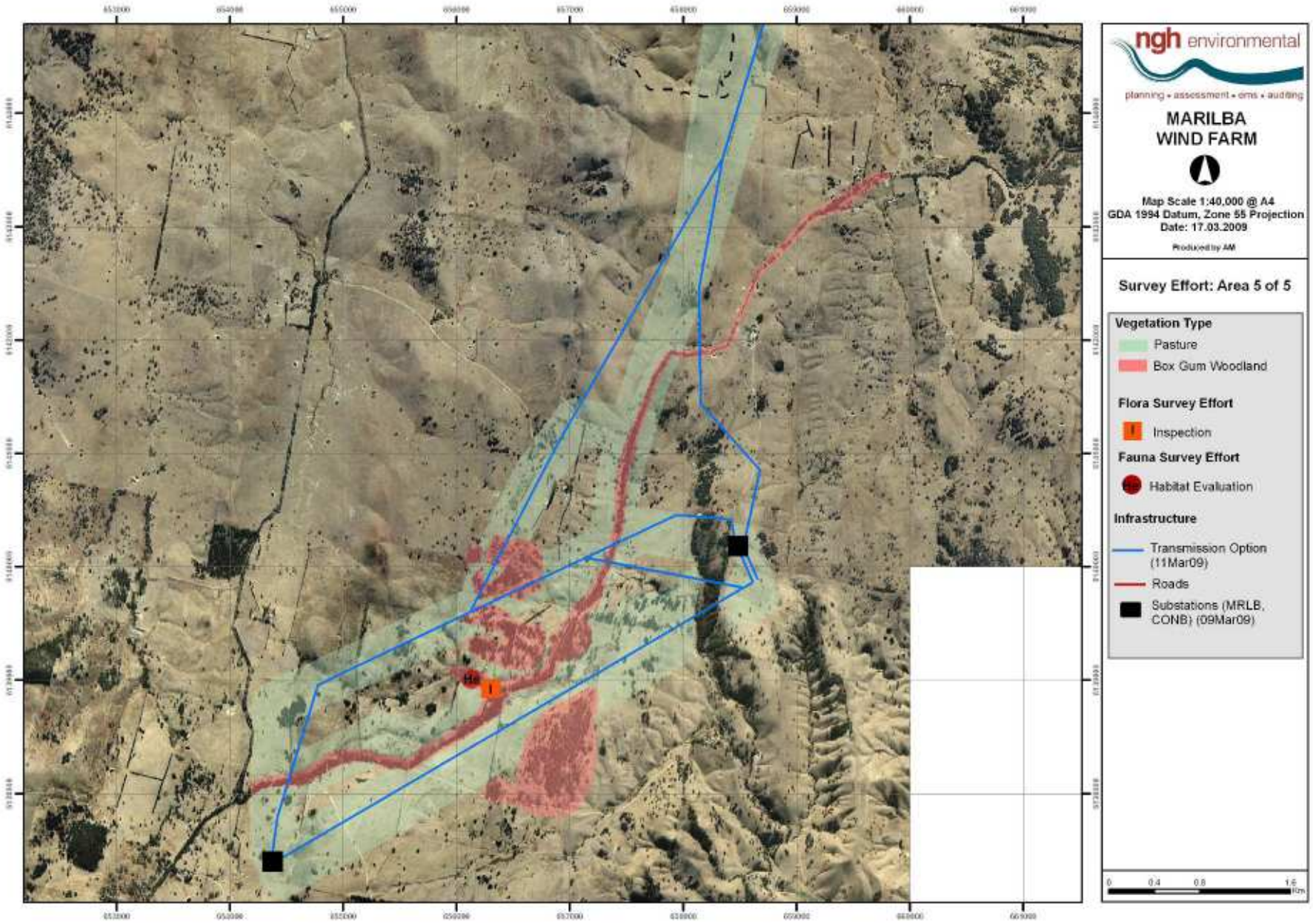
0.3
0.6
1.2
Km


ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 5 of 5
Vegetation Type
Pasture
Box Gum Woodland
Flora Survey Effort
Inspection
Fauna Survey Effort
Habitat Evaluation
Infrastructure
Transmission Option (11Mar09)
Roads
Substations (MRLB, CONB) (09Mar09)
0
0.4
0.8
1.6
Km

5.2 SURVEY AND ASSESSMENT RESULTS

5.2.1 Vegetation communities

The majority of the study area is farmland that has been cleared and grazed for many decades. These areas generally lack sufficient integrity to enable confident attribution to the Southern Region vegetation types defined by Thomas *et al.* (2000) and Gellie (2005), which are based primarily on vascular plant structure and composition. There appears to be remnant native vegetation derived from two Southern Region dry shrub/grass forest types and several box gum woodland types present in the study area. The vegetation types which most closely correspond to remnants in the study area at the site are described below. The types, their local distribution, condition range and significance are summarised in Table 5.1. The indicative distribution of these types in the survey area is shown in Map Set 2. Full diagnostic species lists and habitat information for the Southern Region CRA vegetation types mentioned are contained in Thomas *et al*. (2000) and Gellie (2005). Species recorded in the vegetation types in the survey zones, with their cover/abundance scores, are listed in Appendix A, with examples of representative quadrat results.

Box gum woodland

Vegetation was conservatively assigned to box gum woodland if Yellow Box (*Eucalyptus melliodora*), White Box *(E. albens*) or Blakely's Red Gum (*E. blakelyi)* was present, even as a minority or sub-dominant component. Vegetation dominated by Long-leaved Box (*E. goniocalyx*) was also included, since this species usually occurs in association with the box gum woodland tree species at the subject site, and has an identical grassy understorey.

Box gum woodland remnants, in varying condition are present at all cluster sites, and is the dominant vegetation on most of the ridge crests, saddles and upper slopes in the survey area. Unlike many tableland areas where this community occupies lower slopes and valley floors and is replaced by a different assemblage (usually including *E. dives* and *E. mannifera* forest) on more exposed ridge tops, at the Marilba Hills Precinct this community also occurs on ridgelines. This is possibly a result of the volcanic geology and relatively deep, fertile soils on ridges over most of the Marilba Hills study area.

The community is dominated by White Box on more exposed crests and upper slopes in the north and west of the survey area (clusters 1, 2, 3 and 4). Yellow Box is dominant on more sheltered saddles and crests, usually on sites with gentler gradients (particularly clusters 4a and 7). Blakely's Red Gum is widespread as a dominant and sub-dominant, favouring moister slopes (eg clusters 2 and 7) and is dominant in post-grazing regeneration on ridgelines in clusters 4a and 4b. Some variants are locally dominated by Red Box (*E. polyanthemos*) (cluster 4a), Red Stringybark (*E. macrorhyncha)* (cluster 4b) and Long-leaved Box (*E. goniocalyx*) (clusters 3, 4a, 5). The small tree *Allocasuarina verticillata* is dominant over much of the large remnant on the western side of cluster 4a and 4b, possibly a result of past eucalypt clearing or thinning. Dense scrubs of Burgan (*Kunzea ericoides*) occupy some moist slopes in the south of cluster 4b.

The condition of box gum woodland samples ranges from good in areas with no or low grazing pressure (cluster 4) where a range of forb species are present in the understorey, including threatened and regionally significant species, to poor on crests at sheep camps, where virtually no native understorey species remain. In these latter nutrient enriched locations, thistles, Paterson's Curse (**Echium plantagineum*) and European nettle (**Urtica urens*) tend to dominate.

Most stands however are in poor-moderate or moderate condition, with the understorey dominated by native grasses (*Austrodanthonia* spp*, Microlaena stipoides, Austrostipa scabra* ssp *falcata, Bothriochloa macra, Aristida ramosa*) with relatively low diversity of native forb species (usually including *Rumex brownii* and *Oxalis perennans*, with *Dichondra repens, Hydrocotyle laxiflora* and *Cheilanthes* spp. persisting in small numbers beneath logs and rock outcrops). *Hypoxis vaginatus, Drosera peltata, Wurmbea* spp and *Diuris chryseopsis* are

present in seepage areas. Woodland trees are generally mature, and regeneration is limited to areas with light grazing pressure (mainly cluster 4).

Small areas in moderate-good condition occur at cluster 3 and between clusters 5 and 6, and larger moderate-good areas occur at clusters 4a and 4b. Cluster 4b has an ungrazed stand in good condition (MGA 653629 6148696) comprising regenerating Blakely's Red Gum with a diverse understorey including the shrub *Pimelea treyvaudii*, the grass *Themeda triandra,* the herbs *Solenogyne dominii, Desmodium varians, Convolvulus angustissimus, Linum marginale,* the lilies *Tricoryne elatior, Dichopogon fimbriatus, Arthropodium minus* and *A. milleflorum,* the daisies *Ammobium craspedioides, Triptilodiscus pygmaeus, Vittadinia muelleri, V. cuneata, Leptorhynchos squamatus* ssp A, and the orchid *Microtis unifolia.*

Much of the native pasture in the study area is derived from the box gum woodland community, usually in depauperate form with low native forb diversity. The diverse secondary grassland near the substation site at cluster 7 is also likely to be derived from this community, although no diagnostic tree species remain at or near the site (refer below). This area is grazed as pasture but has retained considerable native species diversity.

Box gum woodland remnants are present outside the impact zone, beside Whitefields and Illalong Roads and on private property to the west, which may be available as offsets for the wind farm project. The road verge sites have a depauperate groundcover, but frequently include large old trees which provide potential threatened fauna habitat. Road woodland remnants occur on routes that may be needed to access the site for the construction and operation of the wind farm. Illalong Road has linear remnants with apparently little floristic integrity but mature trees which provide habitat and a movement corridor for local bird, bat and mammal species. The threatened Superb Parrot was observed along this road on several occasions during the survey period.

Some parts of the site may have some recovery potential if grazing pressure were reduced. Some areas, generally in saddles where native groundcover species tend to dominate more, may be capable of producing some tree regeneration and improved native groundcover diversity. Other areas, mostly heavily grazed or sheep camp areas on the highest points, seem likely to be incapable of recovery. In some dieback affected areas, trees may be too stressed to produce seed, and if grazing pressure were reduced exotic groundcovers would simply become more dominant.

There are several closely related box gum woodland vegetation types in the Thomas *et al.* (2000)/Gellie (2005) classification; Vegetation Group (VG) 116 (*E. macrorhyncha-E. blakelyi*), VG117 (E*. albens-E. blakelyi*), VG120 (*E. macrorhyncha-E. albens*), VG160 (*E. blakelyi-E. melliodora*), VG161 (*E. melliodora*) and VG163 (*E. blakelyi-E. polyanthemos*). These types share many common positive fidelity indicator species and they can be difficult to distinguish in disturbed and depauperate samples. Further, at least in the case of the box gum woodlands, the Southern Region classification is likely to be based on samples from disturbed sites and any variation in species composition may reflect past management rather than any inherent community differences. Given these identification difficulties, and since all of the types have similar conservation status, they have not been treated individually in this assessment.

Box gum woodland derived grassland

This diverse grassland community was recorded from a single site to the south-west of cluster 7, over an upper valley and low saddle area containing potential substation sites. No trees and few shrubs are present, and the groundlayer is variably dominated by the grasses *Austrodanthonia* spp*, Themeda triandra* and *Microlaena stipoides* and, in moister seepage areas, the forbs *Isotoma fluviatilis* and *Hydrocotyle peduncularis*. A wide range of native forbs are present including the threatened Yass Daisy (*Ammobium craspedioides*) and several woodland species which may be declining with woodland habitat in the region (such as *Desmodium varians, Leptorhynchos squamatus, Craspedia variabilis* and *Brachyscome* spp.). Although no box gum woodland tree species are present at the site, it is likely that the site once carried this community, given the topography and groundcover composition.

Native pasture

Most cleared parts of the study area carry a low diversity native pasture used for grazing sheep and cattle dominated by native grasses (variously *Microlaena stipoides*, *Austrodanthonia* spp., *Austrostipa* spp., *Bothriochloa macra*, *Aristida ramosa*). The diversity of grass species and native forbs varies depending on grazing intensity and disturbance history. Forbs are generally dominated by exotic weed and pasture species. A small suite of hardy native forbs persist in most areas including *Rumex brownii*, *Acaena* spp. and *Oxalis perennans.* Other native species are largely confined to rock outcrops in pasture, such as *Crassula sieberiana, Cheilanthes* spp, *Hydrocotyle laxiflora, Geranium solanderi* and *Dichondra repens*. On less disturbed moister slopes, *Drosera peltata, Hypoxis vaginata, Wurmbea* spp and *Solenogyne dominii* are present in native pasture (clusters 4a, 4b and 6). Higher diversity areas also carry *Ammobium craspedioides, Convolvulus angustissimus* and *Desmodium varians* (cluster 4a*), Leptorhynchos squamatus* ssp A (clusters 4a and 4b), *Erodium crinitum* (clusters 3 and 4a) and the orchid *Diuris chryseopsis* (cluster 6). Most native pastures appear to be derived from box gum woodland, which is the most widespread community in the study area. Some restricted areas on ridge crests are used as sheep camps and are wholly dominated by exotic forbs and grass species, including a range of agricultural weeds (refer section 5.2.6 below).

Dry grass forest types

Discrete dry grass forest remnants dominated by Long-leaved Box occur on sheltered slopes on volcanic substrates at the southern end of cluster 7. The understorey has been heavily modified by past grazing and clearing, particularly in the depletion of the shrub layer. The ground layer is dominated by a range of native grasses (*Microlaena stipoides*, *Austrodanthonia* spp., *Austrostipa* spp.) with generally low forb diversity. An exception is the remnant on the south-west side of cluster 6, which carries a relatively diverse groundcover, including the threatened Yass Daisy.

This community corresponds most closely to Vegetation Group 118: Western Slopes Dry Grass Forest in the Southern Region classification (Gellie 2005), though a number of very similar communities are described; VG 119 Western Tablelands Dry Shrub/Grass Forest, VG 121 Northern Tablelands and Slopes Dry Shrub/Grass Forest and VG 122 Northern Tablelands and Slopes Dry Shrub/Grass Forest. All of these types include several positive indicator species found on Marilba Hills sites. The conservation status of each of these types is identified in Table 5.2 below.

Key diagnostic species for VG 118 present at Marilba Hills include the trees *Eucalyptus goniocalyx, E. macrorhyncha* and occasionally *E. blakelyi* or *Allocasuarina verticillata,* the shrub *Hibbertia obtusifolia,* the forbs *Gonocarpus tetragynus, Wurmbea dioica, Senecio tenuiflorus* and *Hydrocotyle laxiflora* and the grasses *Microlaena stipoides, Elymus scaber* and *Austrodanthonia* spp. All these species are also typical of box-gum woodland, with which dry shrub/grass forest intergrades at the subject site. Examples of VG 118 which have a diverse grassy understorey may be included in the box gum woodland EEC/CEEC.

Another more distinctive dry shrub/grass forest assemblage occurs mainly as a single stand on sedimentary geology in the far south of cluster 7. This community is dominated by Brittle Gum (*E. mannifera*) and Broad-leaved Peppermint (*E. dives*) with a minimal shrub layer (scattered *Hibbertia obtusifolia*), grassy groundlayer dominated by *Joycea pallida, Poa sieberiana* and *Aristida ramosa* and forbs including *Stellaria pungens*. This community belongs to Vegetation Group 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest (*E dives - E. mannifera*). Key positive indicator and diagnostic species present at the site include the trees *Eucalyptus mannifera, E. dives* and *E. macrorhyncha*, the shrubs *Hibbertia obtusifolia*, the forbs *Senecio tenuiflorus*, *Gonocarpus tetragynus* and *Hydrocotyle laxiflora*, the grasses *Joycea pallida* and *Poa sieberiana* and the graminoid *Lomandra filiformis* ssp *coriacea*.

Dry forest vegetation on a low granitic escarpment within the Carroll's Ridge – Marilba powerline envelope is attributed to a related vegetation type; Vegetation Group 14: Tablelands Dry Shrub/Tussock Grass Forest (*E. goniocalyx*). This area was surveyed for the Conroys Gap Wind Farm proposal in 2006 (**ngh**environmental 2006).

Lowland box gum woodland, riparian woodland and exotic pasture

The vegetation occupying the lowlands surrounding the clusters, and over much of the proposed powerline routes, is derived from a box gum woodland dominated by Yellow Box and Blakely's Red Gum. Modified remnants are present along roadsides (eg Grace's Flat Road, Illalong Road) and watercourses and in the form of remnant mature paddock trees. In many arable lowland paddocks, soils have been cultivated and fertilised and the understorey has been replaced with exotic pasture, fodder and weed species. Mature trees in paddocks may have high fauna conservation value, particularly those providing hollows for nesting birds and bats.

A riparian community dominated by River Red Gum (*E. camaldulensis*) with occasional Apple Box (*E. bridgesiana*) is present along Illalong Creek to the west. It could be impacted by powerlines or, in areas where creeks cross or run close to access roads, tree-lopping during the construction period to allow large components such as turbine blades to be transported to the sites. Because of its inherent fertility, and impacts arising from clearing, grazing, erosion, sedimentation, and disruption to flow regimes, the riparian habitat has been extensively colonised by exotic pasture grasses and weeds. This community falls within a single vegetation type VG 43 Western Slopes Riparian Moist Sedge Forest/Woodland. It occurs in Travelling Stock Reserve No. 38 on Illalong Road, west of the Marilba Hills Precinct, and various points along Illalong Road where the creek closely approaches the road.

Table 5-1 Summary of vegetation types, survey effort and results

Vegetation Group (VG) (Gellie 2005)	Overstorey dominants	Turbine clusters	Landforms	Survey effort	Condition class range		
					Class	Survey sites	Area[1] within envelope (ha)
Box gum woodland							
Several closely related types likely to be present: VG 116 (*E. macrorhyncha-E. blakelyi*), VG 117 (E. *albens-E. blakelyi*), VG 120 (*E. macrorhyncha-E. albens*), VG 160 (*E. blakelyi-E. melliodora*), VG 161 (*E. melliodora*) and VG 163 (*E. blakelyi-E. polyanthemos*).	Variably *Eucalyptus melliodora, E. albens, E. blakelyi, E. goniocalyx , E. polyanthemos, E. macrorhyncha* and *Allocasuarina verticillata.*	1, 2, 3, 4, 5, 7 Also dominant in adjacent lowland areas, generally in a more highly modified condition	Ridge crests, saddles, gentler slopes and valleys, on volcanics and sediments, all elevations	Quadrats: 10 Random meanders: 14 Inspections: 6	Poor Poor-moderate Moderate Moderate-good Good	6 sites 1 site 11 sites 10 sites 2 sites	497.68 777.31 286.29 232.01 9.09
Box gum woodland derived grassland							
Likely to be derived from one of the box gum woodland types.	*Austrodanthonia* spp, *Themeda triandra*	7	Upper valley and saddle (near substation site)	Quadrats: 0 Random meanders: 1 Inspections: 2	Poor Poor-moderate Moderate Moderate-good Good	- - - - 3 sites	- - - - 21.13
Native pasture							
Mostly derived from box gum woodland types (refer above), some limited areas from dry shrub/grass forest types (VG 122, VG 109)	*Austrodanthonia* spp, *Microlaena stipoides, Austrostipa scabra* ssp *falcata, Aristida ramosa* Exotic component variable – dominant in limited sheep camp areas on ridge crests.	Widespread at all clusters	The dominant type on cleared ridges, saddles and slopes. Also dominant in valley areas with no cultivation history.	Quadrats: 0 Random meanders: 6 Inspections: 1	Poor Poor-moderate Moderate Moderate-good Good	- 4 sites 2 sites 1 site -	2182.74
Long-leaved Box dry grass forest							
VG 118 (*E macrorhyncha - E. goniocalyx* –) on steeper slopes on volcanic soils	*E. goniocalyx*	clusters 4, 6 and 7	Steeper sideslopes, particularly sheltered aspects	Quadrats: 1 Random meanders: 1 Inspections: 0	Poor Poor-moderate Moderate Moderate-good Good	- - 1 site 1 site -	- - 14.72 2.05 -
Broad-leaved Peppermint – Brittle Gum dry grass forest							
VG 109 (*E dives - E. mannifera*) on metasediments in the far south of the site.	*E. mannifera – E- dives*	cluster 7	Rocky ridge crest and upper slope	Quadrats: 2 Random meanders: 0 Inspections: 0	Poor Poor-moderate Moderate Moderate-good Good	- 1 site 1 site - -	- 0.81 8.10 - -

[1] estimates based on air photo interpretation and extrapolation from field survey

5.2.2 Species recorded at the subject site

A full list of species recorded in the four vegetation types present at the subject site, and their cover/abundance, is provided in Appendix A. This list is not exhaustive due to the extensive nature of the survey area, and the omission of some species which flower or are only recordable outside the survey periods.

5.2.3 Disturbance and weeds

Forests and woodlands in the study area have been progressively ring-barked and felled over the past century to provide pasture. Many lowland areas have been repeatedly ploughed, seeded and fertilised to provide improved pasture. Clearing and agriculture has produced a range of direct and indirect impacts to flora habitats, including altered microclimate, loss of pollinator and dispersal fauna, sheet erosion of soils, watercourse bed incision and damming, localised sedimentation, elevated soil nutrients and rising saline groundwater. Gully erosion in drainage lines is widespread and active in some parts of the subject site. Salinity-related tunnel erosion is active around cluster 2.

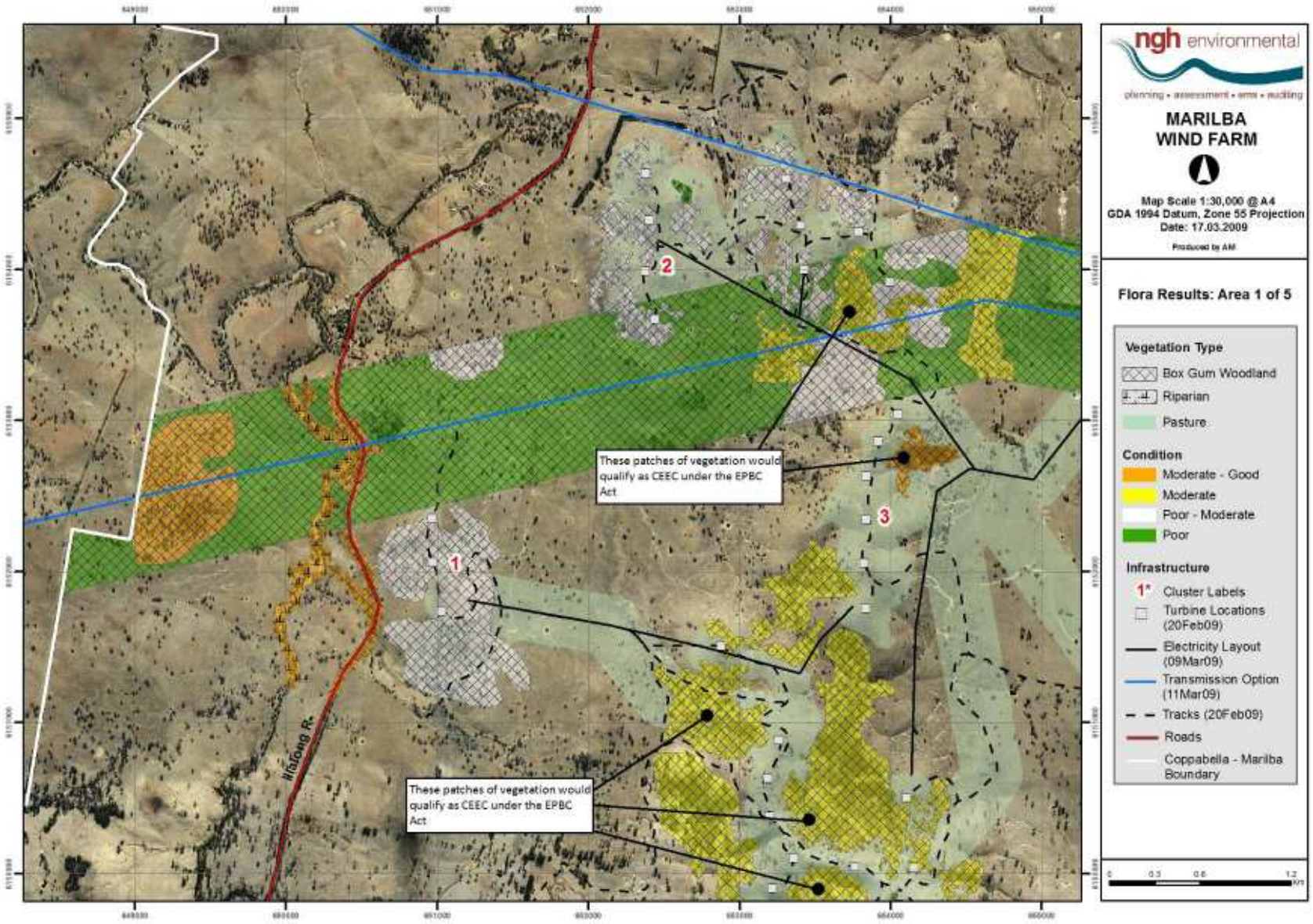
Agricultural activities have also resulted in the colonisation of a range of introduced plant species, with greatest displacement of natives occurring in moister, more fertile valley floor areas and areas subjected to pasture improvement and cultivation. In many areas, grazing is likely to have reduced or eliminated selectively grazed or grazing sensitive species, such as Kangaroo Grass (*Themeda triandra*), terrestrial orchids, wattles and pea shrubs.

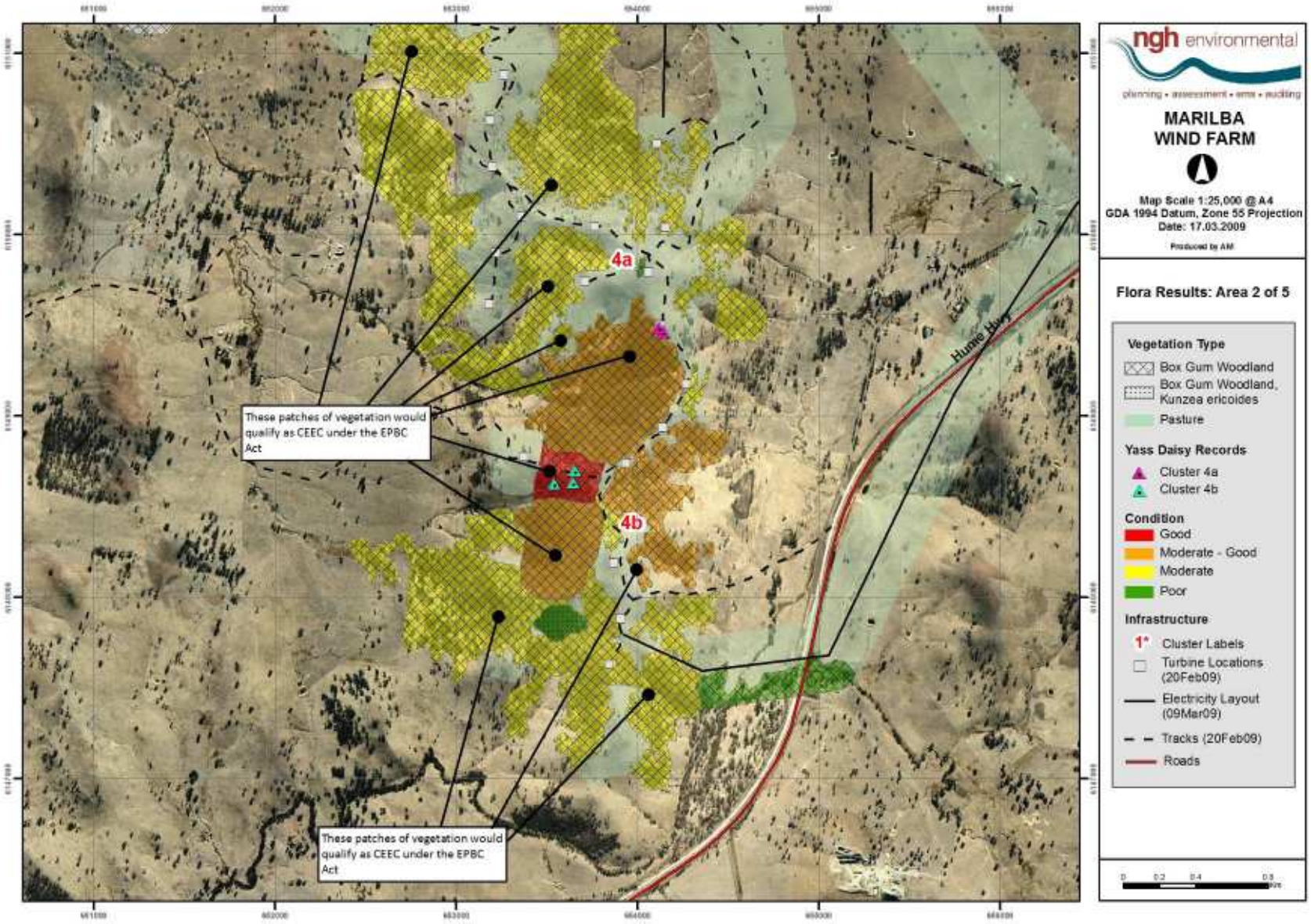
The study area carries a variable proportion of exotic weed and pasture species, ranging from less than one quarter of total herbaceous cover (especially parts of clusters 3, 4, 6 and 7) to almost total displacement of native species. The major exotic species are grasses (**Lolium perenne*, **Hordeum leporinum*), clovers (**Trifolium* spp), asteraceous weeds (Capeweed, thistles), Storksbills (**Erodium* spp), Paterson's Curse (**Echium plantagineum*) and Sheep Sorrel (**Acetosella vulgaris*). In heavily grazed and sheep camp areas on some ridge crests, asteraceous weeds such as Capeweed and thistles (*Carduus* spp*, Onopordum* spp*, Silybum marianum, Carthamus lanatus*), Paterson's Curse (*Echium plantagineum*) and European Nettle (*Urtica urens*) dominate. In less disturbed areas with a tree canopy the most common exotic species at the time of the survey were annuals, particularly Chickweed (**Stellaria media*) and Quaking Grass (**Briza maxima*). These areas would probably appear less weedy later in the season, when these species have seeded and disappeared.

Eight weeds listed as noxious for the Southern Slopes County Council control area under the *Noxious Weeds Act 1993* were recorded in the survey area; Paterson's Curse (*Echium plantagineum*), Horehound (*Marrubium vulgare*) – clusters 1, 2, 4a, 4b, 5, Scotch Thistle (*Onopordum acanthium*) – clusters 1, 2, 3, 4a, 6, St John's Wort (*Hypericum perforatum*) – cluster 4b, Serrated Tussock (*Nassella trichotoma*) – cluster 7, Sweet Briar (*Rosa rubiginosa*) – clusters 4a and 7, Blackberry (*Rubus fruticosus* sp. agg.) – cluster 7 and Yellow-flowered Devil's Claw (*Ibicella lutea*) – a single old fruit at cluster 4a. These records are drawn from vegetation survey site data and opportunistic sightings and are not likely to be exhaustive.

These noxious weed species are listed as Class 4 weeds. The control objective for Class 4 weeds is to minimise the negative impact of those plants on the economy, community or environment of New South Wales. The growth and spread of class 4 weeds must be controlled according to the measures specified in a management plan published by the local control authority.

Map Set 2 – Ecological communities, vegetation condition and significant flora features (5 maps in total)




4a
4b
These patches of vegetation would qualify as CEEC under the EPBC Act
These patches of vegetation would qualify as CEEC under the EPBC Act
Hume Hwy
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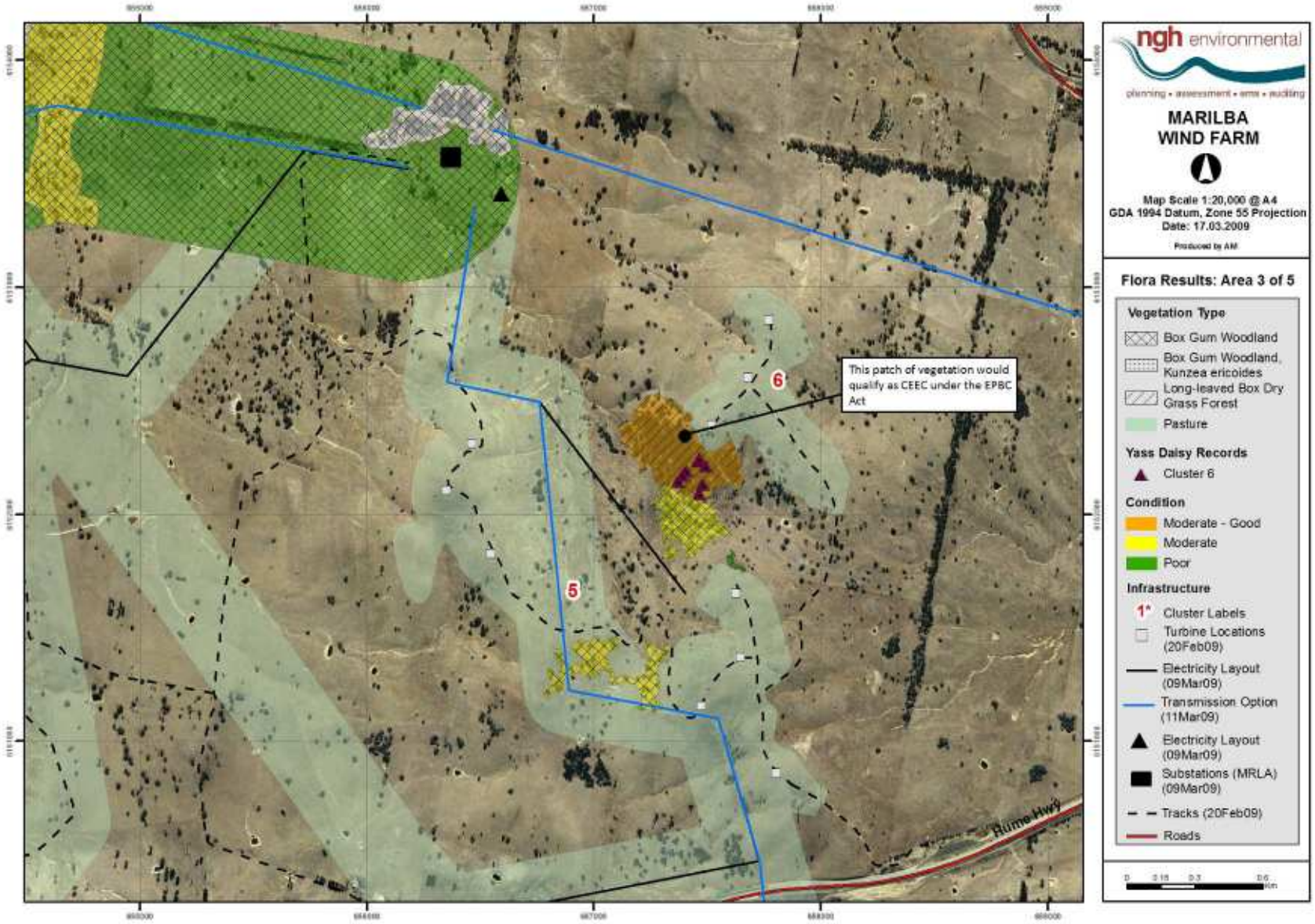
planning • assessment • ems • auditing
MARILBA WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 2 of 5
Vegetation Type
Box Gum Woodland
Box Gum Woodland, Kunzea ericoides
Pasture
Yass Daisy Records
Cluster 4a
Cluster 4b
Condition
Good
Moderate - Good
Moderate
Poor
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads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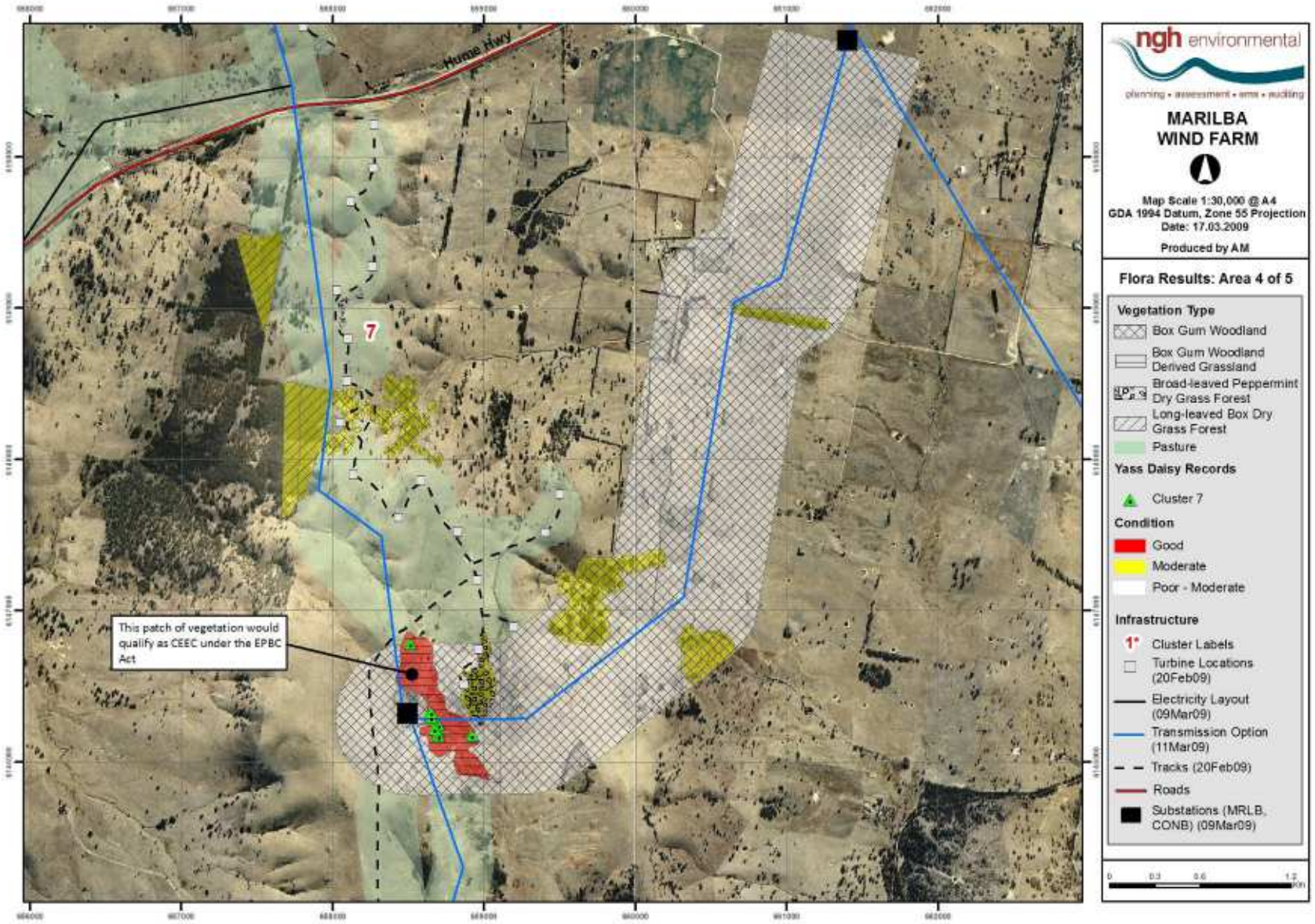
planning • assessment • eims • auditing
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 3 of 5
Vegetation Type
Box Gum Woodland
Box Gum Woodland, Kunzea ericoides
Long-leaved Box Dry Grass Forest
Pasture
Yass Daisy Records
Cluster 6
Condition
Moderate - Good
Moderate
Poor
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
This patch of vegetation would qualify as CEEC under the EPBC Act
6
5
Hume Hwy


Hume Hwy
7
This patch of vegetation would qualify as CEEC under the EPBC Act
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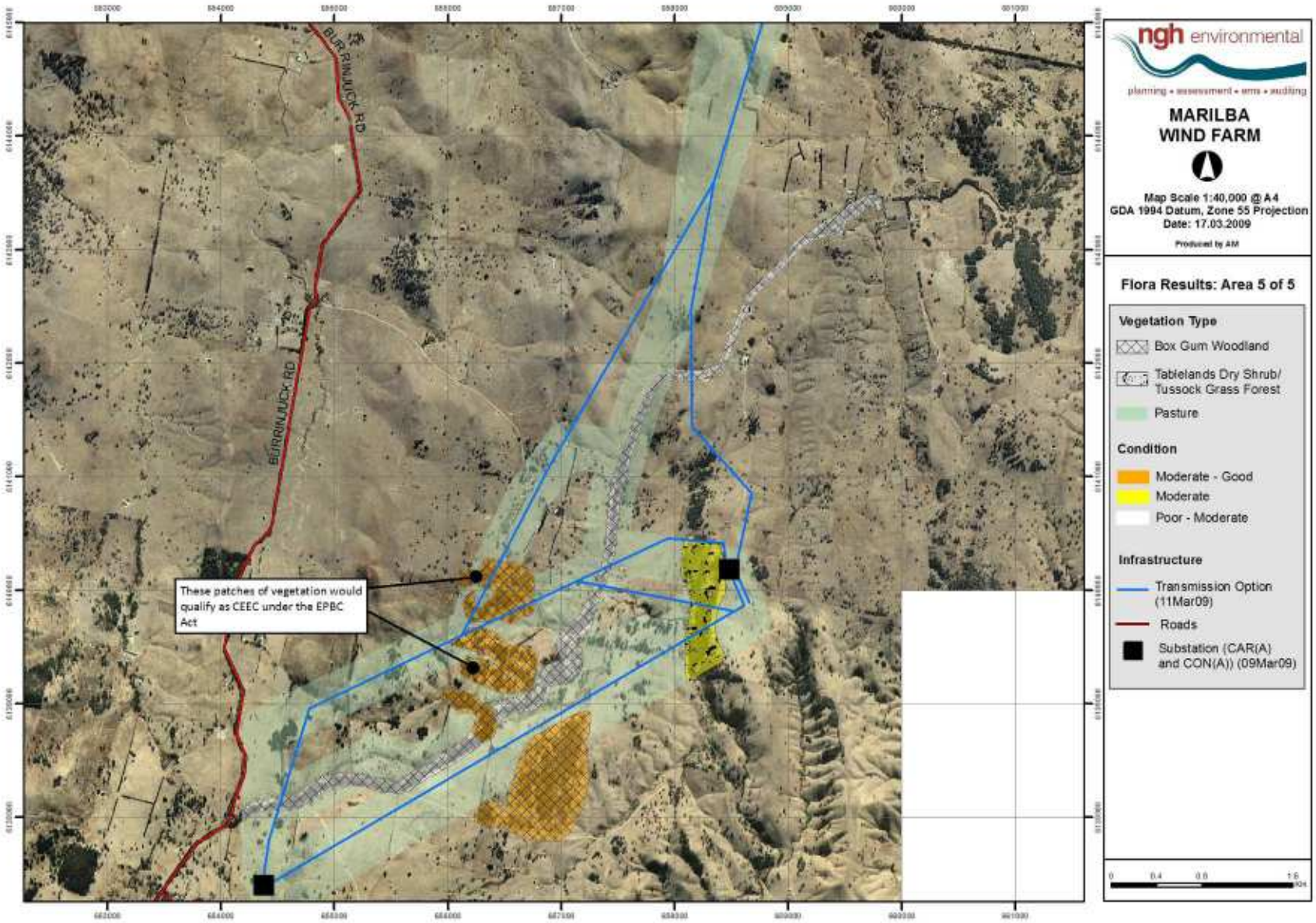
MARILBA
WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 4 of 5
Vegetation Type
Box Gum Woodland
Box Gum Woodland Derived Grassland
Broad-leaved Peppermint Dry Grass Forest
Long-leaved Box Dry Grass Forest
Pasture
Yass Daisy Records
Cluster 7
Condition
Good
Moderate
Poor - Moderate
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substations (MRLB, CONB) (09Mar09)
0 0.3 0.6 1.2 KM


BURRINJUCK RD
BURRINJUCK RD
These patches of vegetation would qualify as CEEC under the EPBC Act
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planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 5 of 5
Vegetation Type
Box Gum Woodland
Tablelands Dry Shrub/ Tussock Grass Forest
Pasture
Condition
Moderate - Good
Moderate
Poor - Moderate
Infrastructure
Transmission Option (11Mar09)
Roads
Substation (CAR(A) and CON(A)) (09Mar09)

5.3 SPECIES AND COMMUNITIES OF CONSERVATION SIGNIFICANCE

5.3.1 Online database searches

The TSC Act and EPBC Act online searches for threatened flora and communities known or with potential to occur in the region identified 15 threatened flora species and 3 threatened ecological communities:

Scientific name	Common name	TSC Act	EPBC Act
Pilularia novae-hollandiae	Austral Pillwort	E	-
Ammobium craspedioides	Yass Daisy	V	V
Senecio garlandii	Woolly Ragwort	V	V
Swainsona sericea	Silky Swainson-pea	V	-
Thesium australe	Austral Toadflax	V	V
Cullen parvum	Small Scurf-pea	E	-
Euphrasia collina ssp. *muelleri*	Mueller's Eyebright/ Purple Eyebright	E	E
Caladenia concolor/Caladenia sp. Burrinjuck	Burrinjuck Spider Orchid	V	V
Prasophyllum petilum	Tarengo Leek Orchid	E	E
Caladenia concolor	Crimson Spider Orchid	E	V
Diuris tricolor	Pine Donkey Orchid	V	V
Grevillea iaspicula	Wee Jasper Grevillea	E	E
Grevillea wilkinsonii	Tumut Grevillea	E	E
Pomaderris cotoneaster	Cotoneaster Pomaderris	E	E
Leucochrysum albicans var. *tricolor*	Hoary Sunray	-	E
Natural Temperate Grassland of the Southern Tablelands (NSW and ACT)	Natural Temperate Grassland of the Southern Tablelands (NSW and ACT)	-	E
White Box Yellow Box Blakely's Red Gum Woodland/ White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grasslands	Box-Gum Woodland	EEC	CE
Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Peneplain; Nandewar and Brigalow Belt South Bioregions	Inland Grey Box Woodland	EEC	-

The Threatened Species Evaluation Appendix C assesses the potential for threatened species and communities to be impacted by the proposed development, based on available habitat, known ecological requirements and local distribution records. Species and communities known to occur, or considered to have the potential to occur on the site are discussed below. Species and communities considered to have the potential to be impacted by the proposal (box gum woodland CEEC, *Ammobium craspedioides, Caladenia* sp Burrinjuck (syn *C. concolor* sens lat.) and *Thesium australe*) are assessed for significance of impacts in Appendices E and F.

