Appendix 3 BIODIVERSITY ASSESSMENTS

Appendix 3.1 Biodiversity Assessment Coppabella Hills

EPURON
POWER FOR PORTFOLIOS

Biodiversity Assessment

COPPABELLA HILLS PRECINCT

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Definition of terms

Site	The area bounded by the property boundaries of involved landowners.
Study area	The subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. Extended as far as necessary to take all potential impacts into account.
Subject site	All parts of the site which has potential to carry infrastructure and be directly affected by the proposal. Also referred to as the 'Development Envelope'.
Survey area	Where active and passive fauna or flora surveys were undertaken within the study area.
Development Envelope (DE)	All parts of the site which has potential to carry infrastructure and be directly affected by the proposal. Also referred to as the 'subject site'. Assessment of the development envelope allows fine-scale development planning and site decisions to be informed by the findings of the assessment.
Direct impacts	Impacts that directly affect flora and fauna values. These may include trampling, pollution, vegetation clearing and soil disturbance.
Development footprint	The area that would be directly displaced by proposed infrastructure, including footings, easements and room to manoeuvre machinery.
Blade-strike	Mortality caused by direct collision with turbine blades and by birds being swept down by the wake behind a turbine blade.
Barotrauma	Rapid or excessive air-pressure change near moving turbine blades has been linked to bat fatalities as a result of haemorrhaging of the lungs (pulmonary barotrauma) (Baerwald *et al.* 2008).

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1 INTRODUCTION

This Biodiversity Assessment presents the findings of investigations into biodiversity values and likely impacts associated with a proposed wind farm on the 'Coppabella Hills Precinct' site near Yass on the Southern Tablelands, New South Wales. The proposal is one of three geographically separate precincts within the Yass area that together would form the Yass Wind Farm Development (refer to Figure 1-1). This assessment has been undertaken by **ngh**environmental, a specialist study to be included as an attachment to the Environmental Assessment (EA) report prepared on behalf of the proponent Epuron Pty Ltd.

This Biodiversity Assessment:

- Provides a summary description of the proposed works
- Outlines the regional context of the study area in terms of biodiversity values
- Identifies and describes the biodiversity values of the subject site, including descriptions of methodologies and results of detailed flora and fauna surveys
- Identifies species and communities of conservation significance which are present or have potential to be present at the subject site, including potential threatened flora and fauna habitat and endangered ecological communities
- Identifies and assesses the significance of the potential impacts and risks associated with the proposed development and the potential cumulative impacts of the two other wind farm precincts in relation to biodiversity values
- Assesses the significance of the potential impacts of the proposal on identified threatened species and communities listed in the *Threatened Species Conservation Act 1995* (Assessment of Significance, Appendix E)
- Assesses the significance of the potential impacts of the proposal on Matters Of National Environmental Significance listed in the *Environmental Protection Biodiversity Conservation Act 1999* (Assessment of Significance, Appendix E)
- Specifically assesses the risks from bladestrike and habitat impacts to bird and bat species at the site (Section 6.3 and Appendix E and F) and
- Provides a series of recommended mitigation measures designed to reduce risks, minimise the impacts and allow for an overall 'maintain or improve' environmental outcome.

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

Further background information relating to the site and the proposal is contained in the accompanying Environmental Assessment report.

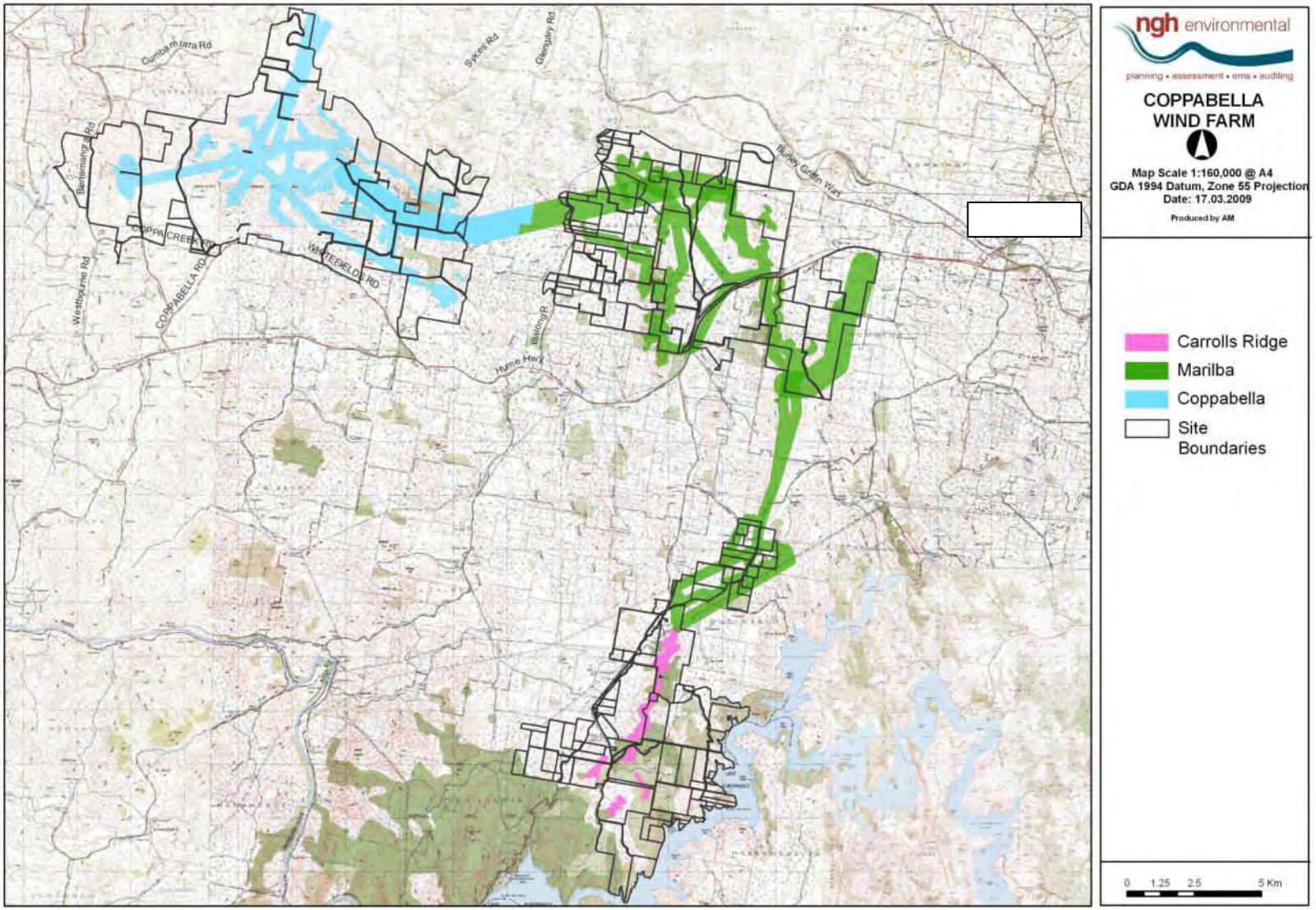

Figure 1-1 Proposed Yass Wind Farm overview map.

Development envelopes of the Coppabella Hills Precinct (top left in blue), Marilba Hills (green) and Carrolls Ridge (pink).

2 ASSESSMENT APPROACH

2.1 AIMS OF THIS DOCUMENT

The preparation of the Biodiversity Assessment involved desktop research, consultations with persons with local and specialist knowledge, fieldwork, data analysis, significance assessment and report compilation. The Biodiversity Assessment covers all of the potential areas of direct and indirect impacts associated with the proposal.

In a step-wise approach, this assessment has sought to:

1. Identify the extent and current condition of biodiversity values with potential to be impacted by the proposal.
2. Evaluate the risks to these values, with recourse to the specifics of this proposal and available literature on the biodiversity impacts of wind farms (risk assessments and threatened species evaluations, Section 5 and 6).
3. Characterise the significance of these risks (using the NSW and Commonwealth Assessments of Significance, Appendix E).
4. Provided a series of measures, including constraints mapping, in order that impacts are avoided or reduced where possible.
5. Apply the 'maintain or improve environmental outcomes' test to the proposal.

2.2 TERMINOLOGY

2.2.1 Subject site and study area

The 'subject site' refers to all areas directly affected by the proposal, and is also referred to as 'development envelope'. '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 (DEC 2004).

For referencing purposes in this assessment, each of the eleven discrete turbine clusters has been numbered from west to east. The larger turbine Clusters (3 and 7) have been split into smaller parts (refer to Figure 3-1) to further aid in referencing and discussion.

2.2.2 Development envelope

For a range of practical reasons (discussed further in the Environmental Assessment report for the project), the proposed locations of the wind turbines, transmissions easements 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 infrastructure,

termed the 'development envelope'. The development envelope approach allows fine-scale development planning and siting decisions to be informed by the findings of this assessment. For example, high biodiversity value areas can be identified and avoided early in the project design process.

The development envelope encompasses ridge and upper slope areas which are nominated for turbine development, transmission access corridors 100 metres wide, proposed road access corridors 50 metres wide and existing road access corridors 20 metres wide. The development envelope for the proposed Coppabella Hills Precinct wind farm is 2829.1 hectares in area, and is shown in Figure 3-1.

Where relevant, the Biodiversity Assessment covers the range of possible impacts within the development envelope, including worst case impact scenarios. This approach is a precautionary response to the uncertainty of wind farm infrastructure positioning and the paucity of scientific research on the impacts of wind farms on biodiversity in Australia.

2.3 DESKTOP RESEARCH AND CONSULTATIONS

Consultation

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 tools and publications focusing on relevant species and the study area were sourced. Several experts with local and specialist knowledge have been contacted in relation to threatened flora and fauna in the Yass district specifically for this study, and for earlier surveys within the region (**ngh**environmental 2006). These references are cited in relevant sections of the Biodiversity Assessment. In addition, government representatives and landholders provided relevant local information.

Desktop assessment

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 assessments and records contained in national and state databases were consulted to identify known and potential values.

Key web-based databases were used to identify significant environmental features. The Commonwealth Protected Matters search tool using a 50 kilometre buffer was consulted for threatened species, communities and other values listed on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that have been recorded or are predicted from the region. The Department of Environment and Climate Chance (DECC) Threatened Species Database was consulted for threatened species, populations or ecological communities listed on the *Threatened Species Conservation Act 1995* (TSC Act) that have been recorded or are predicted to occur from the relevant Catchment Management Authority (CMA) sub-regions: Upper Slopes and Murrumbateman within the Murrumbidgee CMA region. Records of threatened species were obtained from BioNet (which includes collections from the Australian Museum, DECC, NSW State Forests and NSW Fisheries) and the DECC (NPWS) Wildlife Atlas. The full searches are provided in Appendix C.

2.4 FIELD WORK

Site fieldwork for this Biodiversity Assessment was undertaken on 1-3 September, 16-19 September, 8-9 November 2008 and January 19-23 and March 9-10 2009.

A reconnaissance 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. The September and November fieldwork sessions 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. The January survey was undertaken specifically to address the potential for high microbat activity onsite[1]. The March survey documented a transmission easement onsite, proposed after the main survey effort.

2.5 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 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 were 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. Further, recommendations address the requirement to 'maintain or improve' environmental outcomes as a consequence of the development.

[1] The January microbat survey will be documented as a separate report.

3 THE PROPOSAL

3.1 DESCRIPTION OF THE SITE

The Coppabella Hills Precinct development envelope is located on farmland north the Hume Highway, approximately 35 kilometres west of Yass, New South Wales. The area is characterised by undulating to hilly terrain with broken ridgelines, mostly on volcanic geology.

The site consists of one main north-west to south-east oriented ridgeline and surrounding hills. Areas within the nominated development envelope contain a combination of native and exotic pasture and remnant and regrowth woodland. The ridgelines within the subject site are cleared and have been grazed for many decades and generally carry only scattered remnant trees or small isolated woodland patches.

The site is situated in the upper catchment of Jugiong Creek, which drains to the Murrumbidgee River and the Murray River. There are no major watercourses present at the subject site and there is little remnant tree cover. Several small or intermittent watercourses drain the site northwards to the Jugiong Creek system and south to Lake Burrinjuck.

3.2 PROPOSED WORKS

The Coppabella Hills Precinct would involve the construction, operation and eventual decommissioning of:

- Up to 86 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 100 metres high. When operational, the minimum height of the turbine blades would be 44 metres above the ground, and the maximum height would be 156 metres.
- Electrical connections between wind turbines using overhead cabling up to 37.5 kilometres long connecting the turbines to the substation
- A substation and transmission connection linking the wind turbines to the existing Transgrid 132kV transmission system located adjacent to the site
- Access tracks to turbines and other facilities, and upgrades to access via Whitefields Road and Coppabella Road (subject to consultation and engineering assessments), for the construction and maintenance of the wind turbines
- An onsite control room and equipment storage facilities
- A temporary concrete batching plant
- A number of freestanding permanent monitoring masts for wind speed verification and monitoring

The precinct would have a maximum capacity of approximately 3.6 megawatts (likely capacity 2.5MW) and an operational life of up to 30 years. The total area of the development footprint (habitat permanently removed) would be approximately 70 hectares. Turbines may be recommissioned or

decommissioned at the end of 30 years. During decommissioning, all above ground infrastructure would be removed; footings would remain in place.

3.3 GENERAL IMPACT TYPES

Environmental impacts would be associated with construction, operation and decommissioning of the wind turbines and associated infrastructure, as discussed below.

3.3.1 Construction

Construction impacts would occur within a discrete period of between 12-24 months. Direct impacts arising from construction would be temporary. These include vegetation clearing, excavation, and the noise and vibration associated with large machinery. Associated indirect impacts are likely to include erosion, dust, sedimentation and weed ingress. Specific to biodiversity, these impacts equate to removal, modification and fragmentation of habitat.

Vegetation clearing and habitat removal

Turbine footing areas and crane hard stand areas (required adjacent to each turbine), the substation and associated control buildings, access tracks, underground cabling trenches, overhead electricity pole footings, compound areas and stock pile sites would require removal of existing vegetation. The area required to manoeuvre turbine blades into place on top of each tower would require removal of mid and upperstorey vegetation. Similarly, areas beneath electricity easements would require loss or modification of vegetation (i.e. slashing).

Several farm tracks are in place on the property and may be utilised as part of the access requirements. As these are likely to require upgrade, Table 3-1 does not subtract the area of existing tracks. Access roads to the site may also require lopping of removal of upperstorey vegetation in specific areas to allow oversize vehicles to pass.

Excavation

Excavation, including footings, cut and fill batters and the storage and movement of soil, equates to a direct loss of habitat as well as generating potential for indirect impacts including dust, erosion, sedimentation and weed ingress. These indirect impacts can often extend much further, spatially and temporally, than the area of direct excavation.

Increased sedimentation or nutrients that find their way to drainage lines can create ongoing deterioration of water quality and aquatic habitat for many kilometres downstream. Compaction and erosion processes can reduce the ability of soil to support viable vegetation communities and leave them susceptible to weed infestation.

Other construction activities

A concrete batching plant and / or rock-breaking equipment may be established during the construction period to facilitate the construction of turbine footings, hard stand areas and roads. The concrete batching would generate potential for pollution from alkaline wash.

The construction of the substation and gear boxes within the turbines, as well as the use of hydrocarbon fuels carries with it the risk of chemical spills. There is also a risk of soil compaction and fauna collision due to the movement of vehicles across the site.

These activities have the potential to cause direct mortalities as well as remove and modify terrestrial and aquatic habitats. There is potential for indirect impacts including dust, erosion, sedimentation and weed ingress. Spills may affect much larger offsite areas, transported within drainage lines.

Table 3-1 Summary of construction impacts

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.

Coppabella Hills Precinct				
Infrastructure	**Quantity**	**Width (m)**	**Length (m)**	**Area (ha)**
Turbine footing [a]	86.00	25.00	25.00	**5.38**
Crane hardstand [c]	86.00	22.00	40.00	**7.57**
Crane operation area (includes footing and hardstand) [c]	86.00	50.00	50.00	**21.50**
Tracks [a]	1.00	8.00	67063.65	**53.65**
Underground powerlines onsite [c]	1.00	2.00	21905.29	**4.38**
Overhead powerline cabling / easement [b]	1.00	20.00	14517.82	**29.04**
Overhead power pole footings [a]	145.18	1.00	1.00	**0.01**
Substation and control bldg [a]	3.00	2.00	18330.43	**11.00**
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)				**2829.10**
Percentage of DE permanently removed				**2.48**
Breakdown by impact type:				
a Permanent habitat loss (includes all footings and tracks)				**70.04**
b Habitat modification (transmission easement maintenance)				**29.04**
c Temporary habitat loss (areas that can be rehabilitated post construction)				**24.26**

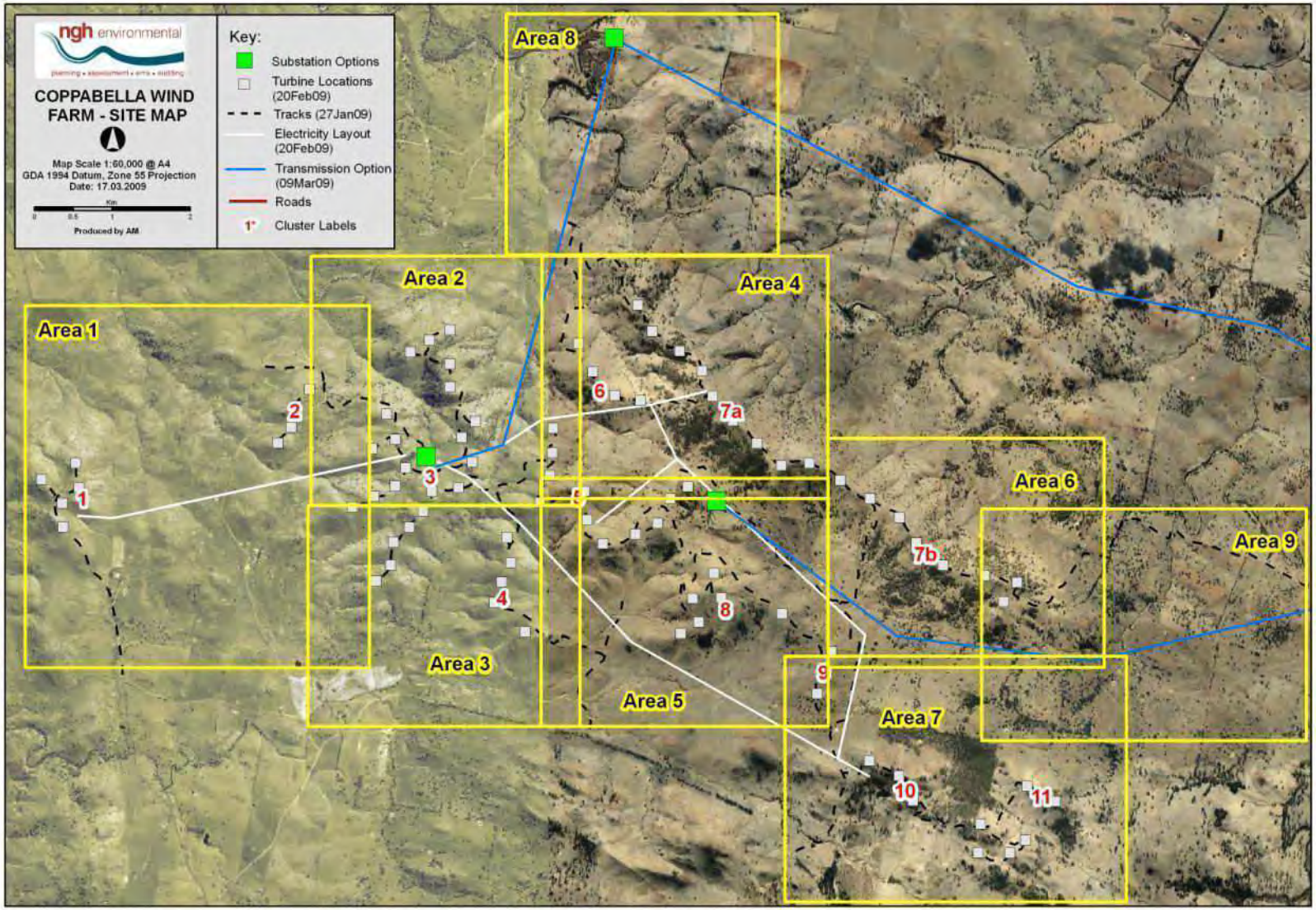

Figure 3-1 Coppabella Hills Precinct development envelope and site boundaries.

The site has been divided into nine map areas and 11 turbines clusters to allow easier discussion.

3.3.2 Operation

Operational impacts on biodiversity values would occur for the duration of the project (considered as 30 years). These may include:

- Habitat avoidance, including alteration of movement or dispersal routes. This may include shadow flicker when the sun is low on the horizon and subaural or low frequency noise effects. This impact is treated as a loss or modification of habitat, for this purpose of this assessment.
- Bird and bat collision with turbine blades
- Barotrauma in bats as a result of atmospheric-pressure drop at turbine blades
- Fauna collision with maintenance vehicles
- Risks of compaction and spills from maintenance vehicles or activities

3.3.3 Decommissioning

Decommissioning impacts are difficult to accurately determine given that construction techniques will progress over the next 30 years. Taking into account these potential technological changes, decommissioning impacts are expected to include the following:

- Vegetation clearing / branch lopping to facilitate the movement of oversize vehicles to the site and to each turbine site. Additional clearing may be required to manoeuvre turbine blades and other infrastructure during disassembly.
- Removal of all above ground infrastructure, requiring limited excavation (concrete slabs and underground cabling would remain in situ)
- Noise and dust would be generated in carrying out the above mentioned activities
- Risks of fauna collision with vehicles
- Risks of compaction and spills from maintenance vehicles or activities

4 REGIONAL CONTEXT

The construction and operation of wind farms have specific characteristics that make it particularly important to examine a broad environmental context when assessing their impact as:

- The turbines can impact migration paths and movement corridors of birds and bats through collision and barotrauma related mortalities, aerial habitat removal and avoidance of habitat
- The transmission easements required to connect the wind farms to the electricity grid can be very long, potentially fragmenting areas of habitat for species of flora and fauna, restricting the movement and dispersal of species
- Upgrades to roads and access trails to facilitate the movement of large machinery onto the locations can disturb road-side vegetation remnants. In modified landscapes, these road side remnants often retain rare species
- The construction of turbines and associated infrastructure may result in key threatening processes such as vegetation clearing, invasion of exotic plants and habitat resource removal. This may result in impacts on local populations of species and communities which may already occur in a cleared and fragmented landscape

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

- **Regional scale:** using data compiled for established regionalisations (South Western Slopes bioregion). Key regional attributes include the abundance, distribution and conservation status of communities and species and the prevalence of threats and disturbance regimes.
- **District scale:** the district scale includes the site, broader study area and the area around for a radius of up to 50 kilometres. Important district-scale factors include foraging and breeding ranges; dispersal patterns and migration routes for fauna; and dispersal and genetic exchange opportunities for flora species.

4.1 REGIONAL 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 in the South Western Slopes bioregion, close to the South Eastern Highlands Bioregion. Both bioregions capture a wide range of geophysical and biological variation.

Catchment Management Authority (CMA) regions

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 2008). Box-Gum Woodland and Native Grassland in particular have been extensively cleared and degraded.

CMA sub-regions

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 2008). The study area is located close to the boundary between two sub-regions: Upper Slopes to the west and Murrumbateman to the east. The 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, with Red Stringybark, Bundy and White gum on ridges (Morgan 2001 in NPWS 2003).

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

The proposal site also occurs within the South Western Slopes bioregion, 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. The Yass Unit is characterised by undulating country largely carrying Box-Gum Woodland. 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). Endemic features include:

- 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 the Yass Daisy distribution
- A minor karst landscape within Hatton's Corner NR.

4.1.2 Flora

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 supports 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 South-eastern 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).

Waterbirds are likely to move between large waterbodies and wetland habitats at the region scale. Lake George (c. 65 kilometres south-east of the subject site), Lake Burley Griffin and associated wetlands (60 kilometres to the south), Lake Burrinjuck (3 kilometres to the south) and major rivers in the region are likely to form part of the foraging range for several mobile waterbird species. Most wetland bird species in the region show signs of long-term decline (Reid *et al.* 2004).