5.3.2 Ecological communities

The conservation status of each of the natural vegetation types present as remnants in the study area is summarised in Table 5.2, based on data presented in Gellie (2005).

Table 5-2 Conservation status of vegetation types at the subject site

Vegetation type	Pre-1750 extent (ha)	Extant area (ha)	Reserved in CRA Southern Region (ha)
Box gum woodland types			
Vegetation Group 116: Western Slopes Herb/Grass Woodland	83,000	6,500 (8% of 1750 extent)	nil
Vegetation Group 117: Western Slopes White Box Dry Grass Woodland	107,200	8,400 (8% of 1750 extent)	nil
Vegetation Group 120: Western Slopes Shrub/Herb/Grass Dry Forest	131,300	20,200 (16% of 1750 extent)	2,500 (2% of 1750 extent)
Vegetation Group 160: Western Slopes Dry Grass Woodland	247,500	7,000 (3% of 1750 extent)	nil
Vegetation Group 161: Tablelands and Slopes Dry Herb/Grass Woodland	87,100	3,800 (4% of 1750 extent)	nil
Vegetation Group 163: Central North Slopes Dry Grass Woodland	7,400	260 (22% of 1750 extent)	nil
Long-leaved Box dry grass forest types			
Vegetation Group 118: Western Slopes Dry Grass Forest	6,900	3,100 (45% of 1750 extent)	500 (7% of 1750 extent)
Vegetation Group 119: Western Tablelands Dry Shrub/Grass Forest	121,800	23,000 (19% of 1750 extent)	1,300 (1% of 1750 extent)
Vegetation Group 121: Western Slopes Grass/Herb Dry Forest	90,800	56,400 (62% of 1750 extent)	16,900 (19% of 1750 extent)
Vegetation Group 122: Northern Tablelands and Slopes Dry Shrub/Grass Dry Forest	48,600	11,800 (24% of 1750 extent)	nil
Brittle Gum - Broad-leaved Peppermint dry grass forest			
Vegetation Group 109: Widespread Tablelands Dry Shrub/Tussock Grass Forest	158,000	70,600 (45% of 1750 extent)	16,200 (10% of 1750 extent)
Long-leaved Box dry shrub/tussock grass forest			
Vegetation Group 114: Tablelands Dry Shrub/Tussock Grass Forest	202,415	95,557 (47.2% of 1750 extent	11,681 (5.8% of 1750 extent)

Table 5.2 shows the high level of depletion and poor conservation status of the box gum woodland vegetation types which would have originally occupied much of the study area. Since box gum woodland habitat coincides with prime farmland, this community has been heavily impacted by clearing, grazing, cultivation and the introduction of weed and pasture species. The impact of this depletion is compounded by the severe fragmentation and continuing degradation of remaining stands. Box-Gum Woodland EEC remnants are threatened by a range of processes, including further clearing, firewood cutting, livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance, increased nutrient loads, soil acidification and salinisation and loss of connectivity (NSW SC 2002).

Applying the general JANIS reservation target of 15% for each forest type (JANIS 1997), all of the box gum vegetation types and most of the dry grass forest types are under-represented in the

conservation reserve system. Under JANIS criteria, 60% of the remaining stands of vulnerable types and 100% of endangered types should be reserved or otherwise protected.

Box gum woodland Endangered Ecological Community

Box gum woodland is listed as threatened under both the NSW TSC Act (as the White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community) and the Commonwealth EPBC Act (as Yellow Box – White Box- Blakely's Red Gum Grassy Woodland and Derived Native Grasslands). In relation to community condition, the identification criteria differ between the state and Commonwealth systems, with the Commonwealth community representing a higher quality subset of the NSW community.

NSW TSC Act

The EEC definition under the TSC Act is broad in terms of stand structure and condition. It encompasses woodlands and treeless formations dominated by native grasses, including examples in poor-moderate condition with low forb diversity. The EEC therefore covers a wide range of relative conservation significance. EEC status does not necessarily equate to high conservation value. For example, grazed native pastures derived from box gum woodland and dominated by native grasses but with very low native forbs diversity would form part of the EEC. However, this vegetation is locally very abundant, is likely to have low natural recovery potential and is considered to have relatively low conservation value. Condition, conservation value and impact significance are taken into account as part of the Assessment of Significance of impacts to the community (Appendix E).

Woodland examples

The box gum woodland EEC includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) or *Eucalyptus blakelyi* (Blakely's Red Gum). Recent verbal advice from DECC staff (A. Treweek, R. Rehwinkel, pers. comm.) on interpretation of this EEC is that these three species need not be the dominant trees, but may be a small proportion of the total tree cover. Remnants with even a single tree of White Box, Yellow Box or Blakely's Red Gum present are regarded as belonging to the EEC. Whether remnants lacking any of those species are regarded as belonging to the EEC should be determined at the landscape scale, considering the presence of the box gum woodland trees in surrounding vegetation.

Consistent with DECC advice, vegetation dominated by Long-leaved Box (*E. goniocalyx*) was considered part of the EEC, since this species usually occurs in association with the box gum woodland tree species on the volcanic soils of the subject site. Long-leaved Box is among the tree species listed in the Determination as potentially occurring in the EEC. Long-leaved Box stands appear to occupy a discrete landscape position on sheltered slopes, although these stands have essentially the same grassy understorey as box gum woodland and share a similar function in the landscape (for example, as fauna habitat).

Under the EEC Determination, disturbed remnants form part of the EEC. Some remnants survive partly or wholly cleared of trees, or with the tree layer intact but with the understorey degraded or lost through grazing or pasture modification. The EEC includes '*remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact*', but does not specifically exclude stands with no natural understorey or with no assisted natural regeneration potential or soil seed bank (although the NPWS identification guidelines appear to do

this). The EEC includes degraded remnants which have few, if any native species in the understorey (NPWS undated). So long as one or more of the diagnostic tree species are present in woodland formation, remnants form part of the EEC irrespective of the groundcover stratum (DECC 2008a).

Hence, all parts of the study area carrying Yellow Box, Blakely's Red Gum or White Box in a woodland formation would be considered part of the EEC, regardless of understorey condition. Box gum woodland with these species as dominants, or as minority species in association with *E. goniocalyx,* is the most common vegetation type in the study area, with stands present in varying condition at all of the clusters. The conservation value of degraded stands is influenced by stand condition, the presence of significant species, local levels of depletion, fauna habitat values, recovery potential and connectivity with other areas of natural vegetation. Condition in the study area ranges from sparse dieback-affected White Box over a heavily grazed exotic understorey (eg parts of clusters 1 and 2) to mature Blakely's Red Gum regrowth over a diverse natural grassy understorey with a range of significant species (eg parts of cluster 4b). In extreme cases examples of the former condition would have very little or no capacity for regeneration of even the tree layer, and none whatever of the understorey, even if grazing pressure was removed.

Nearly all of the vegetation within the Marilba Hills project area in the proposed powerline route envelopes between Coppabella and Marilba substations and Marilba and Carroll's Ridge substations route would fall within the TSC Act definition of box-gum woodland EEC, since at least scattered eucalypts are present throughout the route, with trees denser in some areas. The groundcover is predominantly native for most of the proposed route, with the exception of some paddocks in the eastern part of the Mylora property, and one on the Weilora property which have been cropped or converted to exotic pasture (Phalaris). However, since these paddocks include some Yellow Box or Blakely's Red Gum trees, and have some potential for tree regeneration, they would also fall within the EEC definition. Dominant groundcover species over most of the route are the grasses *Austrodanthonia* spp. and *Bothriochloa macra*, with patches of corkscrew grass (*Austrostipa falcata*) and Microlaena. Generally groundcover condition is poor-moderate, with one or two native grass species dominant and few or no native forbs.

There are areas of higher tree density where vegetation appears to fit the definition of the Critically Endangered box-gum woodland ecological community listed under the EPBC Act. Although it does not have the higher groundcover species diversity required by the EPBC Act definition, it satisfies the other criteria: patch size is >2 hectares, tree density appears to be >20 trees per hectare and/or tree regeneration is present. These areas are located across most of the width of the Weilora property, where the proposed route cuts across the southern end of the ridge with the northern-most turbine cluster on the Marilba site, close to where a small creek skirts the end of the ridge.

The Determination notes that native species within the EEC which do not appear to tolerate grazing by domestic stock include *Dianella revoluta, Diuris dendrobioides, Microseris lanceolata, Pimelea curviflora* and *Templetonia stenophylla* (Prober & Thiele 1995 in NSW SC 2002). These species were not recorded in grazed parts of the subject site. Suspected *Pimelea curviflora* seedlings were recorded in ungrazed woodland west of cluster 4.

Treeless examples – native pasture

The EEC determination also includes treeless areas with an 'intact understorey'. The key in the NPWS identification guidelines for the community includes treeless areas which would once have carried one of the box gum tree species and which are now 'predominantly grassy'. Subsequent DECC advice has

also confirmed that secondary grassland derived from the past clearing of box gum woodland forms part of the EEC (DECC 2008a, A. Treweek, R. Rehwinkel pers. comm.).

The majority of pasture in the study area dominated by native grasses would therefore form part of the EEC. Some heavily grazed areas or sheep camps on ridge crests are dominated by exotic forbs and would be excluded from the EEC. The vast majority of native pasture in the study area, while dominated by native grasses, shows very low levels of native forb diversity (typically 1-4 species) and high levels of exotic forb cover (pasture and weed species). The relative cover of exotic annuals and native grasses varies between seasons.

Dominant pasture species typically change from *Themeda triandra* and *Poa* spp. to *Austrostipa falcata, Austrodanthonia* spp. and *Bothriochloa macra* as grazing intensity increases (Moore 1953a in NSW SC 2002). The native pasture in the study area is dominated by *Austrodanthonia* spp and *Austrostipa scabra* ssp *falcata* (syn. *A. falcata*), with occasional *Bothriochloa macra* and *Aristida ramosa,* on ridges, saddles and slopes*,* and with *Microlaena stipoides* in sheltered sites, indicating a long history of grazing. While derived from box gum woodland and technically part of the EEC, these pastures probably have limited natural recovery potential.

The 'diverse secondary grassland' recorded at potential substation sites to the west of cluster 7 may be derived from box gum woodland, although no box gum woodland trees are present at or near the site. The vegetation at this site is variably dominated by the grasses *Austrodanthonia* spp*, Themeda triandra* and *Microlaena stipoides* and, in moister seepage areas, the forbs *Isotoma fluviatilis* and *Hydrocotyle peduncularis*. The groundlayer is generally consistent with box gum woodland understorey. A 2005 survey of similar habitat on property immediately south of cluster 7 recorded species such as *Diuris* and *Thelymitra* orchids and *Bulbine bulbosa* and *Craspedia variabilis.* The ACT Lowland Woodland Conservation Strategy (ACT Government 2004) notes that these species are moderately to highly sensitive to disturbance. As well as *Craspedia variabilis,* the cluster 7 substation sites carry *Ammobium craspedioides*, which is also known to be sensitive to grazing pressure. The presence of these species in reasonable abundance at the site suggests that the soil seed bank may be intact and the site may have good understorey recovery potential. This site is considered to have high conservation value.

The indicative distribution of the EEC in the study area is illustrated in Map Set 2. An assessment of the significance of the impact of the proposal on the EEC is included in Appendix E.

Commonwealth EPBC Act

The identification criteria for the box gum woodland endangered ecological community are considerably more stringent under Commonwealth legislation. Vegetation forms part of the Critically Endangered Ecological Community (CEEC) if one of the most common overstorey species is/was Yellow Box, Blakely's Red Gum or White Box, the understorey is predominantly native, the patch is greater than 0.1 ha, and either:

a) there are 12 or more non-grass species in the understorey including at least one important species (based on a list issued by the Environment Department), or

b) the patch is greater than 2 ha with an average of 20 or more mature trees per hectare, or natural regeneration of the dominant overstorey eucalypts.

Under the diversity criterion (a), a remnant to the east of cluster 3 and much of the fenced portion on the western side of clusters 4a and 4b would be included in the listed community. A ridgeline carrying

Eucalyptus blakelyi regeneration at cluster 4a (MGA 653629 6148696) was surveyed by random meander and recorded 34 listed native non-grass species in the understorey, including 16 important species. Other survey sites within the large remnant on the western side of cluster 4 qualify as CEEC, including some stands which are now dominated in the midstorey by the small tree Allocasuarina verticillata.

The treeless diverse secondary grassland near cluster 7 supports at least 16 listed non-grass species (10 of which are important). Given its topographic position and groundlayer composition, this vegetation appears likely to be derived from box gum woodland although there are no remnant box gum woodland trees in the immediate vicinity. This site has recovery potential with the reinstatement of the tree stratum, stabilisation of soils and appropriate grazing management.

A remnant on the south-west side of cluster 6 carries similar understorey with more than 12 non-grass species including several important species, but is a regrowth stand now dominated by Eucalyptus goniocalyx (Yellow Box, Blakely's Red Gum and White Box are generally absent, but present in woodland south of the site). The understorey composition is however consistent with box gum woodland, and supports at least 22 listed non-grass species including at least 7 important species and the threatened Yass Daisy (refer Map Set 2 and quadrat data in Appendix A). Vegetation at this site may have supported box gum tree species prior to disturbance and has also been included in the Commonwealth CEEC on a precautionary basis.

Under the structural criteria (b), additional CEEC areas are present within the development envelope at cluster 4, cluster 2 and powerline routes between clusters. These woodland patches are more than 2 hectares in size and carry mature trees at a density greater than 20/hectare. The areas are grazed with generally depauperate groundcover and no regeneration.

The indicative distribution of the Commonwealth listed CEEC in the study area is illustrated in Map Set 2. An assessment of the significance of the impact of the proposal on the CEEC is included in Appendix E.

Dry grass/shrub forest types

Because of the generally high levels of native vegetation loss in the district, all dry forest remnants have at least moderate conservation value. Relatively intact samples of two dry grass/shrub forest types are present in the study area; Long-leaved Box forest on the south-west side of cluster 6 and northwest side of cluster 7, and Brittle Gum- Broad-leaved Peppermint forest in the far south of cluster 7.

The former community, VG 118 Western Slopes Dry Grass Forest under the Gellie (2005) system, intergrades strongly with box gum woodland and locally shares a similar understorey structure and floristics. Long-leaved Box is dominant on slopes at other clusters; some of these stands have been identified as box gum woodland because of this similarity in understorey and because one or more of the box gum tree species are present. VG 118 has been moderately depleted since European settlement (45% remains) and is poorly represented in the reserve system in the Southern Region. Woodland vegetation at the subject site has moderate-high conservation significance for fauna regardless of its EEC status, in view of the general depletion of grassy woodland vegetation in the region. However, the conservation value of remnants on the site is reduced by the loss of floristic and structural integrity.

The latter forest type, VG 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest (Gellie 2005), is more clearly distinguished from box gum woodland on the basis of floristics. This community is present

as a small stand in the south of cluster 7. The related VG 114 Tablelands Dry Shrub/Tussock Grass Forest is present as a single stand within the Marilba – Carroll's Ridge powerline envelope. Both communities have been moderately cleared but are under-represented in the reserve system, based on JANIS (1997) reservation targets.

5.3.3 Species of conservation significance

Threatened and nationally significant species

A number of threatened flora species have potential distribution ranges which include the study area. These species, their known distribution and habitat requirements and their likelihood of being present at the subject site are identified in the Threatened Species Evaluation in Appendix C. Eleven threatened species have some potential to be present at the subject site:

Yass Daisy	*Ammobium craspedioides*
Burrinjuck Spider Orchid	*Caladenia* sp Burrinjuck
Mauve Burr-daisy	*Calotis glandulosa*
Small Scurf-pea	*Cullen parvum*
Hoary Sunray	*Leucochrysum albicans*
Tarengo Leek Orchid	*Prasophyllum petilum*
Button Wrinklewort	*Rutidosis leptorhynchoides*
Woolly Ragwort	*Senecio garlandii*
Small Purple-pea	*Swainsona recta*
Silky Swainson-pea	*Swainsona sericea*
Austral Toadflax	*Thesium australe.*

Of these species, only *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Swainsona sericea, Cullen parvum* and *Thesium australe* are considered to have at least moderate potential to be present at the subject site, considering site quality, disturbance history, distribution ranges and the results of the field surveys. These species have been included in the Assessment of Significance in Appendix E.

Yass Daisy (*Ammobium craspedioides*)

In surveys conducted in the Booroowa Shire to the north, all of the occurrences of this species were on land characterised by a light grazing regime (NPWS 2002). The species was recorded at clusters 4, 6 and 7 at the subject site. At each site, Yass Daisy colonies were sizeable (hundreds). The cluster 4 site is fenced and apparently ungrazed. Some Yass Daisy plants were recorded in grazed pasture at this site, but only in close proximity to colonies on ungrazed land. At clusters 4 and 6, and in the Coppabella Hills to the west, this species appears to favour sheltered south-facing slopes, although this may be the result of reduced grazing pressure on these aspects. The location of Yass Daisy records is shown in Map Set 2, and listed in Appendix A.

During an earlier survey undertaken in 2005, the Yass Daisy was also observed to be scattered in roadside remnants beside Black Range Road south of the subject site, east from GDA/MGA 661089 6143407. Some of these occurrences are recorded in the Wildlife Atlas and Bionet databases.

Burrinjuck Spider Orchid (*Caladenia* sp Burrinjuck)

This species has marginal potential habitat in dry shrub forest remnants dominated by *E. goniocalyx*, *E. dives* and *E. mannifera* at clusters 4, 6 and 7. This community is very broadly analogous to known habitats in Burrinjuck Nature Reserve to the south (NPWS 2003a), particularly the Broad-leaved

Peppermint – Brittle Gum community on sediments in the south of cluster 7. Forest remnants at the subject site north of cluster 7 occur on higher fertility volcanic substrates, rather than the infertile sediments at Burrinjuck, which may reduce habitat suitability for this species. A targeted search of the isolated cluster 7 remnant was undertaken as part of the September fieldwork. While the fieldwork was undertaken within the late August - October flowering period for this species, it may not have been flowering or recordable at the time of survey.

Silky Purple Pea (*Swainsona sericea*)

The Silky Purple Pea is an erect perennial to 10 centimetres high, flowering October-December. Potential habitat for this species exists in remnant grassy woodland understorey, particularly at clusters 4 and 7. As noted above, grazing at the subject site over many decades is likely to have resulted in a general reduction in the density of native legumes, and the loss of some grazing-sensitive species. Given the disturbance history of the site, and the failure to detect it during the survey, the chances of the species being present are probably low.

Small Scurf-pea *(Cullen parvum*)

The Small Scurf-pea is listed under the TSC Act as endangered in NSW. It is a small erect or trailing perennial pea with three elongated leaflets and purple-pink (or sometimes white) flowers usually also in threes, appearing in summer. Plants tend to die back over summer and resprout with rain in winter or spring; in dry years, plants apparently do not always produce shoots but survive below the ground. Flooding has been suggested as a mechanism for seed dispersal. The species is threatened by intensive grazing by stock, clearing of habitat and agricultural practices such as cropping (DECC 2008a).

Until recently the Small Scurf-pea was known in NSW from only two herbarium collections; one from Wagga Wagga in 1884 and the other from Jindera (near Albury) in 1967 (DECC 2007a). A small population was discovered in 2006 in a Box-Gum Woodland remnant at Galong, around 20 kilometres north of the proposal site (Douglas 2006). The species therefore has a potential distribution in the local area. However, the level of grazing pressure over most of the site site reduces this potential considerably. Native legumes were generally uncommon at the subject site, with low density records of *Desmodium varians* and *Glycine clandestina* from woodland and forest remnants, and rarely, native pasture. Pea shrubs are generally absent from the site. The long grazing history is the probable cause of this loss of native legumes, which are usually quite common in lightly grazed remnants of grassy woodland types.

The elevated nature of the cluster sites, the grazing history and the failure to detect it during the survey, probably makes it unlikely that this species occurs within the subject site.

Austral Toadflax (*Thesium australe*)

Thesium australe is a sprawling perennial herb growing in grassland and woodland. It is semi- parasitic on grasses, particularly Kangaroo Grass, and shows a preference for moist areas. It is found in small populations across eastern NSW, along the coast and from the Northern to Southern Tablelands. It has not been recorded in the region. The long history of grazing precludes the possibility of this species being present over the majority of the subject site. The ungrazed remnant on the western side of cluster 4 has sparse and scattered Kangaroo Grass and has some potential to support *Thesium australe*. Despite targeted searches, this species was not recorded during the field surveys.

Regionally significant species

There are a number of grassland and grassy woodland species which are of regional conservation significance due to the general depletion of these communities. These species include Zornia (*Zornia dyctiocarpa*), Australian Anchor Plant (*Discaria pubescens*), Emu-foot (*Cullen tenax*), Mountain Swainson-pea (*Swainsona monticola*), Wedge Diuris (*Diuris dendrobioides*), Purple Diuris (*D. punctata* var. *punctata*), Hairy Buttons (*Leptorhynchos elongatus*), Austral Trefoil (*Lotus australis*), Yam Daisy (*Microseris lanceolata*), *Picris* species, a milkwort (*Polygala japonica*) and Wild Sorghum (*Sorghum leiocladum*) (ACT Government 2004). These species may occur on less disturbed remnants in the Yass area, but none were recorded within the subject site.

Several grassy woodland species were recorded which may also be declining in the region along with grassy woodland habitat. These species were recorded in Box Gum Woodland remnants (cluster 4) and diverse secondary grassland (cluster 7) and include the Chocolate Lily (*Dichopogon fimbriatus*), Vanilla Lilies (*Arthropodium milleflorum* and *A. minus*), Milkmaids (*Burchardia umbellata*), Early Snake Orchid (*Diuris chryseopsis*), Onion Orchid (*Microtis unifolia*), Scaly Buttons (*Leptorhynchos squamatus*), Austral Sunray (*Triptilodiscus pygmaeus*), New Holland Daisy (*Vittadinia cuneata* and *V. muelleri*), Billy Buttons (*Craspedia variabilis*), Blue Heron's Bill (*Erodium crinitum*), Native Flax (*Linum marginale*), Tick Trefoil (*Desmodium varians*) and Australian Bindweed (*Convolvulus angustissimus*). Most of these species are listed as important species belonging to the box gum woodland community by the Commonwealth Environment Department (DEH undated).

6 FAUNA

6.1 METHODS

6.1.1 Preliminary assessments

A preliminary assessment of fauna habitat values and the likelihood of threatened fauna species being present was undertaken based on species distribution records and known habitat requirements. Online databases were interrogated and the results of previous fauna survey work in the region were reviewed for threatened fauna records (refer section 6.3.1).

6.1.2 Field survey

Survey timing

Following an initial reconnaissance on 1-3 September 2008, the main survey work was carried out for diurnal and nocturnal vertebrates and their habitats on 16-22 September 2008. The survey was undertaken by Jim Reside and Steve Coulson, fauna specialists engaged by **ngh**environmental. Follow-up visits occurred on 9 November (habitat assessment), in January 2009 (microbat and nocturnal survey – reported separately) and March 2009 (habitat assessment). Cluster 7 was surveyed as part of an earlier superseded proposal on 26-28 March 2007.

Survey methodologies and effort

Survey effort targeted habitats within and adjacent to the development envelopes of the proposed turbine ridges and associated electricity and road infrastructure. Within the development envelope, surveys were stratified by habitat and vegetation type (box gum woodland, Long-leaved Box forest, Brittle Gum – Broad-leaved Peppermint forest, native pasture and wetlands) and landscape position (ridges, slopes, flats, gullies) to ensure that the assessment covered the diversity of habitats that would be directly or indirectly impacted by the proposal.

All vertebrates and their habitats were surveyed, however priority was given to areas considered most likely to provide habitat for threatened fauna. Standard survey methods were employed including mammal trapping, nocturnal survey, bird, reptile and frog survey, Anabat recording and habitat assessment. Survey sites are indicated in Map Set 1.

Trapping

Trapping targeted small and medium-sized mammals, including the threatened Squirrel Glider and the Spotted-tailed Quoll. Trapping studies aim to provide information on the diversity of small mammals on the site, which reflects overall habitat quality and the availability of prey for larger carnivorous species such as forest owls and raptors. Mammal trapping was undertaken in large woodland remnants at cluster 4a and 4b, and in dry forest remnants and a cleared drainage line at cluster 7.

The trapping survey effort was biased toward larger, less disturbed woodland and forest remnants. Formal habitat evaluations were used to assess the potential for other parts of the subject site to support mammal fauna.

Bird census, reptile survey, frog censuses and habitat assessment

Bird censuses and general habitat assessments were undertaken at and near most clusters within representative areas of all vegetation, habitat and landform types. Reptile searches (rock and log rolling) were undertaken where suitable habitat (rocky outcrops and woodland) was present at clusters 1, 6 and 7, sampling a range of aspects. Reptile surveys targeted ridges and upper slopes within the nominated development envelope, and were also conducted opportunistically on lower slopes and valleys in suitable habitat. Reptile habitat assessments were conducted on rocky outcrops to assess their potential to support threatened reptile species.

Frog censuses and aquatic habitat assessments were undertaken in representative examples of riparian corridors, drainage lines and farm dams to identify the diversity of frog species present and the condition and quality of these habitats. Frogs species were also recorded during spotlighting surveys.

Habitat assessments considered vegetation composition and structure, disturbances, potential for threatened species habitat and fauna sign.

Nocturnal surveys

Nocturnal surveys targeted nocturnal bird and mammal species. The surveys commenced with call playback of the threatened Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider and were followed by foot-based or vehicle-based spotlighting traverses. Microbat echolocation recording was conducted in two locations at cluster 7 during the March 2007 survey of this part of the subject site. Microbats were recorded at cluster 4, a lower slope east of cluster 4 and in a roadside lowland woodland remnant on Illalong Road during the September 2008 survey. Further microbat recording and trapping was conducted in January to ensure surveys coincide with microbat activity periods.

Opportunistic records

Searches for fauna, fauna sign and key habitat features were conducted opportunistically whilst conducting other surveys.

The overall survey effort is summarised in Table 6.1 and illustrated in Map Set 1. Fauna survey effort details, survey location and results data are presented in Appendix B.

Table 6-1 Summary of fauna survey effort

SURVEY TYPE	DESIGN	LOCATIONS	TOTAL SURVEY EFFORT	TARGET SPECIES
Ground Elliot trap (A)	March 07: 100 trap nights over 3 transects Sept 08: 116 trap nights over 3 transects Bait – rolled oats, peanut butter and pistachio essence	Cluster 7 – 2 forest remnants and cleared gully line Cluster 4 - woodland remnants	216 trap nights	Small mammals (Antechinus species and rodents) Target threatened species: diversity and abundance of prey for carnivorous species including Large forest owls, Spotted-tail Quoll and raptors (such as the Square-tailed Kite)
Cage trap transects	**March 07:** 24 trap nights over 3 transects Bait - peanut butter, rolled oats, cat food and honey	Cluster 7 – 2 forest remnants and cleared gully line	**Mar 07:** 24 trap nights	Medium sized animals (quolls, bandicoots and potoroos, reptiles) Target threatened species: Spot-tailed Quoll
Bird censuses	Species seen and heard were recorded. Surveys involved spot surveys and transects through representative habitats. The height of individuals was recorded when observed flying above 30m from the ground. If species were observed to be flocking, the number of individuals in each flock was recorded.	Surveys were undertaken in representative areas of all vegetation, habitat and landform types.	**Mar 07:** 8 transects of 30 minutes duration (total 4 person hours) **Sept 08:** 9 transects of 20 person minutes duration (total 3 person hours)	All avifauna. Surveys focused particularly on threatened and migratory birds, raptors, flocking species and wetland birds
Reptile searches	Rocks were rolled and the soil raked with a hand rake. A variety of slope aspects and disturbance regimes were surveyed.	Representative reptile habitat was surveyed. Searches focused on ridge and slopes with extensive rock outcropping, however woodland, leaf litter, hollow logs, tussocks, and sheets of metal were also searched.	**Mar 07:** 3 surveys of 30 minutes duration **Sept 08:** 14 surveys of 20-80 minutes: 465 person minutes	All reptile species. Particular focus was given to potential habitat for threatened reptiles *(Delmar impar, Aprasia parapulchella*)

SURVEY TYPE	DESIGN	LOCATIONS	TOTAL SURVEY EFFORT	TARGET SPECIES
Nocturnal survey (Frog census, spotlighting)	Riparian sites (creek lines and drainage lines) and dams were visited and frog species were identified by call. Spotlighting was preceded by playback of Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider calls. Calls of each species were played for 2.5 - 5 minutes. Listening for responses was carried out for an additional ten minutes. Spotlighting was conducted from vehicle and on foot using hand-held 12v 50w spotlights. Foot-based transects were a minimum of two persons for 15 minutes in duration.	Ridge crest, drainage line and lowland woodland remnants and associated aquatic and riparian habitats. **Mar 07:** riparian and lowland woodland, ridge forest remnants **Sept 08:** riparian and lowland woodland, ridge crest and saddle woodland, riparian woodland below ridgeline	**Mar 07:** 4 surveys of 45-75 minutes duration (240 minutes) **Sept 08:** 4 surveys of 14-110 minutes duration (194 minutes)	Threatened nocturnal bird and arboreal mammal species (Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider) All frog species.
Microbat echolocation call (Anabat)	The September Anabat survey timing was not optimal – follow-up surveys undertaken in January 2009 (reported separately).	**Mar 07:** ridge dam site, forest remnants and lowland woodland remnant **Sept 08:** saddle dam and lowland woodland sites	**Mar 07:** 3 nights (12 hrs/night) **Sept 08:** 3 nights (12 hrs/night)	Microbats, including threatened species.
General habitat assessment	A standard assessment form was used to record habitat and vegetation type; habitat structure, condition and disturbance; important habitat features and resources; and quality of habitat for threatened fauna species. Edited examples of habitat survey forms are is provided in Appendix B.	Habitat assessments were undertaken at all clusters in representative areas of all vegetation, habitat and landform types.	17 sites	All fauna species and their habitats
Opportunistic records	All opportunistic records of fauna were recorded. Searches for signs of fauna presence and use of the habitat were also carried out opportunistically in the course of other surveys.	Various, at all clusters	119 observations	All fauna species, with particular focus on vulnerable bird species.

6.1.3 Mapping

Fauna habitat types were identified from habitat assessments and vegetation surveys conducted in the study area. The spatial extent of these habitats was mapped using habitat point data collected using hand-held GPS receivers (GDA 94) which were projected onto aerial photographs of the site using ArcGIS. Habitat areas within and adjacent to the development envelope were then extrapolated using the aerial photographs and were based primarily on tree cover and the location of rocky outcrops and water features.

6.1.4 Threatened and significant species

Threatened and migratory fauna declared under the TSC Act and the EPBC Act recorded or predicted to occur from the region were identified using previous survey records and online database search tools. Following the field surveys, risk assessments were compiled to determine the potential for threatened and migratory species to be present at the subject site, and the risk to these fauna from the impacts of the wind farm proposal. Species either recorded during the surveys, with potential to be present and with potential to be impacted by the proposal have been included in the Assessments of Significance (Appendices E and F). Where relevant, specific mitigation measures have been developed to reduce impacts to these species (refer chapter 8).

6.1.5 Survey limitations

Survey extent

The surveys covered the proposed development envelope as well as key habitat areas in the wider study area. The large size of the subject site (nearly 3 hectares), together with access difficulties limited the comprehensiveness of the survey in terms of areal coverage. Nocturnal survey was particularly restricted by access across the site. However, all habitat types have been included in representative and replicated fauna survey sites, and the highest quality habitats have been included in the survey. It is therefore considered that fauna survey will have adequately sampled the full range of habitats and species at the subject site, within the practical limitations of the area, access and time.

Survey timing

The limited duration and intensity of the surveys may have resulted in the omission of some sparsely distributed, ephemeral or seasonal species. For example, some occasional wetland bird species which visit small dams and watercourses at the site are likely to have been omitted.

The autumn timing of the March 2007 fauna survey of the cluster 7 site, following a dry summer and extended period of drought is likely to have affected fauna distribution and abundance records. The survey is likely to have been too early for the winter immigrant species such as the Swift Parrot, and winter emigrants such as the Superb Parrot may have left the study area. The dry conditions are likely to have depressed food resources available from local eucalypts; many trees were seen to be dying back and coppicing during the survey. The restricted aquatic resources available from farm dams and watercourses will also have been further reduced by the drought.

The cool conditions during the September 2008 survey was not optimal for recording frogs, reptiles and microchiropteran bats which are generally less active in the cooler months. To address this limitation, additional surveys were conducted January 2009 and focused specifically on microbats and other nocturnal species. This survey coincided with the dispersal of cave-dwelling bats for known roost sites (including as the Eastern Bent-wing Bat).

Mapping

Fauna habitat mapping was conducted by field data extrapolation using aerial photographs. Given the scale of the site, not all areas could be ground-truthed or included in the field survey. The habitat mapping can therefore only be considered to be a general representation of the vegetation composition on the site. A precautionary approach has been used where classification of habitat types is uncertain.

Threatened species

Threatened species were assessed for their potential to occur based on the habitat available, known habitat requirements and known distribution records. A precautionary approach to the assessment of impacts to threatened species has been adopted, as these species are often cryptic, sparsely distributed and difficult to survey, and distribution and habitat information is frequently incomplete or uncertain.

6.2 ASSESSMENT AND SURVEY RESULTS

Survey weather conditions

The weather during the March 2007 survey was calm, cloudy and mild (to 22°C) during the day, and partly cloudy, cool (10-12°C), calm with a near-full moon at night. During the September 2008 survey, the weather was variable, ranging from very warm and sunny to cold days and nights. Wind speeds were also variable for the duration of the survey (refer Table 6-2).

Three nights were spent spotlighting for nocturnal fauna. The first two nights (17 and 18 September 2008) were cool (ranging from -1 to 15.8°C over the two days), although fine with light winds from the south-west. The third night was warmer (ranging from 6.3-24.5°C), conditions were calm and fine. On all survey nights the moon was bright (full moon on 15 September 2008).

Daytime conditions were generally fine, warm and sunny (maximum 24.5°C on 19 and 20 September), with moderate to fresh easterly winds developing on 19 and 20 September.

Recent rains had provided good local conditions for wetland birds and frogs; however conditions were not optimal for bat detection. The warm, sunny weather which prevailed over the early part of the survey was favourable for reptile observation.

Table 6-2 Weather conditions during September 2008 survey

Summarised information from the Yass (Linton Hostel) Bureau of Meteorology weather station

Date	Minimum temp. (°C)	Maximum temp. (°C)	Rainfall (mm)	9am			3pm		
				Cloud amount (oktas)	Wind direction	Wind speed (km/h)	Cloud amount (oktas)	Wind direction	Wind speed (km/h)
16/09/2008	4.8	11.1	2.2	6	W	33	6	WSW	37
17/09/2008	-1	15.8	0	2	SW	4	3	SW	4
18/09/2008	0.5	19.5	0	6	SW	4			
19/09/2008	6.3	24.5	0	0		Calm	1	NW	22
20/09/2008	8.5	24	0	3	E	22	0	E	37
21/09/2008	4.5	20	0	1	NW	20	1	W	26

6.2.1 Fauna habitats in the study area

The study area provides a variety of habitat resources to fauna. The type and quality of these resources present in any one location is related to variable factors such as the disturbance history (grazing, clearing and weed invasion), vegetation composition and structure, topography and seasonal and climatic variables.

Five broad fauna habitat types were identified across the study area:

1. box gum woodland and Long-leaved Box forest (variable age structure and condition)
2. dry grass forest
3. native pasture (variable diversity and exotic component)
4. wetland and riparian habitats (seepages, creeks, dams and drainage lines)
5. rock outcrops.

These habitats in the study area are shown in Map Set 3. Habitat evaluation data are provided in Appendix B. The area of habitat types within the development envelope is given in Table 6.1.

1. Box gum woodland and Long-leaved Box forest

Description and location

- Box gum woodland habitat is present at or near all of the clusters and along the proposed powerline routes. Remnant size varies from a few trees to around 150 hectares at cluster 4. As well as valleys, remnants occur on ridges and slopes, particularly southerly aspects. They are generally highly fragmented, and separated by cleared valley lowland pasture areas.
- Tree canopy cover ranges from 10% in disturbed stands, 20-30% in mature stands and over 50% in regrowth or regenerating stands. Tree age classes include sapling regeneration (uncommon, eg cluster 4b), even age young mature regrowth with few hollows (eg cluster 6), and scattered old growth paddock trees with medium and small hollows. These latter trees are usually dieback-affected (eg cluster 1).
- Groundcover in some discrete ridge crest areas are dominated by exotic weeds (sheep camps), but most sites have groundcover dominated by native grasses with few native forb species. Exceptions occur at clusters 3, 4 and 6 trees where a higher diversity native groundcover is present. At all sites, shrubs are either very sparse or totally absent.

Habitat values

- Most of the hollow-bearing trees occur in heavily disturbed ridge crest stand or as isolated paddock trees. Many of these isolated trees appear too stressed to reproduce and in many cases there is no evidence of flowering and fruiting.
- Regrowth stands have fewer hollows but higher crown cover, and higher floristic and structural diversity. The paucity of hollows and fragmentation of woodland at the subject site reduces the likelihood of less-mobile hollow-dependent species such as the threatened Squirrel Glider being present.
- The better quality stands provide habitat for woodland birds, including the threatened Speckled Warbler and Diamond Firetail and terrestrial fauna such as ground-dwelling mammals and reptiles. This habitat recorded the highest bird diversity at the subject site.

2. Dry grass forest

Description and location

- This habitat occurs mainly in a single remnant dry grass forest patch dominated by Brittle Gum and Broad-leaved Peppermint in the far south of cluster 7, on lower fertility sedimentary geology. This forest is young mature regrowth, with mid-dense crown cover (up to 50%), very few shrubs, and a low diversity groundlayer dominated by native tussock grasses (such as *Joycea pallida*). Older trees with hollows are scattered in the stand, but not common.
- This habitat type is rare at the subject site, and generally absent on the higher fertility volcanic soils at cluster sites north of the highway. The stand is fenced but has been grazed in the past.

Habitat values

- This dry forest patch is better suited to forest rather than woodland fauna. Woodland birds dependent on box nectar, open vegetation structure or diverse, productive groundcover are not likely to use this habitat. Forest canopy bird species and the Yellow-footed Antechinus were recorded in this habitat.

3. Native pasture and ridges

Description and location

- This is the most common habitat type within the development envelope. It encompasses all areas with no or low tree cover and is generally derived from box gum woodland (with the exception of southern parts of cluster 7).
- Most areas are dominated by native grasses, with forb component dominated by exotic weed and pasture species. Some restricted areas have higher native forb diversity, usually in proximity to better condition woodland. All pasture areas were affected by grazing at the time of the survey.

Habitat values

- Because of the level of grazing at the subject site, native pasture provides limited shelter value and nest site opportunities for most fauna. The native grasses and forbs (and some exotics) provide food resources for herbivorous mammals and seed-eating birds. Native pasture close to getter quality woodland remnants is likely to be used by woodland birds, including the threatened Diamond Firetail and Speckled Warbler.
- Many of the ridge crests carry dead trees, stumps and logs which provide potential nest sites and shelter for birds, reptiles and microbats, and vantage points for raptors and woodland birds. Anthropogenic habitat resources are present at the site, including old fence posts and building materials, which provide shelter habitat reptiles. Rocky outcrops are also generally located in native pasture (refer below).
- Open pasture areas also represent prime hunting areas for raptors such as the Wedge-tailed Eagle (which feed primarily on the rabbit populations which live and feed in pasture areas). The ridges produce updrafts and thermals used by raptors for soaring, hunting and courtship displays.
- Isolated paddock trees in pasture areas are often the oldest trees in the study area, with small to large hollows. These trees are likely to be used by hollow-nesting birds (including the threatened Superb Parrot) and microbats. They are generally located in lowland areas outside the development envelope.

4. Wetland areas, seepages, dams and watercourses

Location and description

- Numerous small dams are present at and around the subject site. There is generally little or no aquatic vegetation and water quality is poor. Dams in the lowland areas tend not to retain water for long periods (Keith Smith, 'Ryalla' manager, pers. comm.).
- There are no permanent watercourses at the subject site. An intermittent watercourse with pools and rock bars runs between clusters 5 and 6. Drainage lines in the study area are often incised and without riparian vegetation. Low gradient watercourse pools in lowland areas have reed and sedge vegetation.
- Illalong Creek, 3 kilometres to the west of the site, is a permanent watercourse supporting aquatic and riparian vegetation under an intermittent River Red Gum canopy.
- Some pasture slopes adjacent to the subject site are seasonally wet and carry a range of moisture-loving plant species (particularly south of cluster 6 and south of cluster 7).

Habitat values

- Waterbodies and watercourses at the subject site are small, degraded and mostly ephemeral, and are not likely to provide sustained habitat for waterbirds.
- Better quality aquatic habitat is present in lowland areas around the subject site, particularly creek pools. These habitats are likely to support a range of frog and reptile species, and provide nest sites for bird such as the Clamorous Reed Warbler and forage opportunities for waterbirds such as Herons and Ibises.
- Dams and creek pools also provide forage habitat for microbats, including the threatened species such as the Eastern Bent-wing Bat and Large-footed Myotis.

5. Rock outcrops

Description and location

- Surface rock is present at all of the clusters, generally on volcanic geology. In most areas, rock is either massive and deeply embedded or scattered small surface rock. Some sites (notably cluster 2 and 4) have areas of surface rock fragments in a range of sizes.
- Most sites, outcrops occur on ridge crests and slopes in pasture, in both exotic and native groundcover. At cluster 4, outcrops occur in remnant woodland.

Habitat values

- These outcrops provide shelter and basking habitat for reptile species in particular. Threatened species such as the Striped Legless Lizard and the Pink-tailed Legless Lizard use rock outcrop microhabitats; however, these species were not recorded at the subject site, the site provides only very marginal habitat and the proposal presents a low risk for these threatened reptiles.
- Reptile habitat assessments and reptile searches targeted this habitat type.
- Crest areas dominated by exotic forbs such as thistles and nettles are less likely to support reptile species because of the dense shade at ground level.

Rare or limiting habitat features

Large and intact areas of box gum woodland

Woodland habitats have been extensively cleared and modified for agriculture throughout the region. Box-gum woodland remnants occur at or near all cluster sites, usually with heavily degraded understorey. A few sites – notably clusters 4 and 6 –have regrowth stands in reasonably good

condition, with a diverse grassy understorey. Some sedentary and poorly dispersing woodland bird species require large remnants to sustain a viable population. Woodland is generally heavily fragmented in the study area and large remnants are very rare. The cluster 4 remnant, around 140 ha in area, is relatively large and consequently of high conservation value. Stands combining large area, old age class trees and intact understorey are extremely rare in the region and are not present at the subject site.

Hollow-bearing trees

Mature trees with hollows provide essential habitat resource for many arboreal mammals (such as gliders, possums and bats) and birds (Gibbons and Lindenmayer, 2002). Large hollow-bearing trees have been depleted by clearing for agriculture throughout the district and are now a limiting habitat resource for dependent species.

Mature trees are generally rare across the study area and tend to occur only in disturbed lowland woodland remnants or as isolated paddock trees in lowland areas. Many of these lowland stands and trees are dieback affected, with no regeneration. Trees in larger remnant woodland and forest patches on slopes and ridge crests at the subject site are generally mature regrowth yet to reach hollow-forming age. Hollow-dependent fauna populations may be significantly stressed if the lowland trees are lost before these younger woodland remnants develop hollows.

6.2.2 Species recorded at the site

In total, 107 introduced and native vertebrate species were recorded during the surveys. This comprises 62 birds, 11 terrestrial and arboreal mammals, 12 microbats, 17 reptiles and 5 frog species. The highest fauna species richness was recorded from woodland habitats. Most species were recorded in multiple habitat types. Fauna survey and habitat evaluation data are provided in Appendix B.

Birds

Bird species recorded in the habitats at the subject included:

- Woodland patches on ridge crests and slopes: whistlers, thornbills, pardalotes, robins, fantails, cuckoos, choughs, honeyeaters, parrots, gerygones, silvereye, superb fairy wren, treecreepers and currawong. Raptors recorded in this habitat included the Brown Goshawk, Wedge-tailed Eagle and Nankeen Kestrel.
- Pasture with scattered trees on flats: open country species including raptors, pipits, parrots, crested pigeon, red wattlebird, noisy friarbird, honeyeaters, welcome swallow, tree martin, willy wagtail, weebill, kookaburra, magpie and starling.

Greatest bird richness was recorded in woodland habitats, including threatened and declining bird species (Superb Parrot, Speckled Warbler, Diamond Firetail). Two migratory bird species listed under the EPBC Act - the Rainbow Bee-eater and Satin Flycatcher- were observed in woodland at the site.

Many of the woodland bird species recorded are specialist species and were not recorded in other habitats. Woodland bird species that have been identified as declining in the wheat-sheep belt region of NSW that were recorded on the site include the Red-Capped Robin and Dusky Woodswallow, recorded in woodland habitat (Reid 1999).

On other, more disturbed sites, surveys showed that habitats were dominated by only a few generalist or aggressive species. For example, in scattered trees and small remnants the Crimson Rosella, Common Starling and Australian Magpie were more abundant than any other species, and the Galah and Sulphur Crested Cockatoo were common in cleared pasture areas over the entire site.

Raptors recorded from pasture and ridge areas at the subject site include the Brown Falcon, Nankeen Kestrel, Black-shouldered Kite, Little Eagle and Wedge-tailed Eagle. Nocturnal birds recorded include the Tawny Frogmouth and Australian Owlet-nightjar.

Waterbirds and waterbird habitats were rare at the site. The White-face Heron and Australian Wood Duck were observed in a valley in the south of the site.

Mammals

Mammals habitats at the subject site have been heavily modified by clearing, grazing and weed invasion. Woodland and forest patches are mostly young-mature regrowth and highly fragmented. Connectivity is commonly limited to scattered paddock trees and eroded drainage lines.

The mammal survey targeted microbats, and ground-dwelling and arboreal mammals in and near remnant woodland patches and creeklines. Brushtail and Ringtail Possums were the only arboreal mammals recorded during spotlighting, in lowland woodland (beside Illalong Creek and east of cluster 7), and mid-upper slope woodland (cluster 4). The Yellow-footed Antechinus was the only small ground-dwelling mammal recorded. This species was trapped in both forest remnants at cluster 7, and in 2 of 3 traplines set in the large woodland remnant at cluster 4.

The scarcity of hollows and other shelter habitat and low connectivity in many parts of the subject site is likely to be limiting the abundance of arboreal mammals. Fragmentation and grazing are known to reduce the capacity of the landscape to support small mammals (Bennett, 1990; Lindenmayer et al., 2000), and this is likely to have consequences for larger fauna (owls, quolls, foxes) that prey on these species.

Several macropod species were observed at the subject site; Eastern Grey Kangaroo, Eastern Wallaroo, Red-necked Wallaby and Swamp Wallaby. Only the Eastern Grey Kangaroo was observed in pasture habitats. Introduced fauna recorded at the site included the European Rabbit, Brown Hare, Red Fox and House Mouse, as well as grazing stock (sheep, cattle).

Local fox numbers are kept low by biannual cooperative baiting programs undertaken by farmers in the district using baits supplied by the Rural Lands Protection Board (James Payne, local landholder pers. comm.). The European Rabbit and Brown Hare are likely to be principal food sources for local Wedge-tailed Eagles.

Microchiropteran bats

12 microbat species were recorded at the subject site, with additional two species as possible records (refer Appendix B and Table 7.3). These species were identified beside dams and woodland and forest patches at clusters 4 and 7.

Many microbats forage in the forest canopy and use large hollow-bearing trees for roosting (Pennay and Freeman 2005). Many species also use multiple roosts to avoid predation and reduce parasite loads (Kunz and Lumsden 2003 in Rhodes 2006). Hollow-bearing paddock trees have been shown to provide critical roosting and nesting resources for microbats (Gibbons and Boak, 2002; Manning *et al*., 2006).

One threatened species was identified with confidence: the Eastern Bent-wing Bat, listed as vulnerable under the TSC Act and Conservation Dependent under the EPBC Act. The threatened Large-footed Myotis and Yellow-bellied Sheathtail Bat were possible records from the cluster 4 site.

Anabat microbat call detection equipment was placed near ridgetop forest, saddle dam and remnant valley woodland habitats. The recorded habitat and call identification confidence for each species is presented in Table 7.3. The recorded diversity of microbat species may have been increased by the position of the site in an area where the ranges of coastal and western species overlap.

Calls analysis was undertaken using the latest guide to call identification (Pennay *et al*. 2004). All identified calls were ranked using a confidence rating (confident, probable, possible) (DEC 2004; Pennay et al. 2004). Where the call analysis indicates the possiblity of a threatened species, the species was assumed present in accordance with DEC guidelines (DEC 2004). Suspected threatened species calls were confirmed by Glenn Hoye and Ecotone Environmental Consultants. The threatened Eastern Bentwing Bat was recorded at the cluster 7 site to at least a 'probable' level of confidence, and at the cluster 4 site at confidence levels 1-3.

Table 6-3 Microbat call detection results

March 2007 survey – cluster 7

Species	Common name	Ridgetop forest	Saddle dam	Woodland
Chalinolobus gouldii	Goulds Wattled Bat	positive	possible	possible
Chalinolobus morio	Chocolate Wattled Bat	probable	positive	possible
Miniopterus schreibersii	Eastern Bentwing Bat	probable	possible	-
Mormopterus sp. no.4 lpf		positive	positive	positive
Mormopterus sp. no.3 spf		probable	possible	probable
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	positive	positive	positive
Scotorepens balstoni	Inland Broad-nosed Bat	positive	positive	-
Scotorepens greyii	Little Broad-nosed Bat	positive	positive	possible
Vespadelus darlingtoni	Large Forest Bat	positive	positive	-
Vespadelus regulus	Southern Forest Bat	positive	positive	-
Vespadelus vulternus	Little Forest Bat	positive	prob	-
Tadarida australis	White striped Freetail bat	-	-	positive

September 2008 survey – cluster 4 and TSR west of site

Species	Common name	ID confidence	No. records
17.9.08 – cluster 4 saddle adjacent to woodland/scrubland on upper slope, adjacent to farm dam			
Miniopterus schreibersii	Eastern Bentwing Bat	1	2
Miniopterus schreibersii	Eastern Bentwing Bat	2	16
Miniopterus schreibersii	Eastern Bentwing Bat	3	2
Chalinolobus morio	Chocolate Wattled Bat	1	1
Chalinolobus morio	Chocolate Wattled Bat	2	1
Chalinolobus morio	Chocolate Wattled Bat	3	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	2
Nyctophilus sp. or *Myotis macropus*	Long-eared Bat	2	1
18.9.08 - Travelling Stock Reserve beside Illalong Road, on creekline flat under woodland			
Miniopterus schreibersii	Eastern Bentwing Bat	1	1
Miniopterus schreibersii	Eastern Bentwing Bat	2	3
Vespadelus regulus	Southern Forest Bat	2	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	5

Species	Common name	ID confidence	No. records
Vespadelus sp. or Miniopterus schreibersii	Little Forest Bat	1	1
Mormopterus sp. no.4		2	1
Mormopterus sp. no.3 or 4		2	2
Mormopterus sp. no.3 or 4 or Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	1	2
Nyctophilus sp.	Long-eared Bat	2	1
Nyctophilus sp. or Myotis macropus	Long-eared Bat	1	5

Further surveys were undertaken to support a more detailed assessment of the potential impacts of the wind farm on microbat species. This assessment will be included in a specialist microbat report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

Reptiles

Fifteen reptile species were recorded during the survey, comprising 9 skinks, 1 legless lizard, 1 gecko, 1 dragon and 3 elapid snakes. Reptile habitats present at the site include rock outcrops and woody ground debris in both pasture and woodland communities. The most commonly recorded species were the Three–toed Skink, Garden Skink, Southern Rainbow Skink and Copper-tailed Skink, recorded in both woodland and cleared habitats. Boulenger's Skink, the Marbled Gecko and the Olive Legless Lizard were recorded under rocks on ridge crests at cluster 2.

Outcropping rock and surface rock in particular is relatively common on ridge crests and upper slopes at the subject site. The quality of these habitats for reptiles is related to the extent of exotic grass and forb cover and grazing pressure. These factors have been shown to be negatively correlated with reptile diversity on rock outcrops (Fischer *et al*., 2004; Michael et al., 2008). Ridge crests were frequently the areas most heavily impacted by grazing, nutrient loading, soil erosion and weeds.

Frogs

Four frog species were recorded during the nocturnal survey at the subject site: Plains Froglet (*Crinia parinsignifera),* Common Eastern Froglet (*Crinia signifera),* Southern Banjo Frog or Pobblebonk *(Limnodynastes dumerilii)* and Spotted Marsh Frog *(Limnodynastes tasmaniensis*), in drainage line and dam habitats. These species are likely to be common and widely distributed in the region.

6.2.3 Profile of potential bird usage

The recorded abundance and diversity of birds on the cleared ridgetops of the subject site was generally low. The most commonly recorded species in these habitats were Magpies, Crimson Rosellas, Richards Pipits and Wedge-tailed Eagles. Single Wedge-tailed Eagles were observed at the site on each day of the survey, ranging 10-100 metres above the ground. During the March 2007 survey two birds were observed exhibiting possible courtship behaviour clasping talons and tumbling. During earlier surveys conducted immediately south of cluster 7, a group of five eagles were observed.

Remnant forest and woodland patches provide habitat for a wider range of species. Larger remnants, such as at cluster 4, provide habitat for species intolerant of habitat disturbance and fragmentation. Waterbodies and watercourses at the subject site are small and ephemeral, and are not likely to provide a sustained habitat for large numbers of waterbirds.

Survey data on species recorded, numbers of individuals and relevant behaviours are provided in Appendix B, and these findings are used in the risk and impact assessments.

Ramsar wetland and migratory wetland species

There are no Ramsar wetlands close to the subject site, and no large concentrations of migratory wetland species are expected to occur in the local area. Local waterbodies are small and largely ephemeral, and degraded by clearing, siltation, weeds and drought. The closest large waterbodies include Lake Burrinjuck (9km to the south), Lake Bethungra (60km to the west) and Lake George (70km south-east).

Migratory species and migration corridors

Seasonally migratory species recorded at the site include the threatened Superb Parrot, the EPBC Act–listed Rainbow Bee-eater, and woodland species such as Silvereyes and honeyeaters. Several other migratory or nomadic species also potentially use woodland and wetland habitats in the study area. Precise migratory routes are largely unknown.

Waterbirds

Daily and seasonal migration corridors for waterbirds in the study area are not known. Nomadic and migratory water birds may pass over the site during dispersal, migration between breeding and foraging grounds, or in response to seasonal availability of resources.

The subject site is not located between significant habitat areas and bird movements across the site may be diffuse and irregular, rather than concentrated and seasonal. Potential long-distance migration paths that intercept the site include east-west movements from larger wetland systems in the west to wetlands on the coast, and north-south movements between Lake Burrinjuck and Lake Cowal, Lachlan River and Lake Wyangala.

No congregations of waterbirds were recorded at the subject site during the survey, and, given the habitat scale and quality, none would be expected to occur there. The Australian Wood Duck and White-faced Heron were the only waterbirds recorded at the site during the survey.

Under suitable conditions, waterbird species such the White Ibis, White-faced Heron and ducks, would be expected to disperse to forage in farmland north of Lake Burrinjuck, including the study area. However, rather than crossing the turbine ridges, waterbirds are likely to more frequently move through valley areas between lowland dams and pools, or along watercourses such as Illalong Creek. Dams constructed in these lowland areas do not tend to hold water for long periods (Keith Smith, Manager, 'Ryalda' pers. comm.), waterbird use of these habitats is likely to be seasonal and dependent on rainfall.

White Ibises used Lake Burrinjuck, south of the subject site, for breeding until the recent drought (C. Davey CSIRO, retired, pers. comm.). With the breaking of the drought, breeding would be expected to resume and Ibis numbers in the study area may increase. Ibis and other waterbirds may travel between Lake Burrinjuck and the large waterbodies in Canberra, to the south.

Waterbirds travelling long distances from and to Lake Burrinjuck, located nine kilometres to the south of the subject site, are likely to have attained a travelling altitude greater than the turbine height. No waterbirds or migratory wetland species were assessed as being at moderate or high risk of bladestrike or habitat impacts at the Marilba Hills site (refer bird and bat impact risk assessment Appendix D).

Woodland birds

Daily and seasonal migration corridors for woodland birds and other species in the study area are not known. Most woodland passerines in the study area are likely to use habitat with at least some tree cover. Many threatened woodland species, such as the Diamond Firetail and Speckled Warbler, are poor dispersers and are unlikely to venture far from remnant woodland patches.

Superb Parrots use woodland remnants as corridors, and they avoid open areas on foraging flights (DNRE 1992), and rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999, Garnett and Crowley 2000). Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and use the same route for return journeys (Fischer and Lindenmayer 2002a).

Woodland remnants with tree cover are present at the subject site in the form of small degraded and fragmented stands on ridges and sideslopes, separated by cleared valley areas. Woodland birds are likely to move between woodland patches in close proximity to forage and disperse, although movement ranges are likely to be limited given the extent of fragmentation.

The principal long distance flight paths for woodland species are likely to follow riparian and roadside remnant corridors, such as Illalong Road and Illalong Creek to the west, and Black Range Road to the south. Birds moving at tree canopy height through these remnants are unlikely to be affected by the wind turbines located on the cleared ridge crests.

Woodland habitat loss and fragmentation has been linked to the decline of many woodland birds, particularly species with low fecundity, poor dispersal or those that require specialised habitat resources such as hollow-bearing trees.

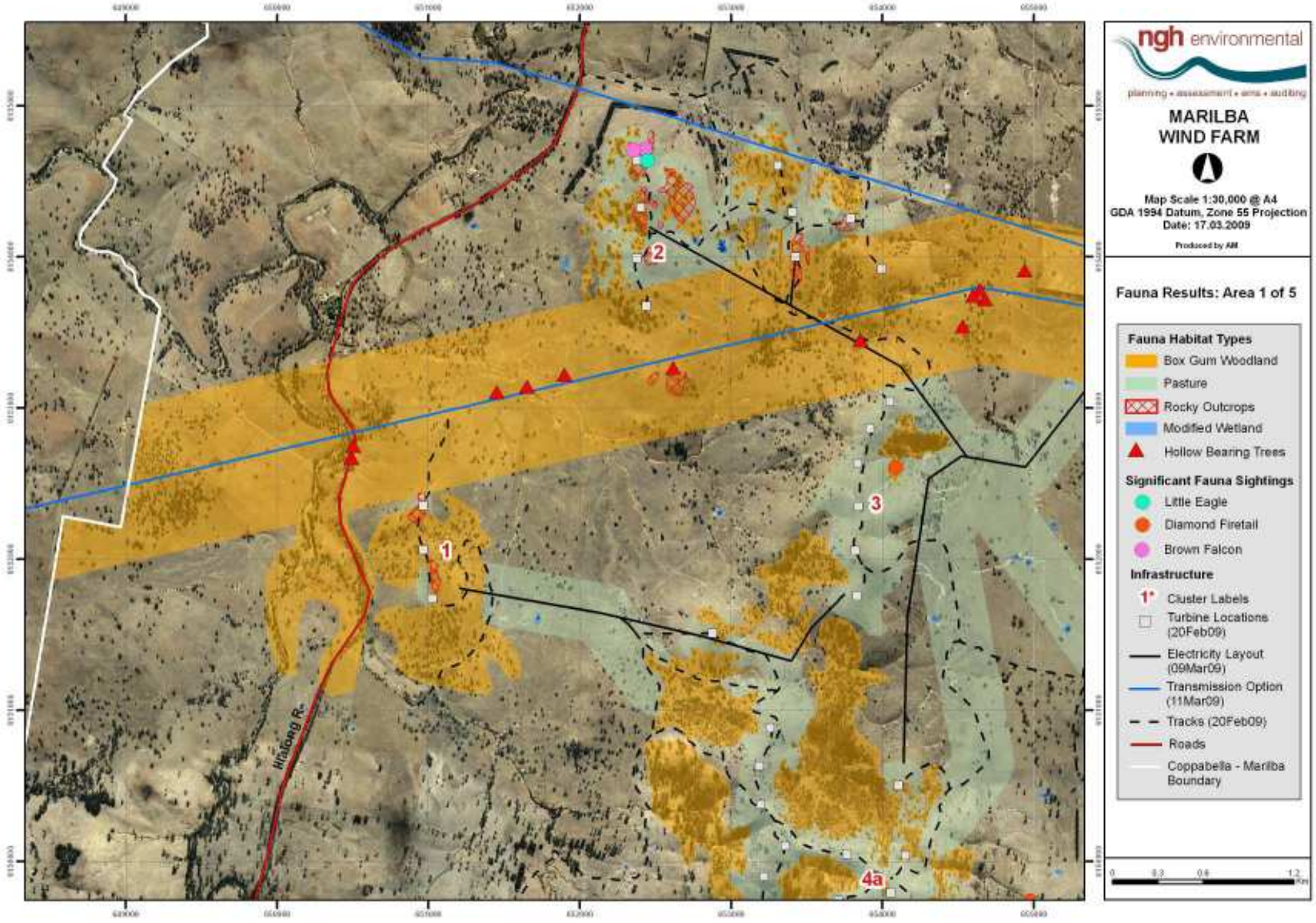
Geographical features that concentrate bird movements

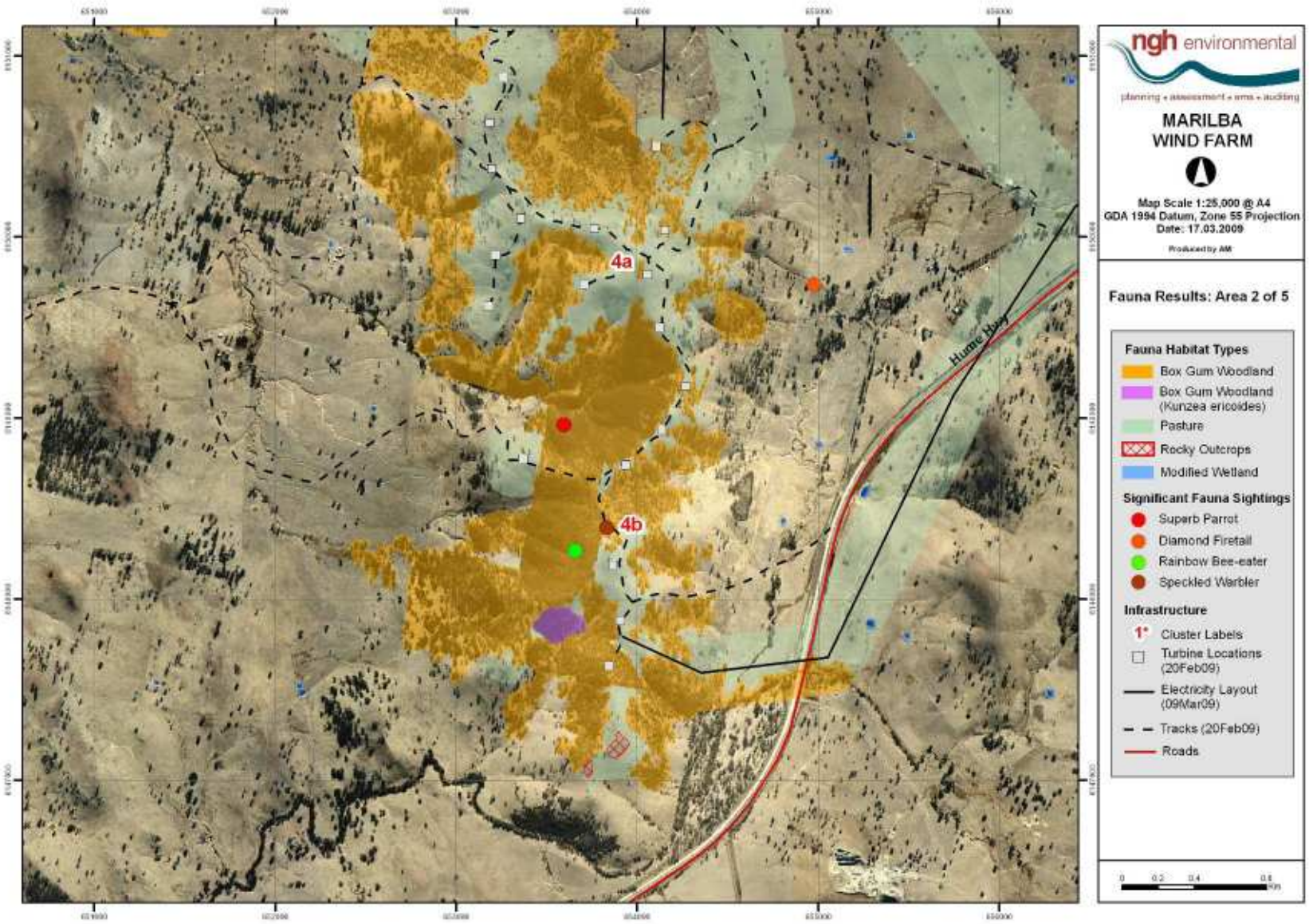
The proposal is located on a series of valleys and ridgelines oriented roughly north-south. These features may concentrate hunting and foraging behaviour for some species (particularly raptors) and dispersal movements for waterbirds.

Raptors

Five raptor species were recorded at the subject site – the Brown Falcon, Nankeen Kestrel, Black-shouldered Kite, Little Eagle and Wedge-tailed Eagle. These species are likely to breed locally and use open woodland/pasture areas and ridge updrafts for hunting. Rabbits are likely to provide a prime food source for larger raptor species. No confirmed raptor nests were observed at the subject site, although several stick nests were recorded (eg at cluster 7 MGA 659579 6146357) which may be used by Currawongs, Magpies or smaller raptors.

Map Set 3 – Fauna habitat and significant fauna features (5 maps in total)




4a
4b
Hume Hwy
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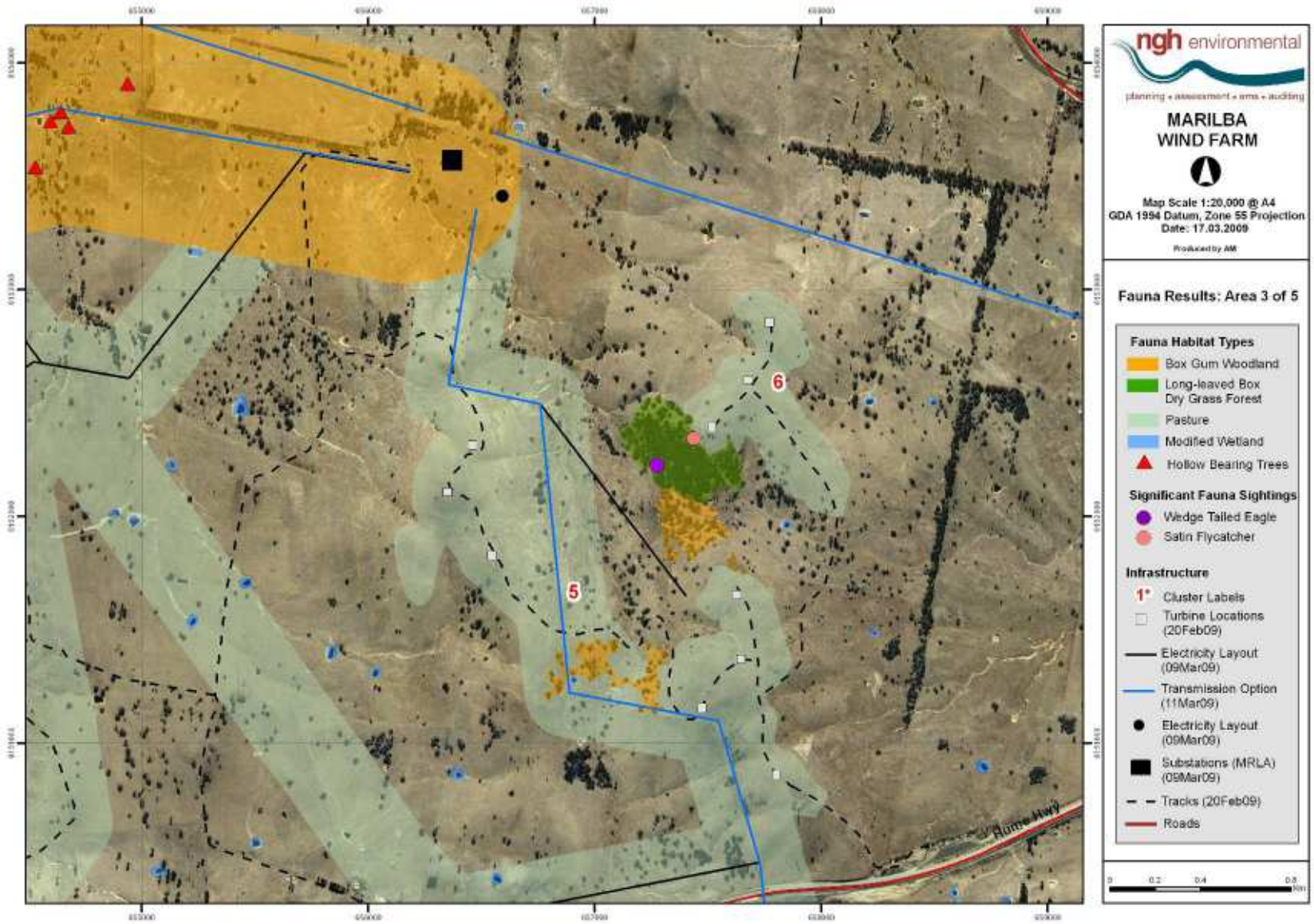
planning + assessment + ems + auditing
MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 2 of 5
Fauna Habitat Types
Box Gum Woodland
Box Gum Woodland (Kunzea ericoides)
Pasture
Rocky Outcrops
Modified Wetland
Significant Fauna Sightings
Superb Parrot
Diamond Firetail
Rainbow Bee-eater
Speckled Warbler
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
0 0.2 0.4 0.8 Km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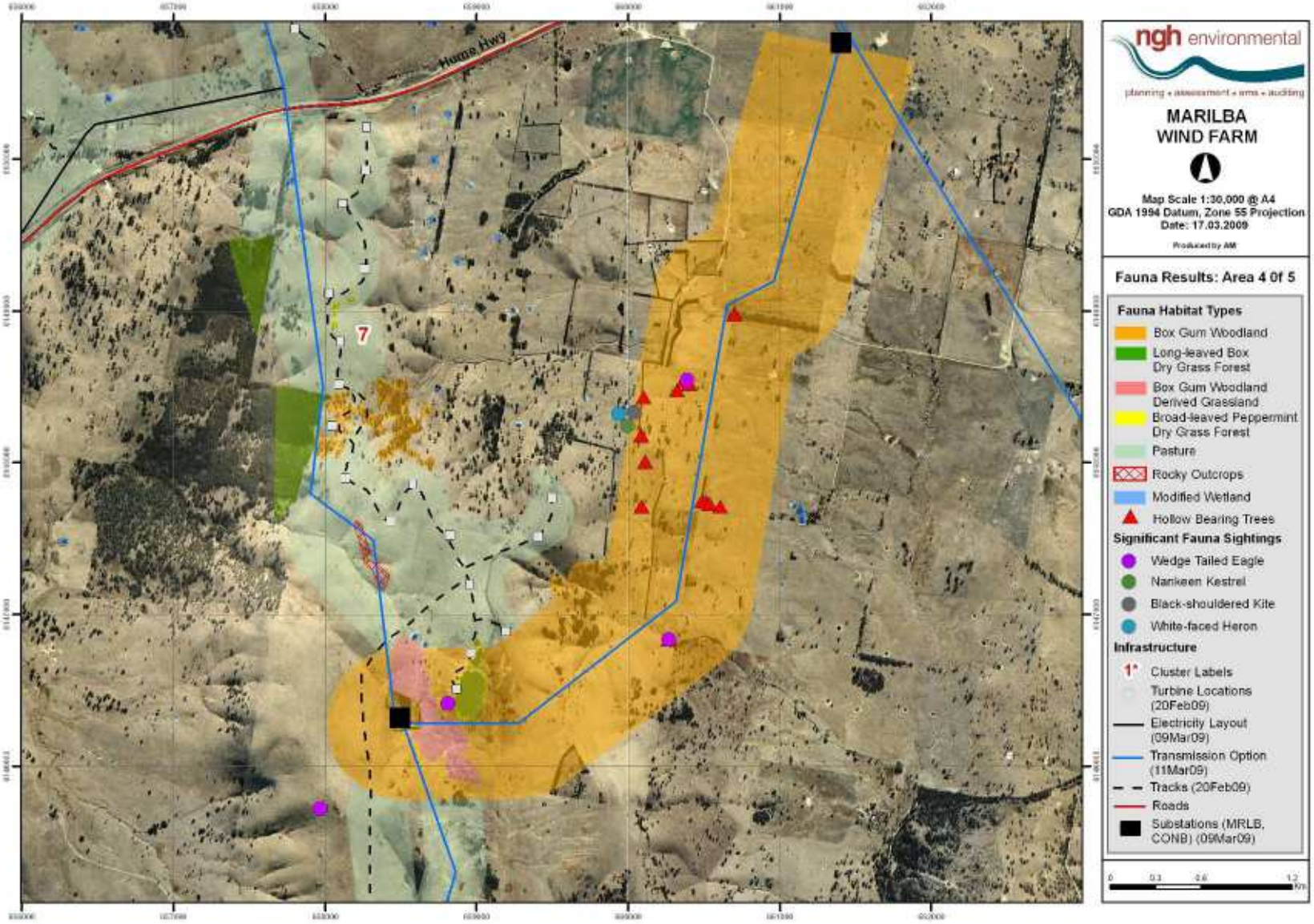
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 3 of 5
Fauna Habitat Types
Box Gum Woodland
Long-leaved Box Dry Grass Forest
Pasture
Modified Wetland
Hollow Bearing Trees
Significant Fauna Sightings
Wedge Tailed Eagle
Satin Flycatcher
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
5
6
Hume Hwy


Hume Hwy
7
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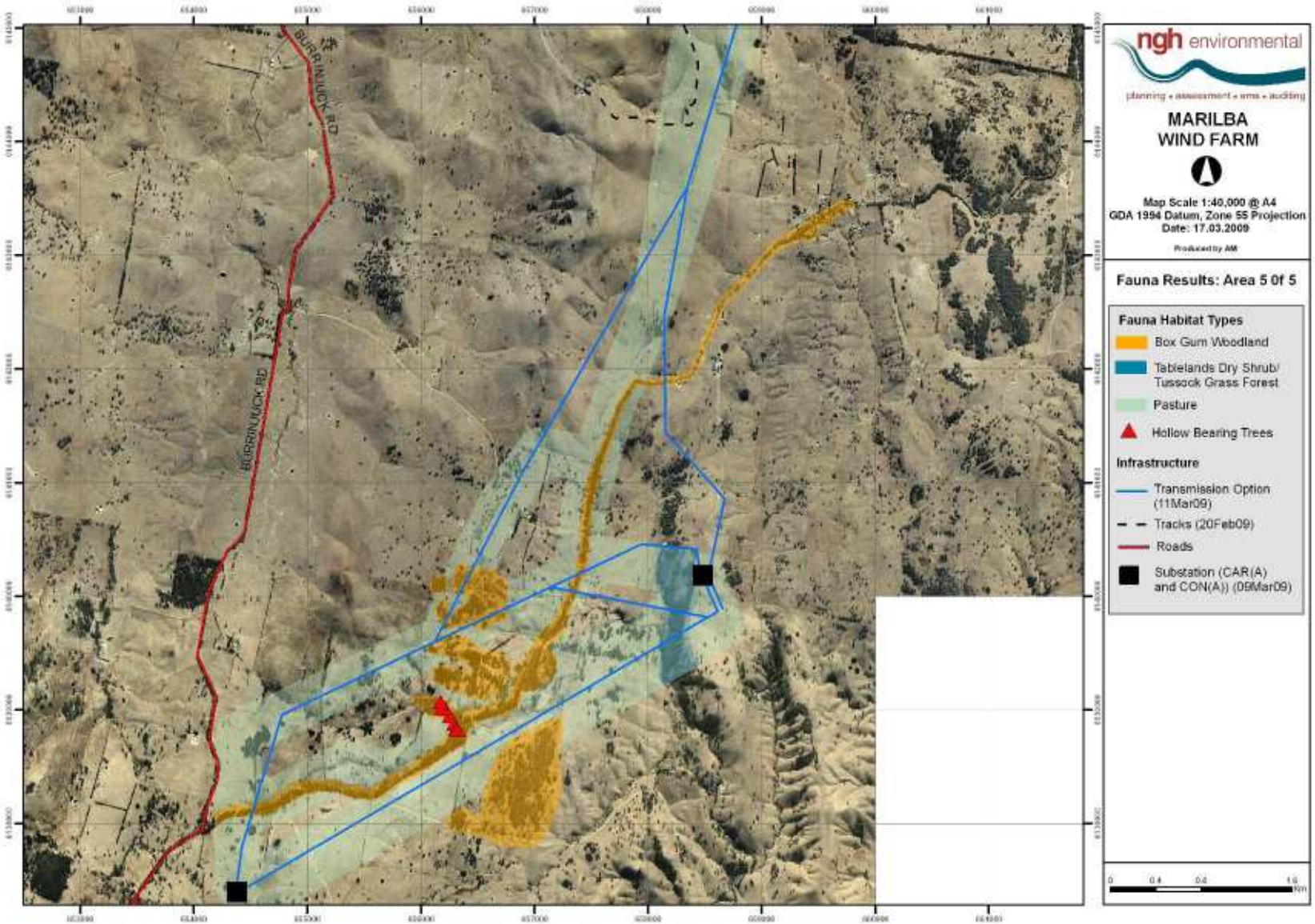
planning + assessment + ems + auditing
MARILBA
WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 4 0f 5
Fauna Habitat Types
Box Gum Woodland
Long-leaved Box Dry Grass Forest
Box Gum Woodland Derived Grassland
Broad-leaved Peppermint Dry Grass Forest
Pasture
Rocky Outcrops
Modified Wetland
Hollow Bearing Trees
Significant Fauna Sightings
Wedge Tailed Eagle
Nankeen Kestrel
Black-shouldered Kite
White-faced Heron
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substations (MRLB, CONB) (09Mar09)
0 0.3 0.6 1.2 Km


BURRINJUCK RD
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MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 5 0f 5
Fauna Habitat Types
Box Gum Woodland
Tablelands Dry Shrub/ Tussock Grass Forest
Pasture
Hollow Bearing Trees
Infrastructure
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substation (CAR(A) and CON(A)) (09Mar09)
0
0.4
0.8
1.6
Km

6.3 SPECIES OF CONSERVATION SIGNIFICANCE

6.3.1 Online database searches

The Commonwealth EPBC Act Matters of National Environmental Significance Reporting Tool (using a 50 km radius) and NSW DECC Wildlife Atlas database (using relevant CMA sub-regions) were used to identify threatened or otherwise significant species with potential to occur at the subject site. The results of the searches are presented in Appendix C and the Commonwealth Matters of National Environmental Significance search report is provided at Appendix G.

6.3.2 Threatened species evaluation and risk assessment

The Threatened Species Evaluation in Appendix C assesses the potential for threatened species to be present at the proposal site, based on available habitat, known ecological requirements, local distribution records and the results of online database searches. The evaluation indicates that 25 threatened or migratory fauna species have potential to be present at the subject site:

Waterbirds		
Blue-billed Duck	*Oxyura australis*	V
Raptors		
Square-tailed Kite	*Lophoictinia isura*	V
Barking Owl	*Ninox connivens*	V
Woodland Birds		
Speckled Warbler	*Pyrrholaemus saggitatus*	V
Brown Treecreeper	*Climacteris picumnus Victoriae*	V
Diamond Firetail	*Stagonopleura guttata*	V
Black-chinned Honeyeater	*Melithreptus brevirostris*	V
Painted Honeyeater	*Grantiella picta*	V
Regent Honeyeater	*Anthochaera phrygia*	E
Hooded Robin	*Melanodryas cucullata cucullata*	V
Swift Parrot	*Lathamus discolour*	E
Turquoise Parrot	*Neophema pulchella*	V
Superb Parrot	*Polytelis swainsonii*	V
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V
Satin Flycatcher	*Myiagra cyanoleuca*	M (EPBC)
White-throated Needle-tail	*Hirundapus caudacutus*	M (EPBC)
Rainbow Bee-eater	*Merops ornatus*	M (EPBC)
Cattle Egret	*Ardea ibis*	M (EPBC)
Microbats		
Eastern Bentwing-bat	*Miniopteris schriebersii*	V
Large-footed Myotis	*Myotis macropus*	V
Yellow-belied Sheathtail-bat	*Saccolaimus flaviventris*	V
Arboreal mammals		
Squirrel Glider	*Petaurus norfolcensis*	V
Koala	*Phascolarctos cinereus*	V
Reptiles		
Pink-tailed Legless or Worm Lizard	*Aprasia parapulchella*	V
Striped Legless Lizard	*Delma impar*	V

These species include 15 threatened bird species - 1 waterbird, 2 raptors and 11 woodland species – and 3 microbat species. These species have been included in a preliminary risk assessment (refer bird

and bat impact risk assessment Appendix D) and those species determined to be at risk from the wind farm proposal have been included in the Assessment of Significance presented in Appendix E. Three threatened woodland bird species were recorded in and near the site – Superb Parrot, Diamond Firetail and Speckled Warbler. The locations of these records are shown in Map Set 3.

7 BIODIVERSITY CONSTRAINTS ANALYSIS

7.1 APPROACH AND METHODS

An environmental constraint, for the purposes of the assessment, is an environmental condition that reduces the capability of a site to accommodate development.

The biodiversity constraints operating at the Marilba Hills subject site have been classified and mapped using a 'traffic light' model to display areas of high, moderate and low constraint.

The constraint class maps consolidate a range of significant biodiversity values to enable project planners to avoid and minimise impacts. Suggested planning responses to the three constraint classes are indicated in Table 7.1 below.

Table 7-1 'Traffic light' constraint classes and recommended planning responses

Level of constraint	Colour	Recommended response
High constraint	Red	Impacts to these areas and habitat resources are difficult to offset and should be avoided
Moderate constraint	Orange	Impacts to these areas should be avoided or specific measures taken to mitigate impacts. Losses should be offset with similar or better condition examples
Low constraint	Green	No special mitigation measures required

7.2 APPLICATION TO THE PROPOSAL

A two-stage process was used to firstly identify and map key biodiversity constraints at the Marilba Hills site, and secondly modify the proposal in response to these constraints. The final proposal is the result of numerous minor and more significant modifications, including the relocation of proposed infrastructure such as tracks, powerlines, turbines and the substation.

7.2.1 Constraining values

Biodiversity values that constrain the suitability of the Marilba Hills site for wind farm development and which have been included in the constraints mapping include:

- box gum woodland Endangered Ecological Community
  - present in a range of condition classes; **poor and poor-moderate classes without tree cover represent low constraint**, poor and poor-moderate classes **with tree cover** represent moderate constraint, moderate and good condition classes represent high constraint.
- presence of threatened flora and fauna
  - three threatened bird species were recorded at the subject site - Speckled Warbler (cluster 4), Diamond Firetail (cluster 3 and 4); and Superb Parrot (cluster 4) and one threatened plant species was recorded - Yass Daisy (clusters 4, 6 and 7)

- woodland habitat supporting threatened species is considered a high constraint

- rare, limiting, potential threatened species habitats
  - rock outcrops, hollow-bearing trees (including dead trees) and woodland are key habitats present at the site.