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

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 Coppabella Hills Precinct is located in the upper catchment of the Murrumbidgee River. It is estimated that over half of the catchment has been 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 examined. The assessment was limited by air photograph quality and existing road access, 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 across a radius of 50 kilometres. Key conservation values include:

- The district forms part of the core breeding area for the threatened Superb Parrot
- The district forms part of the core foraging area for the threatened Eastern Bent-wing Bat and a known maternity cave
- The district is the centre of distribution for the threatened Yass Daisy
- The district contains remnant Box-Gum Woodland (a threatened ecological community)
- A number of conservation reserves are present in the district

4.2.1 District habitat features

Watercourses and wetlands

Two permanent creeks are located to the north of the subject site; Illalong Creek and Jugiong Creek. Each has sections carrying substantial tree cover. The subject site itself contains lower order drainage lines, with little natural vegetation cover.

Jugiong Creek is a tributary of the Murrumbidgee River which runs west-east and is impounded by Lake Burrinjuck around 29 kilometres south-east of the site. The Murrumbidgee 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-west and south –east

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. Woodland remnants contain depauperate or exotic understorey, with many affected by sheep camps. There are some highly restricted and fragmented examples of woodland understorey without tree cover in paddocks and saddles within the study area. There are also fragmented patches of remnant and regrowth woodland with tree cover and relatively intact understorey.

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 pers. comm.). Lowland paddocks are also likely to carry remnant box-gum woodland. Paddock tree density varies throughout the district and is generally low in the vicinity of the study area. 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 and declining woodland bird species. Threatened and regionally significant plant species are also known to occur in woodland remnants in the district.

Remnant forest in the district is commonly associated with steep slopes and ridges. In view of the general loss of native vegetation in the district, all structurally and floristically intact forest remnants can be considered to have regional conservation value. The closest large area of intact forest is Burrinjuck Nature Reserve, Burrinjuck Waters State Park and adjoining private land[2], which carry tableland dry sclerophyll and montane wet sclerophyll forest types.

4.2.2 Conservation reserves in the district

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.

[2] Some of this private land includes the Carrolls Ridge Precinct, included within the proposed Yass Wind Farm, see Figure 1-1.

Burrinjuck Nature Reserve and Burrinjuck Waters State Park

Burrinjuck Nature Reserve occupies 5,250 hectares and is located approximately 20 kilometres south-west of the study area. The reserve is contiguous with Burrinjuck Waters State Park, on the shores of Lake Burrinjuck, which has a strong recreational management and water catchment 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 (3.9 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 45 kilometres east of the study area. The reserve occupies 1,470 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 45 kilometres south of the study area. Significant fauna recorded in the reserve includes the Eastern Bent-wing Bat, Regent Honeyeater, Gang-gang Cockatoo and White-throated Needle-tail.

Black Andrew Nature Reserve

This is a 1,559 hectare reserve located south of Burrinjuck, around 30 kilometres south 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 hectare 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.

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 (Figure 4-1 Coppabella Hills Precinct district context. The location of Eastern Bentwing-bat maternity cave at Wee Jasper is also shown as this is a target species for the impact assessment.

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Large water bodies in the district include Lake Burrinjuck, Lake Bethungra and Lake George (semi-permanent). 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 NATIONAL AND STATE 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 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 D and summarised in Sections 5 and 6.

4.3.2 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Matters of National Environmental Significance reporting tool (ERT) 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 (Appendix C). The likelihood of the presence of these species, populations and communities at the subject site is evaluated in Appendix D and summarised in Sections 5 and 6.

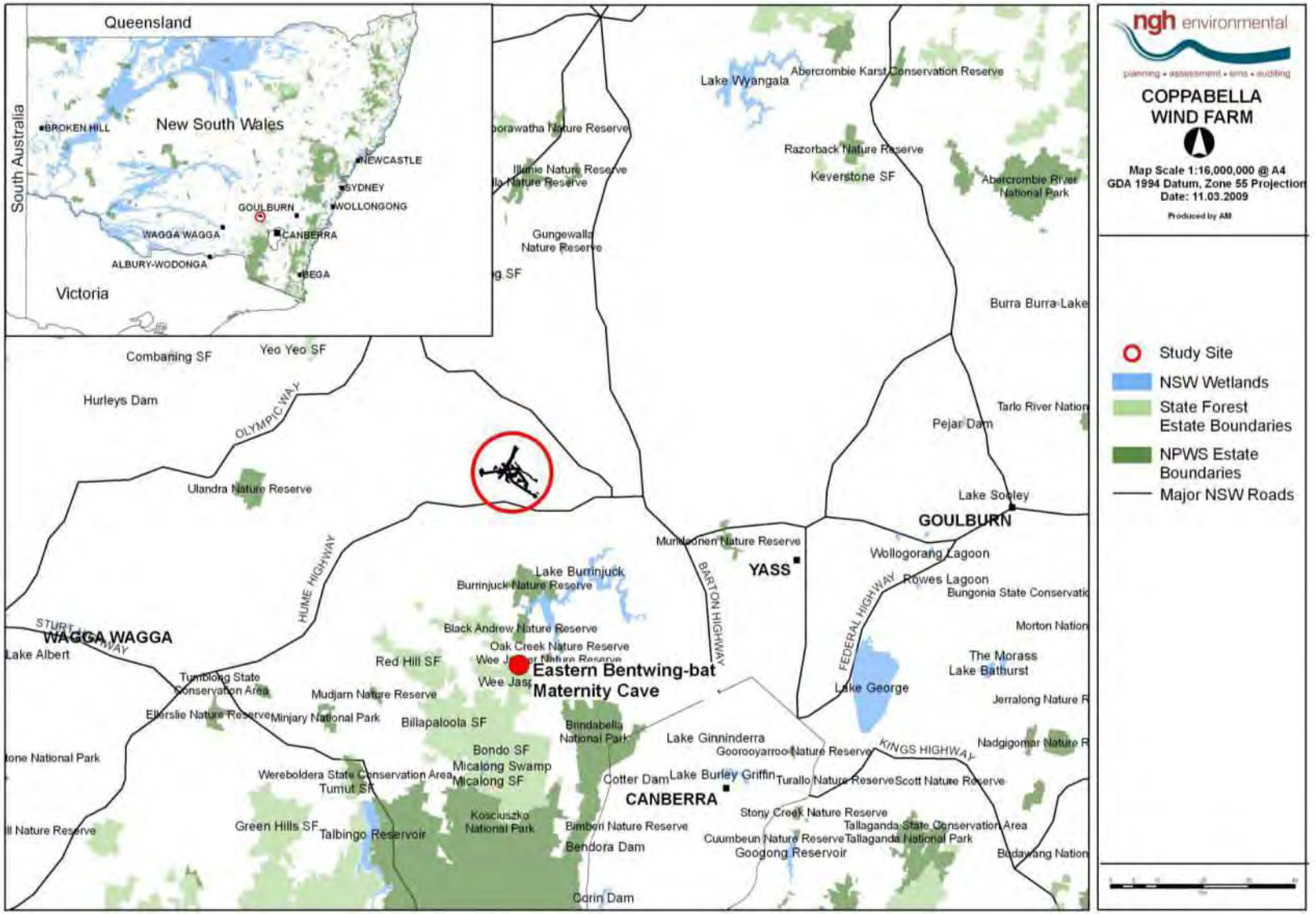


Figure 4-1 Coppabella Hills Precinct district context. The location of Eastern Bentwing-bat maternity cave at Wee Jasper is also shown as this is a target species for the impact assessment.

5 FLORA AND ECOLOGICAL COMMUNITIES

5.1 METHODS

5.1.1 Preliminary assessments

The 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 included the Commonwealth Protected Matters search tool using a 50 kilometre buffer, Bionet and the DECC Wildlife Atlas.

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.

Vegetation typing, mapping and nomenclature

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 GPS unit (Garmin 76), and are based on the GDA 94 datum. The study area is covered by the Binalong and Bookham 1:25,000 topographic map sheets.

5.1.2 Field survey and mapping

Survey effort

The development envelope including representative sections of the grid connection transmission routes were surveyed for flora values on 16-22 September 2008. Additional surveys in areas identified as having potential threatened species habitat were carried out in a follow-up visit, 8 November 2008.

A further survey was undertaken on 10-11 March 2009 to investigate a new transmission easement option, linking the Coppabella Hills and Marilba Hills Precincts substations[3]. This survey focussed on vegetation types and condition.

A total of 70 person hours was spent on the vegetation survey (not including scoping visit). The survey methods and outputs are intended to meet the requirements of the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft (DEC 2004).

The survey area targeted all areas within the 'development envelope' that would potentially be directly or indirectly affected by the proposal. In addition, existing roads and tracks at the site which may be used during construction was examined for significant or sensitive vegetation features. Nearby areas of natural vegetation were also inspected for potential use as offset[4] areas.

Stratification

Following a preliminary scoping visit to the subject site and using aerial photographs, the survey area was stratified based on preliminary vegetation typing, landform and vegetation condition.

5.1.3 Survey methods

A three-tiered approach incorporating plot-based quadrats, traverse (random meanders) and general spot 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 have been mapped on Figure 5-1[5].

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 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.

[3] Only the portion of this transmission easement within the Coppabella Hills Precinct site boundary is discussed in this report. The remainder is dealt with in the Marilba Hills Precinct Biodiversity Assessment.

[4] Under the Native Vegetation Act clearing of remnant vegetation or protected regrowth can only be approved when the clearing will improve or maintain environmental outcomes. An 'Offset Plan' can be developed to ensure this outcome is achieved, for example, by managing identified areas for conservation outcomes in perpetuity.

[5] Flora and fauna survey effort are included on the same map set. Separate map sets have been produced for flora results, fauna results and biodiversity constraints.

Spot inspections

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 to Appendix D). A return visit on 8 November targeted areas with greatest potential to support threatened species which may not have been detectable during the September survey such as flowering orchids. Representative areas of heavily disturbed habitats or areas carrying mainly exotic species, such as improved pasture and cropped paddocks, were surveyed to record species composition. Because of their low conservation significance, not all of these highly modified areas were inspected in detail.

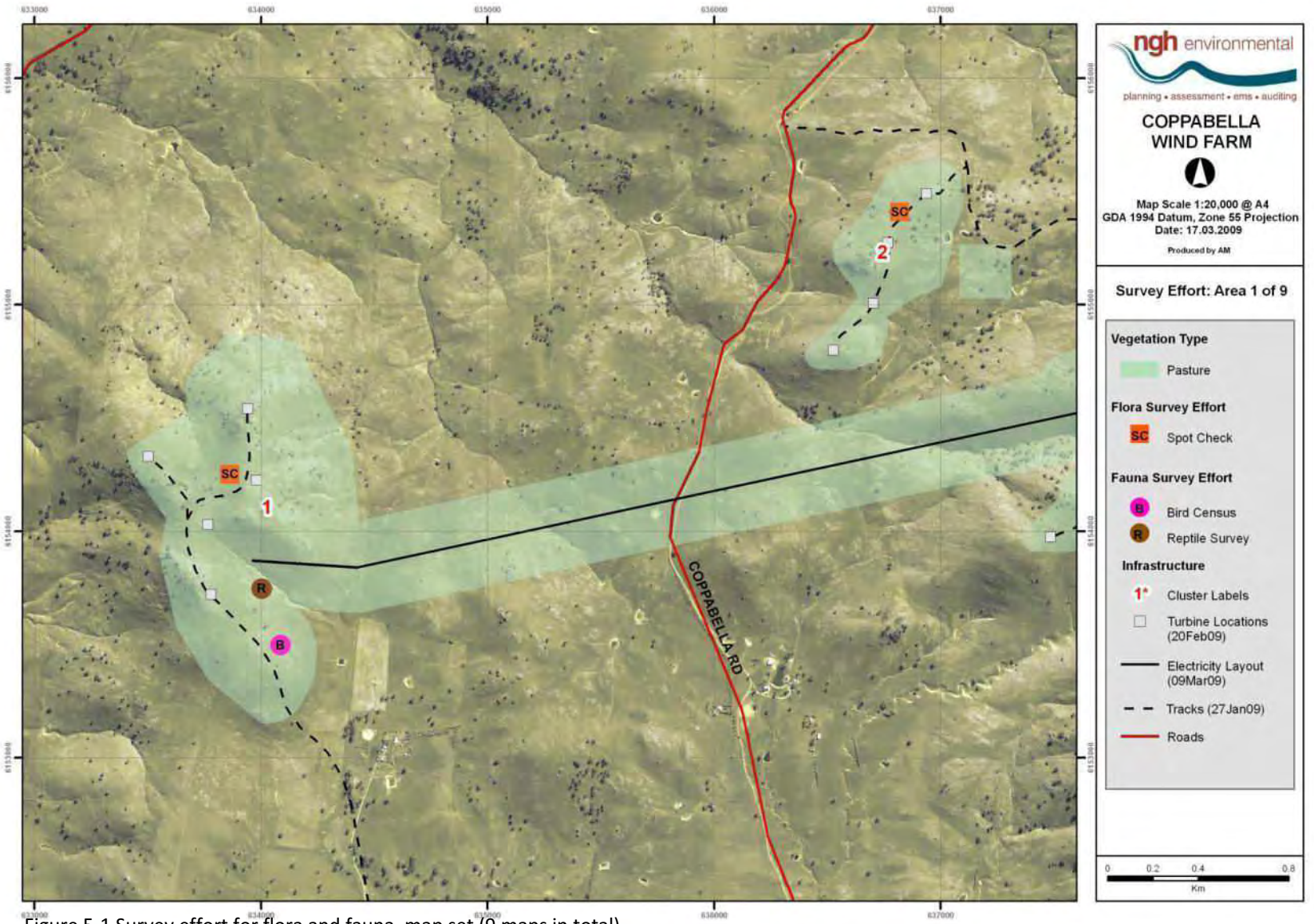
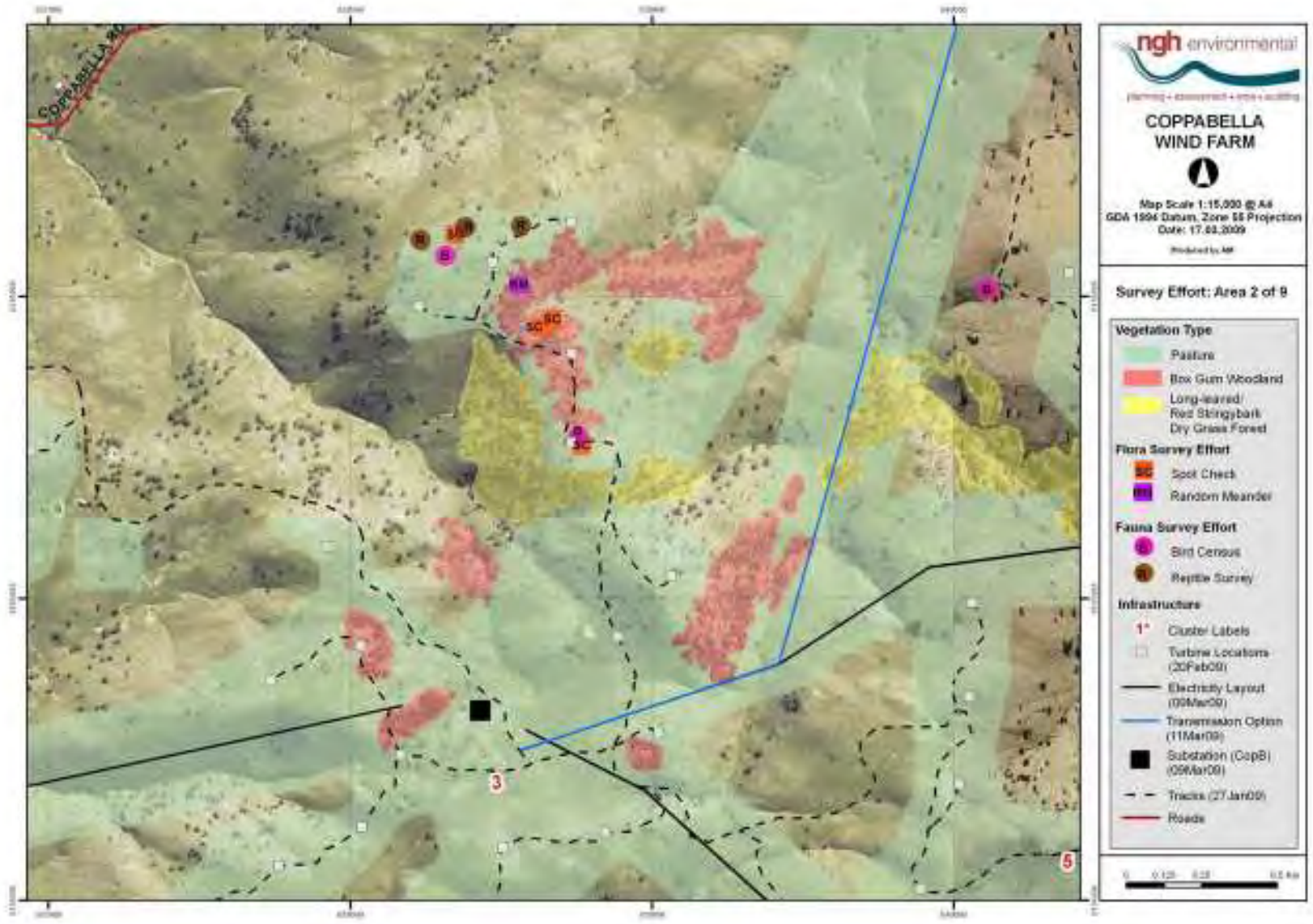


Figure 5-1 Survey effort for flora and fauna, map set (9 maps in total)