7.2.2 Constraint classes

The constraining biodiversity values have been classified into the three constraint classes. Table 7.2 identifies the key biodiversity values and respective constraint class within the development envelope.

Note that the classification scale is relative, and specific to the particular combination of project characteristics and biodiversity values.

Table 7-2 Key biodiversity constraints within the development envelope

Biodiversity feature	Extent within envelope	Location	Constraint class
Vegetation types			
Box gum woodland EEC in moderate, moderate-good and good condition	527 ha with tree cover, 21 ha of diverse grassland derived from woodland	All clusters except 1. Cluster 7 has a 20 ha patch of diverse grassland derived from box gum woodland.	**High**
Box gum woodland EEC (with tree cover) in poor and poor-moderate condition	1275 ha	Cluster 1, 2 and 4. Localised patches of poor condition woodland also occur on ridge crest sheep camps.	**Moderate**
Native pasture (derived from box-gum woodland)	Total pasture: 2182 ha	The majority of cleared pasture areas at all cluster sites. While this vegetation is derived from woodland and has EEC status, diversity, integrity and habitat values are relatively low and similar vegetation is locally abundant.	**Low**
Exotic pasture and croplands	Not mapped	Occupies some lowland areas which may be affected by the powerline and access routes.	**Low**
Habitat features			
Threatened species habitat	-	Woodland remnants at clusters 3, 4, 6 and 7.	**High**
Hollow-bearing trees and mature paddock trees	Not all mapped	Present in all remnant woodland areas and as isolated living or dead trees in native pastures on ridges and in valleys	**High**
Rocky outcrops	Not all mapped	All ridge tops and side slopes within the development envelope	**Moderate**

7.2.3 Biodiversity constraint mapping

The constraint classes have been mapped for the subject site, together with the wind farm infrastructure to show areas of potential impact. The biodiversity constraint class maps are provided in Map Set 4. Constraint areas based on vegetation type and condition class have been extrapolated from survey plot data and air photographs.

7.3 PLANNING AND MODIFYING THE PROPOSAL

The constraint class maps provide a simple visual representation of areas key biodiversity values which may be impacted by the proposal. The maps also allow for the selection of alternative less constrained sites for development works.

Map Set 4 shows the main modifications to the proposal that have resulted from the constraints analysis and mapping process. Specific modifications that the proponent has made to the proposal in response to the analysis include:

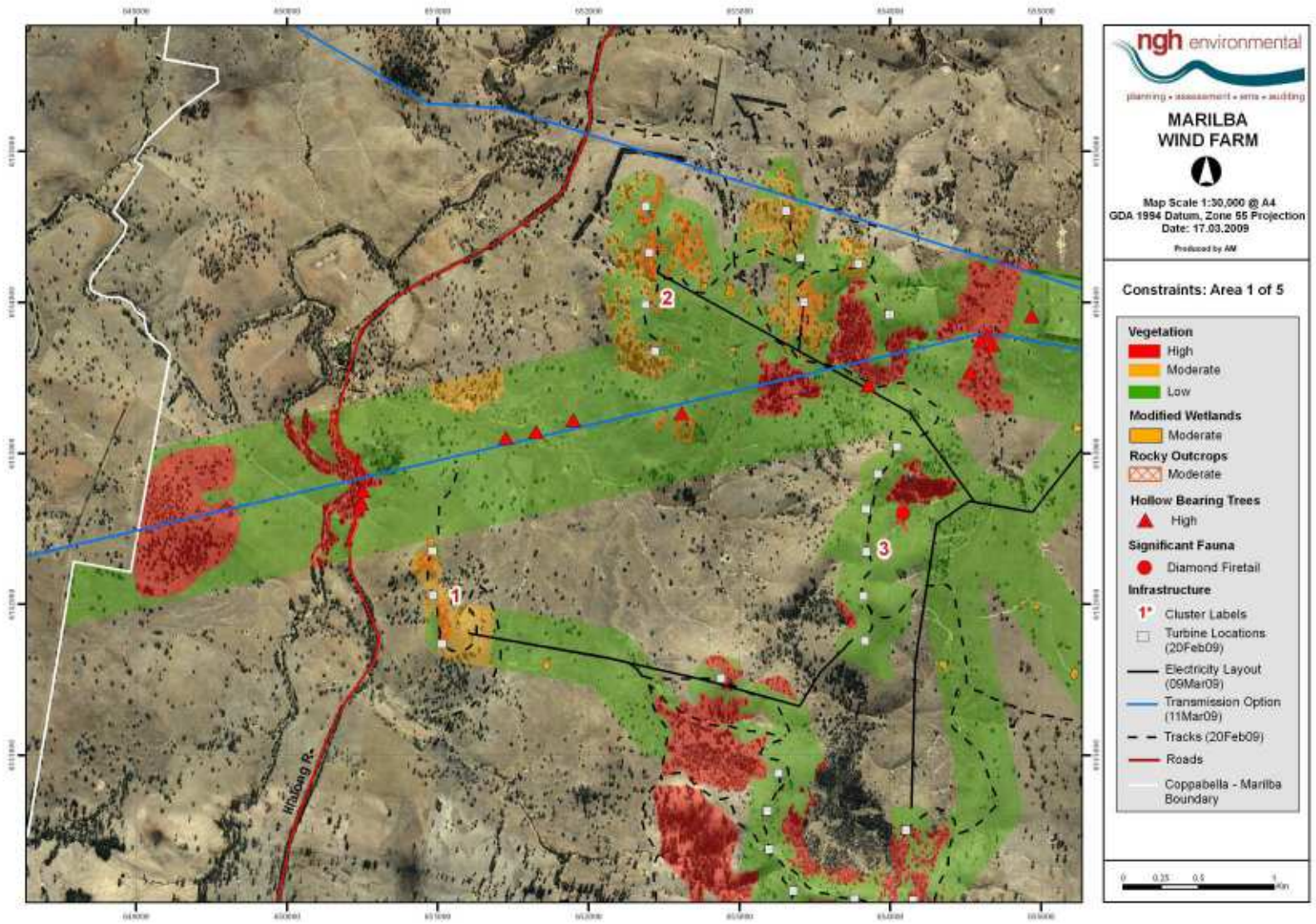
- locating the substation in cluster 7 within a disturbed treelot (low constraint) area to avoid a high constraint area (secondary grassland derived from box gum woodland, and Yass Daisy habitat)
- relocating access track routes to avoid moderate condition woodland at cluster 4a
- minimising the area of impact of turbine infrastructure at the cluster 6 site to avoid a high constraint area (box gum woodland and Yass Daisy habitat)
- modifying design and construction methods to minimise impacts to box gum woodland woodland in good condition in cluster 4b, including reducing the track width, siting to avoid the need for road battering, using the natural soil and vegetation surface, low impact clearing and trenching methods and rehabilitation with native grass species following the works
- routing the Coppabella – Marilba and Marilba – Carroll's Ridge powerline routes to avoid potential CEEC box gum woodland areas of large patch size, high tree density or with large mature or hollow-bearing trees. On the Weilora property, the route would be shifted 200-250 metres to the south to avoid CEEC areas if practicable.

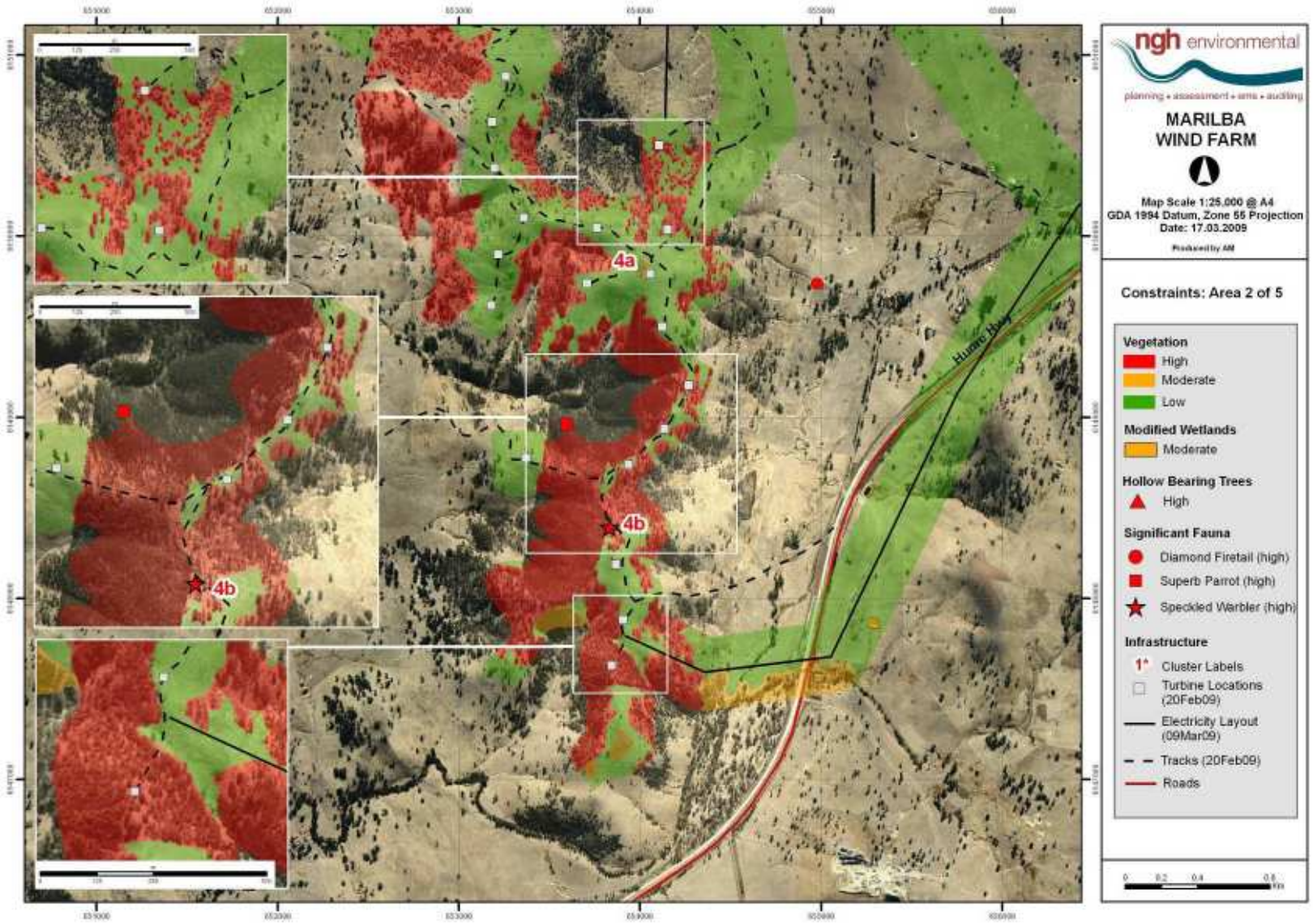
The process also highlights areas where project infrastructure would be sited close to constrained areas. These areas are indicated Map Set 4 and include:

- turbine and access track locations at clusters 4a, 4b and 7
- substation access track at near cluster 7.

Track widths would be reduced to 4.5 metres in these areas (topography and turning requirements permitting), and an ecologist would be used in the finescale planning of the location of infrastructure (refer also section 8 mitigation measures).

Map Set 4 - Biodiversity constraint classes and project modifications (5 maps in total)

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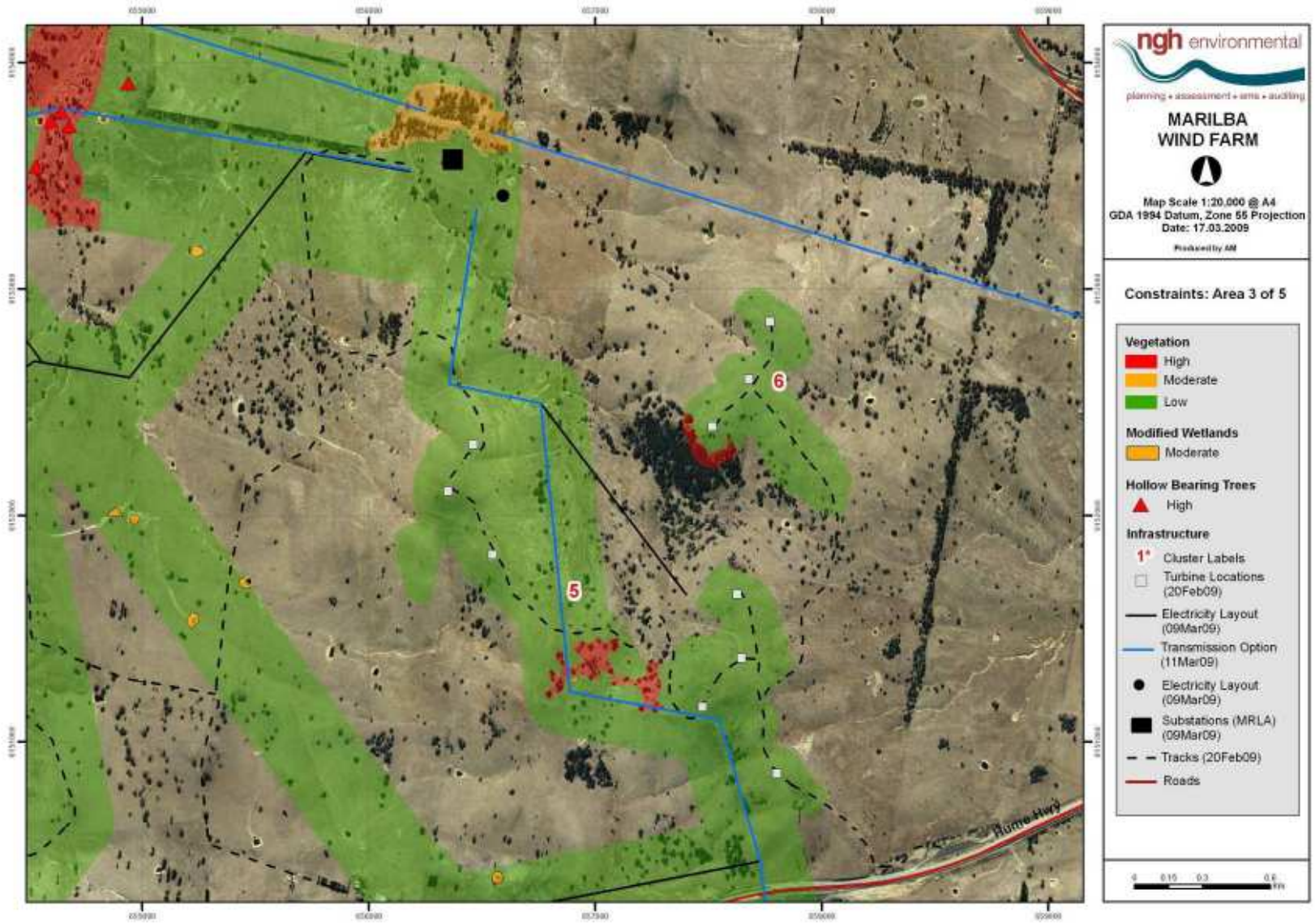
MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Constraints: Area 2 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Hollow Bearing Trees
High
Significant Fauna
Diamond Firetail (high)
Superb Parrot (high)
Speckled Warbler (high)
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
4a
4b
4b
Hume Hwy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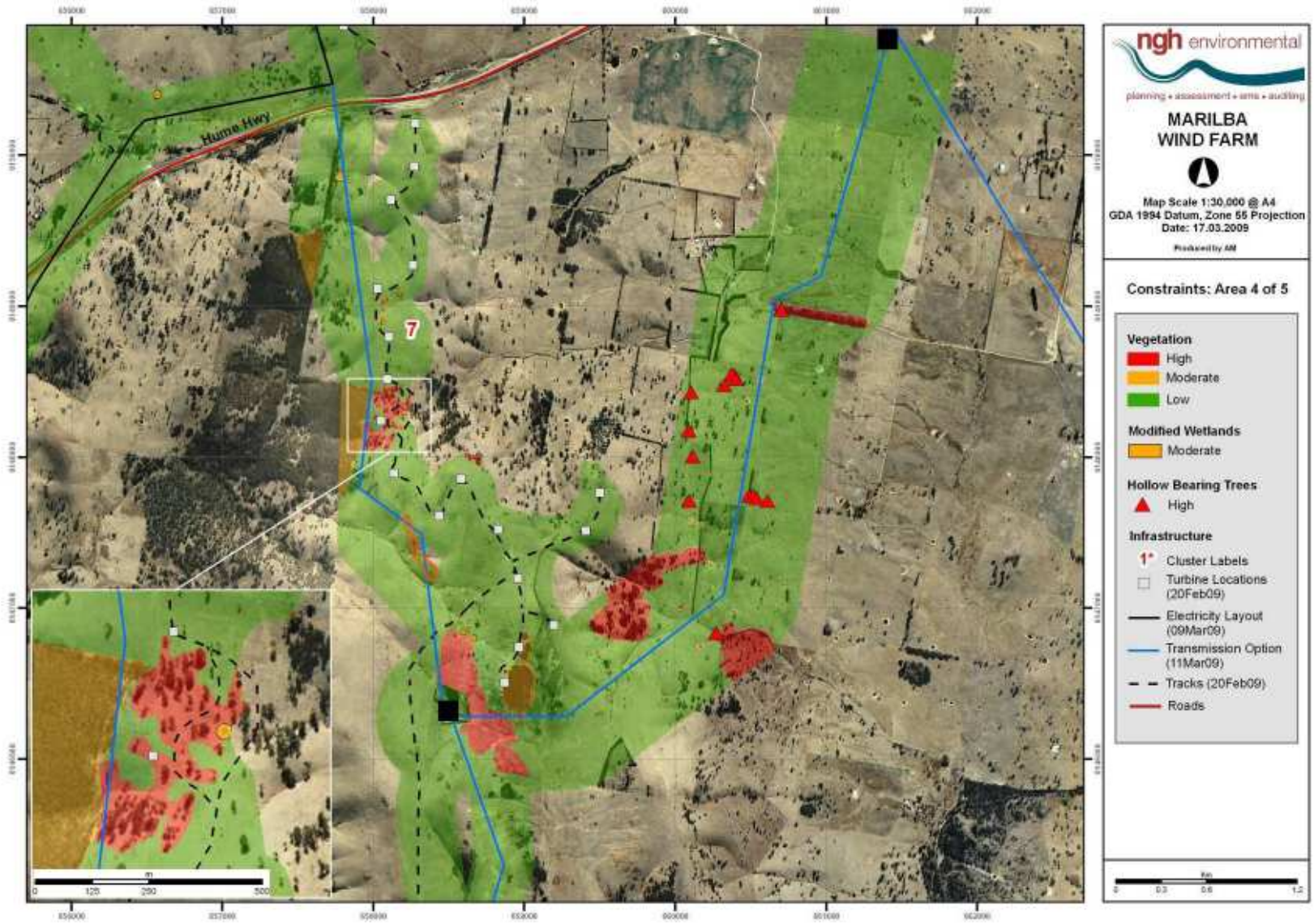
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Constraints: Area 3 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Hollow Bearing Trees
High
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
5
6
Hume Hwy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WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Constraints: Area 4 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Hollow Bearing Trees
High
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
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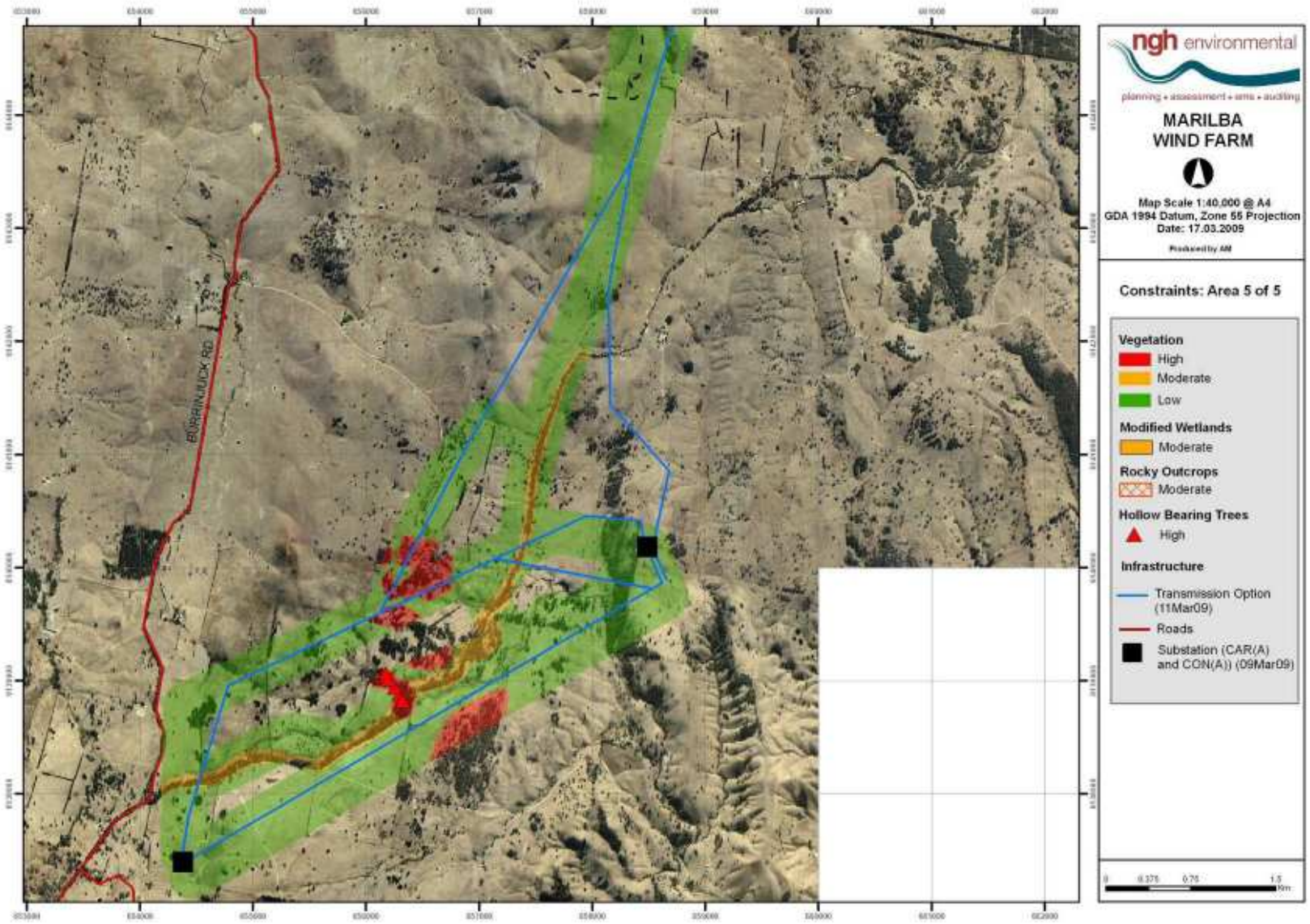
0 0.3 0.6 1.2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MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Constraints: Area 5 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Rocky Outcrops
Moderate
Hollow Bearing Trees
High
Infrastructure
Transmission Option (11Mar09)
Roads
Substation (CAR(A) and CON(A)) (09Mar09)

8 IMPACT ASSESSMENT AND MITIGATION

8.1 CONSTRUCTION IMPACTS

8.1.1 Flora and ecological communities

Direct impacts

The proposal would result in the removal of vegetation under the development footprint, including the turbine towers and surrounding hardstand areas, control building, substation, new and widened access tracks and powerline poles. This vegetation would be removed for the life of the wind farm (up to 30 years).

Underground cabling between turbines on the ridgelines would generally follow access tracks constructed to and between the wind turbines and other facilities. The route for the main onsite construction access track was not precisely determined at the time of assessment, but is assumed to be generally contained within the potential powerline survey corridors surveyed between the turbines and the potential substation sites. The actual track routes may move outside the powerline corridors in places to achieve design requirements.

The powerline between the substation and turbines would be constructed as an overhead cable on single wood or concrete poles approximately 17-22 metres high, spaced approximately 100–200 metres apart. Some temporary disturbance to vegetation would occur during construction of the powerline, and the poles would permanently displace a small area of groundlayer vegetation at their base. The powerline would require a cleared easement of 20 metres and would be located to minimise clearing of trees. Where possible, the powerline route would avoid remnant box gum woodland, particularly large paddock trees and linear remnants beside roads and watercourses.

Grass cover may be able to be restored over much of the permanent access routes running between the turbines to assist track stability and reduce runoff. It is proposed that a concrete batch plant would be located on an existing hardstand area at the Bogo Quarry on Paynes Road.

Estimates of permanent and temporary vegetation loss for each of the affected vegetation types are presented in Tables 8.1.

Table 8-1 Impact areas per vegetation community

Marilba Hills Precinct										
Infrastructure	**Quantity**	**Width (m)**	**Length (m)**	**Area (ha)**	**P**	**BGW**	**BGBPF**	**DSTF**	**LBDGF**	**BGWke**
Turbine footing [a]	66.00	25.00	25.00	**4.13**	3.25	0.82	0.06	0.00	0.00	0.00
Crane hardstand [c]	66.00	22.00	40.00	**5.81**	4.58	1.14	0.09	0.00	0.00	0.00
Crane operation area (includes footing and hardstand) [c]	66.00	50.00	50.00	**16.50**	13.00	3.25	0.25	0.00	0.00	0.00
Tracks [a]	1.00	8.00	63834.46	**51.15**	43.80	7.35	0.00	0.00	0.00	0.00
Underground powerlines onsite [c]	1.00	2.00	18330.43	**3.67**	2.92	0.75	0.00	0.00	0.00	0.00
Overhead powerline cabling / easement [b]	1.00	20.00	40031.00	**80.06**	40.52	37.89	0.21	1.44	0.00	0.00
Overhead power pole footings [a]	400.31	1.00	1.00	**0.04**	0.02	0.02	0.00	0.00	0.00	0.00
Substation and control bldg [a]	5.00	150.00	85.00	**6.38**	2.55	3.83	0.00	0.00	0.00	0.00
Concrete batch plant [c]	1.00	75.00	100.00	**0.75**	0.75	0.00	0.00	0.00	0.00	0.00
Construction compound, staging and storage [c]	1.00	300.00	100.00	**3.00**	3.00	0.00	0.00	0.00	0.00	0.00
Development envelope (DE)				**4140.00**						
Percentage of DE permanently removed				**1.81**						
Breakdown by impact type:										
a Permanent habitat loss (includes all footings and tracks)				**61.70**	49.62	12.01	0.06	0.00	0.00	0.00
b Habitat modification (transmission easement maintenance)				**80.06**	40.52	37.89	0.21	1.44	0.00	0.00
c Temporary habitat loss (areas that can be rehabilitated post construction)				**19.79**	16.42	3.18	0.19	0.00	0.00	0.00

P: Pasture, BGW: Box Gum Woodland, BGBPF: Brittle Gum – Broad-leaved Peppermint Forest, DSTF: Dry Shrub – Tussock Grass Forest, LBDGF: Long-leaved Box Dry Grass Forest, BGWke: Box-Gum Woodland – *Kunzea ericoides*

Based on these estimates, the proposed works would permanently remove up to 12 ha of box gum woodland; the areas impacted within each condition class are indicated in Table 8-2. Up to 1.47 ha of box gum woodland in good, moderate-good or moderate condition would be affected. Around 38 ha would be required to be maintained as transmission easement and 3.18 ha would be rehabilitated following construction. Woodland vegetation would be avoided using micrositing adjustments and route modifications where possible.

In addition, up to 50 ha of pasture would be permanently removed during construction of the turbines, access tracks and substation. The majority of this is likely to be native pasture in generally poor-moderate condition derived from box gum woodland vegetation types. Native pasture dominated by native grasses and derived from box gum woodland belongs to the box gum woodland EEC listed under the TSC Act (but not the EEC listed under the Commonwealth EPBC Act). Around 16.42 ha of pasture would be reinstated following removal of the construction facilities.

This vegetation belongs to the box gum woodland EEC listed under the TSC Act. The majority would not qualify as EEC under the Commonwealth EPBC Act. The proposal would involve the clearing of a small area of woodland in good condition in cluster 4b would form part of the Commonwealth EEC (refer Map Set 2). 0.25 ha would be cleared to provide a construction access track 4.5 metres wide and to install underground cabling in a 0-5-1 metre wide trench. Box gum woodland in good condition is very rare in the region and usually restricted to public reserves such as cemeteries, travelling stock reserves and roadsides with a light grazing history. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

Less than 1 ha of Brittle Gum - Broad-leaved Peppermint dry forest would be impacted by the construction of turbine, powerlines and tracks.

Some of the powerline routes will overlap with tracks, reducing the overall area of disturbance. In addition, low gradient sections of the inter-turbine access tracks may be reinstated with native grass cover following the works to reduce runoff and improve long term stability. Some powerline and access track routes have been modified to reduce the extent of impact on woodland vegetation (refer section 7).

Parts of the cluster 7 ridge, particularly areas on sedimentary geology, are derived from dry grass forest types (non-EEC). Some flatter lowland areas traversed by tracks and powerlines are likely to be dominated by exotic crop and pasture species.

Table 8-2 Maximum impact areas on Box Gum Woodland EEC[1] vegetation based on condition class and constraint level

Calculations are based on the indicative infrastructure layout provided by the Proponent.

Marilba Hills Precinct						
EEC	**Permanent habitat loss a within each condition class**					
	Good	**Moderate / good**	**Moderate**	**Poor / moderate**	**Poor**	**Total**
Box Gum Woodland	0.29	0.00	1.18	7.84	2.69	12.00

Marilba Hills Precinct			
EEC	**Permanent habitat loss [a] within each class**		
	High constraint EEC	**Moderate constraint EEC**	**Low constraint EEC**
Box Gum Woodland EEC	1.47	7.84	
Total area within the DE	527.00	1275.00	2182.00

[1] Box-Gum Woodland EEC includes both box-gum woodland and long-leaved box dry grass forest remnants. In general terms, poor and poor-moderate condition class EEC without tree cover (native pasture) represent low constraint, poor and poor-moderate classes with tree cover represent moderate constraint, moderate and good condition classes represent high constraint (refer Section 7). Condition classes are defined in section 5.1.2 of the Marilba Hills Precinct Biodiversity Assessment, Appendix 3.2.

Indirect and peripheral impacts

Vegetation surrounding the development footprint would be affected by vehicle access and parking, materials laydown and spoil deposition and retrieval. Peripheral impacts may include soil compaction, soil erosion and sedimentation. The works have the potential to introduce and spread weed species. The concrete batch plant and associated flush pit, if used, would alter local subsoil conditions over the medium term.

Pollution risks are associated with the use of concrete, fuels and lubricants and construction chemicals. With appropriate safeguards and practices (refer Environmental Assessment), these risks to native vegetation are expected to be low. Similarly, the increased bushfire risks to vegetation caused by construction activities are expected to be manageable and acceptable. Dust would be generated from the excavation and building activities at the construction sites, and by traffic using unsealed access routes, over the 6-9 month construction period. The limited duration of dust deposition is not expected to significantly affect soils and vegetation at the site.

Impacts on threatened species and communities

The impacts of the proposal on the threatened Yass Daisy (*Ammobium craspedioides*) and the Box-Gum Woodland Endangered Ecological Community are discussed in the Assessments of Significance presented in Appendices E and F.

Yass Daisy populations are located close to proposed works areas in the following locations:

- in remnant woodland on the western side of cluster 4a/4b
- in remnant woodland on the south-western side of cluster 6
- in secondary grassland west of cluster 7 (near potential substation sites).

Yass Daisy records in these habitat areas are shown in Map Set 2. The proposal has been modified so that turbine construction works would avoid impacts to these habitats (refer section 7). In particular, the proposed substation site beside cluster 7 has been relocated to a less sensitive site outside the Yass Daisy population. Special measures would be implemented to minimise impacts to good condition box gum woodland adjacent to the Yass Daisy colony in cluster 4b (refer section 8.1.5).

Sensitive areas adjacent to works would be clearly marked and protected from direct and indirect impacts during the construction phase. Where necessary, finescale development area boundaries would be identified with the assistance of an ecologist.

The Assessment of Significance also concludes that the proposal would not significantly impact on other threatened species which have potential to be present at the subject site, subject to mitigation measures and precautions to account for uncertainty identified below.

The majority of vegetation at the subject site falls within the Box-Gum Woodland EEC listed under the TSC Act. This includes:

- woodland and forest with relatively intact native understorey,
- woodland trees with depauperate understorey dominated by native grasses and with few native forb species and
- native pasture derived from box gum woodland.

The indicative distribution of these forms of box gum woodland at the subject site is shown in Map Set 2. The proposal would avoid disturbance to woodland and forest with intact native understorey and impacts to this vegetation are expected to be minor. Approximately 12 ha of degraded woodland in generally poor, poor-moderate and moderate condition and up to 50 of pasture derived from box gum woodland would be

permanently removed by the proposal. The Assessment of Significance (Appendix E) concludes that, in view of the condition of this vegetation, and the limited scale of the clearing, this impact is not expected to be significant.

The survey recorded four areas of box gum woodland have sufficiently high diversity or patch size to qualify as part of the Critically Endangered Ecological Community (CEEC) listed under the Commonwealth EPBC Act (at clusters 3, 4, 6 and 7). Woodland on the slopes beside cluster 3 is outside the area of impact and would be protected from indirect impacts or associated impacts such as access track construction. Treeless secondary grassland which is likely to be derived from box gum woodland near cluster 7 would be excluded from the proposal and protected during the works (refer Map Set 2).

Some areas within the Coppabella – Marilba powerline envelope also appear to belong to the Commonwealth CEEC, based on patch size (> 2 ha), tree density (>20 trees per hectare) and presence of regeneration. These areas are located across most of the width of the Weilora property, where the proposed route cuts across the southern end of the ridge with the northern-most turbine cluster on the Marilba site, close to where a small creek skirts the end of the ridge. A more southerly route would avoid most, if not all, such vegetation.

Since the groundcover is of low native species diversity even in areas which fit the CEEC definition, the main issue of concern is tree removal, particularly of large old trees with hollows, or of an age to begin forming hollows soon. Trees in better health would also be of greater conservation significance than trees severely affected by dieback, and Yellow Box or Blakely's Red Gum trees of greater significance than Long-leaved Box or Red Stringybark trees. Some CEEC may have to be traversed at the eastern-most gully crossing on the Weilora property, and the route of least tree density should be chosen. This constraint applies also to areas of the route which were not inspected, such as the western part of the Myrana property.

A small area of CEEC woodland with intact understorey and a regenerating Blakely's Red Gum tree layer in cluster 4b would be affected by construction vehicle access and the installation of underground cabling (refer Map Set 2). 0.25 ha would be cleared to provide a construction access track and 0.5-1 metre wide cable trench. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation* below. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works. It should be possible to install this infrastructure while maintaining the conservation values of the remnant. Impacts to the Commonwealth CEEC in this area are therefore not expected to be significant.

Conclusion

In view of the local abundance and degraded nature of vegetation affected by the proposal, the results of the threatened species evaluation and flora survey and the conclusions of the Assessments of Significance regarding impacts to threatened species and communities, the construction phase of the proposal is not expected to significantly affect flora and ecological community values.

Under the Commonwealth EPBC Act, an action is considered likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will reduce the extent of a community. The proposed clearing would reduce the extent of the box gum woodland CEEC at the subject site, and a referral to the Commonwealth Environment Minister will be made on this basis.

8.1.2 Fauna

Vegetation clearing

Based on the infrastructure layout in Figure 3.2, the proposed wind farm would permanently remove approximately 12 ha of box gum woodland habitat with tree cover in poor, poor-moderate and moderate condition. Additionally, around 38 ha of woodland would be affected by powerline easement maintainance.

Around 50 ha of pasture would be cleared during construction of the turbines, access tracks and substation. The majority of this is likely to be grazed native pasture in generally poor-moderate condition derived from box gum woodland vegetation types. Some of the powerline routes will overlap with tracks, reducing the overall area of disturbance. Some powerline and access track routes have been modified to reduce the extent of impact on woodland vegetation (refer section 7). Track widths would be reduced to 4.5 metres in constrained areas, where contours and turning requirements allow.

The cleared ridgetop habitats most affected by turbine construction are used by reptiles, birds, macropods, rabbits and microbats. This habitat is generally not high quality and is abundant throughout the district. The minor areal losses are not expected to significantly affect any local fauna population. The proposed wind farm is not expected to result in the loss of substantial microbat roosting habitat at the site, or substantially alter flyways or prey sources. This conclusion is provisional, subject to the findings of a more detailed specialist assessment that will form an attachment to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

The size and integrity of larger remnants at the subject site are critical to the persistence of some woodland species, including the threatened Speckled Warbler. The works would avoid impacts to the large remnant on the western side of cluster 4, where two threatened woodland bird species and areas of woodland in good condition were recorded.

A small area of woodland with intact understorey and a regenerating Blakely's Red Gum tree layer in cluster 4b would be affected by construction vehicle access and the installation of underground cabling (refer Map Set 2). 0.15 ha would be cleared to provide a 350 metre long and 4.5 metre wide access track and 0.5-1 metre wide cable trench. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation* below. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The relatively narrow disturbance corridors of clearing required for the proposal is not likely to significantly add to existing habitat fragmentation at the subject site.

As far as possible, the powerline routes would be sited to avoid mature woodland eucalypts on the lowland sections, and larger forest remnants on sideslopes. Isolated hollow-bearing trees in particular may be important and uncommon habitat resources in modified landscapes.

Removal or degradation of offsite roadside habitats

Some sections of roads accessing the site (such as Illalong Road) may require lopping or pruning of roadside trees to accommodate large construction vehicles. Roadside remnants frequently contain old hollow-bearing trees and provide movement corridors for woodland species. Illalong Road carries some heavy vehicle traffic and may not require extensive clearing. A traffic study would be completed for the wind farm which would identify trees requiring pruning. Graces Flat Road would not be used for construction access to cluster 7 to avoid impacts to roadside box gum woodland habitats.

Following the construction period, any branches removed would be allowed to regrow. The branch pruning impacts required for the wind farm is not expected to be significant. Where hollows are required to be removed, these should be replaced by nest boxes of similar size in nearby trees.

A final site inspection should be carried out after road and electricity easements are finalised, to ensure that threatened species habitat and EEC vegetation has been avoided and identify any required mitigation measures.

Wetland and riparian habitats

Wetland and riparian areas at the subject site generally provide poor quality fauna habitat. These sites do however contribute to habitat diversity and provide water sources for a range of species. If dams are removed during site development works, alternative watering points should be established to compensate for their loss.

Dust, noise, vibration, visual disturbances and vehicle collision risks

The dust, noise, vibration and activity associated with the 6-9 month construction phase at the construction sites and along the access routes may affect the foraging behaviour of local fauna species, particularly birds and macropods. Given the local abundance of similar habitat, this temporary effect on habitat utilisation is not likely to significantly affect local populations of these generally highly mobile species. Since construction would occur principally during daylight hours, nocturnal and crepuscular species are unlikely to be affected by construction activity. Standardised access routes, low speeds (max. 40km/hr) and temporary destocking of paddocks would reduce the risk of vehicles colliding with stock or native fauna during the construction period.

The threatened Superb Parrot has been shown to be particularly vulnerable to vehicle collisions after feeding on roadside grain spills (Sydney Morning Herald 4 January 2009). Several Superb Parrot sightings were recorded along Illalong Road during the survey, a sealed road located west of the subject site. Contractors and staff would be made aware of this issue and would limit driving speed on Illalong Road and Burley Griffin Way to 80 kph and report any grain spills to DECC.

Pollution risks

The construction activities using concrete and the storage and use of fuels, lubricants and construction chemicals carry a pollution risk for aquatic habitats. These risks are considered acceptable and manageable using appropriate safeguards and practices (refer Environmental Assessment).

8.1.3 Cumulative impacts

The Marilba Hills Wind Farm project forms part of a wider proposal including wind farm sites at Coppabella Hills to the west and Carroll's Ridge to the south. Together, the Coppabella Hills and Marilba Hills wind farms involve:

- the construction of up to 152 turbines, approximately 130 kilometres of access tracks and 54 kilometres of powerlines
- the permanent removal of up to 23.33 ha of box gum woodland with tree cover (generally in poor, poor-moderate and moderate condition).

In the context of the wider study area, this level of habitat loss in not considered significant in areal terms.

8.1.4 Offsetting

In order to meet the 'maintain or improve' test for biodiversity values, the proposal may be required to provide for the long term protection of areas of native vegetation as offsets for the clearing required by the works. Offsetting would be subject to a further process of assessment and planning.

A Habitat Restoration Plan covering the study area would be useful in determining priority areas and actions for recovering threatened species and communities. One aim for selecting offset areas should be to improve the size, integrity and connectivity of existing high value remnants, such as the cluster 4 remnant.

8.1.5 Impact avoidance and mitigation

Further pre-works survey and assessment

- If the dry forest remnant in the far south of cluster 7 would be impacted by the proposed works, another targeted survey for the Burrinjuck Spider Orchid would be undertaken in mid-October. If found to be present at the site, works would be re-sited to avoid impacting this species.
- If the secondary grassland on the south-western side of cluster 7 would be substantially impacted, such as by the construction of an access track, powerline or substation, a spring survey would be undertaken targeting threatened grassy woodland species.
- A final site inspection should be carried out after road and electricity easements are finalised, to ensure that threatened species habitat and EEC vegetation has been avoided and identify any required mitigation measures.
- A referral to the Commonwealth Environment Minister will be made to obtain approval for clearing within the area of box gum woodland CEEC at the cluster 4b site.

Microscale site selection

- An ecologist will assist with the finescale siting of the development in sensitive areas such as around the substation site at cluster 7 and the cluster 4 remnant to avoid and minimise impacts to the significant biodiversity values associated with these sites.
- The access track through the small area of good condition box gum woodland in cluster 4b (refer Map Set 2) would be sited on the level part of the ridge crest to avoid the need for road battering. The track would coincide with the powerline route through this vegetation.
- Approach routes to the subject site should be selected to minimise the need to clear or trim remnant eucalypts along local roads such as Illalong Road and Grace's Flat Road, since most of this vegetation falls within the Box-Gum Woodland EEC definition and is likely to be significant for threatened fauna species such as Superb Parrot.
- Powerline and access track routes, and turbine sites should be selected to avoid forest and woodland remnants and individual mature and hollow-bearing trees (refer Map Set 3), which provide habitat for threatened fauna and potential seed sources for future site rehabilitation.
- The Coppabella – Marilba and Marilba – Carroll's Ridge powerline routes should also be selected to avoid potential CEEC box gum woodland areas of large patch size, high tree density or with large mature or hollow-bearing trees wherever possible (refer Map Set 4). On the Weilora property, the route should be relocated to the south to avoid CEEC areas. If areas of box gum woodland of large patch size and/or high tree density would be impacted by powerline clearing, a further approval from the Commonwealth to impact the box gum woodland CEEC may be required under the EPBC Act.
- Powerlines would be routed to avoid the moderate-good condition box gum woodland remnant and Diamond Firetail habitat near cluster 3 (refer Map Sets 2 and 3).
- All proposed works would be sited outside known Yass Daisy population areas and Commonwealth-listed CEEC areas, with the exception of the cluster 4b remnant.
- The cluster 4 woodland remnant would be protected from peripheral and indirect impacts and would not be used for site access or materials/equipment laydown. Contractors and staff will be made aware of the significance and sensitivity of the remnant.

Design and construction

- The identified Yass Daisy populations located close to the proposed works areas

- in remnant woodland on the western side of cluster 4a/4b
- in remnant woodland on the south-western side of cluster 6
- in secondary grassland west of cluster 7 (near potential substation sites)

would be clearly marked during construction and protected from the direct and indirect impacts of the proposal (refer Map Set 2). Contractors and staff will be made aware of the significance and sensitivity of these areas.

- Work sites adjacent to the Yass Daisy colonies would be revegetated with native tussock grasses to provide continuing potential habitat for this species.
- Track construction and powerline corridor impacts in the small area of good condition box gum woodland in cluster 4b would be minimised by:
  - siting the track on the level part of the ridge crest to avoid the need for road battering
  - minimising the track width (to 4.5 metres)
  - retaining the natural vegetation and soil as the driving surface (the track would not be bulldozed)
  - removing young trees and shrubs from the driving surface and powerline corridor using a chainsaw, and treating cut stumps with glyphosate herbicide (using a brush or applicator)
  - installing the powerline as an underground cable. Topsoil and subsoil removed from the trench would be placed on either side of the trench on geotextile fabric. The trench would be revegetated with locally native grasses following the works (such as Weeping Grass, Wallaby Grasses and Kangaroo Grass).
- The other recorded areas of box gum woodland forming part of the Critically Endangered Ecological Community listed under the Commonwealth EPBC Act (beside clusters 3, 4, 6 and 7 – refer Map Set 2) would be clearly marked during construction and protected from the direct and indirect impacts of the proposal. Contractors and staff will be made aware of the significance and sensitivity of these areas.
- In areas dominated by exotic groundcover species, exposed soils in the excavation corridor will be lightly mulched with chipped vegetation or sterile hay, and sown with a cover crop such as oats or millet, depending on season and seed availability, or an appropriate pasture seed mix (in consultation with landowners).
- In areas dominated by native grasses, exposed soils will be lightly mulched with chipped native vegetation or sterile hay, and sown with Weeping Grass (*Microlaena stipoides*) and/or Wallaby Grass (*Austrodanthonia* spp), or a cover crop such as oats or millet, depending on season and seed availability. In such areas, seed-bearing native pasture hay could be used for mulching, depending on availability.
- Fertiliser will not be used to promote revegetation in native grass-dominated areas of the site to reduce weed pressures.
- The development sites will be inspected for weeds prior to the commencement of works, in consultation with the Southern Slopes County Council. Noxious weeds in the vicinity of the works site will be treated prior to the commencement of works, subject to seasonal factors.
- Contractors and staff would be made aware of the potential risk of vehicle collision to the threatened Superb Parrot feeding on spilt grain beside local roads, particularly Illalong Road and Burley Griffin Way. Staff and constractors would limit driving speed on Illalong Road to 80 kph and report any grain spills to DECC.
- Where cement is included in cable trench backfill, at least 20 centimetres of cement-free topsoil will be replaced as the top layer in the backfill.
- Where practicable, grass surfaces will be retained or restored on infrequently used vehicle routes.

- Site stabilisation, rehabilitation and revegetation will be undertaken without delay, following the rehabilitation guidelines in the EA.
- Works will avoid impacts to mature eucalypts wherever possible. Wherever practicable, excavations and vehicle/machinery movements will occur outside the canopy dripline of large eucalypts.
- As a general rule, disturbed areas will be used for vehicle and machinery access, materials laydown, stockpiling of cleared vegetation and the deposition and retrieval of spoil whenever practicable.
- Works will be avoided during, and immediately following heavy rainfall events to protect soils and vegetation at the site.
- Any compaction of soil resulting from vehicle access and laying of materials, particularly during saturated soil conditions, will be avoided and remediated as necessary.
- Excavated topsoil, subsoil and weathered rock will be stored separately and replaced in a manner that approximates the original profile as closely as possible.
- Where practicable, whole sods will be removed with an excavator where these areas are well-vegetated with dense root systems. Sods will be stored in moist, shaded conditions and replaced following the works. Sod storage time will be minimised and sods will be replaced in a manner that maximises the chances of re-establishment.
- Appropriate fire fighting equipment will be held on site when the fire danger is high to extreme, and a minimum of one person on site will be trained in its use.
- Machinery and vehicles used in construction works will be washed before and after site access to reduce the introduction and spread of weeds and pathogens.
- Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds wherever practicable.
- Weed monitoring will be carried out at all sites after the completion of construction works and ongoing weed control will occur where noxious or invasive species are recorded. In particular, monitoring will be undertaken during the following late spring/early summer, and remedial action taken as required.
- Only certified weed free hay bales will be used for sediment control, if available.
- Imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or *Phytophthora* infection.
- Where tree hollows are required to be removed, these should be replaced by nest boxes of similar size in nearby trees.
- If dams are removed during site development works, alternative watering points should be established to compensate for their loss.

8.2 OPERATIONAL IMPACTS

8.2.1 Flora and ecological communities

The operational impacts of the proposal may include alteration to the prevailing grazing regime at the turbine sites, and some alteration to native fauna use of the sites.

Inspection, maintenance and monitoring visits would be required, although existing farm and construction tracks would be used and impact on vegetation is expected to be minimal. Access tracks would be maintained to minimise ongoing erosion and sedimentation impacts. The maintenance program would also include regular inspections for weed and rabbits, and control as required.

The impacts of major repairs would be similar in nature to construction impacts, but more limited in extent. The proposal would produce an ongoing pollution risk from the oil-cooled substation; design measures have been incorporated to ensure that any spill would be contained by bunding and treated expeditiously.

The operational impacts of the proposal on vegetation are not expected to significantly affect flora and ecological community values.

8.2.2 Fauna

General

The key operational impacts of the proposal relate to the operation of the wind turbines. The potential bladeswept area of the turbines would range from 34 to 150 metres above the ground. Generally the turbines begin rotation when the wind speed reaches 4 metres/second and shut down at 25 metres/second (or around 90km/h). The impacts of the wind farm would be most acutely felt by those species utilising aerial habitat within the bladeswept zone. At the Marilba Hills subject site, this fauna belongs to two groups; birds and microchiropteran bats.

Terrestrial fauna may be affected by turbine noise and blade flicker, although, given the low terrestrial fauna diversity and abundance at the site, these impacts are not likely to be significant.

A review of research literature and monitoring data relating to bird and bat impacts of wind farms and a discussion of monitoring and impact management options is presented in a specialist microbat report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009). The Biodiversity Assessment draws on this study where relevant.

Birds

Impact risk assessment

Impact risk assessments have been undertaken for bird species from vulnerable groups - raptors, waterbirds, migratory and threatened species - recorded at the subject site, or with potential to use habitat at the site. The risk assessment is provided in Appendix D.

The bird impact risk assessment identifies and evaluates risks posed by the proposed wind farm development at the subject site in terms of:

- collision with wind turbines, or 'bladestrike'. For these purposes, 'bladestrike' refers to mortality caused by direct collision with turbine blades and by birds being swept down by the wake behind a turbine blade; and
- habitat loss or avoidance caused by the presence of the turbines and associated infrastructure.

The risk assessment incorporates all species listed as threatened or migratory under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* which have been recorded in the relevant CMA sub-regions or are included on the EPBC Act Matters of National Environmental Significance search report.

A preliminary risk matrix has been used to identify threatened species which are at particular risk from operational impacts of the wind farm. An impact risk rating is allocated to each species, derived from the cumulative scores of eight risk factors, including likelihood of presence at the subject site and behavioural traits. Threatened species with high cumulative risk scores are included in the relevant Assessments of Significance of the potential impacts in Appendices E and F.

Species from vulnerable bird groups are included in a qualitative assessment of risk (refer Appendix D); the results of this assessment are summarised in Table 8.4 below. Assessments of likelihood and consequence are combined to produce an overall risk assessment of low, moderate or high risk for selected species. Likelihood

incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and bladestrike in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status. A distinction is drawn between the significance of impacts to individual birds at the site and impacts to the wider population.

The risk assessment is based on the proposed works described in section 4 and the expected vegetation and habitat loss quantified in sections 8.1.1 and 8.1.2. Importantly, the assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 identified in section 8.1.5.

The assessment draws on the Interim Standards for Risk Assessment relating to birds and wind farms (Brett Lane and Associates 2005) and the Australian Standards for Risk Assessment (AS/NZS 4360) and Environmental Risk Management (HB203:2000).

Table 8-3 Overall impact risk for vulnerable bird groups (bladestrike and habitat impacts)

Species	Risk to individuals at site	Risk to population
Raptors		
Wedge-tailed Eagle (*Aquila audax)*	Moderate	Moderate-high
Little Eagle (*Hieraaetus morphnoides*)	Moderate	Moderate
White-bellied Sea-eagle (*Haliaeetus leucogaster)*	Low	Low
Australian Kestrel (*Falco cenchroides)*	Low-moderate	Low
Square-tailed Kite (*Lophoictinia isura*)	Low-moderate	Low-moderate
Brown Falcon (*Falco berigora*)	Moderate	Low-moderate
Peregrine Falcon (*Falco peregrinus*)	Low-moderate	Low
Australian Hobby, Little Falcon (*Falco longipennis*)	Low-moderate	Low
Spotted Harrier (*Circus assimilis)*	Moderate	Low
Barking Owl (*Ninox connivens*), Barn Owl (*Tyto alba)* and other owl species	Low-moderate	Low-moderate
Tawny Frogmouth (*Podargus strigoides)*	Low	Low
Threatened species (passerines and parrots)		
Diamond Firetail (*Emblema guttata)*	Low	Low
Speckled Warbler	Low	Low-moderate
Regent Honeyeater (*Xanthomyxa phrygia*)	Low-moderate	Low-moderate
Superb Parrot (*Polytelis swainsonii)*	Low-moderate	Low-moderate
Swift Parrot (*Lathamus discolor)*	Low-moderate	Low-moderate
Gang-gang Cockatoo (*Callocephalon fimbriatum)*	Low-moderate	Low-moderate
Waterbirds and migratory species		
Painted Snipe (*Rostratula benghalensis*)	Low	Low
Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*)	Low	Low
White Ibis (*Threskiornis molucca*)	Low-moderate	Low
Australian Wood Duck (*Checonetta jubata)*	Low-moderate	Low
White-faced Heron (*Ardea novaehollandiae)*	Low-moderate	Low
White-throated Needle-tail, Spine-tailed Swift (*Hirundapus caudacutus*)	Low-moderate	Low
Satin Flycatcher (*Myiagra cyanoleuca*)	Low-moderate	Low

Raptors

Six raptor species were considered to be at moderate or moderate-high risk at the individual level; Wedge-tailed eagle, Little Eagle, Australian Kestrel, Brown Falcon, Australian Hobby and the Spotted Harrier. Two species were assessed to be at moderate or moderate-high risk at the population impact level; Wedge-tailed Eagle and the Little Eagle. These raptor species typically construct stick nests in eucalypts, and soar over open country at turbine blade height. Both are likely to be dependent on rabbits as a local food source. These raptor species are frequently recorded close to human development, and are likely to be able to habituate to the proposed wind farm over time. A Californian study shows a similar number of raptor nests before and after wind plant construction (Howell and Noone 1992 in Strickland 2004). Raptor populations have also been found to co-exist with turbines at Australian wind farms, including at Codrington (Biosis Research Pty Ltd 2002, Wonthaggi EES Panel 2003), Toora (Brett Lane and Associates 2005), Crookwell (URS 2004) and Woolnorth (Hydro Tasmania 2003).

Compared to larger raptors with extensive breeding territories, such as the Wedge-tailed Eagle, the Brown Falcon, Australian Hobby and Spotted Harrier have higher reproductive rates and are more abundantly distributed. Risks to the Wedge-tailed Eagle at the site are discussed in the case study in Box 8.2. Given the low frequency of recorded collisions at existing Australian wind farms, it is unlikely that the bladestrike impacts of the proposed wind farm would create a continuing population sink for the regional Wedge-tailed Eagle population. However, the alienation of ridgetop hunting resources may have more pervasive consequences for this species.

For most species, the proposal area is unlikely to provide limiting, uncommon or significant habitat. In view of the substantial buffer distances involved, the wind turbines are not expected to alter habitat utilisation rates on neighbouring farmland, remnant woodland and wetlands.

In the case of the Wedge-tailed Eagle (refer Box 8.2) and possibly the Little Eagle, the high ridge habitat may provide an important updraft hunting resource and food supply (rabbits). The loss of this habitat may not affect existing birds but, if the area forms part of a breeding territory, it may affect breeding success over the longer term. The precise impact of habitat alienation on the local eagle population is difficult to predict. Further pre-works investigations are required to determine if nests are located near the subject site, and operation-phase monitoring will be required to record bladestrike mortality, habitat avoidance and impact on breeding success.

Waterbirds

No waterbirds or migratory wetland species were assessed as being at moderate or high risk at either the individual or population level (refer bird and bat impact risk assessment Appendix D). Of the waterbirds, species which fly at night, fly at blade height or which form large circling flocks are likely to be at greatest risk of bladestrike.

Overseas studies have shown that some waterbird species are able to perceive and avoid turbines, both during the day and at night (Erickson *et al*. 2001). At Crookwell, property owners noted that waterbirds have habituated to large man-made structures such as powerlines and demonstrate collision avoidance tactics in their flight patterns (URS 2004). Because of this capacity to avoid turbines, the US National Wind Coordinating Committee (2000) considers waterbirds to be at lower risk from bladestrike than some other groups.

In studies of bird mortalities from colliding with powerlines in the Hunter Valley, the species most at risk were found to be those with large bodies and awkward flight characteristics, species which fly in tight and/or fast-moving flocks and night-flying species (Hunter Wetlands Research 1996 in URS 2004). In this case, powerlines were located close to a major roosting/nesting site, and 12-42 metres above the ground. Pelicans, White Ibis and Swans were most affected.

The subject site is not located between significant habitat areas and bird movements across the site may be diffuse and irregular, rather than concentrated and seasonal. Ibis and other waterbirds may travel between Lake Burrinjuck and the large waterbodies in Canberra. Some species, including White Ibis, White-faced Heron and ducks, would also be expected to disperse to forage in farmland north of Lake Burrinjuck, including the study area.

Few waterbirds were recorded at the site during the survey owing to poor habitat quality and the continuing drought. Short-range foraging journeys by waterbirds from core habitat areas may follow chains of small seasonally available wetland habitats scattered over the lowland areas of the district. However, the highly ephemeral nature of lowland dam resources in the study area (Keith Smith, 'Ryalda' pers. comm.) limits their ability to support aquatic and riparian vegetation and hence their food resource value for waterbirds.

Major migration routes for these species are not known. Longer range migrations may involve crossing high ridges at blade height or higher, but the frequency of this occurring at the subject site is likely to be low. Most Australian species are classified as only partial migrants (Dingle 2005), which vary their routes according to

ephemerally available resources. Blade collisions are therefore expected to be rare. The proposal is not considered likely to significantly affect waterbird species at the population level.

While the seasonal and diurnal migration routes for bird species at the site are not known, the subject site is not expected to present a significant migration corridor for waterbirds and woodland species. The site does not appear to lie between significant and localised habitat areas where large numbers of birds congregate. Migration patterns of waterbirds and other species over the site are likely to be diffuse, reducing the risk of catastrophic or frequent collision events. Risks to local bird populations from altered migration patterns are assessed as low.

Terrestrial migratory and woodland birds

No migratory or threatened woodland bird species were assessed as being at moderate or high risk at either the individual or population level (refer bird and bat impact risk assessment Appendix D). Three threatened woodland species were recorded at and near the subject site; the Superb Parrot, Speckled Warbler and the Diamond Firetail. These species may use habitat in and around the development envelope for nesting and foraging. However, foraging and nesting behaviour and migration movements are likely to be concentrated well below the bladeswept area, and more frequent in woodland remnants and lowland areas located outside the area of impact.

Birds moving at tree canopy height through roadside woodland corridors and between other lowland remnants are unlikely to be affected by the wind turbines located on adjacent ridges. These species are considered to be at low and low-moderate risk from the construction and operation of the wind farm.

Bird bladestrike impacts

The proposed wind turbines have the potential to cause mortalities in local bird populations due to collision with turbine blades or being swept down by the wake behind a turbine blade.

Biological, environmental and design factors which may affect risk by contributing to either the likelihood of bladestrike, or the significance of the consequence of bladestrike are discussed in Box 8.1, below.

Cumulative bladestrike risk modelling

Biosis Research Pty Ltd, on behalf of the Commonwealth Department of Environment and Heritage, recently completed an assessment of the cumulative wind farm collision risk for threatened and migratory birds (Biosis Research 2006). The study involved cumulative risk modelling for four threatened species (the Orange-bellied Parrot, Tasmanian Wedge-tailed Eagle, Swift Parrot and White-bellied Sea-eagle) and a preliminary risk assessment for 34 bird species with potential to occur at wind farm sites in Gippsland, Victoria. 39 operating and planned wind farms in south-east Australia were used in the assessment, including Crookwell, Gunning and Taralga on the Southern Tablelands.

The modelling took into account turbine number and size, local population size and density, duration of residency and the ability of birds to actively avoid collision with turbines. Avoidance rates are expressed as a percentage of flights made by a bird in which the bird takes no evasive action to avoid collision. Directly observed avoidance rates have been documented as 100% for a range of species at Codrington, Victoria, including the Wedge-tailed Eagle, Brown Goshawk, Nankeen Kestrel, Swamp Harrier, Brown Falcon, Richards Pipit, Magpie-lark, Magpie, Raven, Straw-necked Ibis, White Ibis, Egret spp. and White-faced Heron (Meredith *et al.* 2002). Calculated avoidance rates at Codrington – taking recorded mortalities into account – showed a reduced rate for the Magpie (99%) and Brown Falcon (>95%) (Meredith *et al.* 2002). The cumulative risk modelling applies three collision avoidance rates; 95%, 98% and 99%.

Swift Parrot

Wind farms are generally sited in cleared areas which would not provide quality habitat for the Swift Parrot. This highly mobile species may however traverse wind farm sites moving between habitat areas. It is considered that a bird species with the flight characteristics of the Swift Parrot would be likely to have an actual avoidance rate

of around 99% (Biosis Research 2006). While collision risks would increase during very windy or foggy weather, this species is unlikely to be active during these conditions.

The model assumed 10 annual movements of birds per annum through the Crookwell, Gunning and Taralga wind farms, and assumed a population size of 10 birds for Gunning and Taralga, and 2 for Crookwell. 25% of flights were conservatively assumed to be within the bladeswept zone. The modelled average annual number of deaths due to turbine collision at these wind farms is less than 0.01452 all cases. The cumulative total of deaths for all of the 39 wind farms modelled is small; between 0.08 and 0.13 birds per annum. This equates to slightly more or less than a single parrot being killed every ten years.

Tasmanian Wedge-tailed Eagle

The cumulative bladestrike collision risk of eight wind farms on the Tasmanian Wedge-tailed Eagle were modelled by Biosis Research (2006) for each of the three given avoidance rates. For the 95% avoidance rate, the predicted annual cumulative mortality rate is 0.1898. This would increase the mortalities of the entire Tasmanian population by 2.5 birds per annum. For 98% avoidance rate, mortalities would increase by 1.4 birds per annum. At 99% avoidance rate, mortalities would increase by approximately 1 bird per annum. The actual avoidance rate is considered to be 99% or higher, and hence the cumulative effects of the wind farms is likely to be one bird per annum (Biosis Research 2006).

The assessment concluded that while the cumulative impacts of collision would be negative, the impacts would be very small and it is highly likely that these effects would be masked by normal fluctuations in the population due to natural variables. A population viability analysis also found that a significant increase in extinction risk would only occur if impacts were five times the predicted level. Refer also *Australian experiences*, below.

Gippsland species preliminary risk assessment

A preliminary assessment of risk to 34 EPBC Act listed species with potential to occur in the vicinity of five operating or planned Gippsland wind farms was recently undertaken by Biosis Research (2006). Species assessed included migratory wetland species, including Lathams Snipe, and the White-throated Needletail. The assessment concludes that collision impacts are likely to be low or negligible for all of these species. It is considered that a very small proportion of the Australian population of these species would ever move through a wind farm site and that, if they do enter a wind farm, they would be likely to actively avoid collisions or fly outside the bladeswept zone (Biosis Research 2006).

Box 8.1 Bladestrike risk factors for birds

A number of factors may operate which affect risk by contributing to either the likelihood of collision with blades, or the significance of the consequences of bladestrike. These factors may be related to particular species, sites or development designs.

Behavioural traits and biology/physiology

Aspects of bird biology and behaviour which may add to bladestrike risk include:

- foraging, courting or migration behaviour at potential bladeswept area height;
- flying during periods of reduced visibility, such as during fog or low cloud or dusk/night travel;
- flocking behaviour, particularly large and/or tight flocking patterns;
- period of residency;
- an inability to see moving blades ('motion smear').

The capacity of birds to 'habituate' to turbines may vary between species. Some species groups appear disproportionately vulnerable to bladestrike. Northern hemisphere studies point to three groups which are most vulnerable to bladestrike; gulls, raptors and migrant songbirds (Airiola 1987 in Canada Bird Studies 2001).

Population factors and conservation status

Species which are rare or declining, or which are naturally distributed at low density (such as top order raptors) may be at greater risk because, while collision rates may be low, each mortality has high significance. Similarly, species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk of significant impacts from blade collisions at the population scale. Species which are very abundant may have a higher frequency of bladestrike, but this impact as a proportion of the total population may not be significant and risk therefore would be considered low.

Local weather patterns

Many studies have shown that poor weather conditions increase the occurrence of turbine collisions (Canada Bird Studies 2001). Weather conditions which reduce the ability of birds to perceive the turbine blades or avoid collisions (such as fog and strong gusty winds) add to risks for susceptible species. Hence, sites which experience these conditions at higher frequency may be correspondingly riskier for these species.

Relative location of habitat and prey sources

The relative location of key habitat areas (such as updraft zones, prey populations, wetlands and nesting sites) and natural diurnal and seasonal migration routes also affects risks to birds.

Development structural factors

Structural characteristics of the development, such as the presence of guy lines (Erickson *et al.* 2001), aerial cabling and perching opportunities (especially lattice structures) may also be critical factors affecting the frequency of bird collision. Warning lights on towers may attract night migrating birds (Cochran and Graber 1958 in Canada Bird Studies 2001) and insect prey. US studies suggest that red flashing lights on wind turbines do not attract night migrants (Kerlinger and Kerns 2003), and would not attract insects, which are generally not sensitive to the red end of the spectrum.

Experiences at existing wind farms

Wind farm impacts are usually site-specific and species-specific. Nonetheless, there are a growing number of studies and monitoring programs in Australia and overseas which provide some insight into the nature and scale of potential risks to birds from wind farms.

Overseas experiences

A recent review of overseas wind farms showed low mortality rates for most wind farms (Langston and Pullen 2002). On average for all birds, new generation projects in the US (outside California) have recorded three fatalities per megawatt per year (Erikson *et al*. 2001). A review of 32 wind farms in North America produced an average of 1.4 birds per turbine per year, with a range of zero to 4.3 (Barclay *et al.* 2007). A review of European and North American wind farms indicates that most wind farms in agricultural settings affect between 2 and 4 birds per turbine per year (Lane and Associates 2004). However, the most commonly recorded bird group to collide with European and North American turbines were night-migrating songbirds, of which there are comparatively few in Australia.

Looking at wind farms in Europe, Winkelman (1994) produced an estimated average of 0.04 to 0.09 mortalities per turbine per day. 43% of these were killed by being swept down by the wake behind a blade, 36% flew directly into a blade, and for 21% the cause of death was unknown. At Altamont Pass in the United States, 55% of raptors were killed by striking a blade, 8% from electrocution, 11% from wire collision and 26% from unknown causes (Orloff and Flannery 1992 in Canada Bird Studies 2001). Winkelman concluded that the number of birds killed per unit of energy produced is low compared to other human-related causes of bird death.

Research conducted on farmland around two wind farms in the East Anglian fens in the United Kingdom found the turbines had no effect on the distribution of seed-eating birds, corvids (the crow family), gamebirds and Eurasian skylarks (Devereux *et al*. 2008). There was only one bird whose distribution was affected by the turbines – the common pheasant – the largest and least manoeuvrable species encountered. The researchers cite this as evidence that the present and future location of large numbers of wind turbines on European farmland is unlikely to have detrimental effects on farmland birds.

Australian experiences

There are relatively few published bird mortality studies at Australian wind farms, and most are of short duration. The studies do however suggest a generally low rate of blade collision, and that species at most risk are locally common birds which are active at the bladeswept height, including some raptors, skylarks, magpies and some seabirds (Meredith 2003, Hydro Tasmania 2004).

Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds killed by wind turbines to date. Searches conducted by Biosis Research for dead birds around seven turbines at the Codrington Wind farm (Victoria) showed three bird deaths attributable to impact with wind generators. The species concerned were the introduced skylark (1), Richard's pipit (1) and Australian magpie (1). Incidental carcass finds showed a further adult brown falcon death. The estimated total number of deaths likely from Codrington's 14 turbines over one year is 18 to 38 birds, or 1.2 to 2.7 birds per turbine per year (Brett Lane and Associates 2005).

At the Toora Wind Farm in Victoria, no bird carcasses were found during a year of monitoring or during informal inspections. Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, not into them (Brett Lane and Associates 2005). A study at Codrington also found that all birds approaching the turbines were observed to take avoidance action, by flying over, around or under the rotating turbine blades (Biosis Research Pty Ltd 2002).

The 140 MW Woolnorth Wind Farm project in north-west Tasmania was progressively developed between 2002 and 2007. The rate of bird collisions for stage 1 of the project is estimated at 14 native birds per year or 2.3 birds/turbine/year (Hydro Tasmania 2004). Monitoring recorded 18 bird collisions in 2003, 7 of which were the introduced Skylark. One of these collisions was a Wedge-tailed Eagle. Eagles have been observed living near the turbines for more than 12 months and the collision occurred during a period of limited visibility (Hydro Tasmania 2003).

Woolnorth's owners Roaring 40s report that 11 Wedge-tailed Eagles (*Aquila audax fleayi*), an endemic and threatened Tasmanian sub-species, have been killed by collision with rotors since operations commenced.

Roaring 40s have managed risks to eagles by reducing food resources around turbines, studying eagle behaviour and breeding success in the local population and protecting nest sites elsewhere in Tasmania (Roaring 40s website 2008).

Bladestrike risks to birds at the subject site

The risk assessment focuses particularly on bird groups which have been shown to be at greater risk in studies at other wind farms (raptors, waterbirds, migratory species), and rare, threatened or protected species which have potential to be present in the study area.

The subject site is located in a heavily cleared agricultural setting with generally small, degraded and fragmented woodland remnants on steeper ridge slopes and along larger watercourses and roadsides. The majority of the site is cleared with low diversity and low abundance of bird fauna.

Important bird habitats at the site include larger woodland remnants (such as cluster 4) and ridgeline updraft and hunting habitat for raptors such as the Black-shouldered Kite, Nankeen Kestrel, Brown Falcon, Little Eagle and Wedge-tailed Eagle. Five raptor species are considered to be at moderate or moderate-high risk; Wedge-tailed eagle, Little Eagle, Brown Falcon, Australian Hobby and the Spotted Harrier. Experience elsewhere in Australia suggests that Wedge-tailed Eagle mortality is a possibility, although there are examples of this species habituating to, and co-existing with wind turbines.

Waterbirds and wetland habitats were uncommon at the subject site. No migratory or wetland bird species or waterbirds were considered to be at moderate or high risk. Three threatened woodland species were recorded at and near the subject site; the Superb Parrot, Speckled Warbler and the Diamond Firetail. The activity of these woodland-dependent species is likely to be concentrated in woodland remnants and lowland areas at heights well below the bladeswept zone. These species are considered to be at low and low-moderate risk from the operation of the wind farm.

There are several bladestrike risk factors operating at the subject site:

- local populations of threatened and vulnerable bird species are present, including declining species and species which are sparsely distributed in the landscape;
- the turbines would be located in high topographic positions and will therefore be more affected by low cloud cover, reducing visibility at times. The subject site may experience winter fog cover, but such occurrences are not common, and are considerably more frequent in lower country east of the site toward Yass (James Payne, local landholder, pers. comm., Cathy Kaveney, local landholder, pers. comm.). In the case of very strong winds (>90 km/hr), turbines would automatically shut down, reducing collision risk.
- while the proposed turbine towers would not have guy wires and would not provide perching opportunities, wind monitoring towers located near the turbines would be supported by guy wires and have a 300mm face width lattice construction that may provide limited perching opportunities for birds.

Some structural and design characteristics of the proposal serve to reduce collision risks, including widely spaced turbines, high turbines and tubular towers without perch opportunities.

These assessments are based on available information. The knowledge base is imperfect in several areas, including in relation to the migration behaviour and routes of local bird species, the importance of raptor habitat at the turbine sites to breeding success and the short and long term responses to the wind turbines.

Bird habitat and habitat utilisation impacts

The operational phase of wind farm developments has the potential to affect bird habitats and habitat utilisation patterns by:

- degrading off-site habitats (for example, from polluted runoff or weed introductions);
- alienating and fragmenting breeding or foraging habitat;
- altering migration behaviour.

Off-site degradation resulting from the construction and operational phases of the project are readily avoided and controlled using standard best-practice mitigation methods. Risks to local bird populations from off-site habitat degradation are assessed as low.

In Europe, the effects of wind farms on habitat utilisation are considered to have a greater impact on birds than collision mortality (Strickland 2004). European studies suggest that most habitat displacement involves migrating, resting and foraging birds. Studies have reported displacement effects ranging from 75 metres to as far as 800 metres away from turbines (Strickland 2004). Winkelman (1994) found that resident birds avoided turbines at distances of 250-500 metres. This is likely to reduce the risk of bird mortality, but may affect populations where the alienated habitat is particularly important or limiting.

Box 8.2 Wedge-tailed Eagle impacts

Biology and behaviour

Wedge-tailed Eagles are sedentary and widely distributed in a range of habitats. They are monogamous and apparently mate for life. If one bird of a pair is killed, the survivor will find a new mate. Established pairs defend breeding territories around their nest sites from other Wedge-tailed Eagles. Nest density varies with food supply but nests are usually 2.5-4 kilometres apart (Australian Museum 2003a). Home ranges around the breeding territories may be shared by two or more breeding pairs and by non-breeding birds (Australian Museum 2003a).

Wedge-tailed Eagles have a relatively slow reproductive rate, mating at an advanced age, raising few chicks and having long incubation (42-45 days) and chick dependency periods (12 weeks-1 year). Eagles begin breeding at 5 years, have a usual lifespan is 20-25 years and a reproductive lifetime of 15-20 years. A clutch usually consists of two eggs. A breeding pair usually rears only one young per clutch, although in a good year, two chicks may fledge (Australian Museum 2003a). During drought periods, eagles may not breed at all for several years. Monitoring of breeding pairs at Lake Burrendong (Central West NSW) in a post-calicivirus environment showed an annual productivity of 1 chick per territory, with fledging success at 76% (Davey and Pech 2001).

Wedge-tailed Eagles feed on a range of small to medium sized fauna. In many areas, native prey, particularly kangaroo pouch young, have declined and eagles have become reliant on rabbits and carrion. They have been observed feeding after dark on a roadkill carcasse (Wren 2002).

Conservation status

Birds Australia surveys indicate that, Australia-wide, the Wedge-tailed Eagle has declined by 28% since the 1980s (Davey 2003). Some regions may produce regular eagle population surpluses ('population sources') which disperse to less productive regions ('population sinks') (Davey 2003). The Marilba Hills locality may form part of a population source upon which flatter, lower rainfall population sink areas to the west are dependent (C. Davey CSIRO, retired, pers. comm.). The significance of the site to regional eagle populations hinges on whether the site forms part of a breeding territory, and hence contributes to the population source.

The Marilba Hills site

At the subject site eagles were observed singly and in a pair displaying courtship behaviour, at 10-80 metres above

ground level. The eagles were observed using ridgeline updrafts for soaring. The local rabbit population provides a likely food source. Eagles also occasionally take lambs (J. Payne pers. comm.) and are likely to scavenge paddock carcasses and roadkill. No nests were observed at the site.

Possible response scenarios

There are a range of possible scenarios regarding the response of local Wedge-tailed Eagles to the proposed wind turbines including:

1. Local birds habituate to the turbines and are able to continue to use local habitat with a low collision rate. **Bladestrike and habitat impacts are low**.
2. Local birds avoid the area of the wind turbines but continue to use surrounding habitat within their territory or home range. Habitat dependence at the site is low and breeding success is not significantly affected. **Bladestrike impacts are low, but habitat impacts are moderate**.
3. Local birds avoid the area of the wind turbines but continue to use surrounding habitat within their territory or home range. Habitat dependence at the site is high and breeding success is significantly affected. **Bladestrike impacts are low, but habitat impacts are high**.
4. Local birds experience high collision rates, retaining local a presence but negating the source population function. **Bladestrike impacts are high, habitat impacts may be low**.
5. Local birds experience very high collision rates, exceeding the reproductive rate of the local population and producing a continuing population sink and possibly regional species decline. **Bladestrike impacts are very high, habitat impacts may be low**.

Bladestrike risks

Raptors appear to have no difficulty avoiding turbines when simply flying or soaring (Canada Bird Studies 2001), but when hunting may focus intensely on prey beyond the turbine without perceiving the rotor blades (Thelander *et al.* 2003). Raptor eyes do however have two foveal regions allowing focusing on the horizon as well as downwards (Hodos *et al*. 2001 in Canada Bird Studies 2001).

Available data from existing wind farms in south-eastern Australia show that large raptors have the capacity to avoid wind turbines, and have a relatively low frequency of collision. However, Wedge-tailed Eagle mortalities at the Starfish Hill Wind Farm in South Australia and Woolnorth (Tasmania) indicate that collision is possible. Risks may be higher during the period immediately following the installation of the turbines, before local birds have habituated. Risks may also be higher for inexperienced, juvenile birds, and during periods of heavy rain, fog or low cloud.

Experiences at other wind farms suggest that local Wedge-tailed Eagles would become habituated to the Marilba Hills Wind Farm over time. Resident Wedge-tailed Eagles have been observed to fly among turbines at wind farms at Codrington (Biosis Research Pty Ltd 2002, Wonthaggi EES Panel 2003) and Toora (Brett Lane and Associates 2005). A range of raptors continue to be present within one kilometre of the Crookwell I turbines (URS 2004). Wedge-tailed Eagles are also resident near the Woolnorth Wind Farm and 11 mortalities due to bladestrike have been reported since commencement in 2002 (SMH, 3 Jan 2008).

At Codrington, Wedge-tailed Eagles were observed to avoid turbines by flying horizontally around them and turning and not entering the turbine area (Biosis Research 2002). Directly observed collision avoidance rates at this site have been documented as 100% (Meredith *et al.* 2002). The collision avoidance rate for the Tasmanian Wedge-tailed Eagle has been estimated to be 99% or higher (Biosis Research 2006).

Assuming breeding productivity of 1 chick/year and a conservative fledging success of 50% (accounting for drought years), a breeding pair of eagles at Marilba Hills would produce an average of one additional bird every two years. Based on the low frequency of collision at these existing wind farm sites, it is considered unlikely that the Marilba Hills Wind Farm would result in bladestrike impacts that would significantly affect the local or regional eagle population, or reduce the value of the region as an eagle population source.

Habitat impacts

In studies at Burrendong Dam, a typical eagle territory was found to consist of a high ridge sweeping down to a flat

plain terminating in the waters of the dam (C. Davey CSIRO, retired, pers. comm.). Nests would typically be found on the upper slope usually in a gully but with a dominant view of the countryside. The birds would spend most of their time soaring along the ridgeline making use of the updraft. Based on the time spent soaring along the ridgeline, this part of their territory must have been extremely important to them (C. Davey CSIRO, retired, pers. comm.).

The Marilba Hills ridgelines, particularly the higher central ridge on the Linbrook property, support rabbit populations and provide updrafts used by eagles. Marilba Hills may be a population source area for the Wedge-tailed Eagle and, if so, the ridge-tops would be a critical part of their territory (C. Davey CSIRO, retired, pers. comm.). The extent to which local eagles are dependent on these resources, and the abundance of similar resources on surrounding lands, are not known. The presence of the wind turbines may reduce the availability of both the rabbit and updraft resources at the Marilba Hills site, and may possibly reduce the reproductive success of a local breeding pair, if present (C. Davey CSIRO, retired, pers. comm.).

These breeding success impacts would not be evidenced by any decline in local eagle numbers in the short term, but may change the area from being a population source to being a population sink. This may have ramifications for areas to the west which are dependent on the southern tablelands source populations. Survey and monitoring is required to determine the presence of breeding eagles and the extent of habitat impacts.

Microchiropteran bat impacts

Impact risk assessments have been undertaken for microbat species recorded at the subject site, or with potential to use habitat at the site. The full risk assessment is provided in Appendix D.

This assessment examines relevant background information and evaluates the risk of significant impact posed by the proposed wind farm in terms of:

- collision with wind turbines
- physical damage caused by sudden decompression (pulmonary barotrauma)
- behaviour modification, including habitat avoidance.

The risk assessment incorporates all species listed as threatened or migratory under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* which have been recorded in the relevant CMA sub-regions or are included on the EPBC Act Matters of National Environmental Significance search report.

A preliminary risk matrix is used to identify threatened species which are at particular risk from operational impacts of the wind farm. Threatened species with high cumulative risk scores are included in the relevant Assessments of Significance of the potential impacts in Appendices E and F.

Species from vulnerable bird groups are included in a qualitative assessment of risk (refer Appendix D); the results of this assessment are summarised in Table 9.4 below. The risk assessment is based on the proposed works described in section 4 and the expected vegetation and habitat loss quantified in section 8.1. Importantly, the assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 identified in section 8.2.4 below**.**

Pulmonary barotrauma

Pulmonary barotrauma, or decompression, has been identified as a significant cause of mortality for microbats. Rapid or excessive air-pressure change can result in fatal haemorrhaging in the lungs as bats pass near moving turbine blades. Moving turbine blades can cause a drop in air pressure by 5 to 10 kPa (Horn *et al.* 2008; G. Richards 2008 pers. comm). Mammals are thought to be more susceptible to barotrauma than birds (Baerwald *et al.* 2008). A recent Canadian study, Baerwald *et al.* (2008) found evidence of barotrauma in 90% of 75 microbats that had been killed at wind turbines, while only 50% of these had had direct contact with turbine blades.

Barotrauma potentially poses significant risks to microbats at wind farms as microbats are unable to detect rapid pressure reductions, even though echolocation may allow microbats to detect and avoid turbine blades. It is possible that some mortalities which have in previous studies been attributed to collision or blade wind may have in fact been caused by barotrauma.

Bladestrike and decompression impacts

12 bat species were recorded at the subject site with reasonable confidence using the Anabat call detection system, including the threatened (vulnerable) Eastern Bentwing Bat. In addition, the threatened Large-footed Myotis and Yellow-bellied Sheathtail Bat were possible records from the cluster 4 site. The proposed wind turbines have the potential to cause mortalities in local bat populations due to bladestrike. The risk of collision is influenced by the behavioural and possibly morphological characteristics of particular bat species, as well as site environmental factors. Relevant notes on the ecology of these species and the identification confidence of the survey records are presented in Appendix D.

Species risk factors

A range of hypotheses have been advanced to explain bat collisions, including echolocation failure, migration along linear corridors, the inability to perceive moving blades ('motion smear'), attraction to lights, attraction to the towers as potential roost sites, attraction to noises emitted by the turbine, curiousity about the blade movement, insect concentrations caused by insect attraction to turbines, and attraction to insect concentrations in rising warm air above ridgetops (Kunz *et al*. in prep. in Arnett 2005). There does not appear to be any published work which demonstrates the veracity or otherwise of any of these hypotheses.

Horn *et al*. (2008) observed that many microbats actively investigated turbine structures when blades were both moving and stationary at a wind farm in West Virginia USA.

Microbats are long-lived and have exceptionally low reproductive rates (Kunz 1982 in Arnett 2005). Most species produce only 1 young per year (Law 1996). Population growth is slow and the ability to recover from population crashes is limited (Racey and Entwhistle 2003 in Arnett 2005). Species characteristics which may affect collision risk include reproductive potential, migration behaviour, echolocation ability, flying manoeuvrability, foraging or flocking responses to weather or resource pulses, foraging height, long-distance flying height, reaction to the new infrastructure and dispersal and recolonising ability.

The relative vulnerability of the various bat species in Australia to bladestrike is not well known. Bats niche partition within their foraging habitat; some forage low in the canopy, some within or just above the canopy and others hundreds of metres above the canopy. Wing morphology reflects the difference in manoeuvrability required in these different environments. Bats that fly rapidly but are not very manoeuvrable are suggested to be less able to avoid collisions with wind farms (Erickson *et al.* 2002). United States studies show that higher flying 'tree bats' were disproportionately affected by bladestrike (AusWEA 2004).

Vision, as well as manoeuvrability, affects the risk of collision. Erickson *et al*. (2002) suggest that individuals most at risk appear to be migrating bats; migrating bats may navigate without use of echolocation, depending on vision, rather than echolocation. During migration, microbats may cease the use of echolocation to conserve energy (Keeley *et al.* 2001 in Sterner *et al.* 2007). Migratory bats comprise the majority of mortalities in all wind farm studies to date (Erickson *et al* 2002, Arnett 2005).

Echolocation has been assessed as functional only over small distances of c.20 metres (Grindal and Bringham 1998). The functional range of echolocation in North American bats is typically 3-5 metres, giving a bat flying at 5 metres/second less than a second to respond to a wind turbine (Kunz *et al*. in prep. in Arnett 2005).

Bat collision with wind turbines was first documented in Australia when 22 White-striped Freetail or White-striped Mastiff Bats (*Nyctinomus australis* syn *Tadarida australis*) collided with wind turbines over a 4-year period (Hall and Richards 1972, in Erickson *et al.* 2002.). This species may be uniquely vulnerable to wind turbine collisions due to its high flight and a low rate of echolocation call emission (Herr and Klomp 1997, in Rhodes

2001). White-striped Mastiff/Freetail Bats were recorded at the subject site. Other high-flying species may also occur at the site and be at risk of bladestrike.

Long distance migration behaviour and foraging within the bladeswept zone are likely to represent important factors that may differentiate risk between species. In Australia, long-distance migrating microbats include the Eastern Bentwing-bat and Yellow-bellied Sheath-tailed Bat; both of these species have been recorded at or near the subject site. Species which fly along the edges or above the canopy during foraging are likely to be most at risk from turbine impacts, compared to those that forage close to the ground or below the forest canopy. The Eastern Bentwing-bat, Yellow-bellied Sheath-tailed Bat and also Gould's Wattled Bat are included among these species. Species which utilise open areas and forage above the canopy may also have limited manoeuvrability, which may further increase turbine impact risks (Van Dyck and Strahan 2008). Examples include the Yellow-bellied Sheathtail-bat, Eastern Free-tailed Bat and Gould's Wattled Bat.

Environmental risk factors

Environmental factors which may affect the potential for collision or barotrauma include wind speeds and weather, proximity to foraging and roosting resources, linear vegetation features which may influence migration behaviour and proximity to other landscape features which may affect bat movements.

Monitoring in the USA has revealed that large numbers of microbats are killed in windfarms situated in forested, ridge top areas as opposed to agricultural areas (Kunz *et al.* 2007). Whilst most microbat species do not utilise open paddocks for foraging, isolated paddock trees are often used as much as forested areas (Lumsden and Bennett 2003).