The overview map is presented in Figure 3-1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Vegetation Type
Pasture
Box Gum Woodland
Long-leaved/
Red Stringybark
Dry Grass Forest
Flora Survey Effort
SC Spot Check
RM Random Meander
Fauna Survey Effort
B Bird Census
R Reptile Survey
Infrastructure
1* Cluster Labels
Turbine Locations
(20Feb09)
Electricity Layout
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Tracks (27Jan09)
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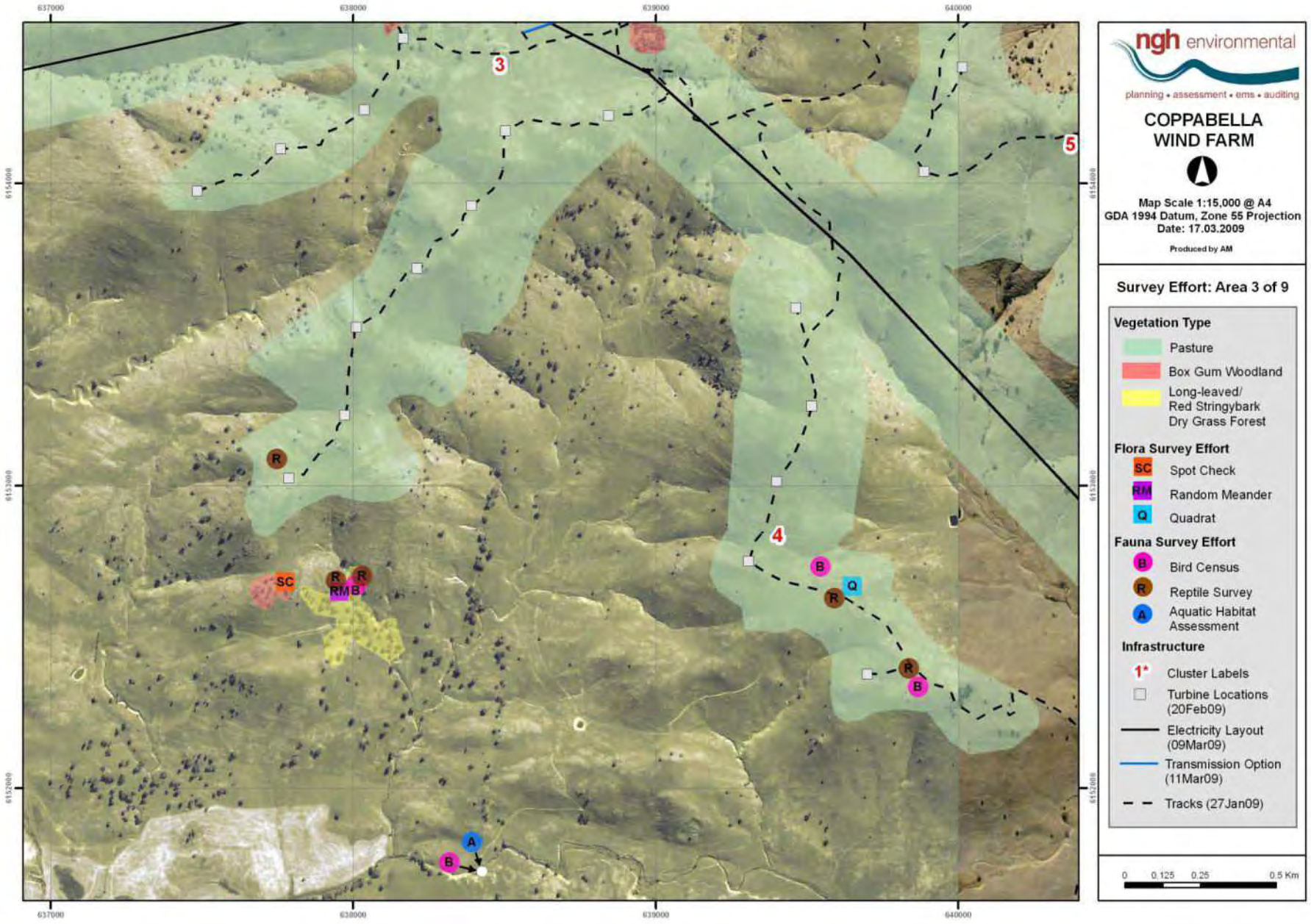
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Vegetation Type
Pasture
Box Gum Woodland
Long-leaved/
Red Stringybark
Dry Grass Forest
Flora Survey Effort
SC Spot Check
RM Random Meander
Q Quadrat
Fauna Survey Effort
B Bird Census
R Reptile Survey
A Aquatic Habitat
Assessment
Infrastructure
1* Cluster Labels
Turbine Locations
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Electricity Layout
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Transmission Option
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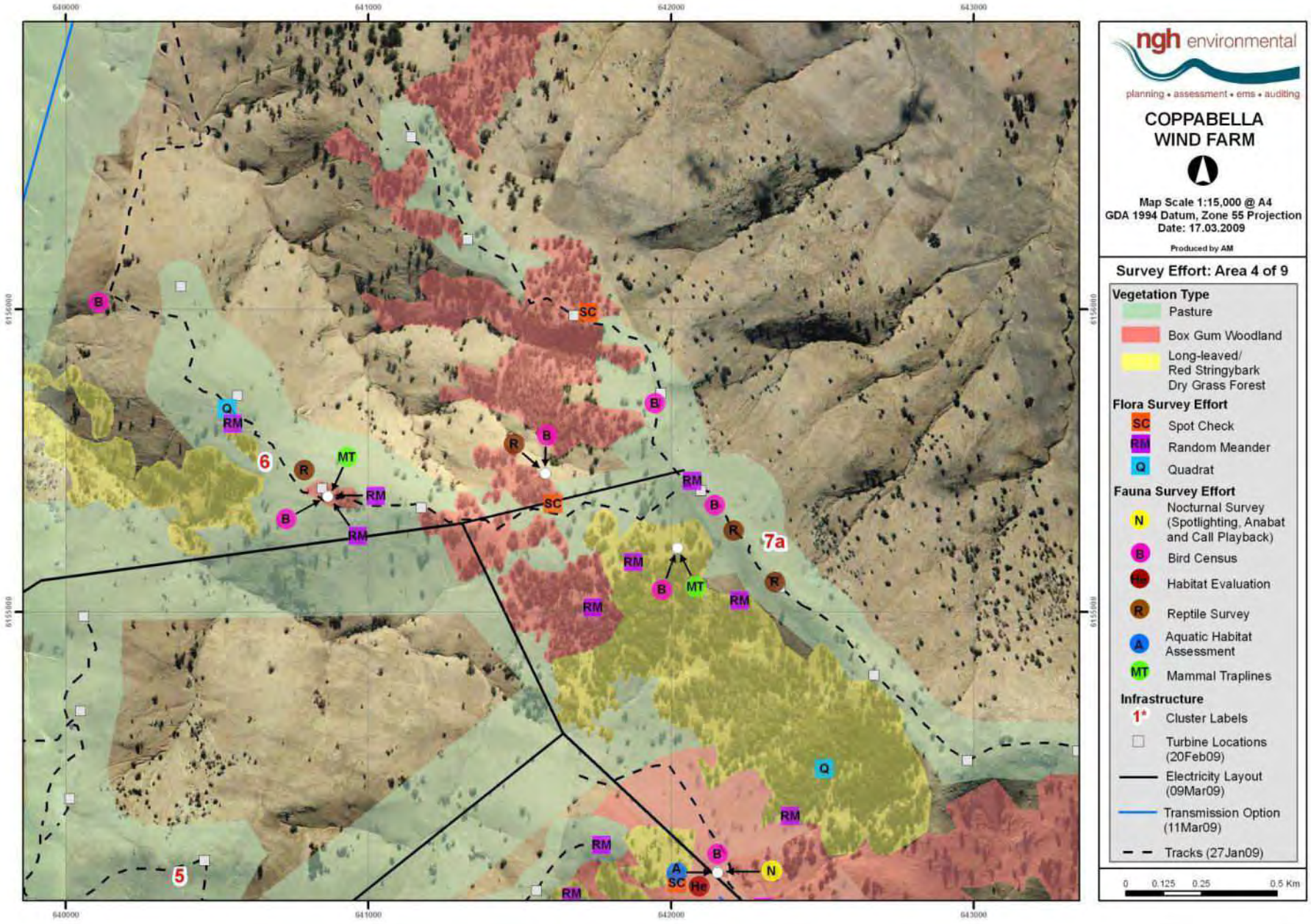
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Survey Effort: Area 4 of 9
Vegetation Type
Pasture
Box Gum Woodland
Long-leaved/ Red Stringybark Dry Grass Forest
Flora Survey Effort
SC Spot Check
RM Random Meander
Q Quadrat
Fauna Survey Effort
N Nocturnal Survey (Spotlighting, Anabat and Call Playback)
B Bird Census
He Habitat Evaluation
R Reptile Survey
A Aquatic Habitat Assessment
MT Mammal Traplines
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
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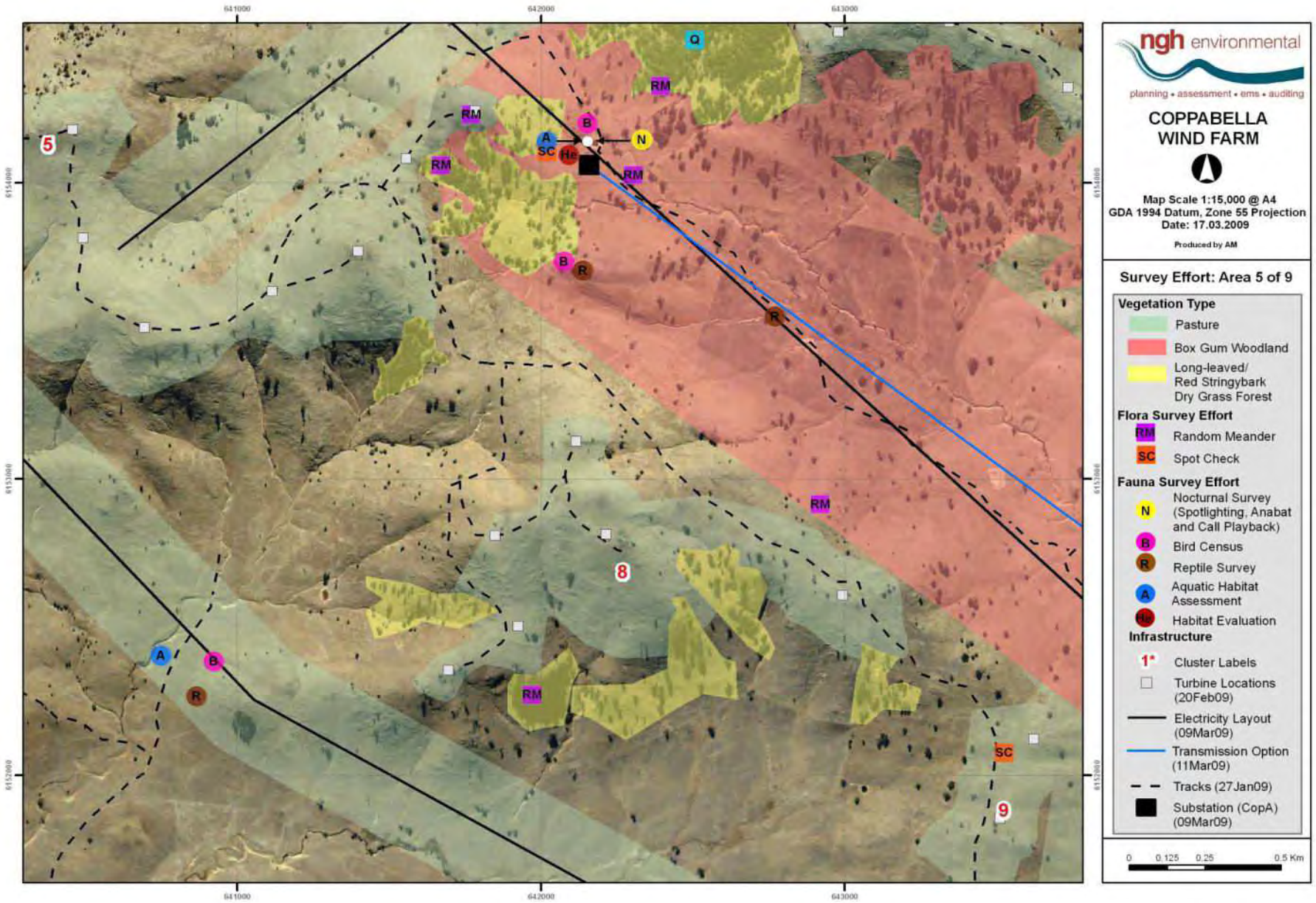
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Survey Effort: Area 5 of 9
Vegetation Type
Pasture
Box Gum Woodland
Long-leaved/ Red Stringybark Dry Grass Forest
Flora Survey Effort
Random Meander
Spot Check
Fauna Survey Effort
Nocturnal Survey (Spotlighting, Anabat and Call Playback)
Bird Census
Reptile Survey
Aquatic Habitat Assessment
Habitat Evaluation
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
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Tracks (27Jan09)
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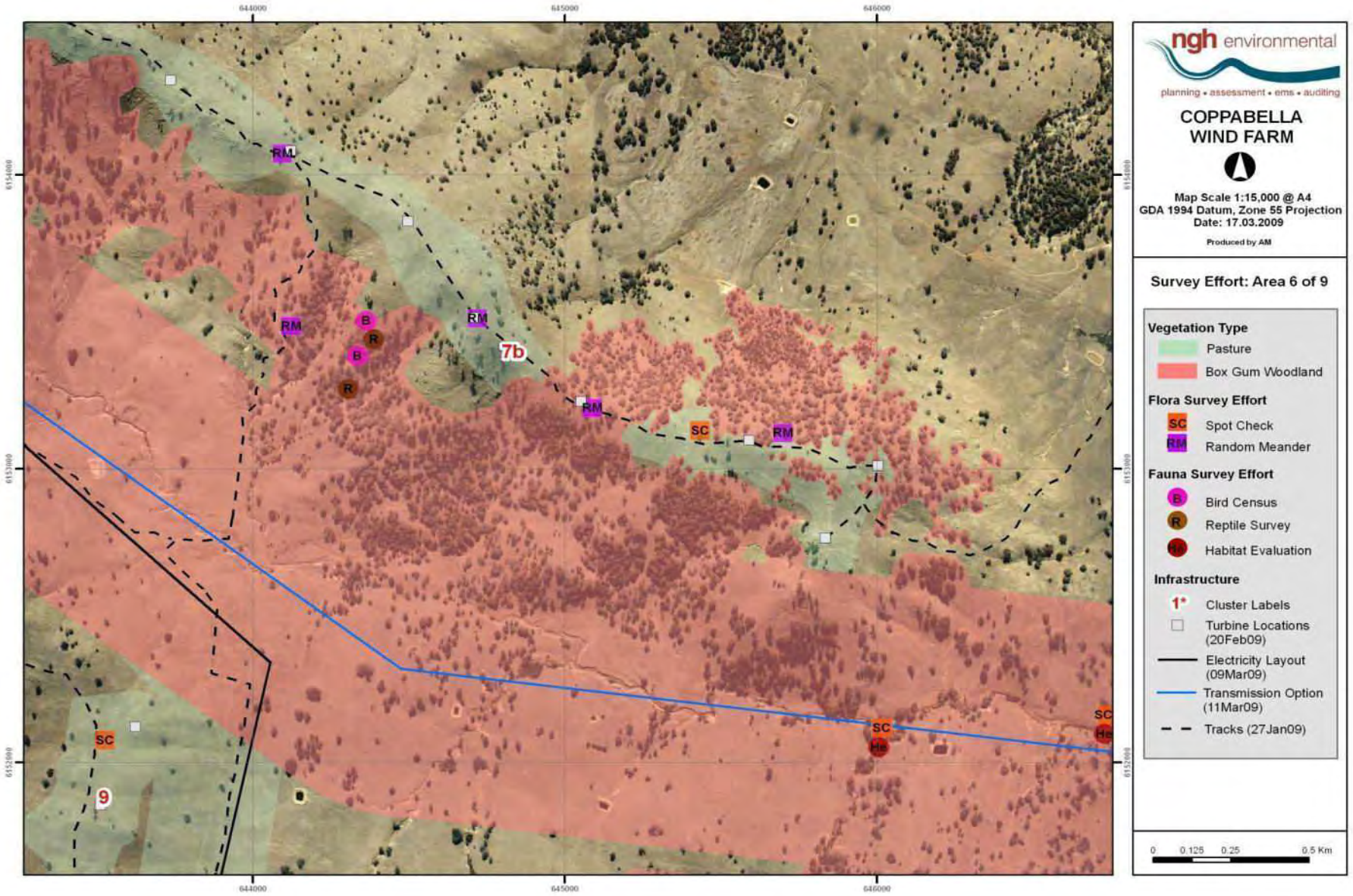
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Vegetation Type
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Flora Survey Effort
Spot Check
Random Meander
Fauna Survey Effort
Bird Census
Reptile Survey
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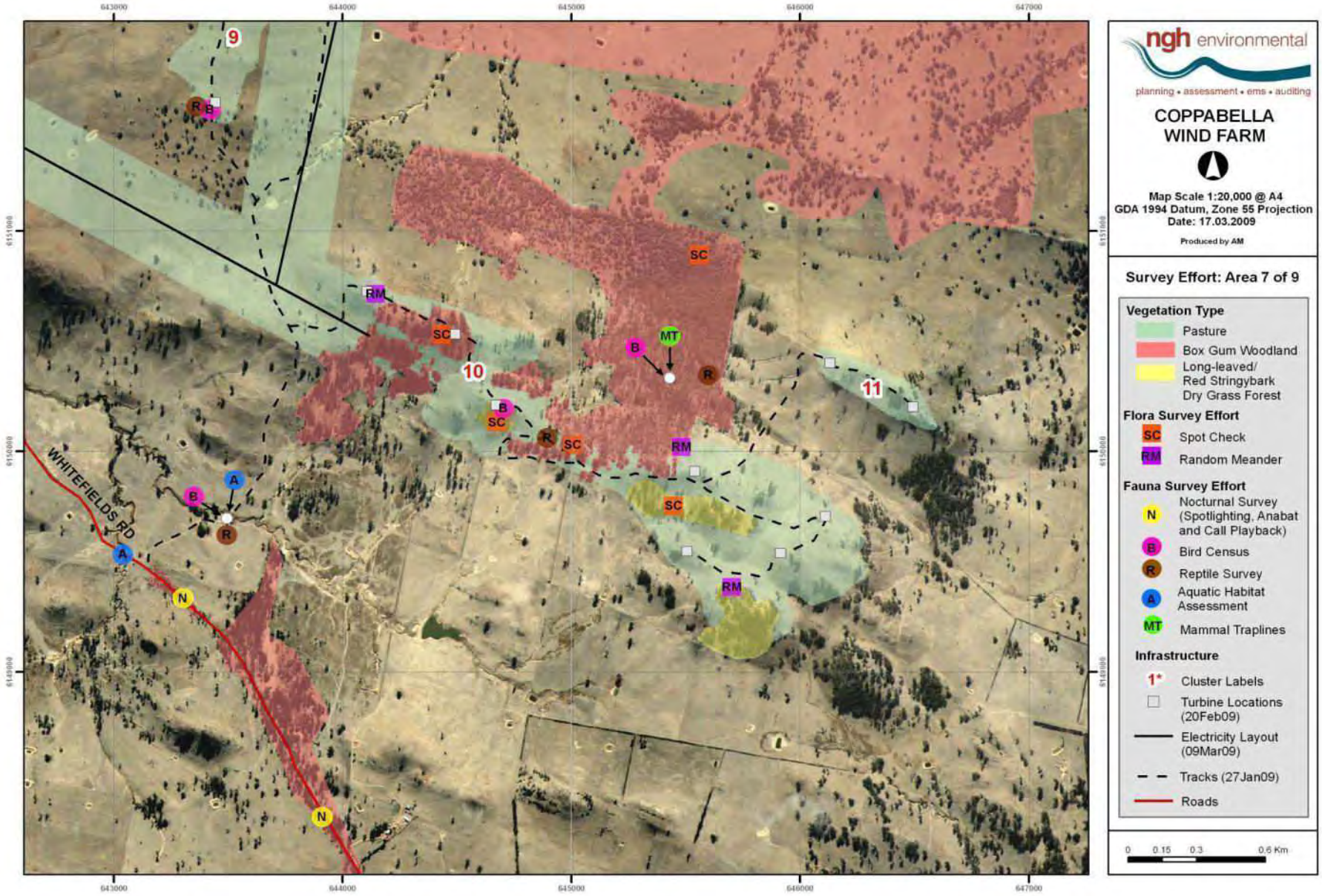
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Vegetation Type
Pasture
Box Gum Woodland
Long-leaved/
Red Stringybark
Dry Grass Forest
Flora Survey Effort
SC Spot Check
RM Random Meander
Fauna Survey Effort
N Nocturnal Survey
(Spotlighting, Anabat
and Call Playback)
B Bird Census
R Reptile Survey
A Aquatic Habitat
Assessment
MT Mammal Traplines
Infrastructure
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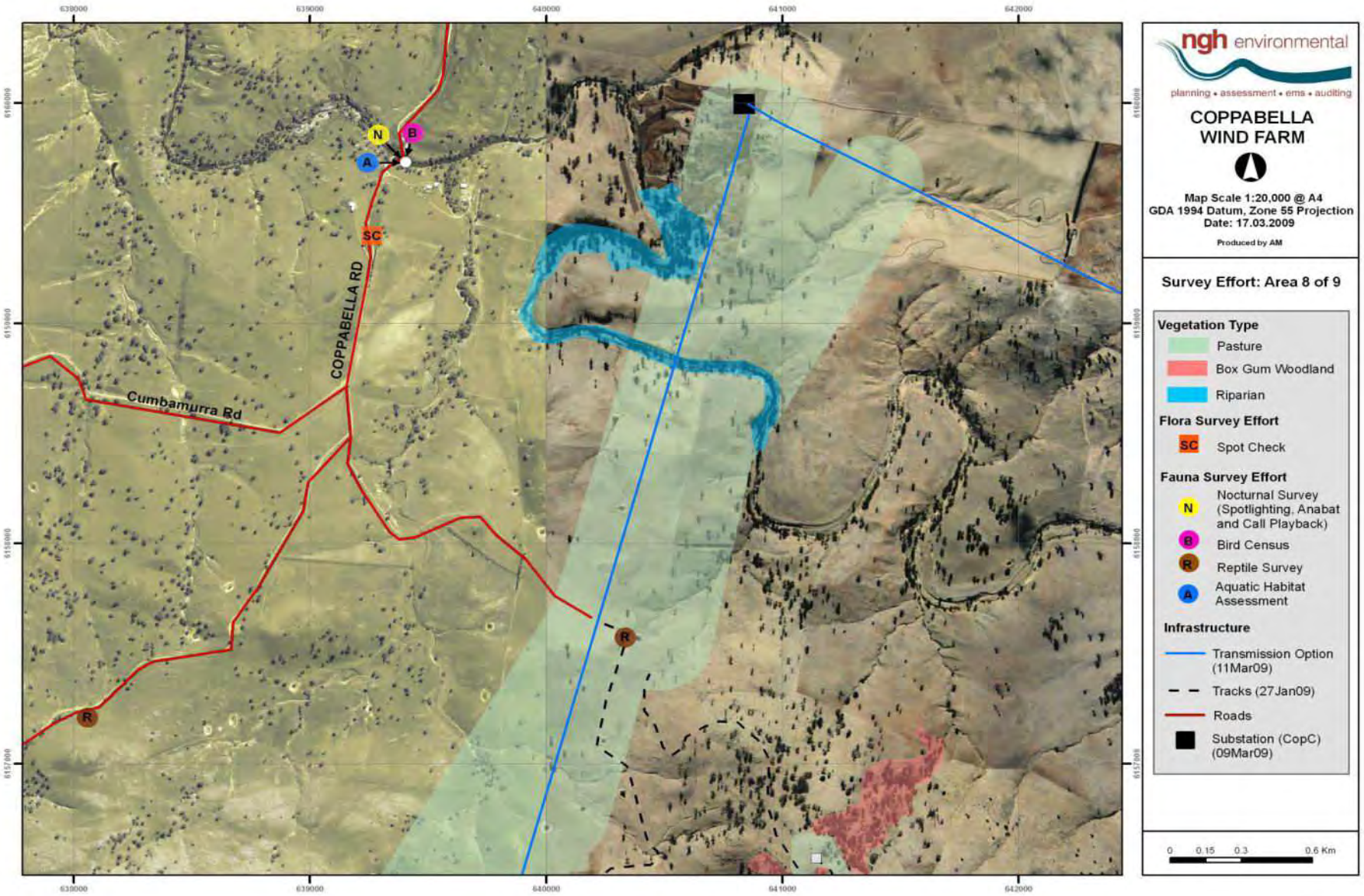
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WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
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Survey Effort: Area 8 of 9
Vegetation Type
Pasture
Box Gum Woodland
Riparian
Flora Survey Effort
SC Spot Check
Fauna Survey Effort
N Nocturnal Survey (Spotlighting, Anabat and Call Playback)
B Bird Census
R Reptile Survey
A Aquatic Habitat Assessment
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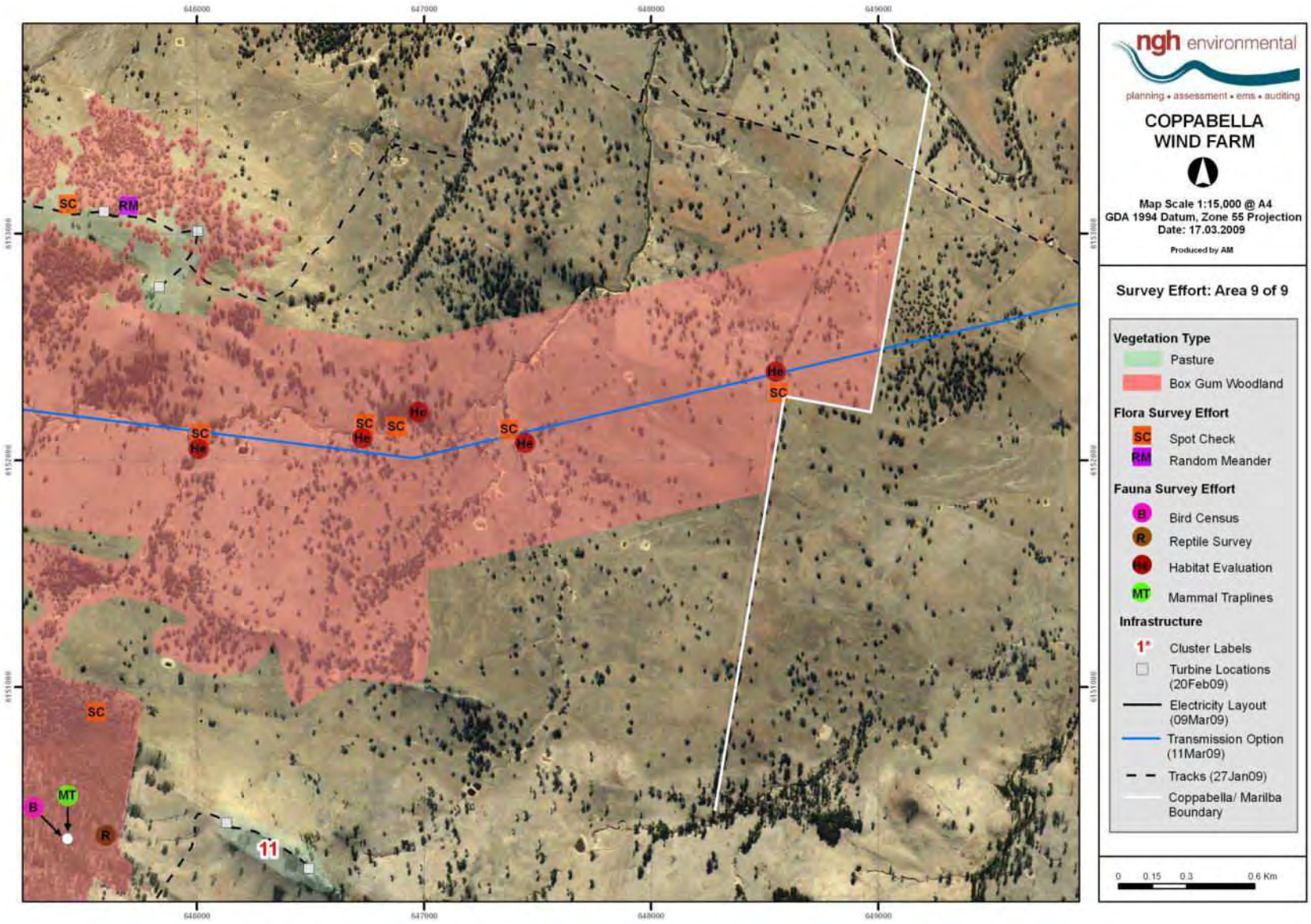
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Survey Effort: Area 9 of 9
Vegetation Type
Pasture
Box Gum Woodland
Flora Survey Effort
SC Spot Check
RM Random Meander
Fauna Survey Effort
B Bird Census
R Reptile Survey
He Habitat Evaluation
MT Mammal Traplines
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
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Coppabella/ Marilba Boundary
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Condition assessment

Condition was rated according to a five-point condition class scale, focusing on floristic integrity in the understorey:

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

5.1.4 Threatened species and communities

Threatened species and communities listed under the TSC Act or the EPBC Act were specifically targeted in the assessment. Threatened species or communities recorded from the region, or with potential to occur there, were identified using previous survey records and a DECC threatened species search based on the relevant Catchment Management Authority (CMA) sub-regions. 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') listing under the TSC Act draws on the definition provided in the DECC online profile (DECC 2008b), the DECC final determination (NSW Scientific Committee 2002), the NPWS fact sheet and the identification guidelines for the EEC (NPWS undated-a; b). Verbal advice was sought from DECC staff (A. Treweek, R. Rehwinkel, pers.com) where matters of EEC definition were problematic. The identification of the Critically Endangered community White Box - Yellow Box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands listed under the Commonwealth EPBC Act relies on the Commonwealth listing and conservation advice provided on the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) website (Threatened Species Scientific Committee 2006a; b). A precautionary approach has been adopted where distribution and habitat information is incomplete or uncertain.