German studies have shown higher collision rates from turbines located near hedgerows (Australian Bat Society 2005). Many species use linear vegetation or topographic features while commuting (Limpens and Kapteyn 1991, in Erickson *et al.* 2002) and migrating (Humphrey and Cope 1976, Timm 1989, in Erickson *et al*. 2002). The Marilba Hills subject site is located in heavily cleared farmland with generally small remnant woodland patches on steeper sideslopes. The nearest linear vegetation features are located some distance from the turbine ridges woodland remnants beside Illalong Road and Illalong Creek to the west, and Graces Flat and Black Range Roads to the south-east and south. Large forest and woodland remnants are present west of cluster 7 and on the western side of cluster 4. These remnants, as well as isolated paddock trees, may provide roost sites and insect food sources.

Although the association between man-made structures and bats is not well understood, evidence suggests that most bat collisions with structures occur during migration and that these are normally associated with inclement weather (Erickson *et al.* 2002). A feature of wind turbines is that in high wind speeds they shut down to protect themselves from damage, thereby also mitigating collision risks. Lights on turbines may increase the probability of bat collisions, as insect abundance is higher under lights (Erickson *et al*. 2002). This can also be mitigated by avoiding or reducing the use of lights on or near turbine towers, or by using red flashing lights that would be less likely to attract insects, which are generally not sensitive to the red end of the light spectrum.

Experiences at existing wind farms

Overseas experiences

Migratory microbats comprise the majority of mortalities in all wind farm studies to date (Erickson et al. 2002, Arnett 2005). Microbat fatalities at USA wind-energy facilities range from 53.3 bats/MW/year at the Buffalo Mountain Wind Energy Centre for small Vestas V47 turbines producing 0.66-MW and 38.7 bats/MW/year for larger Vestas V80 turbines producing 1.8MW (Kunz *et al*. 2007). More turbines equates to more impact, with the Mountaineer Wind Energy Centre in West Virginia accounting for 4000 microbat deaths in the autumn of 2004.

Many microchiropteran bat species hibernate or aestivate during cold periods to reduce their energy requirements when resources are low. In a compilation of survey results for wind farms in the United States, most bat mortality documented occurred in late summer and autumn (nearly 90% from mid-July through mid-

September) with most fatalities attributed to migratory tree bats with no pattern in distribution to suggest the victims were local bats commuting from roosting to foraging areas (Erickson *et al.* 2002). Resource abundance at this time would be expected to be high and bats requiring fat stores for aestivation would need to take advantage of the resource pulse and may migrate in order to do so.

North American research has shown that most bat collisions have involved adult bats, hence collisions were not thought to be attributed to dispersing juveniles (ABS 2005).

Erickson *et al.* (2002) in a North American study, state that based on available data bat collisions during the breeding season are virtually non-existent. Many of the scientific programs in the USA designed to test impacts of wind farms have been hampered by operational requirements (Kunz *et al*. 2007).

US studies show that bats tend to be killed on low wind nights, when blade speeds were at or close to full operational speed (17 rpm) (Arnett 2005). Fatalities tended to increase just before and just after the passage of storm fronts, when microbat activity would increase in response to insect abundance. This study also found that bat activity was greatest during the first two hours after sunset, which may also be a relatively high risk time for collisions. This study showed similar mortality rates at sites lit by aircraft lighting and sites which had no lights.

A review of 32 North American wind farm monitoring studies suggests that bat mortality increases with increased turbine height. The review shows an average of 5.9 bat fatalities per turbine per year, ranging from zero to 42.7. The maximum mortality rate occurred when turbines were at or greater than 65 metres in height (Barclay *et al*. 2007).

Australian experiences

There has been little research into collision or avoidance risks to bats in Australia, and no long term Before and After Controlled Impact (BACI) studies. The limited and disparate survey effort generally completed for impact assessment prior to project developments is inadequate to answer broader research questions such as the locations and importance of migration paths, which species are most vulnerable and what deterrent options are available (ABS 2005). Monitoring of wind farms to date has shown that bats investigate the blades and blade area of turbines and that while collisions do occur, they are able to avoid the blades on most occasions (ABS 2005).

Monitoring at Woolnorth recorded 11 bat collisions in 2003 (Hydro Tasmania 2003). Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds or bats killed by wind turbines to date. Searches conducted by Biosis Research for dead birds around seven turbines at Victoria's Codrington Wind farm (Victoria) showed one bat death (a White-striped Mastiff Bat) attributable to impact with turbines during the 2001-2003 monitoring period (AusWEA 2004). Incidental carcass finds showed a further White-striped Mastiff Bat death. Six bat mortalities were recorded at the Toora wind farm between 2002 and 2003; this impact was not considered to be of conservation significance (AusWEA 2004).

Bladestrike impact potential and significance

The Anabat survey recorded relatively high species diversity at the subject site, possibly reflecting the ecotonal position of the site between coastal/tableland and inland ecosystems. Some environmental risk factors such as ridgetop location of turbine cannot realistically be avoided. Impact risk may be reduced by:

- siting turbines away from woodland and forest remnants (including canopy edges)
- reducing the attractiveness of turbine structures and habitat areas to microbats
- regular or periodic shutdown of the turbines (such as during seasonal migration periods, peak foraging activity times or poor weather conditions).

An assessment of the potential for impact to microchiropteran bat species which were recorded or have at least moderate potential to be present at the subject site is presented in Table 8.4, based on survey data and existing information.

No species is assessed as having moderate or high potential to be impacted at the population level, although further field assessment is required on this matter, particularly in relation to colonial and migratory species such as the Eastern Bentwing Bat. Additional studies and assessment findings have been presented in a specialist bat survey report attached to the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009).

Two threatened microbat species have at least moderate potential to be impacted by bladestrike or decompression at the individual level; the Eastern Bentwing Bat and the Yellow-bellied Sheathtail-bat. In these cases, risk was affected by behaviour (foraging height, agility, colonial roosting, migration), the quality, nature and extent of local habitats (remnant forest, farm dams) and local and regional abundance.

The surveys at the subject site also detected the high-flying White-striped Mastiff Bat. Based on known behaviour and mortalities at other wind farm sites, some level of mortality of this species caused by turbine collision is possible at the site. The presence of farm dams contributes to the attractiveness of the site for water-dependent species such as the Little Pied Bat, Large-footed Myotis and Broad-nosed Bat. The removal of dams close to the turbines should reduce collision risk for these species if mortalities are found to occur, although habitat impacts would then increase.

While considerable uncertainty remains regarding the responses of particular species, the relatively low level of recorded mortalities at existing wind farms in south-east Australia, the absence of recorded significant species mortalities, the degraded and fragmented condition of forest and woodland remnants over most of the subject site and the presence of similar habitat throughout the district combine to suggest that the proposal would not be likely to significantly affect local populations of microbats. This conclusion is subject to the findings of further assessments to be undertaken reported in an attached to the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009). The uncertainty and risk would also need to be managed using operational monitoring and adaptive management.

Table 8-4 Impact potential for microbat species

Species	Potential for impact	
Goulds Wattled Bat (*Chalinolobus gouldii)*	Individual Population	Low Low
Chocolate Wattled Bat (*Chalinolobus morio)*	Individual Population	Low-moderate Low
Little Pied Bat (*Chalinolobus picatus)*	Individual Population	Low Low
Eastern Bentwing Bat (*Miniopterus schreibersii)*	Individual Population	Moderate Requires further assessment
Mormopterus sp.no.4	Individual Population	Moderate Low
Mormopterus sp.no.3	Individual Population	Moderate Low
Eastern Freetail Bat (*Mormopterus norfolkensis)*	Individual Population	Moderate Low
Large-footed Myotis (*Myotis macropus)*	Individual Population	Low Low
Long-eared Bat (*Nyctophilus geoffroyi/gouldi* complex)	Individual Population	Low Low
Inland Broad-nosed Bat (*Scotorepens balstoni)* Little Broad-nosed Bat (*Scotorepens grayii)*	Individual Population	Low Low
Yellow bellied Sheathtail Bat *(Saccolaimus flaviventris)*	Individual Population	Moderate Requires further assessment
White-striped Freetail bat (*Tadarida australis)* (*syn. Nyctinomus australis*)	Individual Population	Moderate Low-moderate
Large Forest Bat (*Vespadelus darlingtoni)*	Individual Population	Low Low
Southern Forest Bat (*Vespadelus regulus)*	Individual Population	Low Low
Little Forest Bat (*Vespadelus vulternus)*	Individual	Low

Species	Potential for impact	
	Population	Low
Eastern False Pipistrelle or Great Pipistrelle *(Falsistrellus tasmaniensis)*	Individual	Low
	Population	Low

Bat habitat and habitat utilisation impacts

The subject site provides potential foraging and roosting habitat for microbat species. During an earlier (spring) survey south of the subject site (**ngh**environmental 2006), abundant insect activity was observed, possibly related to warm updrafts, which would provide foraging resources for microbats. Microbats are also known to forage over cleared paddocks with isolated paddock trees and this may have benefits in terms of regulating herbivorous insects on these trees (Lumsden and Bennett 2004).

Most of the site offers marginal roosting habitat because of the scarcity of tree or cave habitat. Paddock trees are present as individual trees and small copses. Forest and woodland remnants are present, consisting largely of regrowth trees of pre-hollow forming age. The tree clearing or branch trimming that would result from the proposal is not expected to significantly affect available roost habitat, flyways, water sources or prey sources at the subject site. Rock outcrops do not provide suitable roosting habitat for cave-dwelling species. Habitat loss impacts are therefore not expected to significantly affect bat behaviour at the site.

The presence of operating turbines may affect foraging behaviour through habitat avoidance or collision with rotor blades or powerlines. However, similar foraging habitat is locally and regionally abundant. Some degree of localised habitat avoidance may in fact be desirable to reduce collision risks.

Given the extent of habitat loss in the district, habitat utilisation could be expected to be broadly dispersed through the locality, with some focus on the larger forest/woodland remnants and better condition aquatic habitats. The proposed turbines are unlikely to alienate these potential foraging and nesting habitat areas.

Because of the close proximity of large numbers of breeding and foraging individuals, risks to the Eastern Bentwing Bat may be higher than current information suggests. Additional anabat survey work is required to confirm the presence and distribution of the Eastern Bentwing Bat, Large-footed Myotis and Yellow-bellied Sheathtail Bat over the subject site. This work is scheduled for January 2009 and the assessment will be presented in the bat survey report included in the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009). This report will include more detailed assessment potential impacts to threatened microbats.

Operational monitoring will be critical to the ongoing assessment of wind farm impacts to this species. Monitoring techniques and management options are addressed in the Bird and Bat Risk Addendum, included with the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009). If operational monitoring indicates mortality of the Eastern Freetail Bat or the Large-footed Myotis, local habitat could be modified by removing farm dams at the site to reduce feeding activity close to turbines. However, this habitat removal would have ramifications for a range of other species and would be viewed as a last resort. Replacement dams could be constructed at safer distances from the turbines (more than 200 metres) to preserve site habitat and agricultural values. Similar farm dam habitat is likely to be relatively abundant in the surrounding district, including within commuting distance of the subject site.

The impacts on habitat or habitat utilisation are not expected to significantly affect local populations of microbats. However, monitoring and an adaptive management approach would be required to account for the lack of information about these species.

8.2.3 Cumulative impacts

The Marilba Hills Wind Farm project forms part of a wider proposal involving two other project sites; Coppabella Hills 5 kilometres to the west and Carroll's Ridge 10 kilometres to the south. Together, these three projects total up to 185 turbines, 115.5 kilometres of powerlines and 140.5 kilometres of access tracks. The impacts associated with these projects have been assessed in separate Biodiversity Assessments prepared by **ngh**environmental.

The 15 turbine Conroys Gap Wind Farm, located between the Marilba Hills and Carroll's Ridge Precincts, was approved in May 2007.

There are several other wind farms proposed and operating in the region. Most of these are well to the east of the subject site. Figure 8.1 shows the relative location of these wind farm projects.

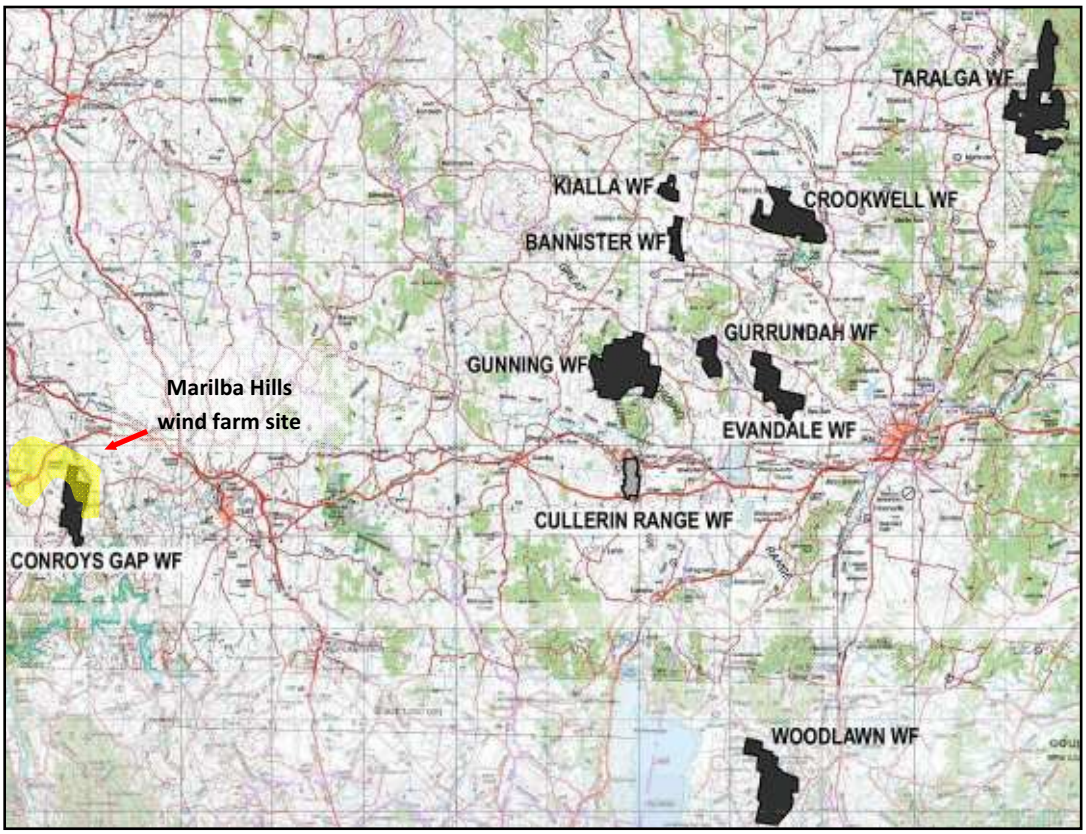

Figure 8.1 Operating and proposed wind farms in the region

There is considerable electrical infrastructure present in the locality, including major transmission lines and electrical substation and powerline infrastructure south of Yass. The construction of a substation and single pole powerlines associated with the wind farm proposal is not considered likely to significantly add to the impacts of existing electrical infrastructure in terms of scale or type of impact.

The construction of the wind turbines would introduce a new and distinctive suite of environmental impacts. Biological impacts can be far-reaching, because of the mobility of migratory, nomadic and territorial fauna species such as bats and birds. The operational and proposed wind farm localities in the district may involve overlapping raptor territories and bird and bat migration routes.

Based on habitat in the local area and elsewhere in the district, and known bat and bird movements, the subject site is not likely to be located on a major migratory route for wetland birds, seasonally migrating birds or microchiropteran bats. Visits from migratory or nomadic species are expected to be infrequent and sporadic. The wind farm is not likely to significantly add to risks to these species.

Other wind farms in the region are located well outside local raptor breeding territories and foraging ranges. The risks of the wind farm to raptors are addressed in Appendix D. Continuing losses of some raptor species with low reproductive rates (such as Wedge-tailed Eagles) could represent a 'mortality sink'. This could have the potential to affect region-level populations, although the likelihood of this is considered low. The subject site provides foraging resources for a range of raptor species. Mortalities are possible, but, given the low rate of bladestrike recorded at other Australian wind farms, are not expected to affect local or regional populations by outstripping the reproductive capacity of any species. For this reason, the proposal is not expected to significantly add to the collective impacts of wind farms in the region. The ongoing monitoring and assessment of the operational impacts of all wind farms operating in the region should however be consistent, centrally analysed and published to ensure cumulative impacts remain within acceptable limits.

The impacts of the wind farm on biodiversity values would combine with existing impacts resulting from land clearing, agricultural activities, weeds and hazards. It is important to recognise that the district has experienced extensive losses to ecosystem integrity and stability. Woodland and grassland communities in particular, which coincide with prime agricultural land, and riparian and wetland communities have been heavily simplified and destabilised. It is likely that many woodland flora and fauna species have become locally extinct, and many are in continuing decline.

There is a time lag, or 'extinction debt', operating which may mean that decline and extinction will continue for many species for decades to come, regardless of management responses. Further impacts on lowland environments are expected from soil and water salinisation, soil erosion and sedimentation, weed invasion and spread, disruption to river hydrology due to farm dam construction and water extractions and habitat fragmentation and clearing resulting from residential sub-division and building.

The offsetting of vegetation losses with the long term protection of similar vegetation in the study area will reduce the cumulative effects of the proposal (refer section 8.1.3).

When the cumulative impacts of all disturbances are considered, it is clear that any significant addition to stresses experienced by flora and fauna in the region need to be avoided. The location of the proposed wind farm turbines on largely cleared ridgetop sites, and avoiding impacts to natural woodland communities and habitats, should restrict the potential to affect declining woodland or wetland species.

The presence of the turbines and powerline would provide additional obstacles and hazards to birds and bats. Existing hazards include electricity transmission lines, and air, rail and road traffic. These hazards at this site are not known to produce significant or unusual impacts on local fauna.

The proposal is not expected to significantly affect waterbirds, migratory species, local raptor populations or threatened species. The project therefore is considered unlikely to produce significant cumulative impacts, in combination with existing obstacles and hazards. An adaptive monitoring and management program would be implemented to ensure that any unforeseen impact on these species are detected and addressed in a timely manner.

A monitoring program should include a combination of techniques to measure impact – monitoring components identified below should form only part of the overall monitoring effort. Monitoring techniques and management options are further addressed in the Bird and bat Impact Addendum attached to the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009).

8.2.4 Impact avoidance and mitigation

Further survey and monitoring work

- Pre-operational monitoring of habitat utilisation by birds and microbats should be undertaken in order to acquire baseline data, accurately assess risk and calculate potential mortality rates (refer **ngh**environmental 2009a, **ngh**environmental 2009b, Brett Lane and Associates 2005).
- Additional anabat survey work was undertaken during January 2009 to confirm the presence and distribution of the Eastern Bentwing Bat, Large-footed Myotis and Yellow-bellied Sheathtail Bat and other significant microbat species over the subject site. The results of this survey and further assessment of potential impacts to threatened microbats will be presented in the specialist bat survey report included in the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009). No further bat work is proposed.
- Prior to the commencement of works, timbered areas within 2 kilometres of the turbines will be surveyed for the presence of Wedge-tailed Eagle nests, access permitting. Active nests will be monitored and breeding success recorded over the forthcoming breeding season (July-January). Both breeding success and habitat use behaviour at the subject site will be recorded to provide a baseline for operational monitoring.
- In conjunction with the above survey, the local abundance of ridgetop hunting habitat (exposed ridges with rabbit populations) will be reviewed to determine the importance of the subject site to the eagle population.

Microscale site selection

- Where practicable, the turbines will be sited centrally on the ridgeline, away from the ends and edges of linear ridges, to minimise disturbance to raptors using updrafts and microbats using ridgelines as navigational aids.
- Where possible, the turbine sites should avoid corridors between microbat and bird habitat areas, and turbines should be sited as far as practicable from the edge of woodland and forest remnants.

Design and construction measures

- The turbine towers will be as widely spaced as possible to reduce bird collision risks.
- To protect aquatic habitats, silt fences will be used around all excavation works, the duration of works will be minimised, and any drainage line and creek crossings will be stabilised (consistent with Fisheries NSW guidelines).
- Where practicable, power poles and overhead powerlines will be bird-safe using flags or marker balls, large wire size and wire and conductor spacing.
- If lights are required to be fitted to the towers (eg for aircraft safety), they should be red flashing lights to reduce attractiveness to insects and possibly night-flying birds (subject to CASA requirements). For similar reasons, turbine paint should be non-reflective if practicable.
- Guy lines will not be fitted to turbine towers. Any guy lines which need to be used on associated structures will be indicated with marker balls or flags.
- The turbine towers and associated structures will minimise perching opportunities.
- Rock and log habitat removed during the construction phase will be reinstated following the works.

- Any trench sections left open for greater than a day would be inspected daily, early in the morning and any trapped fauna removed.

Operational measures

Site modification and management

- It is suggested that Epuron advise landowners that sheep may be preferable to cattle as grazing stock on the turbine ridges (farm operational requirements permitting) to reduce the incidence of insects, which could provide prey for smaller raptors, owls, insectivorous passerines and bats. Restricting lambing on ridges with turbines may be required to reduce the collision risk to raptors. It is recognized this may be sugject to landowner agreement.
- Vegetation at the turbine sites should be kept low to allow a high level of carcass detectability. The use of dogs to find carcasses could improve search efficiency.
- If operational monitoring indicates mortality of the Little Pied Bat, Eastern Freetail Bat and/or the Large-footed Myotis, local habitat could, as a last resort, be modified by removing farm dams at the site to reduce feeding activity close to turbines. Replacement dams could be constructed at safer distances from the turbines (more than 200 metres) to preserve site habitat and agricultural values.

Operation phase monitoring

- The OEMP would contain details of a three-tiered monitoring program for bird and bat mortalities and habitat utilisation impacts. The design of the monitoring program would draw on the Australian Wind Energy Association's *Wind Farms and Birds: Interim standards for Risk Assessment* (Brett Lane and Associates 2005) and the *Wind Farm Risks to Birds and Microbats* study (**ngh**environmental 2009a) (Appendix K). The program would use a range of techniques including the following components:

  1. First six months of operation

  - a more intensive period of monitoring because birds and bats are in the process of habituating to the new development, and sensitive species may experience higher levels of mortality during this period.
  - during this period all turbine sites will be surveyed to determine variation in impact over the study area. Surveys will include regular dead bird and bat searches (with scavenging trials), bird utilisation surveys, observation of bird avoidance/diversion behaviour and targeted surveys for species of concern.
  - if practicable, a reference site located between 500 metres and 1,500 metres from the turbines should also be surveyed.

  2. First three years of operation

  - an extended period of monitoring to assess mortality rates and trends over successive seasons and longer term changes to local species abundance, habitat use patterns and possibly breeding success.
  - the survey may be limited to representative or higher risk turbine sites, based on the results of the first six months of monitoring.
  - surveys will include regular dead bird and bat searches, bird utilisation surveys, observation of bird avoidance/diversion behaviour and targeted surveys for species of concern.
  - dead bird and bat searches may be extended beyond three years if thresholds are exceeded and adaptive management responses are required to be implemented.

- if any active Wedge-tailed Eagle nest sites are located within 2 kilometres of the turbines, these nests will be monitored during breeding seasons (July-January) for **at least 5 years** following the commencement of operations to determine any impacts on breeding success caused by bladestrike mortality or habitat alienation. Ideally, breeding success at a comparable reference nest site not affected by the wind farm should also be monitored concurrently.

3. Ongoing monitoring

- mortality inspection and reporting will be continued for the life of the wind farm. The inspection regime would be linked to turbine inspection and maintenance cycles. Mortalities of any significant species (including threatened species and Wedge-tailed Eagles) will be reported to DECC.
- monitoring methods and data standards for dead bird searches, indirect disturbance impact assessment and habitat avoidance studies will be based on protocols in the Interim Standards for Assessing the Risks to Birds from Wind Farms in Australia (Brett Lane and Associates 2005).

- Given the concentration of operational and proposed wind farms in the Southern Tablelands region, monitoring of bird and bat impacts should ideally be coordinated and consistent with monitoring programs conducted at other wind farms, and the results of monitoring collected and published by AusWEA or government.

Adaptive Management

Adaptive management allows the initiation of a project in the absence of complete knowledge by providing a framework to incorporate new information to adapt management strategies (Johnson 1999). Mortality and habitat avoidance thresholds will be developed and used to trigger specific management responses to mitigate impacts.

Thresholds for mortality rates and habitat impacts for threatened or sensitive bird and bat species will be determined for each of the three monitoring periods during the development of the monitoring program, having regard to species reproductive potential, conservation status and experiences at other Australian wind farms.

Management responses to monitoring threshold exceedances would be dependant on the cause and the impact, but could include further research, detailed risk modelling and population assessments, adjustments or enhancements to turbine and associated infrastructure, the installation of flight diversion or deterrent structures, acoustic deterrents, blade painting (refer Hodos *et al.* 2001), fitting cowls to shield lights, removing local food sources or insect attracting light sources, removal of farm dams near turbines, compensatory off-site habitat protection or enhancement, nest site protection, and the periodic shutdown of one or more turbines (on a daily or seasonal basis or irregularly in response to weather conditions).

8.3 DECOMMISSIONING IMPACTS

Decommissioning impacts would be similar to, but less extensive than, construction impacts. The area of impact would be reduced because all below-ground structures (footings, concrete slabs, underground cabling) would remain in situ. The control building may also be retained on the site. Access tracks would be upgraded as required, and appropriate weed hygiene and rehabilitation measures would be implemented. The decommissioning phase of the proposal is not expected to significantly affect local flora values.

The decommissioning phase of the proposal may temporarily affect the use of habitat at the site by fauna, but is not expected to significantly affect local fauna populations in the medium-long term.

Relevant mitigation measures implemented during the construction phase would also apply to decommissioning works.

A biodiversity assessment would be required prior to decommissioning, to update the knowledge of site attributes and evaluate specific impact types. New measures to avoid and mitigate impacts may be required depending on the results of the assessment.

9 CONCLUSION

9.1 CONSTRUCTION

The construction phase of the proposal is not likely to have a significant impact on flora and fauna values at the subject site.

The proposal would remove 12 ha of box gum woodland, including up to 1.47 ha that would qualify as EEC in good, moderate-good or moderate condition. Clearing areas would be reduced by avoiding individual trees and woodland stands at the finescale site planning stage wherever practicable. Larger remnants in better condition and threatened flora habitats at the subject site would generally be excluded from the development area and protected during construction. A small area of woodland (0.14 ha) of woodland in good condition in cluster 4b would be cleared to provide an access track and cable trench. Special measures would be used to minimise impacts in this area.

Given the local abundance of degraded box gum woodland, the proposed vegetation clearing would not add appreciably to the existing level of habitat depletion and fragmentation, and would not significantly affect threatened species.

9.2 OPERATION

The operation phase of the proposal is not likely to have a significant impact on flora and fauna values at the subject site.

The key operational impacts of the proposal relate to the potential impacts to birds and microbats from collision with turbine blades, decompression and habitat avoidance. Impact risk assessments have been undertaken for bird species from vulnerable bird groups - raptors, waterbirds, migratory and threatened species - and bat species recorded at the subject site, or with potential to use habitat at the site. These assessments are provisional, and based on available information.

Five raptor species are considered to be at moderate or moderate-high risk. Experience elsewhere in Australia suggests that raptor mortality is a possibility, although there are examples of these species co-existing with wind turbines. Waterbirds and wetland habitats are uncommon at the subject site. No migratory or wetland bird species or waterbirds were considered to be at moderate or high risk. Three threatened woodland species were recorded at and near the subject site. The activity of these woodland-dependent species is likely to be concentrated in woodland remnants and lowland areas at heights well below the bladeswept zone. These species are considered to be at low and low-moderate risk from the operation of the wind farm.

Two threatened microbat species have at least moderate potential to be impacted by bladestrike or decompression at the individual level. No microbat species is assessed as having moderate or high potential to be impacted at the population level, although further assessment is required on this matter, particularly in relation to colonial and migratory species such as the Eastern Bentwing Bat. Additional studies and assessment findings are presented in a specialist bat survey report attached to the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009).

The uncertainty and risk in relation to birds and bats would also need to be managed using operational monitoring and adaptive management. Several components of a monitoring program for the project are included with the mitigation measures in the Biodiversity Assessment. Monitoring techniques and management options are also further addressed in the Bird and Bat Risk Addendum, included with the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009).

9.3 IMPACT AVOIDANCE AND MITIGATION

Avoidance and mitigation measures have been developed for the planning/design and construction phases of the project. These include general best practice measures applicable to a wide range of projects, and specific measures tailored to the environmental context and nature of the Marilba Hills Wind Farm proposal. The measures form part of the proponent's Statement of Commitments in the Part 3A development application, and would be implemented through an Environmental Management Plan (EMP) developed for the project.

10 ASSESSMENT PERSONNEL

Personnel	Role	Qualifications	Expertise and experience
Paul McPherson nghenvironmental	Flora survey Report writing and research	Bachelor of Applied Science (Natural Resources)	With nghenvironmental since 1996 undertaking flora and fauna survey, planning assessment and environmental impact assessment for a wide range of projects, environments and clients.
Jackie Miles	Flora survey	Bachelor of Science Honours	Jackie specialises in botanical and zoological surveys. Jackie has worked on a number of large assignments including extensive fauna surveys for the Comprehensive Regional Assessment program, and botanical surveys including CRA full floristic surveys, field validation for the Parks & Wildlife Division - Dept. of Environment and Conservation (formerly NPWS)
Jim Reside	Fauna survey	Associate Diploma in Applied Science Resource Management	Jim is the director of Wildlife Unlimited, a consultancy established in 1996. WU have worked on several projects with nghenvironmental as lead field ecologists.
Steve Coulson	Fauna survey		Steve, from Wildlife Unlimited, has worked on several projects with nghenvironmental as a lead field ecologist. Steve's specialist area is herpetology. For WU, Steve has undertaken a wide range of survey projects.
Joshua Wellington	Technical assistant	B.Sc. (Environmental)	Josh's skills include bush/riparian restoration, fauna handling, field sampling of soils, water, and biological transects. With nghenvironmental Josh has prepared several REFs for roadworks.
Nick Graham-Higgs Principal nghenvironmental	Editorial review	Bachelor of Applied Science	An environmental consultant specialising in environmental impact assessment and natural resource management since 1992. Much of the work undertaken has been within sensitive areas, including major infrastructure development works.

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Appendix A **FLORA SURVEY RESULTS**

A1. Composite species lists for each vegetation type

A2. Representative quadrat results for vegetation types and type variants

A3. Vegetation survey sites locations, methods and results summary

A4. Yass Daisy (*Ammobium craspedioides*) records

The flora survey area included all areas within the development envelope that would potentially be directly or indirectly affected by the proposal, with an appropriate buffer to account for off-site impacts (refer Map Set 1). The survey area was stratified into 4 relatively homogeneous survey zones based on broad consolidated vegetation types:

BGW Box gum woodland (*Eucalyptus albens, E. melliodora, E.blakelyi*)
DGF Dry grass forest (*E. goniocalyx, E. mannifera, E. dives*)
DG Diverse secondary grassland
NP Native pasture, variable exotic component.

Species lists for these vegetation types are presented in Table A1, derived from random meanders (up to 1 ha) undertaken in each type (refer Map Set 1). Representative quadrat data for each type is presented in Tables A2.1-A2.8. Note that these types frequently intergrade at the subject site and transitional stands are common.

Where White Box, Blakely's Red Gum or Yellow Box is present, the vegetation has been assigned to Box-Gum Woodland. The condition, conservation value and relationship between these types and vegetation communities defined by Gellie (2005) are discussed in section 5.

Survey methods are also detailed in section 5. All native and introduced vascular plant species occurring at the random meander and quadrat sites, and their relative abundances, were recorded. Cover/abundance assessments are based on visual estimates of foliage cover (after Carnahan 1997), scored using a modified Braun-Blanquet 6-point scale:

1 1 to a few individuals present, less than 5% cover
2 many individuals present, but still less than 5% cover
3 5 - <20% cover
4 20 - <50% cover
5 50 - <75% cover
6 75 - 100% cover.

Where the cover/abundance of a particular species varies markedly over the random meander survey area, a range of values is provided. In these cases, abundance is based on a standard 20 metre x 20 metre quadrat scale.

Species of conservation significance are bolded. Introduced species are denoted by an asterisk. Noxious weeds declared for the Southern Slopes County Council control area under the *Noxious Weeds Act 1993* are indicated with a 'Δ' symbol.

Where uncertainty exists due to the unavailability of mature reproductive material, the taxon is preceded by a question mark, or plants are identified to genus level only. Botanical nomenclature follows G.J. Harden (ed) (1990-2002) Flora of New South Wales, UNSW Press, except where recent changes have occurred.

A1. Composite species lists for each vegetation type

BGW Box gum woodland (*Eucalyptus albens, E. melliodora, E.blakelyi*)

DG Box gum woodland derived grassland

DGFL Long-leaved Box dry grass forest (*E. goniocalyx*)

DGFB Brittle Gum – Broad-leaved Peppermint dry grass forest (*E. mannifera, E. dives*)

NP Native pasture, variable exotic component.

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
TREES							
Acacia implexa	lightwood or hickory	Fabaceae	0-1			2	0-3
Allocasuarina verticillata	dryland drooping sheoak	Casuarinaceae	0-4				0-1
Brachychiton populneus	kurrajong	Sterculiaceae	0-1				0-1
Eucalyptus albens	white box	Myrtaceae	0-3				0-1
Eucalyptus blakelyi	Blakely's red gum	Myrtaceae	0-3				
Eucalyptus bridgesiana	apple box	Myrtaceae	0-1				
Eucalyptus dives	broad-leaved peppermint	Myrtaceae				0-3	0-1
Eucalyptus goniocalyx	bundy, long-leaved box	Myrtaceae	0-3		3	0-2	
Eucalyptus macrorhyncha	red stringybark	Myrtaceae	0-3				0-1
Eucalyptus mannifera	brittle or red spotted gum	Myrtaceae				0-3	0-1
Eucalyptus melliodora	yellow box	Myrtaceae	0-3				
Eucalyptus polyanthemos ssp *polyanthemos*	red box	Myrtaceae	0-3				
Exocarpos cupressiformis	native cherry	Santalaceae				1	
SHRUBS, SUB-SHRUBS							
Acacia dealbata	silver wattle	Fabaceae	0-1				
Acacia verniciflua	varnish wattle	Fabaceae		0-1			
Amyema miquellii	box mistletoe	Loranthaceae	0-1				
Amyema pendulum	a mistletoe	Loranthaceae	0-1				
Bossiaea prostrata		Fabaceae	0-1				
Dillwynia sericea	hairy parrot-pea	Fabaceae	0-1				
Dodonaea viscosa ssp *angustissima*	hop bush	Sapindaceae	0-1				0-1
Hibbertia obtusifolia	guineaflower	Dilleniaceae	0-2	1	2	1	0-2
Hovea heterophylla	variable hovea	Fabaceae			0-1		
Kunzea ericoides	burgan	Myrtaceae	0-5	0-1			
Leptospermum myrtifolium	swamp teatree	Myrtaceae		0-1			
Leucopogon virgatus	beard heath	Ericaceae	0-1				
Lissanthe strigosa	peach heath	Ericaceae	0-1				
Melichrus urceolatus		Ericaceae		0-1			
Muellerina eucalyptoides	a mistletoe	Loranthaceae	0-1				
?Pimelea curviflora var *sericea* (seedlings)	curved rice flower	Thymeleaceae	0-1				
Pimelea treyvaudii		Thymeleaceae	0-1				
Pomaderris angustifolia		Rhamnaceae	0-3		0-1		
Pultenaea foliolosa		Fabaceae	0-1				
Δ**Rosa rubiginosa*	briar rose, sweet briar	Rosaceae					0-2
Δ**Rubus fruticosus* sp. agg.	blackberry	Rosaceae					0-1
VINES AND TWINERS							
Clematis microphylla		Ranunculaceae				1	
Convolvulus angustissimus	Australian bindweed	Convolvulaceae	0-2				0-2

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
Glycine clandestina	twining glycine	Fabaceae	0-1		0-1		
FORBS							
Acaena echinata		Rosaceae	0-2	1	2		0-1
Acaena novae-zelandiae	bidgee-widgee	Rosaceae	0-1	1			
Acaena ?ovina		Rosaceae	0-2				
**Acetosella vulgaris*	sheep sorrel	Polygonaceae	0-2	0-2		0-1	1-3
Ammobium craspedioides	**Yass daisy**	**Asteraceae**	0-2	0-2	0-2		
**Amsinckia calycina*	fiddleneck	Boraginaceae	0-1				
**Anagallis arvensis*	scarlet pimpernel	Myrsinaceae	0-2				
**Arctotheca calendula*	capeweed	Asteraceae	2			0-2	0-4
Arthopodium milleflorum	pale vanilla lily	Anthericaceae	0-2				
Arthopodium minus	small vanilla lily	Anthericaceae	0-1				
Asperula conferta	common woodruff	Rubiaceae	0-2			1	
Brachyscome ptychocarpa		Asteraceae		0-2			
Bulbine bulbosa	bulbine lily	Asphodelaceae	0-2		0-1		
Burchardia umbellata	milkmaids	Colchicaeae	0-1				
**Capsella bursa-pastoris*	shepherd's purse	Brassicaceae	0-1				
**Carduus pycnocephalus*	slender thistle	Asteraceae	0-1				
**Carduus tenuiflorus*	winged slender thistle	Asteraceae	0-2				
**Carthamus lanatus*	saffron thistle	Asteraceae	0-2				0-2
**Centaurea* sp.	cockspur thistle	Asteraceae	0-1				
**Centaurium erythraea*	centaury	Gentianaceae	0-2	1			
Centipeda minima	sneezeweed	Asteraceae		0-2			
**Cerastium glomeratum*	Mouse-ear Chickweed	Caryophyllaceae	0-1			1	
Chamaescyce drummondii	caustic weed	Euphorbiaceae					0-1
Chenopodium pumilio	crumbweed	Chenopodiaceae	0-2				
**Chondrilla juncea*	skeleton weed	Asteraceae					0-1
**Cirsium vulgare*	black or spear thistle	Asteraceae	1	1		1	0-2
Cotula australis	carrot weed	Apiaceae	1-2				
Craspedia variabilis	billy buttons	Asteraceae		0-2			
Crassula decumbens		Crassulaceae	0-2				
Crassula sieberiana	Australian stonecrop	Crassulaceae	0-1				0-1
**Cucumis myriocarpus*	paddy melon	Cucurbitaceae	0-1				
Cymbonotus sp.	bear's ear	Asteraceae	0-1		1		0-1
Cynoglossum suaveolens	hound's tongue	Boraginaceae	0-2				
Daucus glochidiatus	native carrot	Apiaceae	0-1				
Desmodium varians	slender tick trefoil	Fabaceae	0-1		0-1		0-1
Dianella longifolia	blue flax lily	Phormiaceae			0-1		
Dichondra repens	kidney weed	Convolvulaceae	1				0-1
Dichopogon fimbratum	chocolate lily	Anthericaceae	0-2				
Diuris chryseopsis	early snake orchid	Orchidaceae			0-2		
Drosera peltata ssp *peltata*	sundew	Droseraceae	2		0-1		
Δ**Echium plantagineum*	Paterson's curse	Boraginaceae	0-4		0-2		1-4
Epilobium billardierianum ssp *cinereum*	willow herb	Onagraceae	0-1				
**Erodium brachycarpum*	heronsbill	Geraniaceae	0-2				0-2
**Erodium cicutarium*	common storksbill	Geraniaceae	1			0-2	1-4
Erodium crinitum	blue storksbill	Geraniaceae	0-1				0-1
**Erodium moschatum*	musky storksbill	Geraniaceae	0-2				
Euchiton gymnocephalus	slender cudweed	Asteraceae		0-2	0-1		
**Galium murale*	annual bedstraw	Rubiaceae	0-1				
Galium gaudichaudii	rough bedstraw	Rubiaceae	0-1				
Galium sp.		Rubiaceae	0-1				
**Geranium molle*		Geraniaceae	1-2				
Geranium potentilloides		Geraniaceae	0-2				
Geranium solanderi var. *solanderi*		Geraniaceae	1-2		1	1	0-1
Gonocarpus elatus	tall raspwort	Haloragaceae	0-4				

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
Gonocarpus tetragynus	raspwort	Haloragaceae	1-2	0-2	2	2	0-1
Goodenia hederacea	ivy-leaved goodenia	Goodeniaceae	1				0-1
Goodenia ?paniculata		Goodeniaceae	0-1				
Haloragis heterophylla		Haloragaceae		0-2			
Hydrocotyle laxiflora	stinking pennywort	Apiaceae	2	0-2	2	1	
Hydrocotyle peduncularis	shining pennywort	Apiaceae		0-3			
Hypericum gramineum	native St Johns wort	Clusiaceae	0-1	1			0-1
Hypericum japonicum	small St John's wort	Clusiaceae	0-1	0-2			
Δ**Hypericum perforatum*	St John's wort	Clusiaceae	0-1				
**Hypochaeris glabra*		Asteraceae	0-2				0-2
**Hypochaeris radicata*	cat's ear, flatweed	Asteraceae	1-3	1-2	2	1	0-2
Hypoxis vaginata var. *brevistigmata*	yellow star	Hypoxidaceae	0-2	0-2	0-2		0-1
Hypoxis vaginata var. *vaginata*	yellow star	Hypoxidaceae	0-2				
Δ**Ibicella lutea*	yellow-flowered devil's claw	Martyniaceae	0-1				
Isotoma fluviatilis	swamp isotome	Lobeliaceae		0-4			
**Lactuca serriola*	prickly lettuce	Asteraceae		1			
Leptorhynchos squamatus ssp A	scaly buttons	Asteraceae	0-2	0-2	0-1		
Linum marginale	native flax	Linaceae	0-1				
Lythrum hyssopifolia	hyssop loosestrife	Lythraceae		0-2			
**Malva parviflora*	small-flowered mallow	Malvaceae	0-2				
Δ**Marrubium vulgare*	horehound	Lamiaceae	0-1				0-1
**Medicago arabica*	spotted burr-medic	Fabaceae	0-2				0-2
Microtis unifolia	onion orchid	Orchidaceae	0-2				
**Moenchia erecta*	erect chickweed	Caryophyllaceae	0-1				
Myriophyllum sp.	water milfoil	Haloragaceae	0-2				
Δ**Onopordum acanthium*	Scotch thistle	Asteraceae	0-1		0-1		
Δ**Onopordum ?illyricum*	Illyrian thistle	Asteraceae	0-1				
Oreomyrrhis eriopoda	Australian carraway	Apiaceae	0-1				
**Orobanche minor*	broomrape	Scrophulariaceae	0-2				
Oxalis ?perennans	oxalis	Oxalidaceae	1-2	1-2	2	2	0-2
**Papaver ?hybridum*	rough poppy	Papaveraceae	0-1				
Parietaria debilis	native pellitory	Urticaceae					0-1
**Petrorhagia nanteuilii*	proliferous pink	Caryophyllaceae	0-1	0-2			0-2
Poranthera microphylla		Euphorbiaceae	1-2		2	2	
?Prasophyllum/Microtis sp. (leaf)	leek/onion orchid	Orchidaceae	0-1				
Pterostylis curta	blunt greenhood	Orchidaceae	0-1				
Ranunculus lappaceus	common buttercup	Ranunculaceae	0-1				
**Romelea rosea*	onion weed	Iridaceae	0-2				0-1
Rumex brownii	native dock	Polygonaceae	0-2	0-1			0-1
Scleranthus fasciculatus		Caryophyllaceae		1			
Scutellaria humilis	dwarf skullcap	Scrophulariaceae	0-2				
Senecio prenanthoides		Asteraceae	0-1				
Senecio tenuiflorus		Asteraceae	0-1			1	
**Sherardia arvensis*	field madder	Rubiaceae	0-1				
**Silene gallica*	French catchfly	Caryophyllaceae	0-2				
Siloxerus multiflorus	small wrinklewort	Asteraceae	0-1				
**Silybum marianum*	variegated thistle	Asteraceae	0-1				1
**Sisymbrium officinale*	hedge mustard	Brassicaceae	0-2				
Solanum cinereum	Narrawa burr	Solanaceae	0-1				
**Solanum nigrum*	black nightshade	Solanaceae	0-1				
Solenogyne dominii	smooth solenogyne	Asteraceae	0-1	2	0-1		0-2
Solenogyne gunnii	hairy solenogyne	Asteraceae	0-1	1		1	0-1
**Sonchus asper*	prickly sow thistle	Asteraceae	0-1	1			
**Sonchus oleraceus*	sow thistle	Asteraceae	0-1				
Stackhousia monogyna	creamy candles	Stackhousiaceae	0-1				
**Stellaria media*	common chickweed	Caryophyllaceae	0-2			1-3	0-2

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
Stellaria pungens	prickly starwort	Caryophyllaceae				2	
Stuartina muelleri	Spoon Cudweed	Asteraceae	0-2				
Stypandra glauca	nodding blue lily	Phormiaceae	0-3				
**Taraxacum officinale*	dandelion	Asteraceae	0-1	1			0-1
Thysanotus patersonii	twining fringe-lily	Anthericaceae			0-1		
Thysanotus tuberosus	fringe-lily	Anthericaceae	0-1		0-1		
**Tolpis umbellata*	yellow hawkweed	Asteraceae	0-2				
**Tragopogon porrifolius*	salsify	Asteraceae					0-1
Tricoryne elatior	yellow autumn lily	Anthericaceae	0-1				
**Trifolium angustifolium*	narrow-leaved clover	Fabaceae	0-1				
**Trifolium arvense*	hare's foot clover	Fabaceae	0-2				
**Trifolium campestre*	hop clover	Fabaceae	0-2				0-2
**Trifolium dubium*	yellow suckling clover	Fabaceae	0-2	0-1			
**Trifolium repens*	white clover	Fabaceae				0-2	0-3
**Trifolium subterraneum*	sub clover	Fabaceae	0-1				0-2
**Trifolium* sp.	clover	Fabaceae	1-3			0-2	2-5
Triptilodiscus pygmaeus	austral sunray	Asteraceae	0-2				
**Urtica urens*	stinging nettle	Urticaceae	0-4				
**Veronica anagallis-aquatica*	water speedwell	Plantaginaceae		0-2			
Veronica calycina	hairy speedwell	Plantaginaceae	0-1				
Veronica plebeia	common speedwell	Plantaginaceae	0-2				
Viola betonicifolia	narrow-leaved violet	Violaceae			0-1		0-1
Vittadinia cuneata var *cuneata*	New Holland daisy	Asteraceae	0-2				
Vittadinia muelleri		Asteraceae	0-2				
Wahlenbergia communis	tufted bluebell	Campanulaceae	0-1				0-1
Wahlenbergia gracilis	sprawling bluebell	Campanulaceae					0-1
Wahlenbergia stricta	tall bluebell	Campanulaceae	0-2		0-1		
Wurmbea dioica	early nancy	Colchicaceae	0-2	0-1	0-2		0-1
Wurmbea latifolia	early nancy	Colchicaceae	0-1		0-2		
GRASSES							
**Aira caryophyllea*	hair grass	Poaceae	0-2				0-1
**Anthoxanthum odoratum*	sweet vernal grass	Poaceae	0-2				
Aristida ramosa var. *ramosa*	wiregrass	Poaceae	0-4	0-2	0-1	0-2	1-4
Austrodanthonia auriculata	wallaby grass	Poaceae	0-2				0-3
Austrodanthonia carphoides	wallaby grass	Poaceae	0-3				
Austrodanthonia eriantha	wallaby grass	Poaceae	0-3				
Austrodanthonia monticola	wallaby grass	Poaceae	0-1				
Austrodanthonia pilosa	wallaby grass	Poaceae	0-2	2			
Austrodanthonia racemosa var. *racemosa*	wallaby grass	Poaceae	0-3	1-4			
Austrodanthonia sp.	wallaby grass	Poaceae	2		2		3
Austrostipa bigeniculata		Poaceae	0-1				
Austrostipa densiflora		Poaceae	0-2		0-1		
Austrostipa scabra ssp *falcata*	corkscrew grass	Poaceae	0-4		0-2		0-3
**Avena* sp.	wild oats	Poaceae	0-3				
Bothriochloa macra	red-stem grass	Poaceae	1-4	0-1			0-3
**Briza maxima*	quaking grass	Poaceae	1-4		2	2	0-2
**Briza minor*	shivery grass	Poaceae	0-2	0-1			0-1
**Bromus racemosus*	soft brome	Poaceae	0-2				
**Bromus rubens*	red brome	Poaceae	0-2				
**Bromus sterilis*	sterile brome	Poaceae	0-2				
Chloris truncata	windmill grass	Poaceae	0-1				
Cymbopogon refractus	barbed wire grass	Poaceae	0-2				
Cynodon dactylon	couch	Poaceae		0-3			
**Cynosurus echinatus*	dog's tail grass	Poaceae	1-4		0-1		
Elymus scaber	common wheat grass	Poaceae	1-2		2		
**Holcus lanatus*	Yorkshire fog	Poaceae	0-1				

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
**Hordeum leporinum*	barley grass	Poaceae	0-4				
Joycea pallida	robust wallaby grass	Poaceae	0-1	0-2		1-4	0-3
Lachnagrostis filiformis	blown grass	Poaceae		1			
**Lolium perenne*	perennial ryegrass	Poaceae	0-5				
Microlaena stipoides	weeping grass	Poaceae	0-6	1-3	2-3	1-2	0-4
Δ**Nassella trichotoma*	serrated tussock	Poaceae					0-1
Panicum effusum	hairy panic	Poaceae	1-3		0-2		0-2
**Phalaris aquatica*	phalaris	Poaceae	0-6				
**Poa annua*	winter grass	Poaceae	0-2				0-1
Poa labillardieri	silver tussock	Poaceae					0-2
Poa ?meionectes		Poaceae					
Poa sieberiana var. *sieberiana*		Poaceae	0-2	0-2		0-2	
Poa sieberiana var. *cyanophylla*		Poaceae	0-2			0-2	
Themeda triandra	kangaroo grass	Poaceae	0-5	1-4			
**Vulpia bromoides*	squirrel-tail fescue	Poaceae	0-2				
GRAMINOIDS							
Cyperus sanguinolentus		Cyperaceae		0-2			
Isolepis sp.		Cyperaceae		0-1			
**Juncus articulatus*	jointed rush	Juncaceae		0-3			
Juncus filicaulis	pinrush	Juncaceae	1	1			
Juncus sp.		Juncaceae		0-2			
Lepidosperma laterale	Sword Sedge	Cyperaceae			0-1		
Lomandra filiformis ssp *coriacea*	Wattle Mat-rush	Lomandraceae	1-3		2		0-2
Lomandra filiformis ssp *filiformis*	Wattle Mat-rush	Lomandraceae	0-2				0-1
Lomandra longifolia	spiny matrush	Lomandraceae				1	
Lomandra multiflora	many-flowered matrush	Lomandraceae					0-1
Luzula sp.	woodrush	Juncaceae		0-1	1	1	
Schoenus apogon	bog sedge	Cyperaceae	0-3	0-2			
Typha orientalis	cumbungi, bullrush	Typhaceae		0-2			
FERNS							
Asplenium flabellifolium	necklace fern	Aspleniaceae	0-1				0-1
Cheilanthes austrotenuifolia		Sinopteridaceae	0-4		0-2		0-2
Cheilanthes distans	bristly cloak fern	Sinopteridaceae	0-1				
Cheilanthes sieberi ssp sieberi	rock or mulga fern	Sinopteridaceae	0-3	1	0-1	0-1	0-2
Pellaea sp.	Sickle Fern	Sinopteridaceae	0-1				
Pteridium esculentum	bracken	Dennstaedtiaceae					0-2

A2. Representative quadrat results for vegetation types and type variants

Condition classes:

Poor	groundlayer dominated by exotics
Poor-moderate	groundlayer dominated by one or two native grass species, very few native forbs
Moderate	groundlayer dominated by several native grasses, native forbs present but low diversity
Moderate-good	groundlayer dominated by several native grasses with a range of native forbs
Good	high groundlayer diversity, including significant forb species

A2.1 Box gum woodland – *Eucalyptus albens* on ridgetop

Condition: Poor (heavily grazed by sheep)

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Weilora'	2	MGA 652648 6154493	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Granitic **% surface rock:** 50	562	10°	NE

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	10m	20%	*Eucalyptus albens*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.4m	20%	Unidentified grasses	**Stellaria media*	**Urtica urens*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Eucalyptus albens	White Box	Myrtaceae	3
FORBS			
**Arctotheca calendula*	capeweed	Asteraceae	2
**Carduus tenuiflorus*	winged slender thistle	Asteraceae	1
**Carthamus lanatus*	saffron thistle	Asteraceae	1
**Cirsium vulgare*	black thistle	Asteraceae	1
Cotula australis	Carrot Weed	Apiaceae	2
Crassula sieberiana	Australian stonecrop	Crassulaceae	1
**Erodium moschatum*	musky storksbill	Geraniaceae	2
**Geranium molle*		Geraniaceae	2
**Marrubium vulgare*	Horehound	Lamiaceae	1
**Onopordum acanthium*	Scotch thistle	Asteraceae	1
Oxalis ?perennans	oxalis	Oxalidaceae	1
Rumex brownii	native dock	Polygonaceae	2
**Silybum marianum*	Variegated Thistle	Asteraceae	1
**Stellaria media*	common chickweed	Caryophyllaceae	2
**Trifolium* sp.	clover	Fabaceae	2

Scientific name	Common name	Family	Cover/abundance
**Urtica urens*	Stinging nettle	Urticaceae	2
GRASSES			
Austrodanthonia sp.	wallaby grass	Poaceae	1
Austrostipa scabra ssp *falcata*	corkscrew grass	Poaceae	2
Unidentified grasses		Poaceae	2
Microlaena stipoides	weeping grass	Poaceae	1

A2.2 Box gum woodland – *Eucalyptus melliodora* on saddle

Condition: Moderate

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	4a	MGA 654284 6149179	**Zone:** 55	20m x 20m
Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Rounded saddle	Granitic **% surface rock: <**5	620	<5°	-

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	12m	10%	*Eucalyptus melliodora*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.3m	80%	*Microlaena stipoides*	*Austrostipa scabra* ssp *falcata*	**Erodium brachycarpum*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	1
Eucalyptus melliodora	Yellow Box	Myrtaceae	3
FORBS			
**Acetosella vulgaris*	Sheep Sorrel	Polygonaceae	1
**Arctotheca calendula*	Capeweed	Asteraceae	2
**Carthamus lanatus*	Saffron Thistle	Asteraceae	2
**Cirsium vulgare*	Black Thistle	Asteraceae	1
Crassula sieberiana	Australian Stonecrop	Crassulaceae	1
**Echium plantagineum*	Paterson's Curse	Boraginaceae	2
**Erodium brachycarpum*	Heronsbill	Geraniaceae	2
**Erodium cicutarium*	Common Storksbill	Geraniaceae	1
Erodium crinitum	Blue Storksbill	Geraniaceae	**1**
Geranium solanderi	Native Geranium	Geraniaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	1
**Marrubium vulgare*	Horehound	Lamiaceae	1
**Onopordum acanthium*	Scotch Thistle	Asteraceae	1
Oxalis ?perennans	Oxalis	Oxalidaceae	2
Rumex brownii	Native Dock	Polygonaceae	1
Scutellaria humilis	Dwarf Skullcap	Scrophulariaceae	1
Solenogyne dominii	Smooth Solenogyne	Asteraceae	1
**Trifolium subterraneum*	Sub Clover	Fabaceae	1
**Trifolium* sp.	Clover	Fabaceae	2
GRASSES			
Austrodanthonia sp.	Wallaby Grass	Poaceae	1

Scientific name	Common name	Family	Cover/abundance
Austrostipa scabra ssp *falcata*	Corkscrew Grass	Poaceae	2
Bothriochloa macra	Red-stem Grass	Poaceae	1
**Cynosurus echinatus*	Dogstail Grass	Poaceae	2
Microlaena stipoides	Weeping Grass	Poaceae	5
Panicum effusum	Hairy Panic	Poaceae	2

A2.3 Box gum woodland – *Eucalyptus blakelyi* regeneration (10-30cm dbh) on ridge crest, ungrazed

Condition: Moderate - good

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	4b	MGA 653710 6148717	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Rounded ridge crest and upper slope	Granitic **% surface rock:** 20	653	0-10°	NNE

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	8m	20%	*Eucalyptus blakelyi*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-1m	70%	*Themeda triandra*	*Stypandra glauca*	*Cheilanthes austrotenuifolia*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Allocasuarina verticillata	Dryland Drooping She-oak	Myrtaceae	1
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	3
FORBS			
Acaena echinata	Sheep's Burr	Rosaceae	1
**Carthamus lanatus*	Saffron Thistle	Asteraceae	1
Cynoglossum australe	Hound's Tongue	Boraginaceae	2
Geranium solanderi	Native Geranium	Geraniaceae	2
Gonocarpus elatus	Tall Raspwort	Haloragaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
Oxalis ?perennans	Oxalis	Oxalidaceae	1
Scutellaria humilis	Dwarf Skullcap	Scrophulariaceae	2
Stypandra glauca	Nodding Blue Lily	Phormiaceae	3
Wurmbea dioica	Early Nancy	Colchicaceae	1
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	1
Austrodanthonia sp.	Wallaby Grass	Poaceae	2
Austrostipa ?densiflora		Poaceae	1
**Briza maxima*	Quaking Grass	Poaceae	1
**Cynosurus echinatus*	Dogstail Grass	Poaceae	2
Microlaena stipoides	Weeping Grass	Poaceae	3
Themeda triandra	Kangaroo Grass	Poaceae	3
FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	2

A2.4 Box gum woodland – *Eucalyptus macrorhyncha* dominant on upper slope, ungrazed

Condition: Good

Location			
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**	**Quadrat size**
'Marilba'	4b	MGA 653542 6148641 **Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Granitic **% surface rock:** 5	630	15°	S

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	8m	20%	*Eucalyptus macrorhyncha*		
Small tree	-	-			
Shrub	1-2	10	*Pomaderris angustifolia*		
Groundcover	0-1m	50%	*Gonocarpus elatus*	*Stypandra glauca*	*Microlaena stipoides*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Allocasuarina verticillata	Dryland Drooping She-oak	Myrtaceae	1
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	1
Eucalyptus goniocalyx	Long-leaved Box	Myrtaceae	1
Eucalyptus macrorhyncha	Red Stringybark	Myrtaceae	3
SHRUBS			
Pomaderris angustifolia		Myrtaceae	3
FORBS			
Acaena sp.		Rosaceae	1
Ammobium craspedioides	Yass Daisy	Asteraceae	2
**Anagallis arvensis*	Scarlet Pimpernel	Myrsinaceae	1
Bulbine bulbosa	Bulbine Lily	Asphodelaceae	1
**Centaurium erythraea*	Centaury	Gentianaceae	1
Drosera peltata	Sundew	Droseraceae	1
Geranium solanderi	Native Geranium	Geraniaceae	2
Gonocarpus elatus	Tall Raspwort	Haloragaceae	3
Gonocarpus tetragynus	Raspwort	Haloragaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
**Hypochaeris radicata*	Cat'sear, Flatweed	Asteraceae	2
Hypoxis vaginata var *brevistigmata*		Hypoxidaceae	2
Oxalis ?perennans	Oxalis	Oxalidaceae	1
Poranthera microphylla		Euphorbiaceae	2
Ranunculus lappaceus	Common Buttercup	Ranunculaceae	1
Senecio tenuiflorus		Asteraceae	1
Stackhousia monogyna	Scented Candles	Stackhousiaceae	1
Stypandra glauca	Nodding Blue Lily	Phormiaceae	3
Wurmbea dioica	Early Nancy	Colchicaceae	1
GRASSES			
Austrodanthonia sp.	Wallaby Grass	Poaceae	2
**Briza maxima*	Quaking Grass	Poaceae	1
**Cynosurus echinatus*	Dogstail Grass	Poaceae	1
Elymus scaber	Wheat Grass	Poaceae	1
Microlaena stipoides	Weeping Grass	Poaceae	3
GRAMINOIDS			
Lomandra filiformis var *coriacea*	Mat Rush	Lomandraceae	2

FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	2

A2.5 Box gum woodland – *Allocasuarina verticillata* dominant on upper slope, ungrazed

Condition: Moderate - good

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	4a	MGA 654065 6149009	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Granitic **% surface rock:** 5	600	5°	W

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	5-7m	5%	*Allocasuarina verticillata*		
Small tree	1-4	10	*Allocasuarina verticillata*	*E. melliodora*	
Shrub	-	-			
Groundcover	0-0.4m	80%	*Gonocarpus elatus*	*Cheilanthes austrotenuifolia*	*Austrostipa scabra* ssp *falcata*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Allocasuarina verticillata	Dryland Drooping She-oak	Myrtaceae	3
Eucalyptus melliodora	Blakely's Red Gum	Myrtaceae	1
FORBS			
**Anagallis arvensis*	Scarlet Pimpernel	Myrsinaceae	1
**Arctotheca calendula*	Capeweed	Asteraceae	1
Bulbine bulbosa	Bulbine Lily	Asphodelaceae	1
Drosera peltata	Sundew	Droseraceae	2
**Echium plantagineum*	Paterson's Curse	Boraginaceae	2
Erodium sp.	Blue Storksbill	Geraniaceae	1
Geranium solanderi	Native Geranium	Geraniaceae	2
Gonocarpus elatus	Tall Raspwort	Haloragaceae	4
Gonocarpus tetragynus	Raspwort	Haloragaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	1
**Hypochaeris glabra*		Asteraceae	2
Hypoxis vaginata var *brevistigmata*		Hypoxidaceae	1
Leptorhynchos squamatus ssp A	Scaly Buttons	Asteraceae	1
Poranthera microphylla		Euphorbiaceae	1
**Sonchus oleracea*	Sow Thistle	Asteraceae	1
Stypandra glauca	Nodding Blue Lily	Phormiaceae	2
**Trifolium* sp.	Clover	Fabaceae	1
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	2
Austrodanthonia sp.	Wallaby Grass	Poaceae	1
Austrostipa densiflora		Poaceae	2
Austrostipa scabra ssp *falcata*	Corkscrew Grass	Poaceae	3
**Briza maxima*	Quaking Grass	Poaceae	2
Elymus scaber	Wheat Grass	Poaceae	1
GRAMINOIDS			
Lomandra filiformis var *coriacea*	Mat Rush	Lomandraceae	2
FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	4

Cheilanthes austrotenuifolia	Poison Rock Fern	Sinopteridaceae	1

A2.6 Native pasture on ridge crest

Condition: Moderate

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	5	MGA 657321 6151295	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper saddle slope	Volcanic **% surface rock:** 5	682	10°	NW

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	-	-			
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.6m	75%	*Austrodanthonia* sp.	*Bothriochloa macra*	

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
FORBS			
**Acetosella vulgaris*	Sheep Sorrel	Polygonaceae	1
**Arctotheca calendula*	Capeweed	Asteraceae	1
**Carthamus lanatus*	Saffron Thistle	Asteraceae	2
Dichondra repens	Kidney Weed	Convolvulaceae	1
**Echium plantagineum*	Paterson's Curse	Boraginaceae	1
**Erodium brachycarpum*	Heronsbill	Geraniaceae	2
**Erodium cicutarium*	Common Storksbill	Geraniaceae	1
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	2
Hypoxis vaginata var. *brevistigmata*	Yellow Star	Hypoxidaceae	1
**Marrubium vulgare*	Horehound	Lamiaceae	1
Oxalis ?perennans	Oxalis	Oxalidaceae	2
**Romulea rosea*	Onion Weed	Iridaceae	1
**Trifolium* sp.	Clover	Fabaceae	2
Wurmbea dioica	Early Nancy	Colchicaceae	1
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	1
Austrodanthonia sp.	Wallaby Grass	Poaceae	3
Austrostipa scabra ssp *falcata*	Corkscrew Grass	Poaceae	2
Bothriochloa macra	Red-stem Grass	Poaceae	3
Microlaena stipoides	Weeping Grass	Poaceae	2
Panicum effusum	Hairy Panic	Poaceae	2
FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	1

A2.7 Long –leaved Box dry grass forest (*Eucalyptus goniocalyx*), regrowth 10-30cm dbh

Condition: Moderate – good

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	6	MGA 657491 6152213	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Volcanic **% surface rock:** 5	617	10°	SW

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	7	25%	*Eucalyptus goniocalyx*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.3m	50%	*Microlaena stipoides*	**Briza maxima*	

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Eucalyptus goniocalyx	Bundy, Long-leaved Box	Myrtaceae	3
SHRUBS, SUB-SHRUBS			
Hibbertia obtusifolia	Guinea Flower	Dilleniaceae	1
Hovea heterophylla	Variable Hovea	Fabaceae	1
FORBS			
Acaena echinata	Sheep's Burr	Rosaceae	2
Bulbine bulbosa	Bulbine Lily	Asphodelaceae	1
Cymbonotus sp.	Bear's Ear	Asteraceae	1
Drosera peltata	Sundew	Droseraceae	1
Euchiton gymnocephalus	Creeping Cudweed	Asteraceae	1
Geranium solanderi	Native Geranium	Geraniaceae	1
Gonocarpus tetragynus	Raspwort	Haloragaceae	2
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	2
Hypoxis vaginata var. *brevistigmata*	Yellow Star	Hypoxidaceae	2
Leptorhynchos squamatus ssp A	Scaly Buttons	Asteraceae	1
**Onopordum acanthium*	Scotch Thistle	Asteraceae	1
Oxalis ?perennans	Oxalis	Oxalidaceae	2
Poranthera microphylla		Euphorbiaceae	2
Solenogyne dominii	Smooth Solenogyne	Asteraceae	1
Thysanotus patersonii	Twining Fringe-lily	Anthericaceae	1
Viola betonicifolia	Swamp Violet	Violaceae	1
Wahlenbergia stricta	Tall Bluebell	Campanulaceae	1
Wurmbea latifolia	Early Nancy	Colchicaceae	2
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	1
Austrodanthonia sp.	Wallaby Grass	Poaceae	2
Austrostipa ?densiflora		Poaceae	1
**Briza maxima*	Quaking Grass	Poaceae	2
**Cynosurus echinatus*	Dogstail Grass	Poaceae	1
Elymus scaber	Wheat Grass	Poaceae	2
Microlaena stipoides	Weeping Grass	Poaceae	3
GRAMINOIDS			
Lepidosperma laterale	Sword Sedge	Cyperaceae	1
Lomandra filiformis ssp *coriacea*	Wattle Mat-rush	Lomandraceae	2

A2.8 Brittle Gum – Broad-leaved Peppermint dry grass forest remnant (*Eucalyptus dives – E. mannifera*), ungrazed

Condition: Moderate

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Ryalla'	7	MGA 658927 6146356	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Ridge upper slope and crest	Quartzite? **% surface rock:** 5	750	10°	S

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	10m	30%	*Eucalyptus dives*	*Eucalyptus mannifera*	
Small tree	4m	5%	*Acacia implexa*		
Shrub	0.5m	<5%	*Hibbertia obtusifolia*		
Groundcover	0-0.5m	50%	*Joycea pallida*	*Poa sieberiana*	

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Acacia implexa	Hickory, Lightwood	Fabaceae	2
Eucalyptus dives	Broad-leaved Peppermint	Myrtaceae	3
Eucalyptus goniocalyx	Bundy, Long-leaved Box	Myrtaceae	1
Eucalyptus mannifera	Red Spotted or Brittle Gum	Myrtaceae	3
Exocarpus cupressiformis	Native Cherry	Santalaceae	1
SHRUBS, SUBSHRUBS			
Hibbertia obtusifolia	Guinea Flower	Dilleniaceae	2
FORBS			
Asperula conferta	Woodruff	Rubiaceae	1
**Cerastium* sp.	Mouse-ear Chickweed	Caryophyllaceae	1
Gonocarpus tetragynus	Raspwort	Haloragaceae	2
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	1
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	1
Poranthera microphylla		Euphorbiaceae	2
Senecio tenuiflorus		Asteraceae	1
Solenogyne dominii	Smooth Solenogyne	Asteraceae	1
**Stellaria media*	Common Chickweed	Caryophyllaceae	3
Stellaria pungens	Prickly Starwort	Caryophyllaceae	1
GRASSES			
**Briza maxima*	Quaking Grass	Poaceae	2
Joycea pallida	Robust Wallaby Grass	Poaceae	1-4
Microlaena stipoides	Weeping Grass	Poaceae	1
Poa sieberiana var *cyanophylla*		Poaceae	2
GRAMINOIDS			
Lomandra longifolia	Spiny Mat-rush	Lomandraceae	1
Luzula sp.	Woodrush	Juncaceae	1
FERNS			
Cheilanthes sieberi ssp sieberi	Rock or Mulga Fern	Sinopteridaceae	1

A3. Vegetation survey sites locations, methods and results summary

Key

Survey methods:

Q Quadrat (20m x 20m or areal equivalent)

RM Random meander (in homogeneous vegetation up to 1 ha)

I Inspection

Consolidated vegetation types:

BGW Box gum woodland (*Eucalyptus albens, E. melliodora, E.blakelyi*)

DG Box gum woodland derived grassland

DGFL Long-leaved Box dry grass forest (*E. goniocalyx*)

DGFB Brittle Gum – Broad-leaved Peppermint dry grass forest (*E. mannifera, E. dives*)

NP Native pasture, variable exotic component.

Understorey condition classes:

Poor groundlayer dominated by exotics

Poor-moderate groundlayer dominated by one or two native grass species, very few native forbs

Moderate groundlayer dominated by several native grasses, native forbs present but low diversity

Moderate-good groundlayer dominated by several native grasses with a range of native forbs

Good high groundlayer diversity, including significant forb species

Significance:

EPBC vegetation belonging to the White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grasslands Ecological Community listed as Critically Endangered under the Commonwealth EPBC Act (based on understorey diversity criteria)

TSC vegetation belonging to the White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community listed under the NSW TSC Act

Cluster	Easting	Northing	Survey method	Type	Overstorey dominants	Understorey condition	Significance
1	650932	6152488	RM	BGW	*E. albens*	poor	TSC
2	652643	6154425	RM	BGW	*E. albens*	poor-mod	TSC
2	653760	6154215	RM	NP	*Microlaena stipoides, Bothriochloa macra, Austrodanthonia spp. (E. albens* nearby*)*	poor-mod	TSC
2	653800	6153883	RM	BGW	*E. blakelyi, Allocasuarina verticillata*	mod	TSC
2	652648	6154493	Q	BGW	*E. albens*	poor	TSC
2	653871	6153878	Q	BGW	*E. blakelyi*	mod	TSC
3	654112	6152623	Q	BGW	*E. albens, Allocasuarina verticillata*	mod-good	TSC EPBC
3	653868	6152243	RM	NP	*Austrodanthonia spp. (E. albens* nearby*)*	poor-mod	TSC
3	654056	6152600	RM	BGW	*E. goniocalyx, Allocasuarina verticillata (*with *E. blakelyi)*	mod-good	TSC EPBC
4a	654284	6149179	Q	BGW	*E. melliodora*	mod	TSC
4a	654030	6149850	RM	BGW	*E. melliodora*	poor	TSC
4a	653639	6149825	RM	BGW	*E. melliodora, E. blakelyi*	mod	TSC
4a	654026	6149814	RM	BGW	*E. melliodora*	poor	TSC
4a	654101	6149572	RM	NP	*Austrodanthonia auriculata (E. albens, E. melliodora, E goniocalyx* nearby*)*	mod	TSC

Cluster	Easting	Northing	Survey method	Type	Overstorey dominants	Understorey condition	Significance
4a	653805	6149842	I	BGW	*E. blakelyi*	mod	TSC
4a	653977	6149973	I	BGW	*E. blakelyi*	mod	TSC
4a	654230	6149146	RM	BGW	*Allocasuarina verticillata, E. blakelyi*	mod-good	TSC EPBC
4a	654065	6149009	Q	BGW	*Allocasuarina verticillata* (with *E. melliodora)*	mod-good	TSC EPBC
4a	654255	6149226	Q	BGW	*E. blakelyi, Allocasuarina verticillata*	mod-good	TSC EPBC
4a	654220	6149280	Q	BGW	*E. goniocalyx, Allocasuarina verticillata*	mod-good	TSC EPBC
4a	654140	6149463	RM	NP	*Kunzea ericoides, Aristida ramosa*	mod-good	TSC
4b	653848	6148356	RM	BGW	*E. blakelyi, E. albens*	mod	TSC
4b	653542	6148641	Q	BGW	*E. macrorhyncha (*with *E. blakelyi)*	good	TSC EPBC
4b	653710	6148717	Q	BGW	*E. blakelyi*	mod-good	TSC EPBC
4b	653577	6147898	I	BGW	*Kunzea ericoides thicket*	poor	TSC
4b	653710	6148263	RM	BGW	*Allocasuarina verticillata, E blakelyi*	mod-good	TSC EPBC
4b	653629	6148696	RM	BGW	*E. blakelyi*	good	TSC EPBC
4b	653549	6148105	I	BGW	*Allocasuarina verticillata, E blakelyi*	mod-good	TSC
4b	653928	6148689	RM	BGW	*E. melliodora, E. goniocalyx*	mod-good	TSC EPBC
4b	653746	6148094	I	BGW	*E. albens, E. goniocalyx*	mod	TSC
5	657583	6151782	I	BGW	*E. albens*	poor	TSC
5	657321	6151295	RM	NP	*Austrodanthonia spp., Bothriochloa macra (E. goniocalyx and E. melliodora nearby)*	poor-mod	TSC
5	657285	6151281	RM	BGW	*E. goniocalyx* (with *E. melliodora)*	mod	TSC
5-6	657470	6151933	RM	BGW	*E. mannifera, E. goniocalyx* (with *E. albens*)	mod -good	TSC
6	657491	6152213	Q	DGFL	*E. goniocalyx*	mod -good	TSC EPBC
7	658763	6147540	RM	NP	*Microlaena stipoides, Aristida ramosa, Austrodanthonia spp.*	poor-mod	-
7	658692	6146200	I	DG	*Austrodanthonia spp, Themeda triandra*	good	TSC EPBC
7	658511	6146780	I	DG	*Themeda triandra, Austrodanthonia spp*	good	TSC EPBC
7	658705	6146729	I	NP	*Aristida ramosa*	mod	-
7	658927	6146356	Q	DGFB	*E dives, E mannifera*	mod	-
7	658057	6148879	Q	DGFB	*E mannifera, E. goniocalyx*	poor-mod	-
7	657901	6148256	RM	DGFL	*E. goniocalyx*	mod	TSC
7	658063	6148234	Q	BGW	*E. melliodora, E. goniocalyx*	mod	TSC
7	659023	6145904	RM	DG	*Austrodanthonia spp, Themeda triandra*	good	TSC EPBC
Powerline	651873	6153194	I	BGW		Poor-moderate	TSC
Powerline	653176	6153386	I	BGW		Poor-moderate	TSC
Powerline	660655	6148976	I	BGW		Poor-moderate	TSC
Powerline	656253	6138942	I	BGW		Poor-	TSC

Cluster	Easting	Northing	Survey method	Type	Overstorey dominants	Understorey condition	Significance
Powerline	656322	6138824	I	BGW		moderate Poor-moderate	TSC

March 2009 additional inspection sites

Eastings	Northings	ID
660662	6148984	2
661264	6148891	17
660268	6146834	16
653176	6153389	25
653585	6153544	26
653465	6153588	38
656304	6138926	

A4. Yass Daisy (*Ammobium craspedioides*) records

Cluster	Easting	Northing
4a	654140	6149463
4a	654118	6149485
4b	653538	6148624
4b	653654	6148697
4b	653643	6148630
6	657463	6152090
6	657371	6152144
6	657391	6152173
6	657406	6152193
6	657460	6152234
6	657465	6152245
6	657480	6152130
6	657491	6152213
7	658917	6146173
7	658698	6146240
7	658692	6146200
7	658698	6146170
7	658671	6146215
7	658649	6146291
7	658648	6146324
7	658511	6146780

Appendix B **FAUNA SURVEY RESULTS**

1. Fauna species list

Common Name	Scientific Name
Mammals	
Brown Hare	*Lepus capensis*
Common Brushtail possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Common Wombat	*Vombatus ursinus*
Eastern Grey Kangaroo	*Macropus giganteus*
Eastern Wallaroo	*Macropus robustus robustus*
European Red Fox	*Canis vulpes*
House Mouse	*Mus musculus*
Short-beaked Echidna	*Tachyglossus aculeatus*
Swamp Wallaby	*Wallabia bicolor*
Yellow-footed Antechinus	*Antechinus flavipes*
Microbats	
Goulds Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Eastern Bentwing Bat	*Miniopterus schreibersii*
	Mormopterus sp.no.4
	Mormopterus sp.no.3
Long-eared Bat	*Nyctophilus geoffroyi/gouldi complex*
Inland Broad-nosed Bat	*Scotorepens balstoni*
Little Broad-nosed Bat	*Scotorepens greyii*
White-striped Freetail bat	*Tadarida australis* (*syn. Nyctinomus australis*)
Large Forest Bat	*Vespadelus darlingtoni*
Southern Forest Bat	*Vespadelus regulus*
Little Forest Bat	*Vespadelus vulternus*
Large-footed Myotis (possible)	*Myotis macropus*
Yellow-bellied Sheathtail Bat (possible)	*Saccolaimus flaviventris*
Birds	
Australasian Grebe	*Podiceps ruficollis*
Australian Magpie	*Gymnorhina tibicen*
Australian Owlet-nightjar	*Aegotheles cristatus*
Australian Raven	*Corvus coronoides*
Black faced Cuckoo Shrike	*Coracina novaehollandiae*
Brown Falcon	*Falco berigora*
Brown Goshawk	*Accipiter fasciatus*
Brown Songlark	*Cincloramphus cruralis*
Common Starling	*Sturnus vulgaris*
Crested Pigeon	*Ocyphaps lophotes*
Crimson Rosella	*Platycercus elegans*
Diamond Firetail	*Stagonopleura guttata*
Double-barred Finch	*Poephila bichenovii*
Dusky Woodswallow	*Artamus cyanopterus*
Eastern Rosella	*Platycercus eximius*
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Galah	*Cacatua roseicapilla*
Golden Whistler	*Pachycephala pectoralis*
Grey Butcherbird	*Cracticus torquatus*
Grey Fantail	*Rhipidura fuliginosa*
Horsefield's Bronze cuckoo	*Chrysococcyx basalis*
Laughing Kookaburra	*Dacelo novaeguineae*
Little Eagle	*Hieraaetus morphnoides*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
Little Wattlebird	*Anthochaera chrysoptera*
Magpie Lark	*Grallina cyanoleuca*
Masked Lapwing	*Vanellus miles*

Common Name	Scientific Name
Mistletoebird	*Dicaeum hirundinaceum*
Nankeen Kestrel	*Falco cenchroides*
Noisy Friarbird	*Philemon corniculatus*
Noisy Miner	*Manorina melanocephala*
Olive-backed Oriole	*Oriolus sagittatus*
Painted Button-quail	*Turnix varia*
Pied Currawong	*Strepera graculina*
Rainbow Bee-eater	*Merops ornatus*
Red Wattlebird	*Anthochaera carunculata*
Red-capped Robin	*Petroica goodenovii*
Red-browed Finch	*Neochmia temporalis*
Red-rumped Parrot	*Psephotus haematonotus*
Restless Flycatcher	*Myiagra iniquieta*
Richards Pipit	*Anthus novaeseelandiae*
Rufous Whistler	*Pachycephala rufiventris*
Satin Flycatcher	*Myiagra cyanoleuca*
Scarlet Robin	*Petroica multicolor*
Silvereye	*Zosterops lateralis*
Speckled Warbler	*Chthonicola sagittata*
Splendid Fairy-wren	*Malurus splendens*
Spotted Pardalote	*Pardalotus punctatus*
Striated Pardalote	*Pardalotus striatus*
Striated Thornbill	*Acanthiza lineata*
Sulfur-crested Cockatoo	*Cacatua galerita*
Superb Fairywren	*Malurus cyaneus*
Superb Parrot	*Polytelis swainsonii*
Tawny Frogmouth	*Podargus strigoides*
Wedgetail Eagle	*Aquila audax*
Weebill	*Smicrornis brevirostris*
Welcome Swallow	*Hirundo neoxena*
White-faced Heron	*Egretta novaehollandiae*
White-throated Gerygone	*Gerygone olivacea*
White plumed Honeyeater	*Lichenostomus penicillatus*
White-throated Treecreeper	*Cormobates leucophaeus*
White-winged Chough *s*	*Corcorax melanorhampho*
Willie Wagtail	*Rhipidura leucophrys*
Yellow faced honeyeater	*Lichenostomus chrysops*
Yellow thornbill	*Acanthiza nana*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Reptiles	
Bearded Dragon (eastern)	*Pogona barbata*
Boulenger's Skink	*Morethia boulengeri*
Common Blue-tongued Lizard	*Tiliqua scincoides*
Copperhead Snake	*Austrelaps superbus*
Delicate Skink	*Lampropholis delicata*
Cunningham's Skink	*Egernia cunninghami*
Dwyer's Snake	*Suta spectabilis dwyeri*
Copper-tailed Skink	*Ctenotus taeniolatus*
Garden Skink	*Lampropholis guichenoti*
Marbled Gecko	*Christinus marmoratus*
Olive Legless Lizard	*Delma inornata*
Red-bellied Black Snake	*Pseudechis porphyriacus*
Shingle Back Lizard	*Tiliqua scincoides*
Southern Rainbow Skink	*Carlia tetradactyla*
Southern Rainbow Skink	*Carlia tetradactyla*
Three toed Skink	*Hemiergis decresiensis*
Tree Skink	*Egernia striolata*
	Gehyra variegata
Frogs	
Common Froglet	*Crinia signifera*
Plains Froglet	*Crinia parinsignifera*
Smooth Toadlet	*Uperoleia laevigata*
Southern Bullfrog	*Limnodynastes dumerilii*
Spotted Marsh Frog	*Limnodynastes tasmaniensis*

2. Fauna survey data summary

September 2008 survey site locations and effort (GDA datum)

Survey type	Date	start E	start N	end E	end N	Location	Person hours
trap line 1	19/09/2008	653779	6148685	653753	6148695	Upper slope 4a-4b, open woodland yellow box and red gum, native grasses	8 trap nights
trap line 2	17/09/2008	653751	6148819	653628	6148918	cluster 4a/4b	72 trap nights
trap line 3	17/09/2008	654188	6149265	654006	6149363	cluster 4a/4b	36 Trap nights
bird census 1	22/09/2008	650671	6152297	650904	6152163	Top of rocky ridge with sparse scattered mature eucalypts	20 min
bird census 2	21/09/2008	657438	6152343	657595	6151733	Lower slope Open woodland	
bird census 3	21/09/2008	657538	6152137	657438	6152343	Lower slope Open woodland	20min
bird census 4	20/09/2008	653781	6149920	653544	6149936	Mid slope just above gully in open woodland	20min
bird census 5	19/09/2008	652649	6154954	652405	6154984	Mid slope adjacent to windbreak of direct seeded native trees	20min
bird census 6	18/09/2008	653750	6153996			Lower slope Open woodland Sparse-Nil Groundcover	20min
bird census 7	18/09/2008	654188	6149265	654006	6149363	Trapline TL2 Site 4a/4b Upper slope under allocasuarina and Eucalypt	20min
bird census 8	18/09/2008	653751	6148819	653595	61489631	Midslope with rocky ground under Allocasuarina and Eucalypt Site 4a/4b	20min
bird census 9	17/09/2008	654306	6149248			Upper slope amongst Allocasuarina Site 4a/4b	20min
reptile census 1	18/09/2008	653595	6148963			Cluster 4a/4b, upper slope, small rock outcrop with Allocasuarina woodland, north aspect	40min
reptile census 2	18/09/2008	6533378	6148859			Large rock outcrop in grassland, cluster 4a/4b. North aspect	80min
reptile census 3	18/09/2008	653422	6154040			Rock outcrop in pasture, cluster 2. NW aspect	20min
reptile census 4	18/09/2008	653463	6154052			Rock outcrop in pasture , cluster 2. NW aspect	30min
reptile census 5	18/09/2008	653908	6154112			Sparse rock outcrop in heavily grazed paddock, cluster 2, NE aspect	20min
reptile census 6	19/09/2008	653549	6148269			Rock outcrop, lower pasture, Allocasuarina woodland, N aspect	40min
reptile census 7	19/09/2008	652513	6154795			Cluster 2, rock outcrop in pasture, NE aspect	30min
reptile census 8	20/09/2008	653394	6150004			Rock outcrop, hill crest in pasture, NE aspect	40min
reptile census 9	20/09/2008	653199	6150506			Rock outcrop, hillcrest in pasture, cluster 4a	40min
reptile census 10	20/09/2008	653394	6150004			Cluster 4a, open saddle, dead trees and logs in pasture	20min

Survey type	Date	start	start	end	end	Location	Person hours
reptile census 11	22/09/2008	657549	6152086	657218	6152255	Clusters 5 and 6, transect along small creek lined with rocky outcrops and sedges	45min
reptile census 12	21/09/2008	657549	6152086			Clusters 5 and 6, midslope with rock outcrop and dead wood in grassland	20min
reptile census 13	22/09/2008	650671	6152297			Cluster 1, rock outcrop on upper slope in pasture, many thistles, most rock embedded, NW aspect	20min
reptile census 14	22/09/2008	650904	6152163			Cluster 1, rock outcrop on rocky hill in pasture, some embedded roack, some loose, NW aspect	20min
anabat survey 1	17/09/2008	654165	6149239			Saddle adjacent to woodland/scrubland on upper slope - anabat place on dam	12hrs
anabat survey 2	18/09/2008	649352	6147730			Travelling stock route along Illalong Road, adjacent to creekline flat under woodland	11 hrs 45mins
anabat survey 3	20/09/2008	654306	6149248			To of saddle adjacent to woodland on upper slope (Cluster 4a-4b)	12hrs
nocturnal survey 1	17/09/2008	654306	614248	654006	6149363	Ridgetop	14min
nocturnal survey 2	18/09/2008	649359	6147722			Illalong Road - Travelling Stock Route, River Flat Woodland (50m from creek in mature trees)	20min
nocturnal survey 3	19/09/2008	654306	6149248	653779	614685	Saddle adjacent to upper slope woodland	110min
nocturnal survey 4	21/09/2008	657549	6152086	657218	6152255	Clusters 5 and 6. Riparian vegetation (small creek open woodland)	50min