5.1.5 Survey limitations

Survey extent

The development envelope survey area covers approximately 2,829.1 hectares, which includes substantial buffer areas to allow for the fine-scale planning and siting of elements of the proposed development. Given the large area, not all of the site could be inspected in detail.

Closer attention was paid to areas supporting predominantly native Box-Gum Woodland understorey and remnant forest. Representative areas of pasture dominated by exotics were surveyed to record general species composition. Where potential habitat was present, targeted searches for threatened species were undertaken in representative areas, particularly in Box-Gum Woodland remnants.

Specific areas that would be affected by road construction, realignment, widening or other improvement works were not defined at the time of survey and therefore, could not be surveyed in detail. However observations of EEC presence along access track or road verges were noted.

Survey timing

The main survey effort was undertaken in early spring, following good rainfall approximately a month earlier. This is likely to have introduced a bias toward fast-growing annual and perennial species, particularly exotic weed and pasture species and may have masked the 'normal' representation of native perennial grasses and forbs at the site. Most grasses were not identifiable with certainty at the time of the September survey, 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 accurately. A return visit to the site in November 2008 increased the certainty of grass identification and proportional cover of native grasses.

Some geophytic species (such as terrestrial orchids and lilies) which flower outside the survey period 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 this time (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.

A further survey was undertaken on 10-11 March 2009 to investigate a new transmission easement option, between the Coppabella Hills and Marilba Hills Precincts. Conditions in March were very dry, but grass seed heads were still reasonably abundant in most areas, so it was 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 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.

Disturbance

Most of the subject site was grazed by sheep at the time of survey and this will 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). Conversely 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 greatly impacted species detection.

Mapping

The vegetation communities present on the site intergrade and overlap, making vegetation mapping problematic. The spatial extent of the different vegetation communities in the region and their condition are related to cover and diversity of native groundcover species. Groundcover composition and condition may be highly variable over a small area, and will often change over time depending on

season, water availability and grazing pressure. These factors, combined with the high level of disturbance to the understorey from grazing makes definition and mapping of vegetation types and their condition in the field or using aerial photographs problematic.

Vegetation mapping focused only on the treed areas on the site and involved extrapolation of field data through aerial photographic interpretation. The overlap of vegetation types, the poor condition of many patches, and the error associated with aerial photography interpretation means that the vegetation mapping can only be considered to be a general representation of the vegetation composition on the site. A precautionary approach has been used where classification of vegetation types is uncertain.

Threatened species and communities

In view of the degree of habitat degradation from grazing over most of the site, it is considered unlikely that any threatened species which have been recorded in the region have been overlooked. However, in view of the limitations discussed above, a precautionary approach has been applied to ensure that the potential for impacts on threatened flora is assessed appropriately. The possibility of unrecorded threatened species occurring on the site has been assessed in the threatened species evaluation and the impact assessment in Section 5.3 and 5.4 of this report.

5.2 ASSESSMENT AND SURVEY RESULTS

5.2.1 Species recorded at the subject site

A total of 165 vascular plant species were recorded during the flora survey, including 51 exotic species. A full list of species recorded in the eleven survey zones (Clusters 1-10 and the potential offset area), and their typical cover/abundance, is provided in Appendix A. One threatened species: Yass Daisy (*Ammobium craspedioides*) was identified at the subject site (Section 5.4).

5.2.2 Vegetation communities

The majority of the study area is farmland that has been cleared and carries a high abundance of exotic forbs and pasture grasses. All parts have been impacted by ongoing sheep or cattle grazing, presumably over many decades. These disturbances made it difficult to enable confident attribution to particular vegetation types. Three broad groupings of Box-Gum Woodland and derived native pasture Southern Region vegetation types defined by Thomas, Gellie and Harrison (2000) and Gellie (2005) most closely correspond to the remnant vegetation present in the study area. These include: Box Gum Woodland, Long-leaved Box-Red Stringybark Dry Shrub/Grass Forest and Riparian River Red Gum Forest and are discussed below.

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). Box-Gum Woodland is listed as an Endangered Ecological Community under the TSC Act, and a Critically Endangered Ecological Community under the EPBC Act (Section 5.3.1). All three communities present intergrade and overlap, and this combined with the high level of disturbance to the understorey from grazing makes definition and mapping of vegetation types problematic. A full species list for the subject site can be found in

Appendix A. This species list has not been divided by vegetation type, since most species are common to most vegetation types, with only the proportions differing from type to type.

The extent, location, condition class and conservation significance of vegetation within the development envelope is presented in Figure 5-6, Table 5-1 and Table 5-2. Treeless native and exotic pasture habitats dominate the development envelope. The location, condition and conservation significance of these habitats is also discussed below

Woodland communities

Box-Gum Woodland and derived native pasture

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 component. Box-Gum Woodland with additional tree species Red Box (*E. polyanthemos* ssp *polyanthemos*), Red Stringybark (*E. macrorhyncha*) or Long-leaved Box (*E. goniocalyx*) is present in many parts of the Coppabella Hills Precinct, in varying condition. Unlike many tableland areas where this community is restricted to lower slopes and valley floors and is replaced by a different assemblage (usually including *E. dives* and *E. mannifera*) on more exposed ridge tops, this Box-Gum Woodland community also occurs on ridge tops in parts of the site. This is possibly as a result of the volcanic geology of the area, which has given rise to relatively deep and fertile soils on the ridge tops.

The Box-Gum Woodland community on the site is located on fertile soils, and therefore coincides with prime farmland. It has been heavily impacted by clearing, grazing, cultivation and the introduction of weed and pasture species. Parts of the subject site have lost nearly all evidence of the natural woodland, including most of the ridge crests and much of the intervening valley floors. Relatively intact Box-Gum Woodland remnants are present in a few small areas in saddles on Cluster 10, and in a large remnant on flats north of Cluster 10 (outside the impact zone). Ridgetop woodland remnants generally consist of regrowth eucalypts of Yellow Box, White Box or Blakely's Red Gum with low species diversity groundcover.

Occasional smaller trees, Kurrajong (*Brachychiton populneus*) or Hickory Wattle (*Acacia implexa*), are also a feature of this community. On some cleared ridges only Kurrajongs remain, while Hickory Wattle is most often present as dead trees.

Scattered trees in pasture are frequently in poor condition, with dieback-affected crowns. Shrubs are extremely rare and occur only around Cluster 10 and on the slopes of Cluster 7. Shrubs are generally restricted to only two species: *Hibbertia obtusifolia* and *Melichrus urceolatus*, although a greater diversity of shrubs was found in the woodland flat north of Cluster 10.

The condition of the groundcover of Box-Gum Woodland remnants on the site is extremely variable across the site and appears to coincide with the intensity of grazing. The condition ranges from good in areas with little or no grazing pressure and a range of native forb and grass species present in the understorey (as in parts of Cluster 10); to poor on crests where exotic species are dominant (parts of Clusters 2 and 3). Poor quality Box-Gum Woodland remnants may or may not include a tree stratum and are most often located at the highest points of the landscape where sheep camp. Many poor quality areas carry thistles (**Onopordum acanthium*, **Carthamus lanatus*), Paterson's Curse (**Echium plantagineum*) and European nettle (**Urtica urens*) as the dominant species. In some areas exotic pasture species such as Barley Grass (**Hordeum leporinum*) and Perennial Rye Grass (**Lolium perenne*)

and legumes (*_Trifolium_* spp) may also be abundant, but more often it is exotic forbs which form the bulk of the cover.

Many Box-Gum Woodland remnants along the ridges, saddles and upper slopes on the site are in poor-moderate to moderate condition. These areas generally have few overstorey trees although carry a higher proportion of native grass and forb species, such as grasses *Austrodanthonia* spp., *Austrostipa scabra* ssp *falcata*, *Aristida ramosa*, *Bothriochloa macra*, and *Microlaena stipoides*, with forbs *Rumex brownii, Solenogyne dominii*, *Hypoxis vaginatus, Drosera peltata* and *Wurmbea* spp. In and near some remnant woodland patches forbs such as *Dichondra repens, Hydrocotyle laxiflora* and *Oxalis perennans* persist in small numbers, but often only beneath logs and rock outcrops where grazing pressure is slightly reduced.

Parts of the site with a predominately native understorey have recovery potential if grazing pressure were reduced. Some areas, generally in saddles where native groundcover species tend to dominate, may be capable of producing some tree regeneration and improved native groundcover diversity. Other areas, mostly those on the highest points where turbines would be located, appear to be most heavily impacted by sheep and are unlikely to be capable of recovery as the remaining trees are 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 described by Thomas *et al.* (2000) and Gellie (2005) which include all or two of White Box, Yellow Box and Blakely's Red Gum. Relevant communities are Forest Ecosystem 116 (*E. macrorhyncha-E. blakelyi*, with occasional *E. melliodora* or *E. goniocalyx*), FE117 (*E. albens-E. blakelyi*), FE120 (*E. macrorhyncha-E. albens* with occasional *E. blakelyi* and *E. polyanthemos*), FE160 (*E. blakelyi-E. melliodora*), FE161 (*E. melliodora*) and FE163 (*E. blakelyi-E. polyanthemos*). All these communities are said to have few or no shrubs and a grassy understorey of very similar species composition, and most of the indicator species mentioned by Gellie (2005) for any of these communities occur on or near the Coppabella Hills Precinct. The SCRA classification is likely to be based on samples from highly disturbed remnants, and any variation in species composition may reflect past management rather than any inherent community differences. Given these identification difficulties, and since all the types have similar EEC conservation status, they have not been distinguished in this assessment.

Lowland woodland and exotic pasture

The original vegetation occupying the lowlands surrounding the clusters, and over much of the proposed transmission routes, is likely to have been Box-Gum Woodland dominated by Yellow Box and Blakely's Red Gum. Modified Box-Gum Woodland remnants are present alongside Whitefields and Illalong Roads. The road verge clusters have a depauperate groundcover, but frequently include large mature 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. Mixed pasture is also present in valley floors in mosaic with less modified native pasture.

Long-leaved Box – Red Stringybark dry grass forest

Long-leaved Box (*E. goniocalyx*) tends to dominate patches of remnant forest or woodland on relatively steep slopes often on sheltered aspects, at Clusters 7, 6 and small parts on Clusters 10, 8, and 5. Apart from a small patch on the eastern end of Cluster 10, all examples of this community are outside the development envelope. Long-leaved Box also occurs with Red Stringybark (*E.*

macrorhyncha) on upper slopes and occasionally ridges as small copses or scattered trees over native pasture (Cluster 8 and 5). The largest area of this community is on the south-west facing slopes of Cluster 7, although this area does include scattered Yellow Box trees, causing it to have been classified as Box Gum woodland, despite the predominance of Long-leaved Box.

Occasional small trees in this community include Kurrajong, and much less commonly Hickory Wattle, Native Cherry (*Exocarpos cupressiformis*) and Drooping Sheoak (*Allocasuarina verticillata*). In all stands understorey vegetation has been modified, with the general elimination of the shrub stratum, except for a very occasional plant of *Hibbertia obtusifolia, Dodonaea viscosa* or *Melichrus urceolatus*. The groundcover varies from largely native on steep midslopes as at Cluster 7 to mostly exotic in small remnants on more heavily grazed ridgetop sites as at site 10 (**Lolium perenne, *Hordeum leporinum, *Urtica urens, *Erodium* spp and thistle spp). Native understorey species at less disturbed sites include grasses *Microlaena stipoides, Elymus scaber, Austrodanthonia* spp., and numerous native forbs including *Geranium solanderi, Poranthera microphylla, Cymbonotus* sp*., Hydrocotyle laxiflora, Wahlenbergia stricta* and many other species, along with annual weeds **Briza maxima* and **Stellaria media*.

This community corresponds most closely to Forest Ecosystem 118: Western Slopes Dry Grass Forest in the Southern Region CRA classification, though a number of very similar communities are described (FE119, Western Tablelands Dry Shrub/Grass Forest, FE121, Northern Tablelands and Slopes Dry Shrub/Grass Forest and FE122, Northern Tablelands and Slopes Dry Shrub/Grass Forest, all of which include several indicator species found on Coppabella Hills Precinct). Key diagnostic species for FE118 present at Coppabella 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.

The difference between Long-leaved Box woodland and Box-Gum Woodland is not well defined in the field, since many stands are of mixed tree species composition. Long-leaved Box Woodland intergrades, and shares many understorey and canopy species, with a number of Box-Gum Woodland vegetation types. Examples of FE188 which have a grassy understorey and a representation of *E. melliodora, E. blakelyi* or *E. albens* may be included in the Box-Gum Woodland EEC/CEEC listed under the TSC Act and the EPBC Act.

The understorey composition can be very similar between the two communities, particularly for stands with similar levels of grazing intensity. Management may have caused initially different understoreys to converge over time due to the elimination of shrubs and more palatable native grasses and forbs. It is not clearly apparent on this site that Long-leaved Box Woodland is a different community from Box-Gum Woodland, although its prominence on sheltered slopes suggests that the two communities may have formerly partitioned the landscape between them based on aspect. Clearing and grazing has since blurred the distinction between them.

Modified riparian habitats: Western Slopes Riparian Moist Sedge Forest/Woodland

A riparian community dominated by River Red Gum (*E. camaldulensis*) with occasional Apple Box (*E. bridgesiana*) is present along Jugiong Creek. Because of its inherent fertility, and due to 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 SCRA Forest Ecosystem: FE43 Western Slopes Riparian Moist Sedge Forest/Woodland. The single

sample of this community seen at Jugiong Creek consisted of very sparse mature River Red Gums, a scatter of young saplings in the creek bed as a result of recent fencing of the riparian zone, a few browsed specimens of bottlebrush *Callistemon sieberi* and an entirely exotic groundcover. Similar vegetation was seen in a less disturbed situation in Travelling Stock Reserve No. 38 on Illalong Road south of the Coppabella Hills Precinct and detected at various points along Illalong Road where the creek closely approaches the road.

Pasture habitats

Native pasture

Treeless pasture dominated by native grasses occurs on upper side slopes and in saddles in mosaic with more highly modified areas dominated by weeds (Figure 5-2 and Figure 5-3). The dominant native grass species in pasture areas were *Austrodanthonia* spp, *Aristida ramosa, Bothriochloa macra, Microlaena stipoides, Austrostipa scabra* ssp *falcata,* and occasional *Panicum effusum* at the time of the survey. The diversity and abundance of native grass and forb species is highly variable between sites and within small areas, and is likely to change over time depending on season, water availability and grazing pressure. To account for this spatial and temporal variability, native pasture areas and exotic pasture areas have been mapped as a single vegetation type.

On most surveyed pasture areas, exotic grasses and forbs were found to dominate native groundcover species. Native pasture tends to occur predominately within saddles and more sheltered areas although potentially occurs in small areas on all clusters and along access roads. It was identified at surveys on Clusters: 6 (partial), 8 (ridge), 9 (ridge), the saddle between 6 and 7, 7b (ridge), 10 (saddle) and 3 (partial, south).

The most commonly encountered native forbs are *Wurmbea dioica, W. latifolia, Hypoxis vaginata, Oxalis perennans, Cymbonotus* sp., *Crassula sieberiana, Solenogyne dominii* and *Drosera peltata*, with occasional *Geranium solanderi, Acaena echinata, Dichondra repens* and *Einadia nutans*. Among sheltered crevices created by rocks are ferns are *Cheilanthes* spp, and very rarely, *Asplenium flabellifolium* or *Pleurosorus rutifolius*. Such native pasture is likely to be derived from Box-Gum Woodland, which is the most widespread community in the area. The composition of native pasture sites reflect a long grazing history and is usually low in native species diversity so that although the bulk of the vegetative cover may be composed of native grasses, the majority of the species present are exotic.

Exotic pasture

The most modified parts of the study area generally occur on the highest points (ridge crests and peaks), where sheep camps are generally located. These carry pasture dominated by exotic grasses (**Lolium perenne, *Hordeum leporinum*), legumes (**Trifolium* spp) and weeds (thistles, **Erodium* spp, **Arctotheca calendula, *Echium plantagineum*), with very little representation of native species (*Rumex brownii, Oxalis perennans* and occasional *Cheilanthes* spp, *Dichondra repens* or *Hydrocotyle laxiflora* where logs or rocks provide a little protection from grazing pressure). Forbs are generally dominated by exotic weed and pasture species.

Figure 5-2 Mixed exotic and native pasture on Cluster 7b (looking west)

Figure 5-3 Mixed exotic and native pasture on Cluster 10 (looking east)

Occasional trees (eucalypts or Kurrajong) occur within this vegetation type, often in poor health. Very rocky areas, such as Cluster 1, also tend to be dominated by exotics, mostly thistles (**Onopordum acanthium* or **Carthamus lanatus*) and European Nettle (**Urtica urens*). No rock outcrops of sufficient size or ruggedness to prevent access by sheep, and hence degradation and weed invasion, were seen on all parts of the site.

Surveyed areas that were dominated by exotics include: Clusters 1 (Figure 5-4), 2 (Figure 5-5) and 4, parts of 5 and 6 (upper slope), parts of 7a and 7b (ridge and upper slope); 3a (upper slope); and parts of 10.

Figure 5-4 Exotic pasture on Cluster 1 (looking east)

Figure 5-5 Exotic pasture on Cluster 2 (looking east)

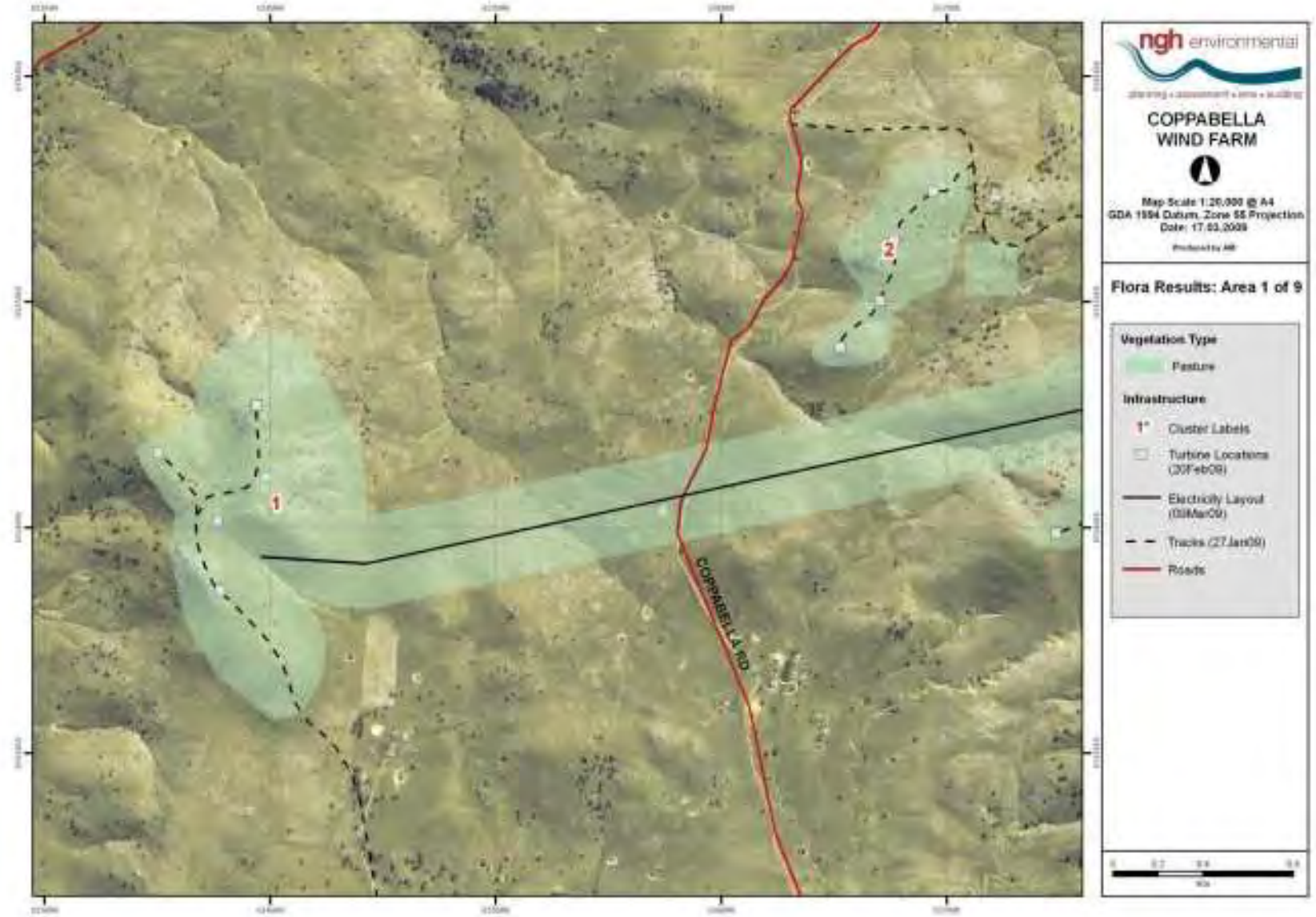
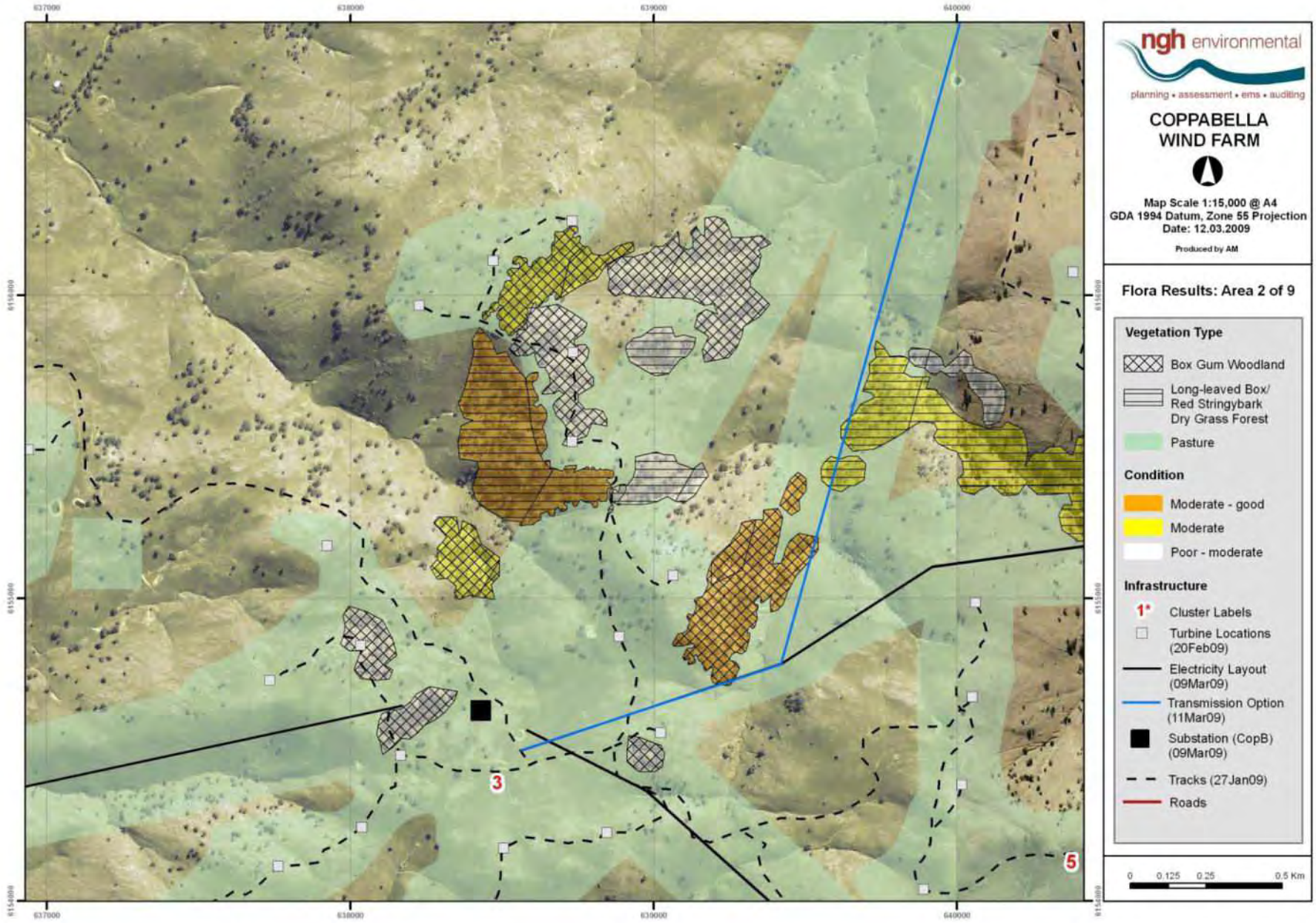