Bird census transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
27.3.07	KG	**B1**		Australian Mapgpie	659405	6146407	10	Sth section of powerline route
27.3.07	KG	**B1**		Wombat	659405	6146407		scat
27.3.07	KG	**B1**		Copperhead Snake	659405	6146407		
27.3.07	KG	**B2**		Black-faced Cuckoo Shrike	658924	6146597	1	
27.3.07	KG	**B2**		Silvereye	658924	6146597	5	
27.3.07	KG	**B2**		Australian Mapgpie	658924	6146597	5	
27.3.07	KG	**B2**		Crimson Rosella	658924	6146597	5	
27.3.07	KG	**B2**		Thornbill sp.	658924	6146597	5	
27.3.07	KG	**B2**		Superb Fairywren	658924	6146597	0	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
27.3.07	KG	**B2**		Willie Wagtail	658924	6146597	0	
27.3.07	KG	**B2**		**Wedgetail Eagle**	658924	6146597	10	single low to ground
27.3.07	KG	**B2**		Red-browed Finch	658924	6146597	5	
27.3.07	KG	**B2**		Richards Pipit	658924	6146597	0	
27.3.07	KG	**B2**		Swamp Wallaby	658924	6146597		
27.3.07	KG	**B2**		Eastern Grey Kangaroo	658924	6146597		
27.3.07	KG	**B3**		Australian Mapgpie	657926	6148436	10	
27.3.07	KG	**B3**		Striated Pardalote	657926	6148436	10	
27.3.07	KG	**B3**		Grey Fantail	657926	6148436	5	
27.3.07	KG	**B3**		Galah	657926	6148436	10	
27.3.07	KG	**B3**		Golden Whistler	657926	6148436	5	
27.3.07	KG	**B3**		Crimson Rosella	657926	6148436	5	
27.3.07	KG	**B3**		Grey Butcherbird	657926	6148436	0	
27.3.07	KG	**B3**		Pied Currawong	657926	6148436	5	
27.3.07	KG	**B3**		Brown Thornbill	657926	6148436	10	
27.3.07	KG	**B3**		Red Wattlebird	657926	6148436		
27.3.07	KG	**B3**		Willie Wagtail	657926	6148436	0	
27.3.07	KG	**B3**		Welcome Swallow	657926	6148436	10	
27.3.07	KG	**B3**		Spotted Pardalote	657926	6148436	5	
27.3.07	KG	**B3**		Eastern Grey Kangaroo	657926	6148436		
27.3.07	KG	**B3**		Fox	657926	6148436		
27.3.07	KG	**B3**		Swamp Wallaby	657926	6148436		
27.3.07	KG	**B3**		Wombat	657926	6148436		
27.3.07	KG	**B3**		skink	657926	6148436		
28.3.07	KG	**B4**		**Wedgetail Eagle**	658081	6145903	60	
28.3.07	KG	**B4**		Crimson Rosella	658081	6145903		
28.3.07	KG	**B4**		Yellow-rumped Thornbill	658081	6145903	0	
28.3.07	KG	**B4**		Striated Thorbill	658081	6145903	5	
28.3.07	KG	**B4**		Richards Pipit	658081	6145903	0	
28.3.07	KG	**B4**		Australian Mapgpie	658081	6145903		
28.3.07	KG	**B4**		**Wedgetail Eagle**	658081	6145903	80	very high on thermals
28.3.07	KG	**B5**		Crimson Rosella	658873	6146366	5	
28.3.07	KG	**B5**		Silvereye	658873	6146366	5	
28.3.07	KG	**B5**		Willie Wagtail	658873	6146366	0	
28.3.07	KG	**B5**		Grey Fantail	658873	6146366	5	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
28.3.07	KG	**B5**		Pied Currawong	658873	6146366		
28.3.07	KG	**B5**		White-throated Treecreeper	658873	6146366	5	
28.3.07	KG	**B5**		Striated Pardalote	658873	6146366	5	
28.3.07	KG	**B5**		Eastern Rosella	658873	6146366	5	
28.3.07	KG	**B5**		Crested Pigeon	658873	6146366	5	
28.3.07	KG	**B5**		Striated Thornbill	658873	6146366	5	
28.3.07	KG	**B5**		Galah	658873	6146366	10	
28.3.07	KG	**B5**		Masked Lapwing	658873	6146366	0	
28.3.07	KG	**B5**		Australian Mapgpie	658873	6146366	0	
28.3.07	KG	**B5**		Swamp Wallaby	658873	6146366		
28.3.07	KG	**B5**		Eastern Grey Kangaroo	658873	6146366		
28.3.07	KG	**B5**		Common Wombat	658873	6146366		
28.3.07	KG	**B5**		Brown Thornbill	658873	6146366	5	
28.3.07	KG	**B5**		Welcome Swallow	658873	6146366	10	
29.3.07	KG	**B6**		Australian Raven	662901	6150662		
29.3.07	KG	**B6**		Willie Wagtail	662901	6150662		
29.3.07	KG	**B6**		Thornbill sp.	662901	6150662		
29.3.07	KG	**B6**		**Australian Mapgpie**	662901	6150662		
29.3.07	KG	**B6**		Grey Fantail	662901	6150662		
29.3.07	KG	**B6**		Red-browed Finch	662901	6150662		
29.3.07	KG	**B6**		**Superb Fairywren**	662901	6150662		
29.3.07	KG	**B6**		Magpie Lark	662901	6150662		
29.3.07	KG	**B7**		Australian Mapgpie	661082	6148915		
29.3.07	KG	**B7**		Crimson Rosella	661082	6148915		
29.3.07	KG	**B7**		Galah	661082	6148915		
29.3.07	KG	**B7**		Noisy Miner?	661082	6148915		
29.3.07	KG	**B7**		Willie Wagtail	661082	6148915		
29.3.07	KG	**B7**		Eastern Rosella	661082	6148915		
29.3.07	KG	**B8**		Australian Mapgpie	660099	6148467	5	
29.3.07	KG	**B8**		Galah	660099	6148467	5	
29.3.07	**KG**	**B8**		**White-faced Heron**	**660099**	**6148467**	**10**	
29.3.07	KG	**B8**		Striated Thornbill	660099	6148467	5	
29.3.07	KG	**B8**		Crested Pigeon	660099	6148467	5	
29.3.07	KG	**B8**		Willie Wagtail	660099	6148467	0	
29.3.07	KG	**B8**		Crimson Rosella	660099	6148467	5	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
29.3.07	KG	**B8**		Little Wattlebird	660099	6148467	5	
29.3.07	KG	**B8**		Superb Fairywren	660099	6148467	0	
29.3.07	KG	**B8**		Sulfur-crested Cockatoo	660099	6148467	10	
29.3.07	KG	**B8**		Eastern Rosella	660099	6148467	20	
29.3.07	KG	**B8**		Australian Raven	660099	6148467		
29.3.07	KG	**B8**		Pied Currawong	660099	6148467	15	
29.3.07	KG	**B8**		White-winged Chough	660099	6148467	5	
29.3.07	KG	**B8**		Fox	660099	6148467	0	
29.3.07	KG	**B8**		Common Starling	660099	6148467	0	
29.3.07	**KG**	**B8**		**Australian Wooduck**	**660099**	**6148467**	**0**	
29.3.07	**KG**	**B8**		**Black-shouldered Kite**	**660099**	**6148467**	**30**	
29.3.07	**KG**	**B8**		**Nankeen Kestrel**	**660099**	**6148467**	**20**	
29.3.07	KG	**B8**		Yellow-rumped Thornbill	660099	6148467	0	
29.3.07	KG	**B8**		Common Bronzewing	660099	6148467	0	

September 2008 survey (GDA datum)

ID	Common Name	Scientific Name	Date of sighting	Location		No. recorded	Height above ground (m)
				Easting	Northing		
b1	Australian Magpie	*Gymnorhina tibicen*	22/09/2008	650671	6152297	2	10-20m
b1	Sulphur crested cockatoo	*Cacatua galerita*	22/09/2008	650671	6152297	19	0
b1	Brown Songlark	*Cincloramphus cruralis*	22/09/2008	650671	6152297	1	N/A
b1	Galah	*Cacatua roseicapilla*	22/09/2008	650671	6152297	13	0
b1	Common Starling	*Sturnus vulgaris*	22/09/2008	650671	6152297	6	2-10m
b1	Striated Pardalote	*Pardalotus striatus*	22/09/2008	650671	6152297	1	N/A
b1	Noisy Friarbird	*Philemon corniculatus*	22/09/2008	650671	6152297	2	Upper Canopy
b1	Willie Wagtail	*Rhipidura leucophrys*	22/09/2008	650671	6152297	2	2m
b1	Laughing Kookaburra	*Dacelo novaeguineae*	22/09/2008	650671	6152297	1	N/A
b1	White plumed Honeyeater	*Lichenostomus penicillatus*	22/09/2008	650671	6152297	1	10m
b1	Crimson Rosella	*Platycercus elegans*	22/09/2008	650671	6152297	4	4-5m
b1	Weebill	*Smicrornis brevirostris*	22/09/2008	650671	6152297	2	N/A
b2	Galah	*Cacatua roseicapilla*	21/09/2008	657438	6152343	2	20m

	Common Name	Scientific Name	Date of sighting	Location			
b2	Crimson Rosella	*Platycercus elegans*	21/09/2008	657438	6152343	1	N/A
b2	Laughing Kookaburra	*Dacelo novaeguineae*	21/09/2008	657438	6152343	1	N/A
b2	Grey Fantail	*Rhipidura fuliginosa*	21/09/2008	657438	6152343	1	N/A
b2	Golden Whistler	*Pachycephala pectoralis*	21/09/2008	657438	6152343	1 (F)	2
b2	Satin Flycatcher	*Myiagra cyanoleuca*	21/09/2008	657438	6152343	1	3
b2	Brown Goshawk	*Accipiter fasciatus*	21/09/2008	657438	6152343	1	15-20m
b2	Pied Currawong	*Strepera graculina*	21/09/2008	657438	6152343	3	10-15m
b2	Sulphur crested cockatoo	*Cacatua galerita*	21/09/2008	657438	6152343	1	20m
b2	**Wedge tailed Eagle**	***Aquila audax***	**21/09/2008**	**657438**	**6152343**	**2**	**100+m**
b2	**Brown Falcon**	***Falco berigora***	**21/09/2008**	**657438**	**6152343**	**1**	**20**
b3	Red Wattlebird	*Anthochaera carunculata*	21/09/2008	657538	6152137	1	N/A
b3	Noisy Friarbird	*Philemon corniculatus*	21/09/2008	657538	6152137	5	N/A
b3	Eastern Rosella	*Platycercus eximius*	21/09/2008	657538	6152137	1	N/A
b3	Australian Raven	*Corvus coronoides*	21/09/2008	657538	6152137	1	N/A
b3	**Nankeen Kestrel**	***Falco cenchroides***	**21/09/2008**	**657538**	**6152137**	**2**	**20m**
b3	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	21/09/2008	657538	6152137	2	N/A
b3	Black faced Cuckoo Shrike	*Coracina novaehollandiae*	21/09/2008	657538	6152137	1	N/A
b3	Australian Magpie	*Gymnorhina tibicen*	21/09/2008	657538	6152137	1	N/A
b3	Magpie Lark	*Grallina cyanoleuca*	21/09/2008	657538	6152137	1	N/A
b3	Striated Pardalote	*Pardalotus striatus*	21/09/2008	657538	6152137	1	N/A
b3	Buff-rumped Thornbill	*Acanthiza reguloides*	21/09/2008	657538	6152137	6	0-3m
b3	Spotted Pardalote	*Pardalotus punctatus*	21/09/2008	657538	6152137	3	3
b3	White Throated Treecreeper	*Cormobates leucophaeus*	21/09/2008	657538	6152137	1	N/A
b3	Weebill	*Smicrornis brevirostris*	21/09/2008	657538	6152137	1	20m
b4	Eastern Rosella	*Platycercus eximius*	20/09/2008	653781	6149920	1	5m
b4	White Throated Treecreeper	*Cormobates leucophaeus*	20/09/2008	653781	6149920	1	N/A
b4	Striated Thornbill	*Acanthiza lineata*	20/09/2008	653781	6149920	2	2-4m
b4	Buff-rumped Thornbill	*Acanthiza reguloides*	20/09/2008	653781	6149920	6	0-3m
b4	Australian Raven	*Corvus coronoides*	20/09/2008	653781	6149920	1	N/A
b4	Australian Magpie	*Gymnorhina tibicen*	20/09/2008	653781	6149920	1	N/A
b4	Grey Fantail	*Rhipidura fuliginosa*	20/09/2008	653781	6149920	1	2m
b4	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	20/09/2008	653781	6149920	1	2m
b4	Spotted Pardalote	*Pardalotus punctatus*	20/09/2008	653781	6149920	1	3m
b4	Red-capped Robin	*Petroica goodenovii*	20/09/2008	653781	6149920	1	3m
b4	Scarlet Robin	*Petroica multicolor*	20/09/2008	653781	6149920	1	1m
b4	Rufous Whistler	*Pachycephala rufiventris*	20/09/2008	653781	6149920	1	N/A

	Common Name	Scientific Name	Date of sighting	Location			
b5	Brown Songlark	*Cincloramphus cruralis*	19/09/2008	652649	6154954	1	N/A
b5	Crested Pigeon	*Ocyphaps lophotes*	19/09/2008	652649	6154954	2	0-2m
b5	White plumed Honeyeater	*Lichenostomus penicillatus*	19/09/2008	652649	6154954	2	2-3m
b5	Willie Wagtail	*Rhipidura leucophrys*	19/09/2008	652649	6154954	2	2-3m
b5	Rufous Whistler	*Pachycephala rufiventris*	19/09/2008	652649	6154954	1	N/A
b5	Australian Magpie	*Gymnorhina tibicen*	19/09/2008	652649	6154954	2	4m
b5	Crimson Rosella	*Platycercus elegans*	19/09/2008	652649	6154954	2	1.5m
b5	Grey Shrike-thrush	*Colluricincla harmonica*	19/09/2008	652649	6154954	1	1m
b5	Superb Fairy wren	*Malurus cyaneus*	19/09/2008	652649	6154954	3	0-1m
b5	Bronzewing Pigeon	*Phaps chalcoptera*	19/09/2008	652649	6154954	1	0-1m
b5	Magpie Lark	*Grallina cyanoleuca*	19/09/2008	652649	6154954	1	N/A
b5	Striated Thornbill	*Acanthiza lineata*	19/09/2008	652649	6154954	1	N/A
b5	Sulphur crested cockatoo	*Cacatua galerita*	19/09/2008	652649	6154954	20	0m
b5	Grey Fantail	*Rhipidura fuliginosa*	19/09/2008	652649	6154954	1	2m
b5	Black faced Cuckoo Shrike	*Coracina novaehollandiae*	19/09/2008	652649	6154954	1	N/A
b5	Common Starling	*Sturnus vulgaris*	19/09/2008	652649	6154954	1	10m
b5	Galah	*Cacatua roseicapilla*	19/09/2008	652649	6154954	2	N/A
b5	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	19/09/2008	652649	6154954	1	0-1m
b5	**Brown Goshawk**	***Accipiter fasciatus***	**19/09/2008**	**652649**	**6154954**	**1**	**20m**
b5	Welcome Swallow	*Hirundo neoxena*	19/09/2008	652649	6154954	1	20m
b6	Australian Magpie	*Gymnorhina tibicen*	18/09/2008	653750	6153996	2	
b6	Galah	*Cacatua roseicapilla*	18/09/2008	653750	6153996	2	
b6	Horsefield's Bronze cuckoo	*Chrysococcyx basalis*	18/09/2008	653750	6153996	1	
b6	Red Wattlebird	*Anthochaera carunculata*	18/09/2008	653750	6153996	1	
b6	Pallid cuckoo	*Cuculus pallidus*	18/09/2008	653750	6153996	2	
b6	**Wedge tailed Eagle**	***Aquila audax***	**18/09/2008**	**653750**	**6153996**	**N/A**	
b6	Crimson Rosella	*Platycercus elegans*	18/09/2008	653750	6153996	1	
b6	Sulphur crested cockatoo	*Cacatua galerita*	18/09/2008	653750	6153996	1	
b6	Grey Fantail	*Rhipidura fuliginosa*	18/09/2008	653750	6153996	2	
b6	White Throated Treecreeper	*Cormobates leucophaeus*	18/09/2008	653750	6153996	N/A	
b6	Striated Thornbill	*Acanthiza lineata*	18/09/2008	653750	6153996	N/A	
b6	Red capped robin	*Petroica goodenovii*	18/09/2008	653750	6153996	1 (M)	
b6	**Nankeen Kestrel**	***Falco cenchroides***	**18/09/2008**	**653750**	**6153996**	**6**	
b6	Rufous Whistler	*Pachycephala rufiventris*	18/09/2008	653750	6153996	N/A	
b6	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	18/09/2008	653750	6153996		
b6	Striated Pardalote	*Pardalotus striatus*	18/09/2008	653750	6153996		

	Common Name	Scientific Name	Date of sighting	Location			
b6	Silvereye	*Zosterops lateralis*	18/09/2008	654188	6149265	N/A	N/A
b6	Australian Raven	*Corvus coronoides*	18/09/2008	654188	6149265	1	N/A
b6	Yellow faced honeyeater	*Lichenostomus chrysops*	18/09/2008	654188	6149265	1	N/A
b6	Rufous Whistler	*Pachycephala rufiventris*	18/09/2008	654188	6149265	1	N/A
b6	Striated Pardalote	*Pardalotus striatus*	18/09/2008	654188	6149265	N/A	N/A
b6	Striated Thornbill	*Acanthiza lineata*	18/09/2008	654188	6149265	N/A	N/A
b6	White winged Chough	*Corcorax melanorhamphos*	18/09/2008	654188	6149265	N/A	N/A
b6	Superb Fairy wren	*Malurus cyaneus*	18/09/2008	654188	6149265	2	1.5m
b6	Red Wattlebird	*Anthochaera carunculata*	18/09/2008	654188	6149265	1	N/A
b6	White Throated Treecreeper	*Cormobates leucophaeus*	18/09/2008	654188	6149265	1	N/A
b6	Grey Shrike-thrush	*Colluricincla harmonica*	18/09/2008	654188	6149265	1	N/A
b6	Scarlet Robin	*Petroica multicolor*	18/09/2008	654188	6149265	1	N/A
b6	Australian Magpie	*Gymnorhina tibicen*	18/09/2008	654188	6149265	3	5-6m
b6	Grey Fantail	*Rhipidura fuliginosa*	18/09/2008	654188	6149265	1	3m
b6	Crimson Rosella	*Platycercus elegans*	18/09/2008	654188	6149265	N/A	N/A
b6	Yellow thornbill	*Acanthiza nana*	18/09/2008	654188	6149265	N/A	N/A
b6	Laughing Kookaburra	*Dacelo novaeguineae*	18/09/2008	654188	6149265	1	N/A
b6	Golden Whistler	*Pachycephala pectoralis*	18/09/2008	654188	6149265	1 (F)	3m
b8	Red capped robin	*Petroica goodenovii*	18/09/2008	653751	6148819	2	2m
b8	Striated Thornbill	*Acanthiza lineata*	18/09/2008	653751	6148819	N/A	N/A
b8	Striated Pardalote	*Pardalotus striatus*	18/09/2008	653751	6148819	N/A	N/A
b8	Yellow faced honeyeater	*Lichenostomus chrysops*	18/09/2008	653751	6148819	2	4-5m
b8	Australian Magpie	*Gymnorhina tibicen*	18/09/2008	653751	6148819	N/A	N/A
b8	**Speckled Warbler**	***Chthonicola sagittata***	**18/09/2008**	**653751**	**6148819**	**1**	**0-2m**
b8	**Brown Goshawk**	***Accipiter fasciatus***	**18/09/2008**	**653751**	**6148819**	**1**	**3m**
b8	Yellow thornbill	*Acanthiza nana*	18/09/2008	653751	6148819	2	2m
b8	Grey Fantail	*Rhipidura fuliginosa*	18/09/2008	653751	6148819	2	2-4m
b8	White winged Chough	*Corcorax melanorhamphos*	18/09/2008	653751	6148819	N/A	N/A
b8	Golden Whistler	*Pachycephala pectoralis*	18/09/2008	653751	6148819	1 (F)	2-3m
b8	Spotted Pardalote	*Pardalotus punctatus*	18/09/2008	653751	6148819	5	2
b8	Pied Currawong	*Strepera graculina*	18/09/2008	653751	6148819	N/A	N/A
b8	Grey Fantail	*Rhipidura fuliginosa*	17/09/2008	654306	6149248	4	2-m
b8	Crimson Rosella	*Platycercus elegans*	17/09/2008	654306	6149248	8	0-4m
b8	Striated Thornbill	*Acanthiza lineata*	17/09/2008	654306	6149248	2	3-4m
b8	Australian Magpie	*Gymnorhina tibicen*					2
b8	Golden Whistler	*Pachycephala pectoralis*	17/09/2008	654306	6149248	1 (F)	4m

	Common Name	Scientific Name	Date of sighting	Location			
b8	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	17/09/2008	654306	6149248	6	0-4m
b8	Yellow thornbill	*Acanthiza nana*	17/09/2008	654306	6149248	2	2-4m
b8	Yellow faced honeyeater	*Lichenostomus chrysops*	17/09/2008	654306	6149248	2	4m
b8	White winged Chough	*Corcorax melanorhamphos*	17/09/2008	654306	6149248	6	4-5m

Reptile search transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Easting	Northing
27.3.07	KG	**R1**	*Carlia tetradactyla*		658924	6146597
28.3.07	KG	**R2**	*Pogona barbata*	Bearded Dragon (eastern)	658757	6147547
28.3.07	KG	**R2**	*Tiliqua scincoides*	Shingle Back Lizard	658757	6147547
28.3.07	KG	**R2**	*Hemiergis decresciensis*	Four Toed Skink	658757	6147547
28.3.07	KG	**R3**	*Lampropholis guichenoti*	Garden Skink	658081	6145903
28.3.07	KG	**R3**	*Tiliqua scincoides*	Shingle Back Lizard	658081	6145903

September 2008 survey (GDA datum)

ID	Common Name	Scientific Name	Location		No. observed
			Easting	Northing	
H1	Red-bellied Black Snake	*Pseudechis porphyriacus*	653595	6148963	1
	Cunningham's Skink	*Egernia cunninghami*	653595	6148963	1
	Copper-tailed Skink	*Ctenotus taeniolatus*	653595	6148963	1
H2	Southern Rainbow Skink	*Carlia tetradactyla*	653378	6148859	
	Copper-tailed Skink	*Ctenotus taeniolatus*	653378	6148859	
	Three-toed Skink	*Hemiergis decresiensis*	653378	6148859	
	Cunningham's Skink	*Egernia cunninghami*	653378	6148859	
	Boulenger's Skink	*Morethia boulengeri*	653378	6148859	
	Unidentified Skink		653378	6148859	4
H4	Olive Legless Lizard	*Delma inornata*	653463	6154052	

	Common Name	Scientific Name	Location		No. observed
	Boulenger's Skink	*Morethia boulengeri*	653463	6154052	
	Southern Rainbow Skink	*Carlia tetradactyla*	653463	6154052	
	Marbled Gecko	*Christinus marmoratus*	653463	6154052	
H6	Copper-tailed Skink	*Ctenotus taeniolatus*	653549	6148269	
	Southern Rainbow Skink	*Carlia tetradactyla*	653549	6148269	
	Dwyer's Snake	*Suta spectabilis dwyeri*	653549	6148269	
	Unidentified Skink		653549	6148269	2
H7	Boulenger's Skink	*Morethia boulengeri*	652513	6154795	
H8	Tree Skink	*Egernia striolata*	653394	6150004	1
H10	Olive Legless Lizard	*Delma inornata*	653394	6150004	
	Southern Rainbow Skink	*Carlia tetradactyla*	653394	6150004	
H11	Common Froglet	*Crinia signifera*	657549	6152086	
	Plains Froglet	*Crinia parinsignifera*	657549	6152086	
	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	657549	6152086	
	Unidentified tadpoles		657549	6152086	1
H12	Olive Legless Lizard	*Delma inornata*	650671	6152297	
		Lampropholis spp.	650671	6152297	
H14	Cunningham's Skink	*Egernia cunninghami*	650904	6152163	

Spotlighting transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Count
27.3.07	KG PM	**S1**	*Lepus capensis*	Brown Hare	662678	6149704	
28.3.07	KG PM	**S2**		Microbat sp.	657926	6148436	
28.3.07	KG PM	**S2**		Australian Mapgpie	657926	6148436	
28.3.07	KG PM	**S2**		Eastern Grey Kangaroo	657926	6148436	
27.3.07	KG	**S3**		Brush-tail Possum	660698	6148969	2
27.3.07	KG PM	**S4**		Microbat sp.	658972	6146624	
27.3.07	KG PM	**S4**		Eastern Grey Kangaroo	658972	6146624	
27.3.07	KG PM	**S4**		Swamp Wallaby	658972	6146624	
27.3.07	KG PM	**S4**		Wombat	658972	6146624	
27.3.07	KG PM	**S4**		Australian Wooduck	658972	6146624	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Count
27.3.07	KG PM	**S4**		Australian Mapgpie	658972	6146624	

September 2008 survey (GDA datum)

ID	Common Name	Scientific Name	Date of sighting	Location	
				Easting	Northing
SL1	Tawny Frogmouth	*Podargus strigoides*	17/09/2008	654306	6149248
SL1	Common Froglet	*Crinia signifera*	17/09/2008	654306	6149248
SL1	Plains Froglet	*Crinia parinsignifera*	17/09/2008	654306	6149248
SL1	Common Ringtail Possum	*Pseudocheirus peregrinus*	17/09/2008	654306	6149248
SL1	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	17/09/2008	654306	6149248
SL1	White-striped Mastiff Bat	*Tadarida australis*	17/09/2008	654306	6149248
SL1	Red Fox	*Vulpes vulpes*	17/09/2008	654306	6149248
SL1	Common Brushtail Possum	*Trichosurus vulpecula*	17/09/2008	654306	6149248
SL2	Common Ringtail Possum	*Pseudocheirus peregrinus*	18/09/2008	649359	6147722
SL2	Common Brushtail Possum	*Trichosurus vulpecula*	18/09/2008	649359	6147722
SL3	Common Ringtail Possum	*Pseudocheirus peregrinus*	19/09/2008		654306
SL3	Common Brushtail Possum	*Trichosurus vulpecula*	19/09/2008		654306
SL3	White-striped Mastiff Bat	*Tadarida australis*	19/09/2008	654306	6149248
SL3	Australian Owlet-nightjar	*Aegotheles cristatus*	19/09/2008	654306	6149248
SL3	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	19/09/2008	654306	6149248
SL3	Southern Bullfrog	*Limnodynastes dumerilii*	19/09/2008	654306	6149248
SL3	Smooth Toadlet	*Uperoleia laevigata*	19/09/2008	654306	6149248
SL3	Plains Froglet	*Crinia parinsignifera*	19/09/2008	654306	6149248
SL3	Common Froglet	*Crinia signifera*	19/09/2008	654306	6149248
SL4	Common Froglet	*Crinia signifera*			
SL4	Plains Froglet	*Crinia parinsignifera*			
SL4	Spotted Marsh Frog	*Limnodynastes tasmaniensis*			
SL4	Australian Owlet-nightjar	*Aegotheles cristatus*			
SL4	White-striped Mastiff Bat	*Tadarida australis*			

Trapping transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Sex	Easting	Northing	Comments
28.3.07	KG PM	**T1**	*Antechinus flavipes*	Yellow-footed Antechinus	F	658897	6146422	
28.3.07	KG PM	**T1**	*Antechinus flavipes*	Yellow-footed Antechinus	F	658897	6146422	
27.3.07	KG PM	**T2**	*Antechinus flavipes*	Yellow-footed Antechinus	M	657900	6148270	male with enlarged testes
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	

September 2008 survey (GDA datum)

Date	Observer	Transect	Result
20/09/2008	JR SC	TL3 of 3	Nil captures
18/09/2008	JR SC	TL1 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
19/09/2008	JR SC	TL1 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
20/09/2008	JR SC	TL1 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
18/09/2008	JR SC	TL2 of 3	Nil captures
19/09/2008	JR SC	TL2 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
20/09/2008	JR SC	TL2 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)

Opportunistic observations

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Scientific name	Common name	Height - metres (if applicable)	Comments
26.3.07	KG		Crimson Rosella		
	KG		Australian Mapgpie		
	KG		Magpie Lark		

Date	Observer	Scientific name	Common name	Height - metres (if applicable)	Comments
	KG		Grey Fantail		
	KG		White-throated Treecreeper		
	KG		**Wedgetail Eagle**		
27.3.07	KG		Australian Mapgpie		
	KG		Crimson Rosella		
	KG		Common Starling		flock of approx. 20-30, approx 10m high
	KG		Richards Pipit		
	KG		Pied Currawong		
			Currawong/magpie nest?		large stick nest, not big enough for wteagle but perhaps raptor or
	KG		(659466 6146173)		raven/magpie, grace flat road
	KG		**Brown Falcon**	**30**	**central west area**
	KG		Brown Thornbill	5	
	KG		Yellow-rumped Thornbill		
	KG		Scarlet Robin		
					Munns property, two observed clasping and tumbling, possible
	KG		**Wedgetail Eagle**	50+	courtship behaviour
					single bird observed, lighter colours (juvenile/young?) ridgetop in
	KG		**Wedgetail Eagle**	50	Waldrens
28.3.07	**KG**		**White-faced Heron**	**20**	
	KG		Sulfur-crested Cockatoo	20	
	KG		Red-rumped Parrot	10	
	KG	*Hemiergis decresciensis*	Three toed Skink		
	KG		White-winged Chough	0	approx. 6 on ground
	KG		**Wedgetail Eagle**	0-10	flushed from ground, possibly feeding, in southern part of site
	KG	*Crinia parinsignifera*	Plains Froglet		drainage line

September 2008 survey (GDA datum)

Common Name	Scientific Name	Location	
		Easting	Northing
European Rabbit	*Oryctolagus cuniculus*	653931	6148902
Common Brushtail Possum	*Trichosurus vulpecula*	653931	6148902
Black Wallaby	*Wallabia bicolor*	653931	6148902
Red-bellied Black Snake	*Pseudechis porphyriacus*	653601	6148949

Common Name	Scientific Name	Location	
Common Blue-tongued Lizard	*Tiliqua scincoides*	653672	6149050
Common Froglet	*Crinia signifera*	653672	6149050
Plains Froglet	*Crinia parinsignifera*	653672	6149050
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	653601	6148949
Pied Currawong	*Strepera graculina*	653601	6148949
Noisy Friarbird	*Philemon corniculatus*	653601	6148949
Spotted Pardalote	*Pardalotus punctatus*	653601	6148949
Splendid Fairy-wren	*Malurus splendens*	653601	6148949
Red Wattlebird	*Anthochaera carunculata*	653601	6148949
Scarlet Robin	*Petroica multicolor*	653601	6148949
Sulphur-crested Cockatoo	*Cacatua galerita*	653601	6148949
Short-beaked Echidna	*Tachyglossus aculeatus*	653601	6148949
Laughing Kookaburra	*Dacelo novaeguineae*	653601	6148949
White-throated Treecreeper	*Cormobates leucophaeus*	653601	6148949
Rufous Whistler	*Pachycephala rufiventris*	654006	6149363
Brown Hare	*Lepus capensis*	654165	6149239
Yellow-footed Antechinus	*Antechinus flavipes*	653014	6148857
Dusky Woodswallow	*Artamus cyanopterus*	654978	6149737
Diamond Firetail	***Stagonopleura guttata***	**654978**	**6149737**
Diamond Firetail	***Stagonopleura guttata***	**654089**	**6152602**
White-plumed Honeyeater	*Lichenostomus penicillatus*	654978	6149737
Crested Pigeon	*Ocyphaps lophotes*	654978	6149737
Shingle-back	*Trachydosaurus rugosus*	654076	6148889
Olive-backed Oriole	*Oriolus sagittatus*	653651	6148888
Delicate Skink	*Lampropholis delicata*	653552	6148382
Short-beaked Echidna	*Tachyglossus aculeatus*	653552	6148382
Brown Thornbill	*Acanthiza pusilla*	653552	6148382
Marbled Gecko	*Christinus marmoratus*	653552	6148382
Southern Rainbow Skink	*Carlia tetradactyla*	653659	6148267
Rainbow Bee-eater	***Merops ornatus***	**653659**	**6148267**
Speckled Warbler	***Chthonicola sagittata***	**653832**	**6148393**
Brown Falcon	***Falco berigora***	**652394**	**6154657**
Little Eagle	***Hieraaetus morphnoides***	**652394**	**6154657**
Superb Parrot	***Polytelis swainsonii***	**653595**	**6148963**
Eastern Wallaroo	*Macropus robustus robustus*	653229	6150484
House Mouse	*Mus musculus*	653229	6150484
Marbled Gecko	*Christinus marmoratus*	653229	6150484
Mistletoebird	*Dicaeum hirundinaceum*	654188	6149265
White-throated Gerygone	*Gerygone olivacea*	654188	6149265
Olive Legless Lizard	*Delma inornata*	653733	6148738
Wedge-tailed Eagle	*Aquila audax*	657275	6152225
Painted Button-quail	*Turnix varia*	654017	6149860

Common Name	Scientific Name	Location	
Garden Skink	*Lampropholis guichenoti*	644844	6149650
Eastern Bearded Dragon	*Pogona barbata*	644844	6149650
Short-beaked Echidna	*Tachyglossus aculeatus*	657438	615343
Black Wallaby	*Wallabia bicolor*	657438	615343
Eastern Grey Kangaroo	*Macropus giganteus*	657438	615343
Red Fox	*Canis vulpes*	657438	615343
Boulenger's Skink	*Morethia boulengeri*	650904	6152163

March 2009 survey (GDA datum)

Common Name	Scientific Name	Location	
		Easting	Northing
Wedge tailed Eagle	***Aquila audax***	660391	6148544
Wedge tailed Eagle	***Aquila audax***	660268	6146834
	Gehyra variegata	653176	6153386

Anabat results

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Species	Common name	Poss	Prob	Positive	Totals
27.3.07: near southern ridgetop forest remnant					
Chalinolobus gouldii	Goulds Wattled Bat	0	2	1	3
Chalinolobus morio	Chocolate Wattled Bat	1	1	0	2
Mormopterus sp. no.4 lpf		1	2	2	5
Mormopterus sp. no.3 spf		0	1	0	1
Miniopterus schreibersii	Eastern Bentwing Bat	0	2	0	2
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	0	0	3	3
Scotorepens balstoni	Inland Broad-nosed Bat	0	0	1	1
Scotorepens greyii	Little Broad-nosed Bat	0	2	1	3
Vespadelus darlingtoni	Large Forest Bat	6	12	4	22
Vespadelus regulus	Southern Forest Bat	2	8	2	12
Vespadelus vulternus	Little Forest Bat	1	3	3	7
28.3.07: near northern saddle dam					

Species	Common name	Poss	Prob	Positive	Totals
Chalinolobus gouldii	Goulds Wattled Bat	2	0	0	2
Chalinolobus morio	Chocolate Wattled Bat	2	2	1	5
Miniopterus schreibersii	Eastern Bentwing Bat	1	0	0	1
Mormopterus sp. no.4 lpf		6	4	1	11
Mormopterus sp. no.3 spf		1	0	0	1
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	2	0	10	12
Scotorepens balstoni	Inland Broad-nosed Bat	3	4	3	10
Scotorepens greyii	Little Broad-nosed bat	3	3	3	9
Vespadelus darlingtoni	Large Forest bat	5	3	3	11
Vespadelus regulus	Southern Forest Bat	1	2	1	4
Vespadelus vulternus	Little Forest Bat	2	1	0	3
29.3.07: Linear roadside woodland remnant (Graces Flat Road)					
Chalinolobus gouldii	Goulds Wattled Bat	1	0	0	1
Chalinolobus morio	Chocolate Wattled Bat	1	0	0	1
Mormopterus sp. no.4 lpf		3	11	6	20
Mormopterus sp. no.3 spf		0	4	0	4
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	2	3	6	11
Scotorepens greyii	Little Broad-nosed bat	1	0	0	1
Tadarida australis	White striped Freetail bat	1	1	2	4

September 2008 survey (GDA datum)

Species	Common name	ID confidence	No. records
17.9.08			
Miniopterus schreibersii	Eastern Bentwing Bat	1	2
Miniopterus schreibersii	Eastern Bentwing Bat	2	16
Miniopterus schreibersii	Eastern Bentwing Bat	3	2
Chalinolobus morio	Chocolate Wattled Bat	1	1
Chalinolobus morio	Chocolate Wattled Bat	2	1
Chalinolobus morio	Chocolate Wattled Bat	3	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	2
Nyctophilus sp. or *Myotis macropus*	Long-eared Bat	2	1
18.9.08			

Species	Common name	ID confidence	No. records
Miniopterus schreibersii	Eastern Bentwing Bat	1	1
Miniopterus schreibersii	Eastern Bentwing Bat	2	3
Vespadelus regulus	Southern Forest Bat	2	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	5
Vespadelus sp. or Miniopterus schreibersii	Little Forest Bat	1	1
Mormopterus sp. no.4		2	1
Mormopterus sp. no.3 or 4		2	2
Mormopterus sp. no.3 or 4 or Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1	2
Nyctophilus sp.	Long-eared Bat	2	1
Nyctophilus sp. or Myotis macropus	Long-eared Bat	1	5

September 2008 habitat evaluation (GDA datum)

Evaluation site location and description

Site no.	Cluster	Date	eastings	northings	General Description	Landscape Position	Habitat type	Disturbance level (0-3)	Size of remnant	% vegetation	% other	% bare ground	% rocks
1	4A	17/09/2008	654130	6149453	Cleared slope	Upper slope	Cleared	2, cattle grazing		95			5
2	4A	17/09/2008	654143	6149316	Eucalypt woodland	Mid slope	Woodland	2, cattle grazing	140ha	95	43		2
3	4B	17/09/2008	653860	6148767	Casuarina woodland	Upper slope	Woodland	2, cattle grazing, regrowth	140ha	95	5		
4	4A	17/09/2008	654137	6149085	Casuarina woodland	Upper slope	Woodland	2, cattle grazing, regrowth	140ha	90	8		2
5	2	17/09/2008	652644	6154428	Cleared with rock outcrops	Upper slope	Cleared/rock outcrop	3, sheep grazing	0	90			10
6	2	17/09/2008	652640	6154488	Cleared with rock outcrops	Upper slope	Cleared/rock outcrop	3, sheep grazing	60m^2	70		5	25
7	2	17/09/2008	653755	6154216	Cleared rocky ridge	Ridge	Cleared/rock outcrop	3, sheep grazing		70		10	20

Site no.	Cluster	Date	eastings	northings	General Description	Landscape Position	Habitat type	Disturbance level (0-3)	Size of remnant	% vegetation	% other	% bare ground	% rocks
8	2	17/09/2008	653789	6153935	Woodland	Mid slope	Woodland	2, sheep grazing	12.5ha	80		10	10
9	1	17/09/2008	650923	6152302	Cleared rocky ridge	Ridge	Cleared/rock outcrop	3, sheep grazing, weed infestation	0	70			30
10	1	17/09/2008	650951	6152422	Cleared rocky slope	Mid slope	Cleared/rock outcrop	3, sheep grazing, weed infestation		50		15	35
11	7	20/09/2008	658698	6146264	Cleared saddle	Lower slope	Cleared	3, sheep grazing		60		30	10
12	6	20/09/2008	657368	6152281	Eucalypt woodland	Mid slope	Forest	1, regrowth, sheep grazing	12.5ha	40	20	20	20
13	6	20/09/2008	657416	6152071	Drainage line	Gully	Forest	2, regrowth, sheep grazing	12.5ha	50			50
14	5	20/09/2008	657327	6151301	Cleared Slope	Mid slope	Woodland	3, sheep grazing	400m^2	90	5		5
15	4	22/09/2008	654000	6154057	Casuarina woodland in gully	Gully	Woodland	1, cattle grazing	140ha	80			20
16	2	17/09/2008	653843	6154057	Cleared Pasture	Upper slope	Cleared	3, sheep grazing		60		30	10
17	2	17/09/2008	653447	6154124	Rock Outcrop	Ridge	Rock outcrop	2, grazing	0	<5			95

Tree habitats

Site no.	Standing Dead Timber Y/N	Hollows or fissures Y/N	Feed trees and mistletoe Y/N	Hollows Y/N	Abundance	Size range	spouts Y/N	crevices/fissures	recruits Y/N	signs of use Y/N
1 2	Y	Y	Y	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	N

3	Y	Y	Y	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	Y
4	Y	Y	Y	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	Y
5	Y	Y	N	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	N
6	Y	Y	N	Y	Abundant	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	N
7										
8	Y	Y	Y	Y	Low	<10cm	N	N	Y	N
9	Y	Y	N	Y	Low	10cm	N	N	Y	N
10										
11										
12	Y	N	Y							
13	Y	N	Y							
14	Y	Y	N	Y	High	10-20cm	Y	Y	Y	N
15	Y	Y	Y	Y	rare	5-10cm	Y (in dead standing timber)	Y (in dead standing timber)	Y	N
16										
17	N	N	Y							

Rock and groundlayer habitats

Site no.	Rock outcrops Y/N	Size range of rocks	Size range of crevices	Black ants present Y/N	Refuge (tussocks, fallen timber)
1	N				
2	N				
3	Y	10cm-3m	N/A	N/A	Y
4	Y	10cm-3m	N/A	N/A	Y
5	Y	10cm-3m	2cm	N/A	Y
6	Y	10cm-3m	N/A	N	Y
7	Y	10cm-1m	2-8cm	N	N
8	N				
9	Y	10-30cm	N/A	Y	N
10	Y	10-1m	N/A	Y	Y

Site no.	Rock outcrops Y/N	Size range of rocks	Size range of crevices	Black ants present Y/N	Refuge (tussocks, fallen timber)
11	N				
12	N				
13	N				
14	N				
15	N				
16	Y	2-15cm	N/A	N	N
17	Y	10cm->5m	2cm->15cm	Y	Y

March 2009 Coppabella – Marilba and Marilba – Carroll's Ridge powerline habitat constraints assessment (GDA)

Northings	Eastings	Constraint level	Recommended response	Comments
6148977	660655	moderate	mitigate	box-gum woodland surrounded by cleared land with scattered trees. Grassy tussocks suitable for reptiles, HBTs with signs of use - may provide small area of habitat for possums, goannas, and variety of birds. Potential for threatened reptiles but unlikely threatened mammal.
6148974	660707	high	avoid	box-gum woodland linear remnant with 20-50% canopy with HBTs with signs of use. Sparse understorey with falls timber and refuse piles. Habitat provision as above. Quite isolated for forest dependent spp by surrounding paddocks.
6153194	651873	low	mitigate	pasture with scattered trees (box-gum woodland) disturbed by grazing and clearing. Hollow-bearing trees (high constraints) and small rocky outcrops scattered around. Fairly homogenous surrounding. Several dams nearby, habitat likely to be used by birds incl, hbt dependent and raptors. Mistletoe present. reptiles may be present although may be reduced by grazing.
6153386	653176	high	avoid	box-gum woodland remnant with sparse understorey (grazed) which covers hillside and saddle area above and within the gully. Features several hollows, incised banks for rainbow bee-eaters, feed shrub species, rocky areas suitable for reptiles (loose and buried rock) with scattered tussocks. Gehyra variegata egg found.
6153898	655056	low	mitigate	pasture with scattered trees (box-gum woodland) disturbed by grazing and clearing. Hollow-bearing trees (high constraints) scattered around. Fairly homogenous surrounding. Habitat likely to be used by birds
6138942	656253	high	avoid	Dry creek incised with fringing mature bgw trees and long native grasses and tussocks. Piles of bark and litter, hbts, likely to be CEEC, habitat suitable fore reptiles, birds and some mammals incl. arboreal.