Figure 5-6 Flora results, map set (9 maps in total)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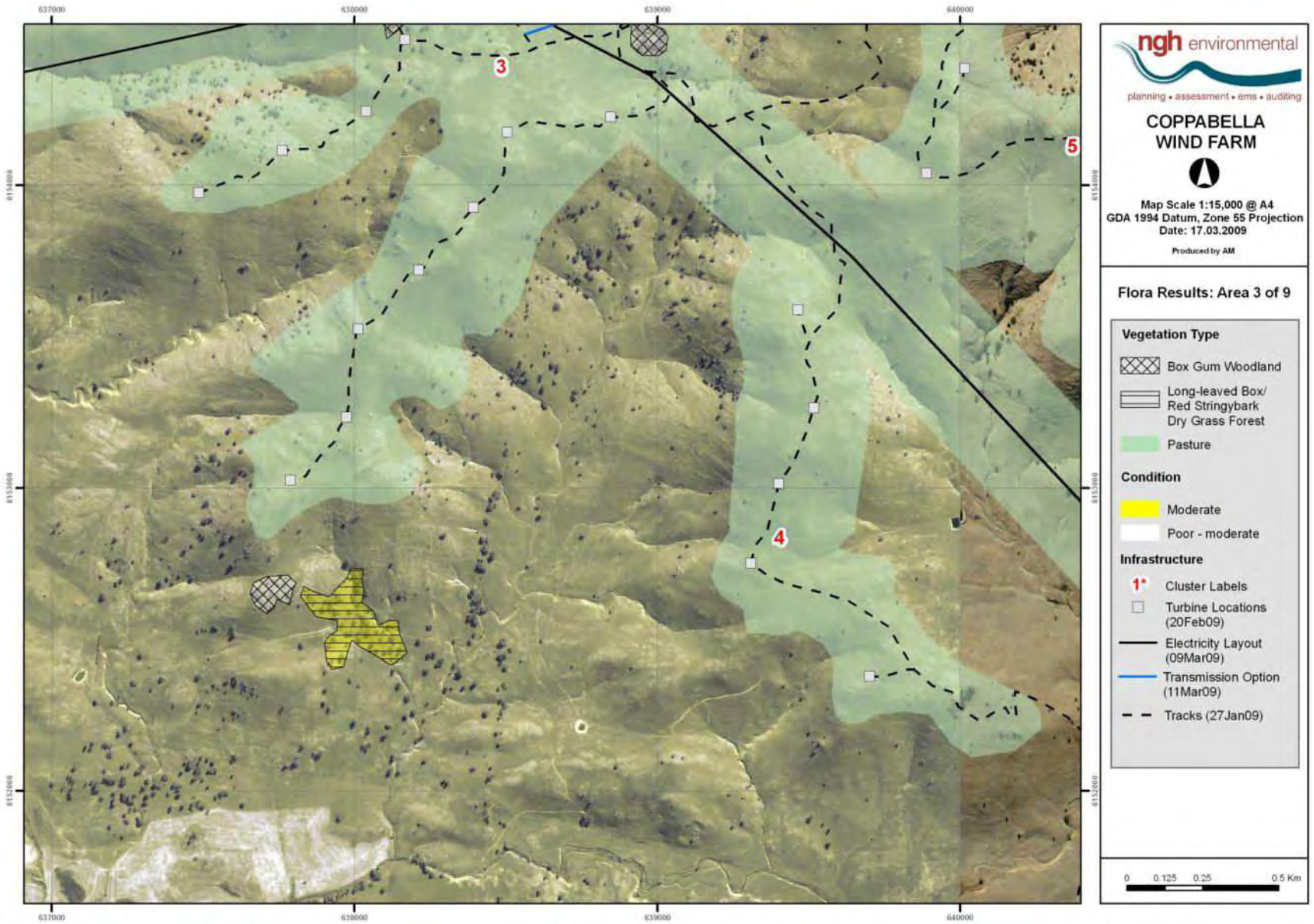
COPPABELLA
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 12.03.2009
Produced by AM
Flora Results: Area 2 of 9
Vegetation Type
Box Gum Woodland
Long-leaved Box/
Red Stringybark
Dry Grass Forest
Pasture
Condition
Moderate - good
Moderate
Poor - moderate
Infrastructure
1*
Cluster Labels
Turbine Locations
(20Feb09)
Electricity Layout
(09Mar09)
Transmission Option
(11Mar09)
Substation (CopB)
(09Mar09)
Tracks (27Jan09)
Roads
0
0.125
0.25
0.5 Km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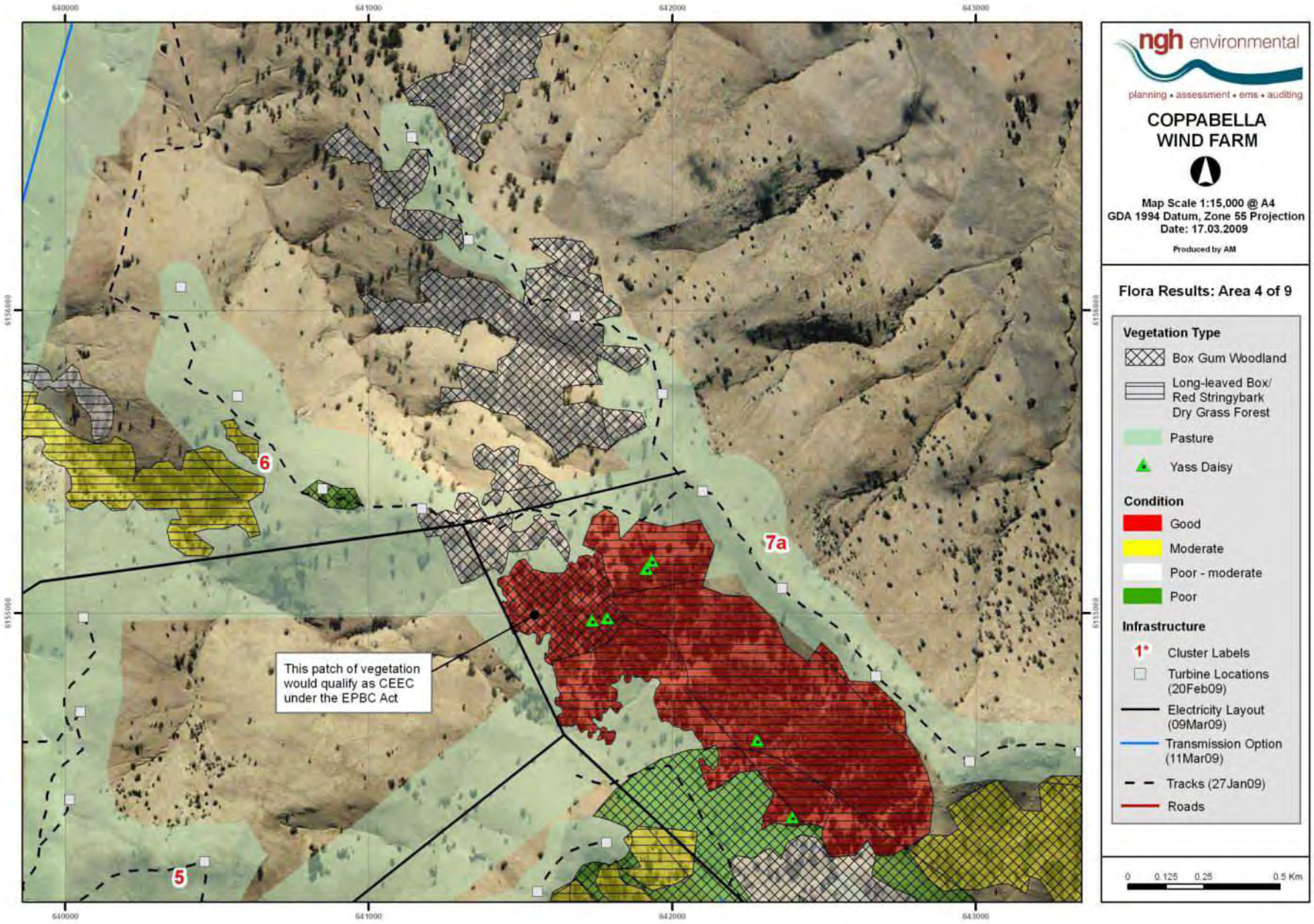
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 3 of 9
Vegetation Type
Box Gum Woodland
Long-leaved Box/
Red Stringybark
Dry Grass Forest
Pasture
Condition
Moderate
Poor - moderate
Infrastructure
1* Cluster Labels
Turbine Locations
(20Feb09)
Electricity Layout
(09Mar09)
Transmission Option
(11Mar09)
Tracks (27Jan09)
0 0.125 0.25 0.5 Km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COPPABELLA
WIND FARM
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GDA 1994 Datum, Zone 55 Projection
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Produced by AM
Flora Results: Area 4 of 9
Vegetation Type
Box Gum Woodland
Long-leaved Box/
Red Stringybark
Dry Grass Forest
Pasture
Yass Daisy
Condition
Good
Moderate
Poor - moderate
Poor
Infrastructure
Cluster Labels
Turbine Locations
(20Feb09)
Electricity Layout
(09Mar09)
Transmission Option
(11Mar09)
Tracks (27Jan09)
Roads
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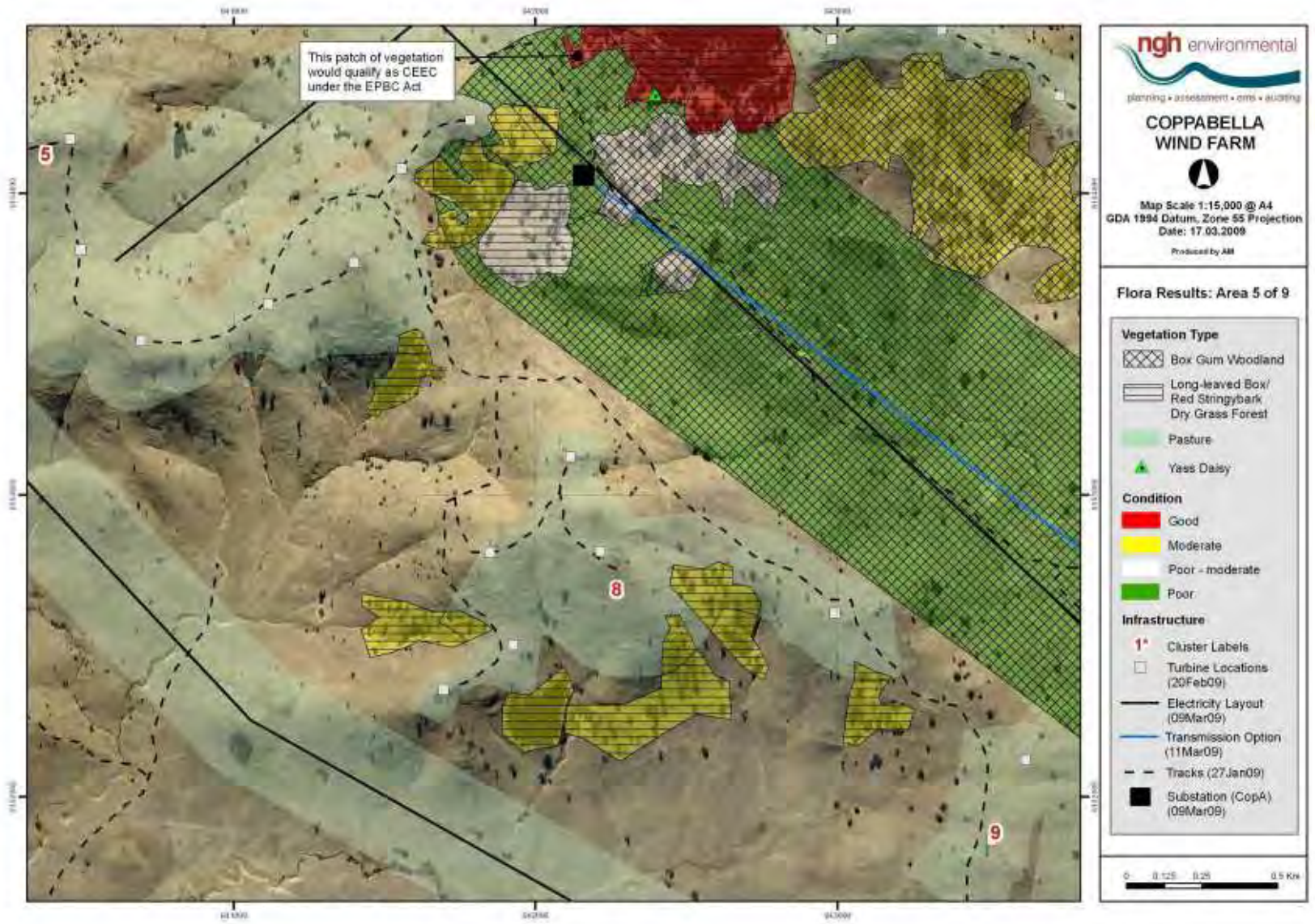
6
7a
5
This patch of vegetation
would qualify as CEEC
under the EPBC Act


This patch of vegetation would qualify as CEEC under the EPBC Act
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GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 5 of 9
Vegetation Type
Box Gum Woodland
Long-leaved Box/ Red Stringybark Dry Grass Forest
Pasture
Yass Daisy
Condition
Good
Moderate
Poor - moderate
Poor
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
Substation (CopA) (09Mar09)
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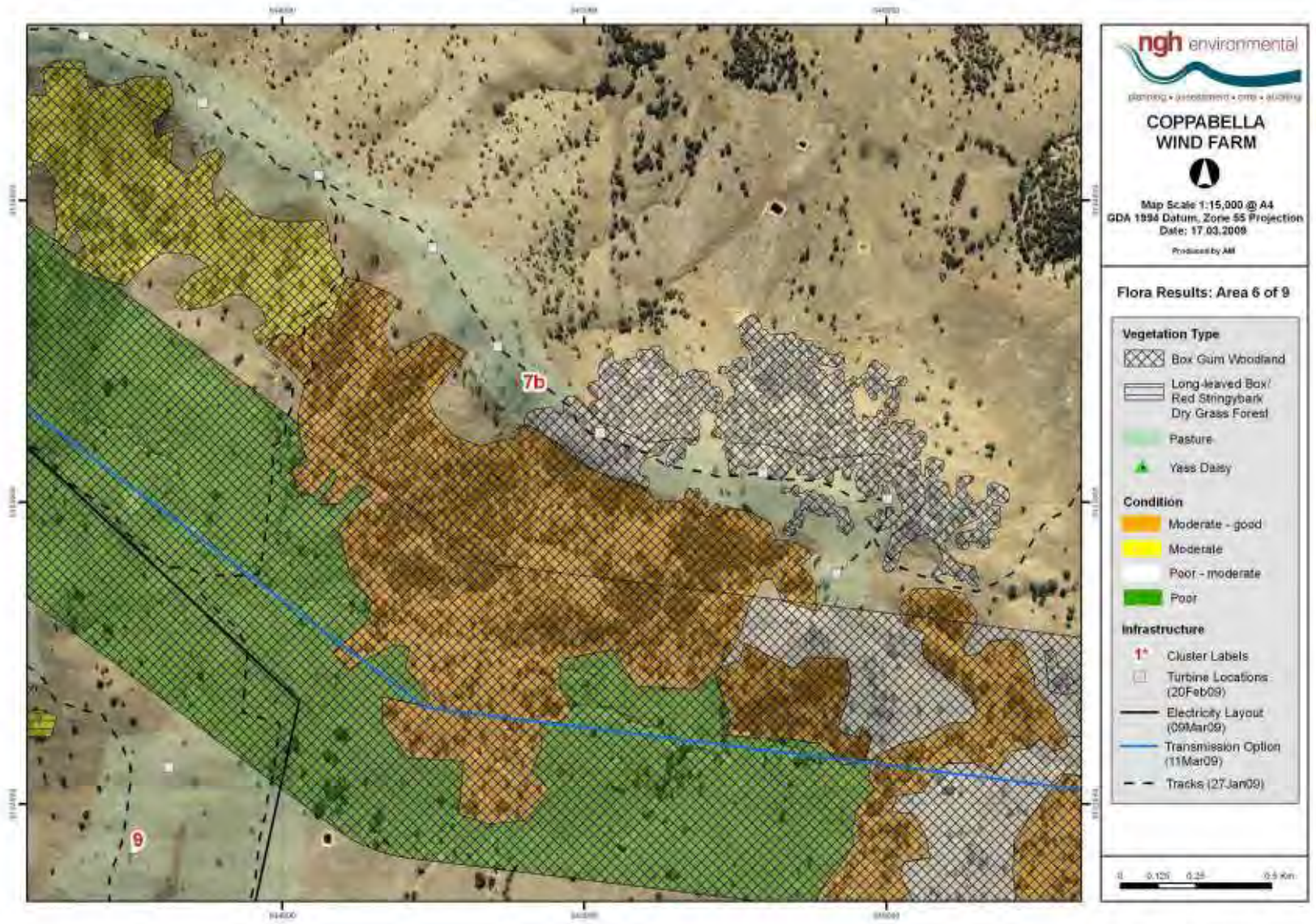
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Flora Results: Area 6 of 9
Vegetation Type
Box Gum Woodland
Long-leaved Box/ Red Stringybark Dry Grass Forest
Pasture
Yass Daisy
Condition
Moderate - good
Moderate
Poor - moderate
Poor
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
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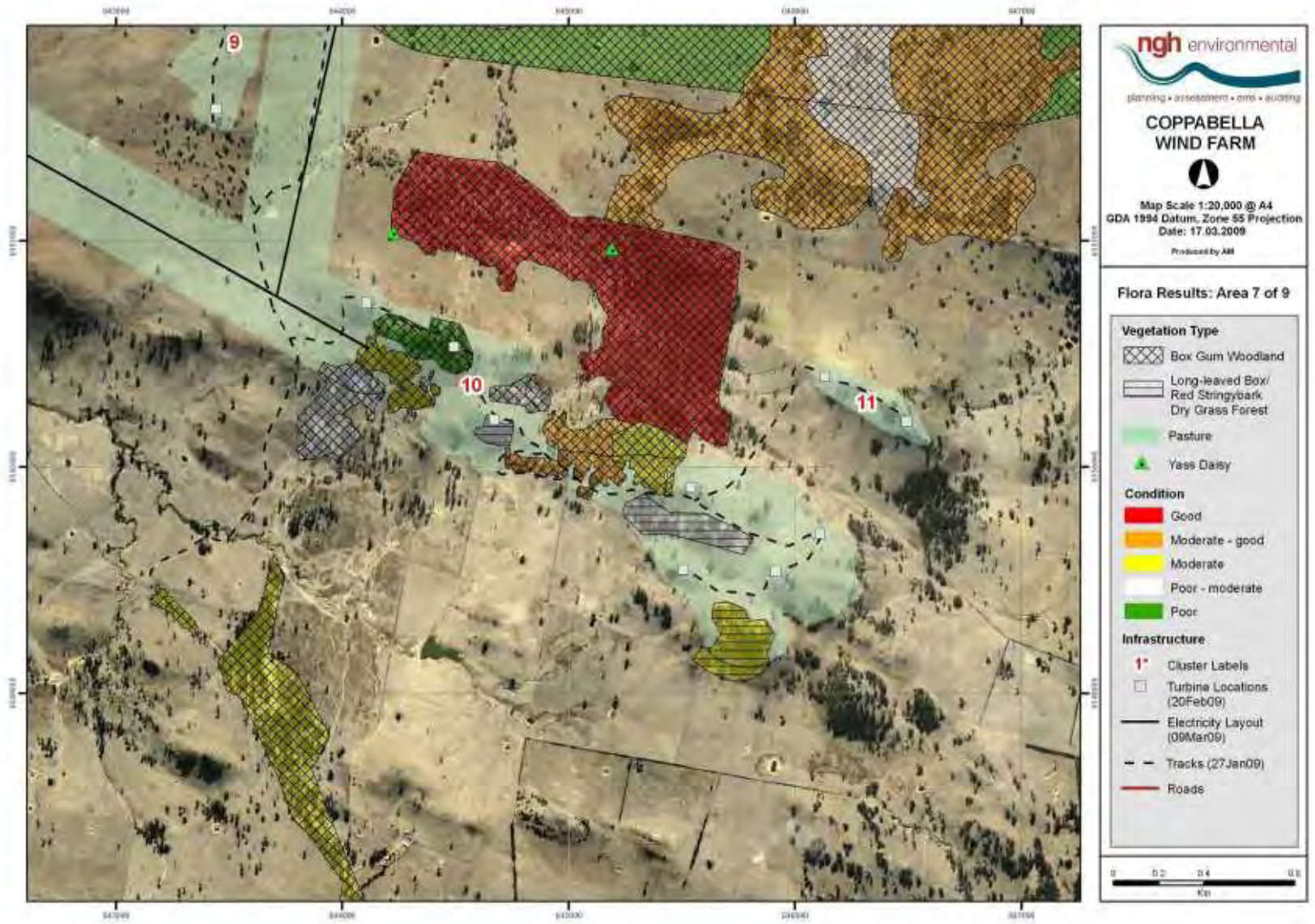
Transmission Option (11Mar09)
Tracks (27Jan09)
7b
9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11
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planning • assessment • ems • auditing
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WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 7 of 9
Vegetation Type
Box Gum Woodland
Long-leaved Box/ Red Stringybark Dry Grass Forest
Pasture
Yass Daisy
Condition
Good
Moderate - good
Moderate
Poor - moderate
Poor
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (27Jan09)
Roads
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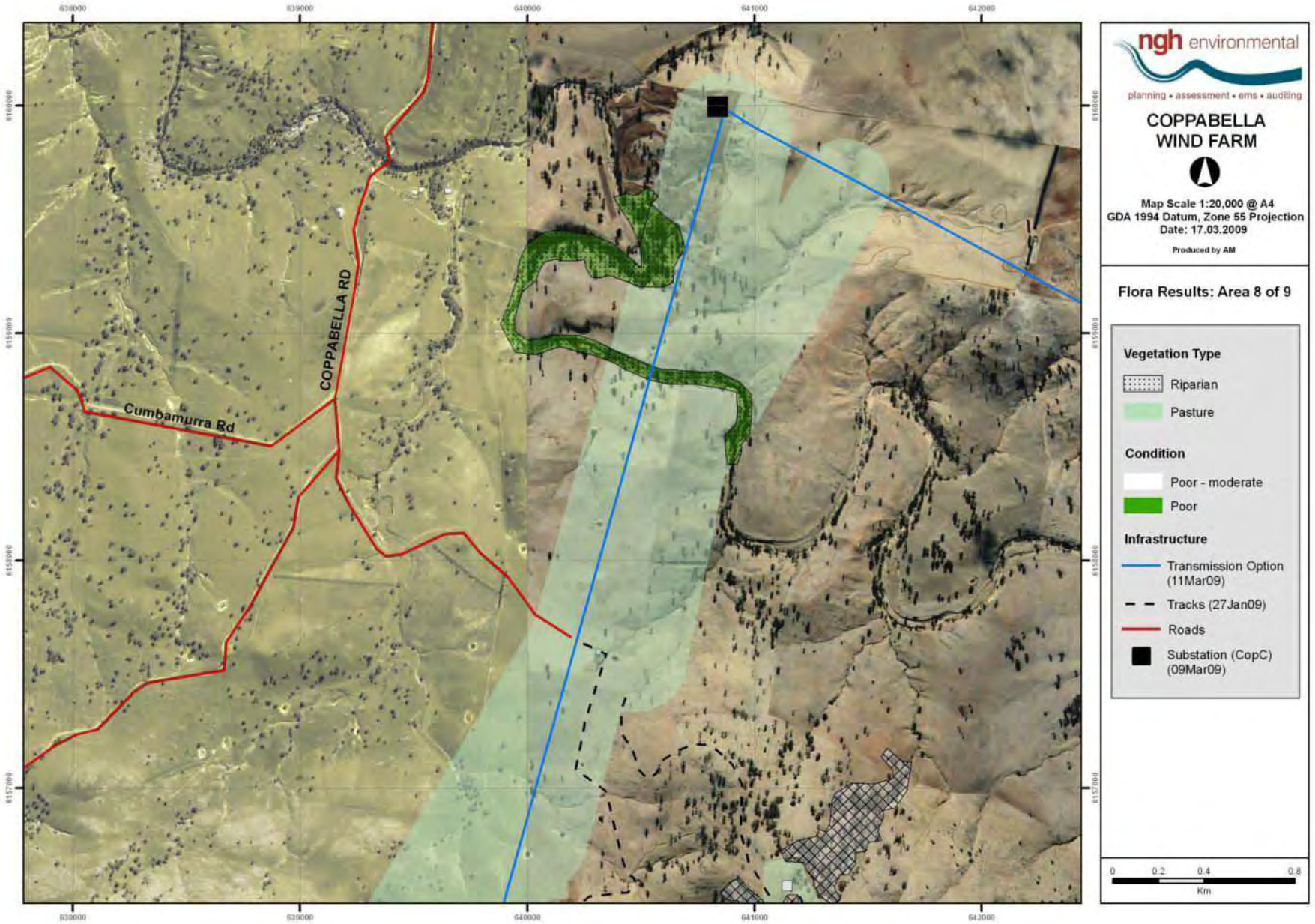
Km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COPPABELLA RD
Cumbamurra Rd
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planning • assessment • ems • auditing
COPPABELLA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 8 of 9
Vegetation Type
Riparian
Pasture
Condition
Poor - moderate
Poor
Infrastructure
Transmission Option (11Mar09)
Tracks (27Jan09)
Roads
Substation (CopC) (09Mar09)
0
0.2
0.4
0.8
Km

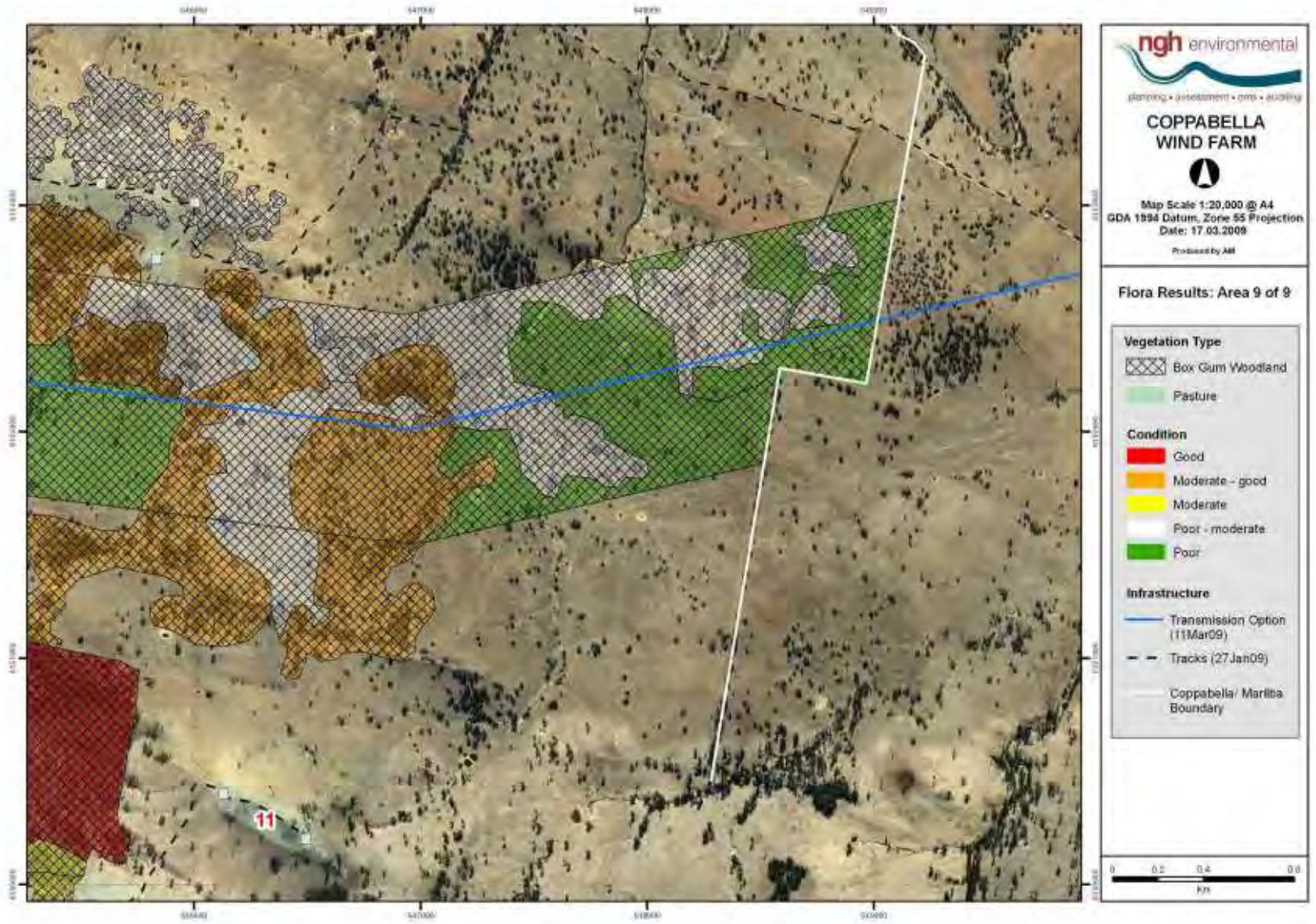

ngh environmental
planning • assessment • ems • auditing
COPPABELLA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 9 of 9
Vegetation Type
Box Gum Woodland
Pasture
Condition
Good
Moderate - good
Moderate
Poor - moderate
Poor
Infrastructure
Transmission Option (11Mar09)
Tracks (27Jan09)
Coppabella/ Marlba Boundary
0 0.2 0.4 0.8
Km
11

Table 5-1 Summary of vegetation types

VEGETATION GROUP (VG) (GELLIE 2005)	OVERSTOREY DOMINANTS	LOCATION	LANDFORMS	SURVEY EFFORT	SIGNIFICANCE[6]
Box-Gum Woodland					
May be derived from one or more of: 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*).	Variably *Eucalyptus melliodora, E. albens, E. blakelyi, E. goniocalyx,* small areas with *E. polyanthemos* or *E. macrorhyncha*	All clusters, though in most cases highly modified. Also dominant in adjacent lowland areas, generally in a more highly modified condition	Ridge crests, saddles, gentler slopes and valleys, on volcanics, all elevations	Quadrats: 1 Random meanders: 22 Inspections: 9	EEC as listed on the TSC Act, 3 examples of CEEC listed on the EPBC Act (north of Cluster 10, and below 7a) Threatened species Yass Daisy was sighted within a transmission envelope between Clusters 7a and 6, below Cluster 7a and within the woodland north of Cluster 10 (refer to Figure 5-6).
Dry grass forest					
May be derived from one or more of: VG 118 (*E. sideroxylon-E. macrorhyncha-E. goniocalyx-E. blakelyi*), VG 119 (*E. macrorhyncha-E. polyanthemos*), VG 121 (*E. macrorhyncha-E. goniocalyx-E. rossii*), VG 122 (*E macrorhyncha - E. goniocalyx*)	*E. goniocalyx*	• South-west facing slope below Cluster 7 • Eastern part of Cluster 10 • Below Cluster 6 • South east facing slope on Cluster 5 • South facing slope on Clusters 8 and 3	Steeper sideslopes, particularly sheltered aspects Rocky knolls only in eastern half of site 10.	Quadrats: 1 Random meanders: 5	Comes under the TSC Act definition of EEC, and one small area of CEEC (lower slopes on 7a). Yass Daisy below Cluster 7a within a transmission envelope between Clusters 7a and 6
Riparian forest					
VG43 (*E. camaldulensis-E.*	*E. camaldulensis*	Present at Jugiong Creek transmission crossing and	Creek banks and flats	Quadrats: 0	A depleted and degraded community but not listed as

[6] EEC – Endangered Ecological Community listed under the NSW TSC Act; CEEC – Critically Endangered Ecological Community listed under the Commonwealth EPBC Act

VEGETATION GROUP (VG) (GELLIE 2005)	OVERSTOREY DOMINANTS	LOCATION	LANDFORMS	SURVEY EFFORT	SIGNIFICANCE[6]
bridgesiana)		patchily along Illalong Road		Random meanders: 1 Inspections: 0	an EEC
Largely Treeless Pasture					
Mostly derived from Box-Gum Woodland types (refer above), some limited areas from dry grass forest types (refer below)	*Austrodanthonia* spp, *Microlaena stipoides, Austrostipa scabra* ssp *falcata, Aristida ramosa* Exotic component variable – dominant in sheep camp areas on ridge crests.	Dominant vegetation type at all clusters	The dominant vegetation type on cleared ridges, saddles and slopes. Also dominant in intervening valley areas.	Quadrats: 2 Random meanders: 3 Inspections: 4	Areas with predominately native pasture come under the TSC Act definition of EEC (derived from Box-Gum Woodland) Does not come under the EPBC Act definition of CEEC

Table 5-2 Extent and location of vegetation type condition classes within the development envelope (DE)

CONDITION CLASS	APPROXIMATE EXTENT WITHIN DE (HA)	LOCATION WITHIN DE
Box-Gum Woodland		
Poor	421.38	**Clusters:** 10 north west, 6 ridge
Poor-moderate	274.59	**Clusters:** 10 central west, 7b far south east,7a far north west, 3 north and central **Transmission envelopes**: between 6 and 7a, below 10, north of 3
Moderate	14.09	**Clusters:** southern edge of Cluster 7, 3 north, 10 north west and 10 central **Transmission:** near 3
Moderate-good	16.15	**Clusters:** 10 central, 7b **Transmission:** east of 3
Good	165.90	**Transmission:** between 6 and 7
Total	**892.11**	
Dry Grass Forest		
Poor	0	No locations
Poor-moderate	21.91	**Clusters:** 10 central east **Transmission:** east of 3
Moderate	35.48	**Clusters:** 10 far east, 8, 6 slope and small areas on 5 **Transmission**: gully between 6 and 3, and between 5 and 7a
Moderate-good	4.03	**Clusters**: 3 central north
Good	29.59	**Transmission:** Western-facing slope of 7a
Total	**91.01**	
Riparian forest		
Poor	11.27	Where the proposed transmission envelope crosses Jugiong Creek to the north of the development envelope
Total	**11.27**	
Largely Treeless Pasture		
Native and mixed pasture	Not mapped	Survey points on Clusters: parts of 6, 8 ridge, 9 ridge, parts of 7a and 7b ridge and parts of 3 south
Exotic pasture	Not mapped	Survey points on Clusters: 1, 2, 4, 5; parts of 6, parts of 7a, 7b and 8 ridge and upper slope; 3a upper slope; parts of 10
Total	**1834.72**	
Totals	**2829.11**	

5.2.3 Disturbance and weeds

Forests and woodlands in the study area have been progressively ring-barked and felled over the past two centuries to provide 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, erosion of soils, particularly wind erosion from exposed ridge tops, elevated soil nutrients and rising saline groundwater.

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, areas subjected to pasture improvement and cultivation and areas selectively targeted by sheep for grazing and camping (the latter usually on ridges and peaks). In many areas, grazing is likely to have reduced or eliminated selectively grazed or grazing sensitive species, such as Kangaroo Grass (*Themeda australis*), terrestrial orchids, native legumes, wattles and other shrubs.

The subject site carries a high proportion of exotic weed and pasture species, ranging from less than one quarter of total herbaceous cover on less disturbed steep side slopes to total displacement of native species on many of the most exposed treeless ridges. The major exotic species are grasses (**Lolium perenne, *Hordeum leporinum*), clovers (**Trifolium* spp), asteraceous weeds (Capeweed, **Arctotheca calendula* and thistles, **Onopordum, *Carthamus* and **Cirsium* spp), Storksbill (**Erodium* spp) and Paterson's Curse (**Echium plantagineum*).

In less disturbed areas with a tree canopy the most common exotic species at the time of the survey were annuals, 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.

Six weeds listed as noxious in the Southern Slopes County Council area [7] control area under the *Noxious Weeds Act 1993* were recorded at the subject site. Locations where these weeds were recorded are provided in Table 5-3 below.

The six noxious weed species are listed as Class 4 weeds for the Southern Slopes County Council control area. 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. They are required to be controlled in accordance with a local management plan published by the local control area authority.

[7] Includes the Councils of Boorowa, Harden, Yass Valley and Young

Table 5-3 Locations of main occurrences of declared noxious weeds

NOXIOUS WEED SPECIES	CLASS	LOCATION
Devil's Claw **Ibicella lutea*	4	Single detached dried fruit in Cluster 1 (near GDA 634006 6153408).
Paterson's Curse **Echium plantagineum*	4	Very common throughout the site, in the more heavily grazed ridge top areas.
Scotch Thistle **Onopordum acanthium*	4	Common in heavily grazed ridge top areas, particularly Clusters 1 and 2.
Sweet Briar **Rosa rubiginosa*	4	Very occasional plants on ridge tops, locations not recorded.
Blackberry **Rubus fruticosus* sp. agg.	4	Sparsely scattered in vicinity of remnant woodland on sheltered slopes, e.g. Cluster 3 southern end (near GDA 637956 6152651), Cluster 9 southern end (near GDA 643336 6152317).
Serrated Tussock **Nassella trichotoma*	4	A single plant tentatively identified on ridge in north-eastern area of Cluster 5 (GDA 641583 6154036).

5.3 COMMUNITIES OF CONSERVATION SIGNIFICANCE

The conservation status of each of the natural vegetation types present as remnants in the study area is summarised in Table 5-4, based on data presented in Gellie (2005).

Table 5-4 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. 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).

Table 5-4 Conservation status of natural vegetation types in the study area

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 159: Northern Slopes Dry Grass Woodland	17,700	1,900 (11% of 1750 extent)	nil
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-Red Stringybark 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
Riparian Forest:			
Vegetation Group 43: Western Slopes Riparian Moist Sedge Forest/ Woodland	29,600	1,300 (4% of 1750 extent)	nil

5.3.1 Box-Gum Woodland Endangered Ecological Community

Box-Gum Woodland is listed as threatened under both the NSW *Threatened Species Conservation Act* (as the White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community and the Commonwealth *Environment Protection and Biodiversity Conservation Act* (as Yellow Box – White Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands, a Critically Endangered Ecological Community). The Commonwealth-listed community represents a higher quality subset of the NSW-listed community.

The condition classes indicate relative patch conservation value. All areas of moderate, moderate to good and good condition woodland patches are considered to be of high conservation significance. Areas of poor, poor to moderate, and treeless examples are considered to be of moderate conservation significance.

NSW TSC Act

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. 2008) 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, and the EEC would still be regarded as being present.

Under the EEC Final 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 definition 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 assisted natural regeneration potential or soil seed bank. It 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 condition of the groundcover stratum (DECC 2008b).

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 remnant or regrowth woodland stands present in varying condition at most of the sites. 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 is generally poor and poor to moderate such as on parts of Cluster 6 with sparse dieback-affected White Box over a heavily grazed exotic understorey; although higher condition remnants are also present such as on parts of Cluster 10 which features Blakely's Red Gum-White Box regrowth over a diverse native grassy understorey.

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.

Woodland dominated by Long-leaved Box is still relatively common on the site. This vegetation type tends to occur on steep sideslopes beyond the impact zone (such as below Cluster 7a) but is occasionally present within the impact zone, as on the knoll at the south-eastern end and those either side of the central saddle on Cluster 10. The groundcover in the latter areas is highly disturbed, and it is impossible to tell whether this type of woodland is floristically distinct from typical Box-Gum Woodland dominated by White Box, Yellow Box or Blakely's Red Gum. The relatively intact stand assessed on the steep slopes below Cluster 7a appears quite similar in understorey composition to the most intact Box-Gum Woodland remnant surveyed on the flat north of Cluster 10.

Woodland dominated by Long-leaved Box has been assigned to a different vegetation type (FE118) under the SCRA classification, but the similarity of the groundcover in the two least disturbed areas surveyed at Coppabella suggests that despite the dominance of Long-leaved Box below Cluster 7a and its almost complete absence from the flat north of Cluster 10, the vegetation in both areas is essentially a grassy woodland with a similar understorey. Remnants with even a single tree of White Box, Yellow Box or Blakely's Red Gum present are regarded as belonging to the EEC under NSW legislation (A. Treweek, R. Rehwinkel, pers. comm.). Whether remnants lacking any of those species are regarded as belonging to the EEC depends on the landscape scale at which the site is viewed, since one of these species is likely to be present within cleared pasture nearby, if not actually present within the woodland remnant. It is therefore considered that the Long-leaved Box remnants are also part of the Box-Gum Woodland EEC, listed under the TSC Act.

Woodland vegetation at the subject site has moderate-high conservation significance, particularly 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 and dominance of the groundcover by weeds in many instances.

Treeless examples – native pasture, with or without sparse trees

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 2008b, A. Treweek and R. Rehwinkel, pers. comm. 2008).

An area of pasture that is dominated by native grasses therefore has the potential to form part of the EEC. The vast majority of native pasture in the study area shows very low levels of native forb diversity (typically 1-4 species) and high levels of exotic forb cover (pasture and weed species). Locations where exotic forbs form a greater proportion of total vegetation cover than native grasses are not uncommon and would not be regarded as belonging to the EEC.

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 are considered to be of relatively low conservation significance due to the highly degraded nature of the groundcover and very limited recovery potential.

Commonwealth EPBC Act

The identification criteria for the Box-Gum Woodland Critically Endangered Ecological Community (CEEC) are considerably more stringent under Commonwealth legislation, than the criteria for the Box-Gum Woodland EEC under the NSW legislation. Vegetation forms part of the CEEC if:

- One of the most common overstorey species is, or was,
    - Yellow Box,

  - Blakely's Red Gum, or
  - White Box.
- The understorey is predominantly native
- The patch is greater than 0.1ha
- And either:
  - 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
  - if native species diversity is lower than this, then the patch is greater than 2ha with an average of 20 or more mature trees per hectare, or with natural regeneration of the dominant overstorey eucalypts.

Under these criteria, the woodland remnant on the flat north of Cluster 10, small patches on the lower slopes of Cluster 7a and in the valley between Clusters 5 and 7a would be included in the listed community. Although much of the area around Clusters 5 and 7a is dominated by Long-leaved Box, with little or no Yellow Box, it is considered to qualify as the CEEC as it has a predominantly native understorey with more than 12 non-grass species, of which several are 'important' species including the threatened Yass Daisy. Some small patches with better quality groundcover around the saddle at the middle of Cluster 10 also qualify as CEEC, where White Box and Blakely's Red Gum regrowth are present above a groundcover with a number of grassy woodland indicator species including *Hibbertia obtusifolia, Melichrus urceolatus, Bulbine bulbosa, Oxalis perennans, Wahlenbergia stricta, Hydrocotyle laxiflora, Geranium solanderi, Wurmbea* spp, *Diuris chryseopsis, Cymbopogon refractus, Themeda australis, Austrostipa* spp and *Elymus scaber*.

The indicative distribution of the Commonwealth listed CEEC in the study area is illustrated on Figure 5-6. Examples of the community are shown in Photographs 7 and 8 in Appendix H.

Additional assessment of the transmission easement connecting to Marilba Hills Precinct substation

All of the vegetation within the proposed route would come under 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 scattered small weedy patches dominated by exotic forbs such as thistles or exotic grass such as phalaris. Dominant groundcover species are the grasses *Austrodanthonia* sp. and *Bothriochloa macra*. Near the 'Whitefields'/'Mylora' boundary there are some small patches of kangaroo grass (*Themeda australis*) on both properties, suggesting a less heavy grazing history. However, no native forbs were seen in these patches, so condition is no better than moderate. Generally groundcover condition is poor-moderate, with two native grass species dominant and few or no native forbs.

In areas of higher tree density, 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).

No areas on the Whitefields section of the route appear to fit the CEEC definition. Areas on the 'Mylora' property which do so are located along Bushrangers Creek and its tributary gully where the

proposed route follows the creek at the eastern end of the ridge on which turbine Cluster 7b is located, and a patch of woodland running south from the creek between two gully crossings immediately south of this section of the creek. Even if there are patches within these areas which have fewer than 20 trees per hectare, the presence of tree regeneration would place these areas within the CEEC definition.

The proposed route close to Bushrangers Creek within the 'Mylora' property should be avoided. The combination of proximity to a steep hillslope, presence of an eroded creek channel, relatively dense trees with some of them hollow-bearing and presence of tree regeneration and even an occasional shrub or small tree in the understorey (*Callistemon sieberi*, Acacia *dealbata, A. implexa*) means this area has construction difficulties as well as biodiversity issues, in comparison with a route located further south. Moving the route to the south by 100-200 metres through this property would avoid the higher conservation value area along the creek, but it would not be possible to find an entirely tree-free route. 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 will probably have to be traversed even if the creek-side route is avoided, and the route of least tree density should be chosen.

On Whitefields, although none of the vegetation fits the CEEC definition, there are a number of large old hollow-bearing Yellow Box and Blakely's Red Gum, particularly in the western half of the route. Putting the route on the northern side of the creek up to a point about 3-400m short of the 'Mylora' boundary, then changing direction and crossing the boundary about 200m south of the proposed crossing point would avoid a lot of trees. There is scope to reroute this transmission line to avoid high constraint areas.

Assessment of significance

Although not a legal requirement of a Part 3a development, an Assessment of Significance (seven-part test) provides a transparent and systematic characterisation for TSC Act listed EEC, to determine the potential for significant impacts on this community arising as a result of the proposed development. The seven-part test is included in Appendix E.

An Assessment of Significance of potential impacts on Box-Gum Woodland CEEC has been undertaken in Appendix E pursuant to the EPBC Act.

5.4 SPECIES OF CONSERVATION SIGNIFICANCE

5.4.1 Threatened and nationally significant species

A number of threatened flora species have potential distribution ranges which include the Coppabella Hills Precinct. 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 D. Based on this analysis, two threatened species are considered to have the potential to be impacted by

the proposed development. One species: Yass Daisy was recorded at the subject site. The second species: Burrinjuck Spider Orchid (*Caladenia* sp *Burrinjuck*) has been recorded close to the site in habitat similar to that on parts of the site and therefore has a low to moderate potential of being present in the study area. Another two species: Hoary Sunray (*Leucochrysum albicans* ssp *albicans* var *tricolor*) and Small Scurf-pea (*Cullen parvum*) have been considered on the basis of either being found close to the site, or being known to tolerate disturbed habitats. Other grassy woodland species (*Thesium australe, Swainsona sericea, Diuris tricolor, Prasophyllum petilum*) or rocky outcrop species (*Senecio garlandii*) which occur in the region are very unlikely to tolerate the level of disturbance present within those parts of the impact zones of the subject site which were inspected.

Yass Daisy (*Ammobium craspedioides)*: Vulnerable TSC Act, Vulnerable EPBC Act

This species was found in two broad locations, neither of them within the proposed turbine cluster development envelope. One is the slope south-west of Cluster 7a and below the saddle which joins Clusters 6 and 7a, in Long-leaved Box forest. The other area is the large woodland remnant on flats north of Cluster 10. In both these areas the plant appears widespread and the population size is likely to number in the hundreds, if not thousands.

nghenvironmental recommend that all proposed infrastructure be microsited away from areas where Yass Daisy occur to avoid significant impacts on this species.[8]

Records have been submitted to the Wildlife Atlas database. The location of records is shown in Figure 5-6 and Appendix A.6.

Burrinjuck Spider Orchid (*Caladenia* sp *Burrinjuck):* covered by the listing of *Caladenia concolor* as endangered under both the TSC Act and the EPBC Act until such time as it is described as a separate species:

This species has potential habitat in forest dominated by *E. goniocalyx* or *E. macrorhyncha* in Clusters 3, 7 and 10. This community is broadly analogous to known habitats in Burrinjuck Nature Reserve to the south (NPWS 2003), though the site is possibly grassier as it is located on relatively fertile soils. The species flowers from late August to October, which coinicides with the September survey, although it may not flower until October, in which case the survey timing (Sept 16-21) would have been too early in September and too late in November. The heavy grazing history over most of the site and the highly restricted distribution of the species reduces the likelihood of its presence at the site.

Hoary Sunray (Leucochrysum albicans ssp albicans var tricolor): Endangered EPBC Act

Hoary Sunray is listed as nationally Endangered under the EPBC Act. It is widespread though uncommon in the Southern Tablelands region and is not listed as threatened in NSW. The species may be sensitive to grazing but can be locally common on road verges in some areas. It is a large conspicuous daisy and the survey coincided with its flowering period. It was not recorded during the survey, though not all suitable habitats were searched. The long grazing history of most of the subject site makes it unlikely that this species would occur there.

[8] See Section 9 for details on how the proposed layout has been modified to address this recommendation.

Small Scurf-pea (*Cullen parvum*): Endangered TSC Act

This small legume has been recorded in Box-Gum Woodland at Galong, only 20km north of the site (Friends of Grasslands, 2006). However, the level of grazing pressure over most of the site makes it very unlikely that this species would occur there. Native legumes were extremely uncommon on the site, with only two occurrences each recorded of *Glycine clandestina* and *Desmodium varians* (on the slope below Cluster 7a and north of Cluster 10). 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 Yass Daisy and Burrinjuck Spider Orchid have been included in the Assessment of Significances pursuant to the TSC Act and the EPBC Act presented in Appendix D. Although not a legal requirement of a Part 3A development, a seven-part test provides a transparent and systematic characterisation for TSC Act listed species, to determine the potential for significant impacts on this community. The Hoary Sunray and Small Scurf-pea and other grassy woodland species have not been included because they were not detected at the subject site during the survey and have a very low likelihood of being present at the site.

5.4.2 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, however none were recorded within the subject site. Single plants of Yam Daisy and Blue Devil (*Eryngium rostratum*) and large numbers of the orchid *Diuris chryseopsis* were detected in the large remnant north of Cluster 10 (off-site).

6 FAUNA

6.1 APPROACH AND METHODOLOGY

6.1.1 Field survey

Survey timing

Following an initial reconnaissance survey on 1-3 September 2008, survey work was carried out for diurnal and nocturnal vertebrates and their habitats on 16-19 September 2008. The survey team consisted of two Biodiversity Project Officers (responsible for fauna survey) and one technical assistant (responsible for habitat assessment). Follow-up visits were conducted between 6-7 November 2008 and 9-11 March 2009 (habitat assessment).

Survey methodologies and effort

The location of the wind turbines and associated electricity and road infrastructure was not able to be precisely defined at the time of the assessments. This assessment was therefore broadened to the 'development envelope' which includes all parts which have potential to carry this infrastructure.

Survey effort within the development envelope was stratified by habitat and vegetation type (Box-Gum Woodland, Long-leaved Box woodland, 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. Additional areas adjacent to the development envelope with higher quality habitat resources or unique habitat types were surveyed in order to maximise the diversity of species and habitat types recorded from the locality. Additional areas surveyed included the woodland remnant on the flat north of Cluster 10, Jugiong Creek (approximately 200m north of the site) and road side vegetation along Coppabella Road and Whitefields Road.

All vertebrate groups and their habitats were surveyed, however areas considered most likely to provide habitat for threatened fauna were focused on. Comprehensive surveying techniques were employed including trapping, nocturnal survey, bird, reptile and frog survey, Anabat recording and habitat assessment.

Trapping

Trapping targeted small and medium-sized mammals, including the threatened Squirrel Glider and the Spotted-tailed Quoll. Trapping surveys aim to provide information on the diversity of small mammals on the site to indicate overall habitat quality of the area and also demonstrate the availability of prey for larger species such as forest owls and raptors. Trapping was undertaken at the north-western end of Cluster 7 and on the flat north of Clusters 10 and 11, where the more extensive areas of vegetation are located. The trapping survey effort was biased toward larger, more intact and less disturbed woodland remnants as it was inferred that these areas would be more likely to support threatened species and also carry a higher species abundance and diversity than the other more disturbed parts of the site. Habitat evaluation was considered sufficient to rule out the potential for threatened small ground mammals to be present at other parts of the subject site.

Bird census, reptile survey, frog censuses and habitat assessment

Bird censuses and general habitat assessments were undertaken within most clusters and along proposed transmission line routes in representative areas of vegetation, habitat and landform types. Bird censuses took into account the flying height of each bird observed.

Reptile searches (rock rolling) were undertaken in suitable habitat (rocky outcrops) on the ridges of most clusters and on different aspects of ridges. Reptile surveys targeted ridges and upper slopes within the nominated development envelope, although were also conducted opportunistically on lower slopes and valleys where ever suitable habitat was present. The abundance of black ants (an indicator for the threatened *Aprasia parapulchella)* was recorded. Reptile searches on ridges and steep slopes were limited by access. Clusters 5, 8 and 11 were not accessible at the time of surveying and habitat assessments of these areas were undertaken from adjacent hill tops and slopes and in adjacent habitat of higher quality.

Habitat assessments considered vegetation composition and structure, disturbances and provision of habitat for threatened species. 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.

Nocturnal surveys

Nocturnal 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 survey. These surveys targeted nocturnal bird and mammal species. Microbat echolocation recording was conducted overnight in three locations during the September survey (along Whitefields road in remnant woodland, at the base of Cluster 7a/5 and at Jugiong Creek). Further microbat survey was undertaken in January 2009.[9]

Opportunistic records

Searches for scats and for signs of animals' presence were conducted opportunistically whilst conducting other surveys. All opportunistic records of fauna were recorded throughout the survey period.

The survey effort is summarised in Table 6-1 and illustrated in Figure 5-1. Refer to Appendix B for further details, including grid references of all survey sites.

[9] The January microbat survey will be documented as a separate report.

Table 6-1 Summary of fauna survey effort

SURVEY TYPE	DESIGN	LOCATION	TOTAL SURVEY EFFORT	TARGET SPECIES
Ground Elliot trap (A)	50 Elliot traps set in 5 transects over 3 nights.	• Site 7a on the western facing slope in woodland • Site 6 on ridge in remnant copse of Long-leaved Box • North of Cluster 10 in intact woodland patch	150 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)
Tree Elliot traps (B)	1 transect of 10 traps over 3 nights. Traps were placed 2-3m above the ground on trunks of mature trees. Baited with a mixture of peanut butter, rolled oats, cat food and honey. Honey dissolved in water was sprayed 1m above and below the trap to attract fauna.	• Site 7a on the western facing slope in woodland. Traps were placed on mature hollow-bearing trees around the northern edge of the woodland	30 trap nights	Small and medium sized arboreal mammals (Squirrel Glider, Common Brushtail Possum, Sugar Glider) Target threatened species: Squirrel Glider, Brush-tailed Phascogale, also diversity and abundance for carnivorous species including forest owls and raptors
Cage trap transects	2 transects consisting of five traps each. Cage traps were placed in between ground Elliot traps along two transects. Cage traps were baited with a mixture of peanut butter, rolled oats, cat food and honey.	• Site 7a on the western facing slope in woodland • North of Cluster 10 in intact woodland patch	30 trap nights	Medium sized animals (quolls, bandicoots and potoroos, reptiles) Target threatened species: Spot-tailed Quoll

SURVEY TYPE	DESIGN	LOCATION	TOTAL SURVEY EFFORT	TARGET SPECIES
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. Birds were identified by sight and by call. The reference CD collection 'A Field Guide to Australian Birds' published by the Bird Observers Clubs of Australian (Plowright 2002) was consulted to assist with call identification.	Surveys were undertaken in representative areas of all vegetation, habitat and landform types.	25 surveys of 20-90 person minutes duration: 17.5 person hours	All avifauna. Surveys focussed particularly on threatened and migratory birds, raptors, flocking species and wetland birds
Reptile searches	Rocks were rolled and the raked with a hand rake. Number of rocks rolled and percentage of rocks with black ants were recorded. A variety of slope aspects and disturbance regimes were surveyed.	Representative herpetofauna 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.	25 surveys of 20-90 person minutes: 11.5 person hours.	All reptile species. Particular focus was given to potential habitat for threatened reptiles *(Delma impar, Aprasia parapulchella*)
Frog censuses	7 surveys of 30-90 person minutes. Riparian sites (creek lines and drainage lines) and dams were visited and frog species were identified by call. The reference CD 'Australian Frog Calls – Subtropical East' of the Nature Sounds series by David Stuart was consulted to assist with call identification (Stuart 1998).	Representative riparian corridors, drainage lines and dams	7 frog censuses at aquatic habitats, 6 person hours	All frog species

SURVEY TYPE	DESIGN	LOCATION	TOTAL SURVEY EFFORT	TARGET SPECIES
Call playback	3 surveys of 65 minutes Vocalisations of the threatened Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider were each carried out after a 5 minute acclimation period. Calls for each species were played for 2.5 - 5 minutes. Listening for responses was carried out for an additional ten minutes. Spotlighting followed call play-back sessions.	Call playback was undertaken at spotlighting locations which included woodland on the lower slopes of Cluster 7a, in remnant roadside vegetation along Whitefields Road and at Jugiong Creek.	3.25 person hours	Threatened nocturnal bird and arboreal mammal species (Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider)
Spotlighting	2 vehicle-based transects and 1 foot-based transect, each conducted by 3 surveyors. Spotlighting was conducted using hand-held 12v 50w spotlights. Foot-based transects were a minimum of two persons for 15 minutes in duration. The length of vehicle-based transects was determined by length of track suitable for spotlighting.	Spotlighting surveys were biased towards areas with mature and hollow-bearing trees to target hollow-dwelling fauna. Spotlighting transects included woodland on the lower slopes of Cluster 7a, in remnant roadside vegetation along Whitefields Road and at Jugiong Creek.	5 person hours	Nocturnal mammals (predominately arboreal although also terrestrial), birds and bats
Microbat echolocation call recording with Anabat	Initial echolocation surveys were undertaken during the September survey using Anabat.	Anabat surveys were undertaken at Jugiong Creek, along Whitefields Road and at a dam in the valley between sites 5 and 7a, west end 7a and middle of 10.	5 overnight surveys (3 in September, 2 in January)	Microchiropteran bats, particularly the threatened Eastern Bent-wing Bat
Habitat assessment	A standard 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. The habitat assessment form trageted the ecological requirements of threatened species.	Habitat assessments were undertaken in representative areas of all vegetation, habitat and landform types.	32 habitat assessments	All fauna species and their habitats
Aquatic habitat assessment	Riparian and wetland (farm dam) habitat was assessed for their potential to provide habitat and resources for fauna in the locality. Specific factors include condition and disturbance; depth, size and shape; and the presence and type of aquatic, fringing and surrounding vegetation.	Representative riparian corridors, drainage lines and dams	11 aquatic habitat assessments	All fauna species, although particularly birds and bats as they may readily move between water sources across the landscape.

SURVEY TYPE	DESIGN	LOCATION	TOTAL SURVEY EFFORT	TARGET SPECIES
Reptile habitat assessment	Rocky areas were assessed for their potential to provide habitat for reptile species. The assessment targeted the known ecological requirements of threatened reptile species. Factors considered included spatial extent; aspect and landscape position; disturbance; groundcover composition and refuge; and number of rocks with ants (relevant to *Aprasia parapulchella*).	Rocky outcrops and ridges and slopes (within and adjacent to the development envelope)	15 targeted fauna habitat surveys in rock outcrops, 27 vegetation and habitat surveys completed in rocky habitats	All reptile species, focussing on threatened species *(Delma impar, Aprasia parapulchella*)
Searches for scats, scratch marks and other signs of fauna presence	Searches for signs of fauna presence and use of the habitat were carried out opportunistically whilst conducting other surveys.	Opportunistically	-	All fauna species
Opportunistic records	All opportunistic records of fauna were recorded. Observations included species type, location of sighting, and the height (above or below 40m) and number of individuals in a flock it the observation was a bird.	Opportunistically	66 observations	All fauna species, with particular focus on birds (also recording their foraging height).

6.1.2 Mapping

Different fauna habitat types were identified from habitat assessments and vegetation surveys conducted on site. The spatial extent of these habitats was mapped using point data collected using hand-held GPS devices (GDA 1994) 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 location of rocky outcrops.

6.1.3 Threatened and significant species

The basis of the field survey program and this biodiversity assessment was to evaluate the risk to threatened species, species at particular risk from construction and operational impacts of wind farms, regionally significant species and more generally, the risk to the integrity of the ecology of the area as a result of the proposed activity.

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 compare the potential risk to threatened and migratory fauna and to fauna specifically at risk from impacts of wind farms. These risk assessments were used to inform the constraints and the threatened fauna evaluation to determine which species had moderate or high potential to be impacted by the proposed activity (for which a seven-part test was prepared), and to develop species-specific mitigation measures to reduce the potential biodiversity impacts of the proposal.

6.1.4 Survey timing

The early spring timing tended to cool conditions in the evenings (see Table 6-2). This was not optimal for recording reptiles and microchiropteran bats which are generally less active in the cooler months. To address this limitation, additional surveys were undertaken (November 2008 and January 2009).

Three nights were spent spotlighting for nocturnal fauna. The first two nights (17 and 18 September 2008) were cool (overnight minimums -1 and 0.5°C), although fine with light winds from the south-west. The third night was warmer (overnight minimum of 6.3°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°C on 19 and 20 September), with moderate to fresh easterly winds developing on 19 and 20 September. Recent rains resulted in good conditions for wetland birds.

Table 6-2 Weather conditions during September surveys

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

				9am			3pm		
Date	Min temp. (°C)	Max temp. (°C)	Rainfall (mm)	Cloud (oktas)	Wind direction	Wind speed (km/h)	Cloud (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

6.1.5 Survey limitations

Survey extent

The surveys targeted areas within the proposed development envelope, which included the proposed turbine envelope, access tracks, transmission easements and electricity substations (refer to Figure 5-1). The large size of the development envelope within it (2,829 hectares), together with access difficulties in particular lack of safe tracks, restricted complete survey coverage of some clusters including the central Clusters 5, 8 and 3 and the eastern portion of Cluster 11. Where access to ridgelines was limited, observations were made from the lower slopes and valleys and from adjacent slopes to ensure a habitat assessment could be made. A follow-up visit in November targeted areas that were not exhaustively covered in the September visit to ensure adequate data was collected across the entire site.

Nocturnal survey (spotlighting and call playback) was particularly restricted by access across the site. Foot-based spotlighting was completed in one woodland location: on the lower slopes of 7a, where the gradients, tracks and creek crossing were considered to be negotiable in the dark. Vehicle-based spotlighting was completed in two locations in areas of remnant paddock trees and mature woodland.

Mapping

Fauna habitat mapping was conducted by field data extrapolation using aerial photographs. The error associated with this technique means that the habitat mapping should be considered only 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

The survey effort is considered by the authors of this report to have been appropriate for the identification of biodiversity constraints. However, this report acknowledges that the field surveys

were limited in spatial and temporal extent and therefore this assessment requires a precautionary approach, as even extensive surveying at optimal periods can fail to detect species. Threatened species were assessed for their potential to occur based on the habitat available, known ecological characteristics of species and known records. Where assumed to occur, areas of potential habitat were identified as constraints to be avoided (for example, woodland).

6.2 ASSESSMENT AND SURVEY RESULTS

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 and seasonal and climatic variables. Static variables are also important for defining the habitat resources available to fauna and include topographical characteristics of the land such as slope, aspect, topography and geomorphology.

Six fauna habitat types were identified across the study area. These include four vegetation-based habitat types and one landform-based habitat type. These were defined as follows:

Vegetation-based

1. Woodland
2. Disturbed woodland
3. Pasture
4. Wetland and riparian habitats: creeks, dams and drainage lines

Landform-based

5. Rocky outcrops and ridges

The spatial extent of these habitat types within and adjacent to the development envelope is shown on

Figure 6-1. The location, description and extent of these habitats are discussed below and summarised in Table 6-4.

Vegetation-based habitat types

1. Woodland

Description and location

- Woodland habitat on the site includes remnant and regrowth Box-Gum Woodland and Dry Grass Forest patches with a relatively continuous overstorey cover (20-30%), occasional shrubs and a predominately native groundcover, although some patches carrying mixed native and exotic grasses and forbs.
- Much of the area is likely to have once been woodland, although has since been cleared and disturbed for grazing and cropping.

- Woodland patches are in areas that have had less grazing pressure than other areas on the site. Woodland habitat occurs on steep, sheltered side slopes (where stock have difficulty to access), and in the south-eastern corner of the site around Cluster 10, where grazing appears to be kept at a minimum.
- The quality of a woodland fauna habitat patch varies according to its degree of connectivity to other patches, the size of the patch and the degree of grazing and weed invasion. High quality woodland patches mostly occur outside the development envelope on the south-facing slopes of 7a and 7b and on the flat north of Cluster 10, which extends on to the saddle of 10, and along the gully in the western portion of the transmission line from substation A ('COP (A) Substation'). Smaller, more isolated patches of woodland occur on the northern end of Cluster 3 (approximately 46 hectares though fragmented); and small patches of dense regrowth woodland occur on south-facing lower slopes on Clusters 5 and 8.
- Clusters 3 and 10, and small areas on 7, have woodland that occurs within the turbine development envelope. The saddle and valley between 5, 6 and 7a, and on the eastern slope of 3 carry woodland habitat that occurs within the proposed transmission envelope. The access track leading up to 7b and the inter-turbine track on 3 pass along-side areas of woodland.

Habitat provision/species observed

- The highest fauna species richness was observed in this habitat type: 45 species, 20 of these occurred only in woodland and no other habitat types. A total 28 fauna species were observed in the high-quality woodland patch north of Cluster 10; many of which were not recorded elsewhere on the site (including Red-capped Robin, Varied Sitella (declining woodland birds), Spotted Pardalote, Leaden Flycatcher, and White-throated Gerygone). Other species observed in woodland habitat include the threatened Superb Parrot, Red-capped Robin, Jacky Winter (a declining woodland bird), Weebill, Boobook Owl, Copper-tailed Skink, Swamp Wallaby and Red-necked Wallaby. Survey results are discussed further below.
- Woodland habitat on the site is generally dominated by regrowth trees and carries only scattered mature hollow-bearing trees, with higher numbers located around the edges of patches. The paucity of hollows in the woodland patches suggests that less-mobile hollow-dependent species such as the threatened Squirrel Glider and Brush-tailed Phascogale are unlikely to occur.
- The habitat features a moderate structural diversity and provides extensive ground habitat and refuge including native grasses and other feed resources, fallen woody debris and litter, and scattered rocky outcrops (as on Cluster 7). These resources are likely to be important for supporting ground-dwelling mammals, reptiles and ground-foraging birds.

2. Disturbed woodland (<50% native groundcover, often on ridges, isolated small stands of trees, also on road sides). Some habitat for mobile species and edge species.

Description and location

- This habitat type is intermediate between woodland habitat and pasture with scattered trees. It includes cleared and fragmented woodland areas that are disturbed by grazing and often weed invasion. Most areas of disturbed woodland have a canopy percentage cover of less than 20% and have a predominately exotic groundcover.
- This habitat type is widespread throughout the study area and occurs on various landform types, including on side slopes, gullies, flats, and occasional ridges. Large areas of the proposed COP (A) Substation transmission line fall into this habitat type also.
- Turbine Clusters 7a and 7b, 3, 6, 8 and 10 feature small areas of this habitat type that occur within the nominated turbine development envelope. It also occurs within the proposed electricity easement envelope in a few locations (in the saddle between 6 and 7a and north of Cluster 3)

Fauna habitat provision/observed fauna

- In general, this habitat type carries more mature trees, and therefore higher numbers of hollow-bearing trees than more continuous woodland remnants. Multiple hollows were observed on the northern end of Cluster 10 and 6, on the edges of woodland habitat on site 7a and b, as well as in road side remnants along Whitefields Road and along the proposed COP (A) Substation transmission line route. Mature trees in this habitat type also provide native floral, sap and nectar feed resources. Ringtail Possum, Brushtail Possum, Superb Parrot, Red-rumped Parrot, Rainbow Lorikeet, Eastern Rosella, Barn Owl, Boobook Owl, Laughing Kookaburra, Sulphur-crested Cockatoo and Galah are among the many fauna species observed on the site that are known to utilise hollows
- Some refuge habitat such as fallen debris and scattered rocky outcrops is available for use by ground-dwelling fauna in this habitat type. However ground habitat resources are generally not as extensive and diverse as those available in woodland habitats. Native groundcover and understorey feed resources have been suppressed by grazing and weed invasion in most examples of this habitat type.
- Thirty nine species of fauna were observed within this habitat type. Species included Brushtail Possum, Ringtail Possum, Striated Pardalote, Red Fox, Brown Thornbill, Yellow Thornbill, Crimson Rosella, Euro and Eastern Grey Kangaroo

3. Pasture with scattered trees

Description/location

- This habitat type is the dominant habitat type within the development envelope. It encompasses all non-treed areas and areas with only scattered paddock trees (Long-leaved Box, Red Stringybark, White Box and Yellow Box) and Kurrajong, often in poor health. Planted shelterbelts (non-indigenous native and introduced species) are present along some fence lines.
- Most pasture areas surveyed were heavily impacted by grazing.
- The proportion of native to exotic groundcover species is highly variable in treeless pasture areas on the site and appears to be negatively correlated to the intensity of grazing pressure. Individual sites that were surveyed were also highly variable over a small

area and this is likely to vary dependent on the time of year, grazing pressure and water availability. As a result of the uncertainty associated with mapping groundcover, no distinction has been made between areas of exotic and native groundcover in the habitat and vegetation mapping.

- As a general rule, native pasture tends to be located in gullies and plains and more sheltered aspects (as in the gully between 6 and 7a, on the northern end of Cluster 3 and large parts of proposed COP (A) Substation transmission line route).
- Although groundcover composition was variable, all survey points on cleared ridges featured an exotic forb component and many were dominated by exotic grasses and forbs (Clusters 1, 2, 4, 5, 6, 7a, and parts of Cluster 10).

Fauna habitat provision/observed fauna

- Fauna habitat provision in pasture areas includes native and exotic grass, rocky outcrops on ridges and side slopes (discussed below) and forb groundcover feed resources, some ground refuge opportunities and scattered mature paddock trees.
- Areas with native groundcover vegetation are likely to provide higher quality foraging resources for native fauna than areas dominated by exotic pasture grasses or exotic forbs. Native grass species provide food and habitat resources to native fauna, including the threatened Diamond Firetail. Exotic species (particularly pasture grasses and weeds such as thistles) tend to dominate native grasses and forbs and reduce the diversity of feed resources available to native fauna species.
- Some ground refuge features are available in this habitat type. Features such as fallen logs, stumps and rock outcrops provide shelter opportunities for fauna (particularly reptiles), as well as perch-and-pounce opportunities for birds such as the threatened Hooded Robin.
- Anthropogenic constructions and materials (farm sheds, refuse and building materials such as tin, tyres and corrugated iron) are also present within this habitat type providing unique habitat opportunities for fauna, particularly reptiles. Reptiles in particular utilise resources such as fence posts and sheets of corrugated iron for refuge. Eastern Bearded Dragon and *Delma inornata* were found around anthropogenic habitat on pasture flats within the study area. Welcome Swallows were observed nesting on the rafters of multiple sheds.
- Hollows are present in some of the scattered eucalypts that occur within examples of this habitat type. Large hollows were observed in many mature trees along Whitefields Road, in the gully south of valley below Cluster 7a along proposed transmission and transmission routes and also along Whitefields Road and Coppabella Road.
- Nineteen fauna species were observed in pasture habitat. Species were of a typical open country assemblage including Galah, Sulphur-crested Cockatoo, Welcome Swallow, Common Starling, Dusky Woodswallow, and Richard's Pipit. Smaller, insectivorous and nectivorous birds were observed within the windbreak vegetation and in the canopies of mature trees including Superb-blue Fairy Wren and Silvereye.

4. Modified wetland areas, dams and watercourses

Location and description

- Small dams and watercourses are present on the site. These areas are generally cleared of tree cover and heavily degraded by weeds, streambed erosion and sedimentation. Many watercourses featured exotic Willow along the banks or within the channel.
- Dam levels were moderately high, and small watercourses were running during survey following recent rains. Some dams were fringed with long grass and sedges, offering refuge for a range of species including frogs, snakes and skinks.
- Higher quality creeks and watercourses are those with clear, running water; fringing grass and sedges; aquatic vegetation; and small, slower running pools. Some areas along Bushrangers Creek, along the proposed COP (A) Substation transmission line route fit this description.

Habitat provision and species observed

- Waterbodies and watercourses at the subject site are small, degraded and mostly ephemeral, and are not likely to provide a sustained habitat for large numbers of waterbirds.
- Forty fauna species were observed in wetland habitats.
- Species observed along watercourses included Clamorous Reed Warbler, Rainbow Bee-eater, Willy Wagtail, *Common Starling, rosellas and parrots, Galah and four frog species (*Crinia signifera, Crinia parinsignifera, Limnodynastes dumerilii, Limnodynastes tasmaniensis*).
- Species observed in dams within the study area include frogs, Eastern Long-necked Turtle, Eurasian Coot, Hardhead, Grey Teal, Australian Wood-duck, Hoary-headed Grebe, Willy Wagtail, White-fronted Chat and Masked Lapwing.
- The September microbat surveys targeted wetland areas (dam and Jugiong Creek). Four species of microbat were identified, although no threatened species.

Jugiong Creek

- Jugiong Creek was surveyed at the Coppabella Road crossing point. This creek has substantial water flow, and features abundant aquatic vegetation, rocky bank, and mature trees. Groundcover is limited to exotic pasture grasses and weeds. Barn Owl, Silvereye, White-plumed Honeyeater and Red-bellied Black Snake were observed at Jugiong Creek.

Landform-based habitat types

1. Ridges and rocky outcrops

- Turbine Clusters are located on a north-west to south-east oriented ridgeline and surrounding hills. The ridge lines are predominantly pasture, with only scattered remnant trees or highly disturbed woodland. Most sites are heavily grazed.

Rocky outcrops

Description/location.

- Rocky outcrops are present within all nominated turbine envelopes. They predominately occur within cleared pasture habitats; although are also present below Cluster 7a and 7b, on 3 and within the development envelope on Cluster 10 in steep woodland and disturbed woodland habitat types (refer to
- Table 6-3 and
- Figure 6-1).
- With the exception of Cluster 10, all ridge-top rocky outcrops surveyed were heavily degraded by grazing and clearing resulting in overall loss of vegetative cover and suppression of native groundcover species. All survey points had an exotic forb component (such as nettle and thistle), and many were dominated by exotic grasses and forbs (Clusters 1, 2, 4, 5, 6, 7a, and parts of Cluster 10). Rocky outcrops among native pasture also occur on the site, for example on the saddle on Cluster 10; and on parts of Clusters 8 and 3. As with the pasture habitat type discussed above, no distinction has been made between areas of exotic and native groundcover in the fauna habitat mapping as the composition is highly spatially and temporally variable.

Table 6-3 Location, extent, vegetation type and condition of rock outcrops at survey locations on the site

HABITAT	SURVEY POINTS ON TURBINE CLUSTERS	UNDERSTOREY	CONDITION	VEGETATION TYPE	EXTENT OF ROCKY OUTCROPPING
Woodland	Cluster 3 saddle, 6 north end on south facing slope, Cluster 7 on west-facing slope and a patch on Cluster 8	Predominately native grasses and mixed forbs	Moderate-good	Dry grass forest and box-gum woodland	Patchy
Disturbed woodland	Cluster 3 south, Cluster 7 on edges of woodland, parts of Cluster 10 (within development envelope)	Mixed grass and forbs	Poor-moderate	Dry grass forest and box-gum woodland	Abundant to patchy
Native and mixed pasture	Cluster 6 slope, Cluster 8 ridge, Cluster 9 ridge, parts of Cluster 7a and 7b ridge and upper slope, parts of Cluster 3 south	Predominately native grasses and mixed forbs/mixed grasses and forbs	Poor and poor-moderate	Derived box-gum woodland and pasture	Abundant
Exotic pasture	Cluster 1, 2, 4, 5, 6, parts of Cluster 7a and 7b ridge and upper slope; Cluster 3a upper slope; parts of Cluster 10	Exotic	Poor	Pasture	Abundant

Habitat provision and survey results

- Abundant volcanic rock outcrops with crevices, smaller loose or partially embedded rocks and scattered fallen logs and stags are present on all ridge tops within the development envelope and these provide potential shelter and basking habitat required by reptiles. The quality of these habitats for reptile use is greatly impacted by intensive grazing, clearing and the predominance of exotic groundcover species (Dorrough and Ash 1999; Fischer *et al.* 2004).
- Reptile habitat assessments and reptile searches targeted this habitat type (discussed below in Section 6.2.2). Three reptile species were observed within this habitat type.
- All of the ridge tops surveyed were heavily grazed, had little remaining top soil, were very dry (even under rocks) and most had extensive patches of exotic forbs (thistles and nettles). The soil was also considerably dry at all ridge sites despite receiving recent rains. These factors may account for the low species richness of the reptile species recorded in this habitat type.

Ridges

- Raptors utilise ridge systems for navigation and for gliding on thermal air currents or upward deflections of winds. Ridges and standing timber can also be suitable perching points for raptors for spying prey in the valleys below. Lambs were observed to venture up to the ridges during lambing time providing abundant prey for raptors. Raptors observed on or above ridges or side slopes include Wedge-tailed Eagle, Nankeen Kestrel, Australian Hobby and Collared Sparrow-hawk.
- Ground debris such as fallen and standing dead timber is present on some ridges, including Cluster 7a and Cluster 10. Debris on cleared ridges creates structural diversity, providing perching points and refuge sites for fauna.
- The treeless ridges are unlikely to provide high quality habitat given that they are highly disturbed by grazing, clearing and weed invasion and carry little foraging resources or refuge for use by fauna to protect from prevailing winds, sun or predation.
- No threatened species were observed on ridges. Species observed include raptors and common open country species such as Richard's Pipit, Australian Magpie and Galah. Smaller insectivorous birds such as the Buff-rumped Thornbill and Striated Pardalote were observed within the canopy of scattered eucalypts.

Other rare or limiting habitat features

Box-Gum Woodland

Woodland habitats have been extensively cleared and modified for agriculture throughout the region. Box-Gum Woodland, and the similar community Dry Grass Forest, occur in a number of locations, in a variety of condition states over the site. Approximately 890 hectares of Box Gum Woodland vegetation occurs within the development envelope. Woodland provides important feed and habitat resources for specialists such as the threatened Koala and the Regent Honeyeater.

Hollow-bearing and mature trees

Mature trees with hollows provide an 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 a limiting habitat resource for dependent species in this landscape

Mature trees are generally rare across the study area and tend to occur only in disturbed woodland remnants, such as along Whitefields Road and on the edges of the woodland below Cluster 7, or as scattered paddock trees. Most trees in larger forest patches are regrowth that are yet to reach hollow-forming age. Only a small number of hollow-bearing trees occur within the proposed development envelope on Cluster 10, Cluster 3 north, on the edges of woodland below Cluster 7a, in paddock trees in low lying areas within transmission envelopes between Clusters 5 and 7a, and also adjacent to Whitefields Road. Hollow-bearing trees are also present on Cluster 6, however in a very small and isolated ridge top patch that is highly disturbed by grazing and weed invasion (European Nettle). Many less mature trees on ridges within the development envelope appear to be in poor health and may develop cavities as they become more senescent.

An exception however is the proposed COP (A) Substation transmission line route, where hollow-bearing trees are abundant along the plains, gullies and lower slopes. Although these hollow-bearing trees occur in disturbed habitats, they are likely to be of high importance for more mobile hollow-dependent species (such as microbats) given the paucity of this resource within the locality.

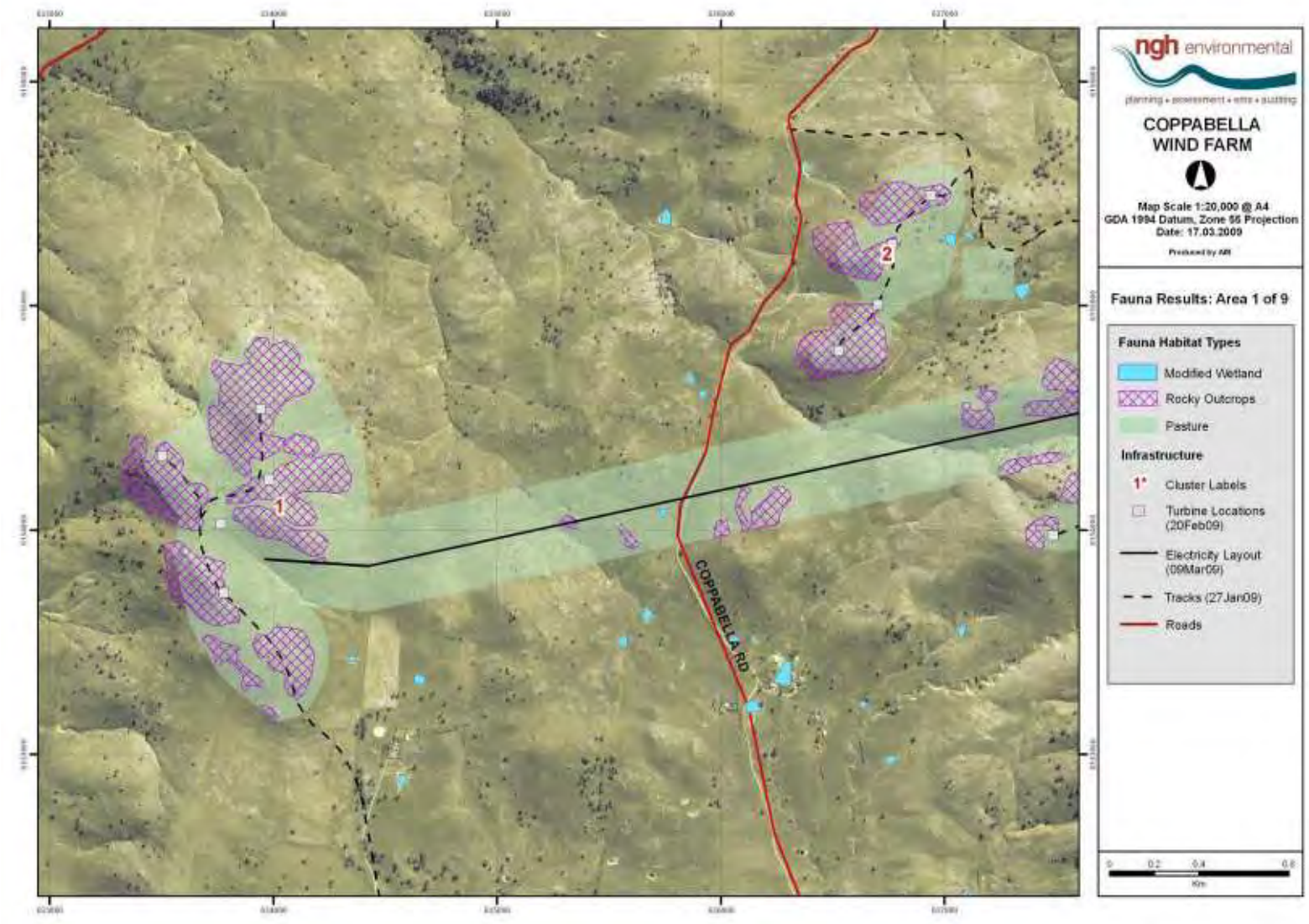
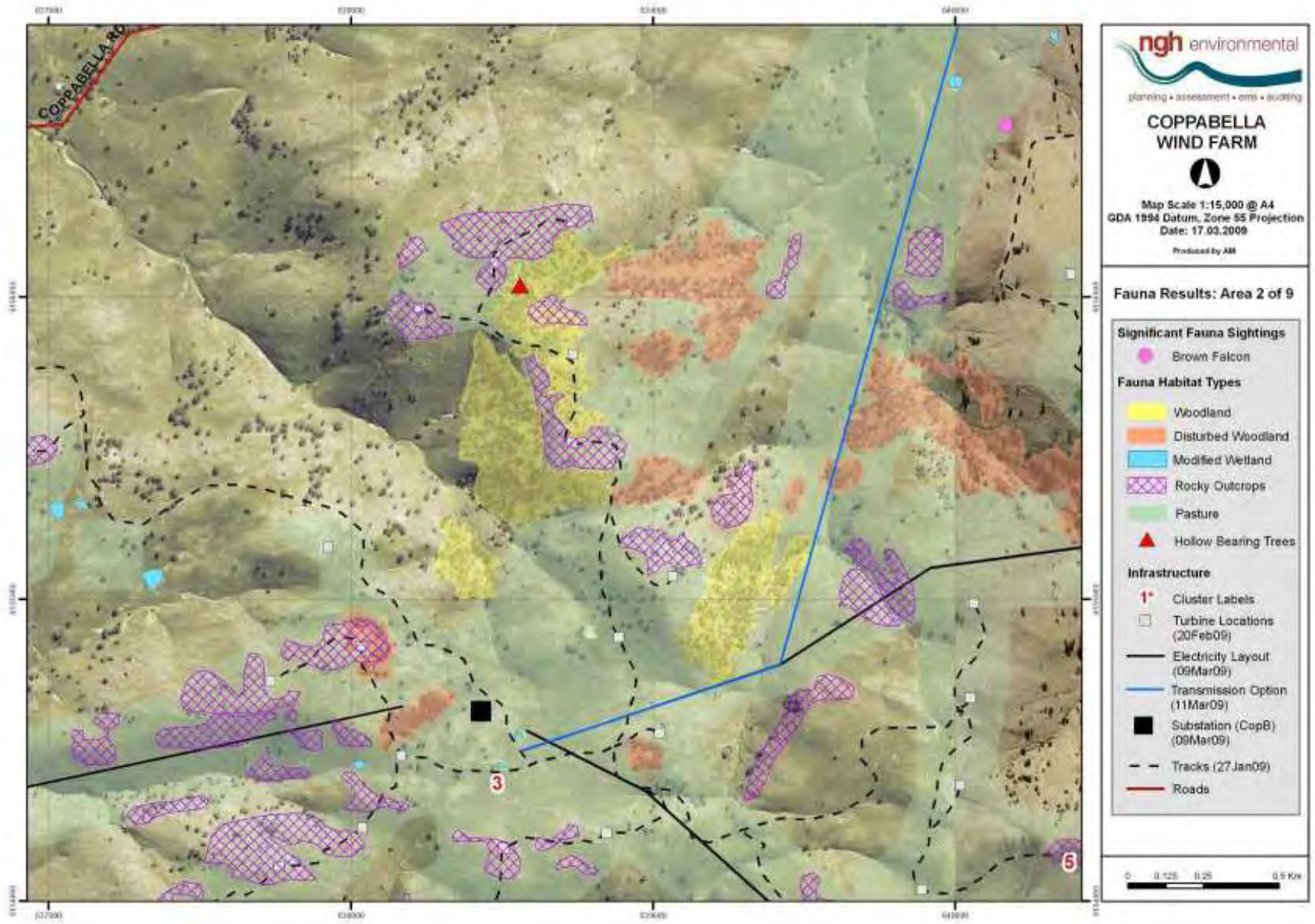


Figure 6-1 Fauna results, map set (9 maps in total)


COPPABELLA RD
ngh environmental
planning • assessment • ems • auditing
COPPABELLA
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 2 of 9
Significant Fauna Sightings
Brown Falcon
Fauna Habitat Types
Woodland
Disturbed Woodland
Modified Wetland
Rocky Outcrops
Pasture
Hollow Bearing Trees
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Substation (CopB) (09Mar09)
Tracks (27Jan09)
Roads
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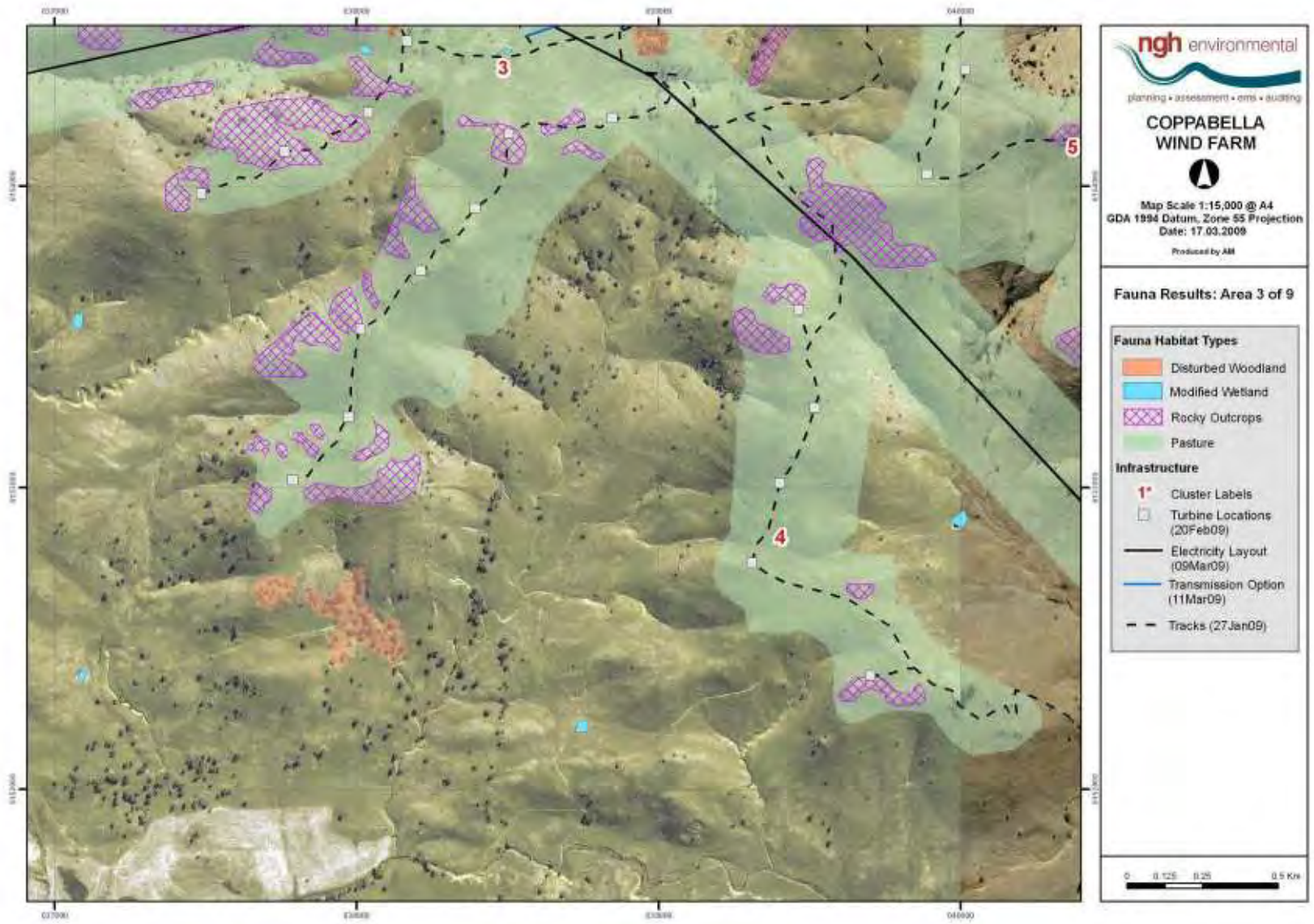
3
5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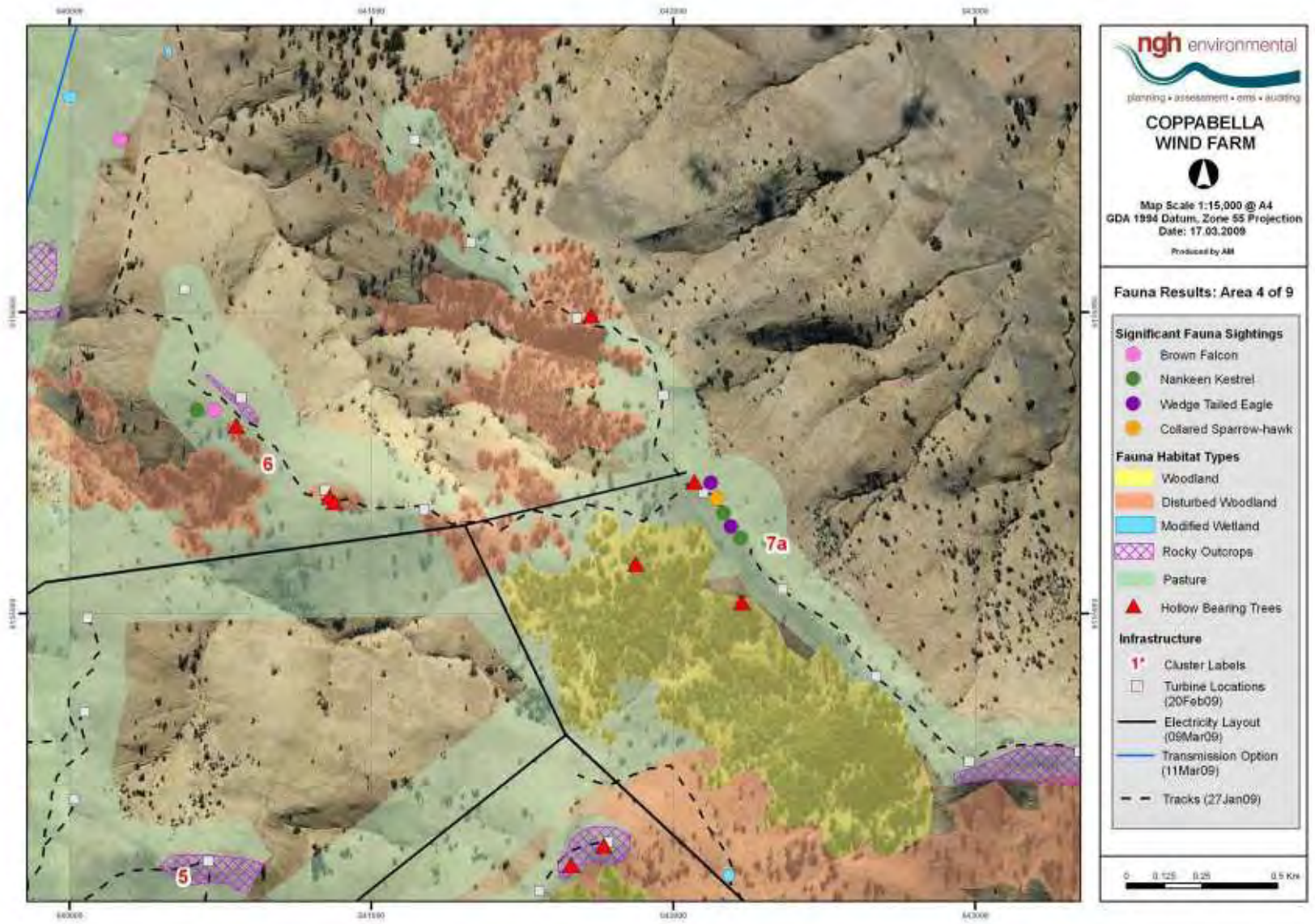
COPPABELLA
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 3 of 9
Fauna Habitat Types
Disturbed Woodland
Modified Wetland
Rocky Outcrops
Pasture
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
0 0.125 0.25 0.5 Km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COPPABELLA
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 4 of 9
Significant Fauna Sightings
Brown Falcon
Nankeen Kestrel
Wedge Tailed Eagle
Collared Sparrow-hawk
Fauna Habitat Types
Woodland
Disturbed Woodland
Modified Wetland
Rocky Outcrops
Pasture
Hollow Bearing Trees
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
0 0.125 0.25 0.5 Km
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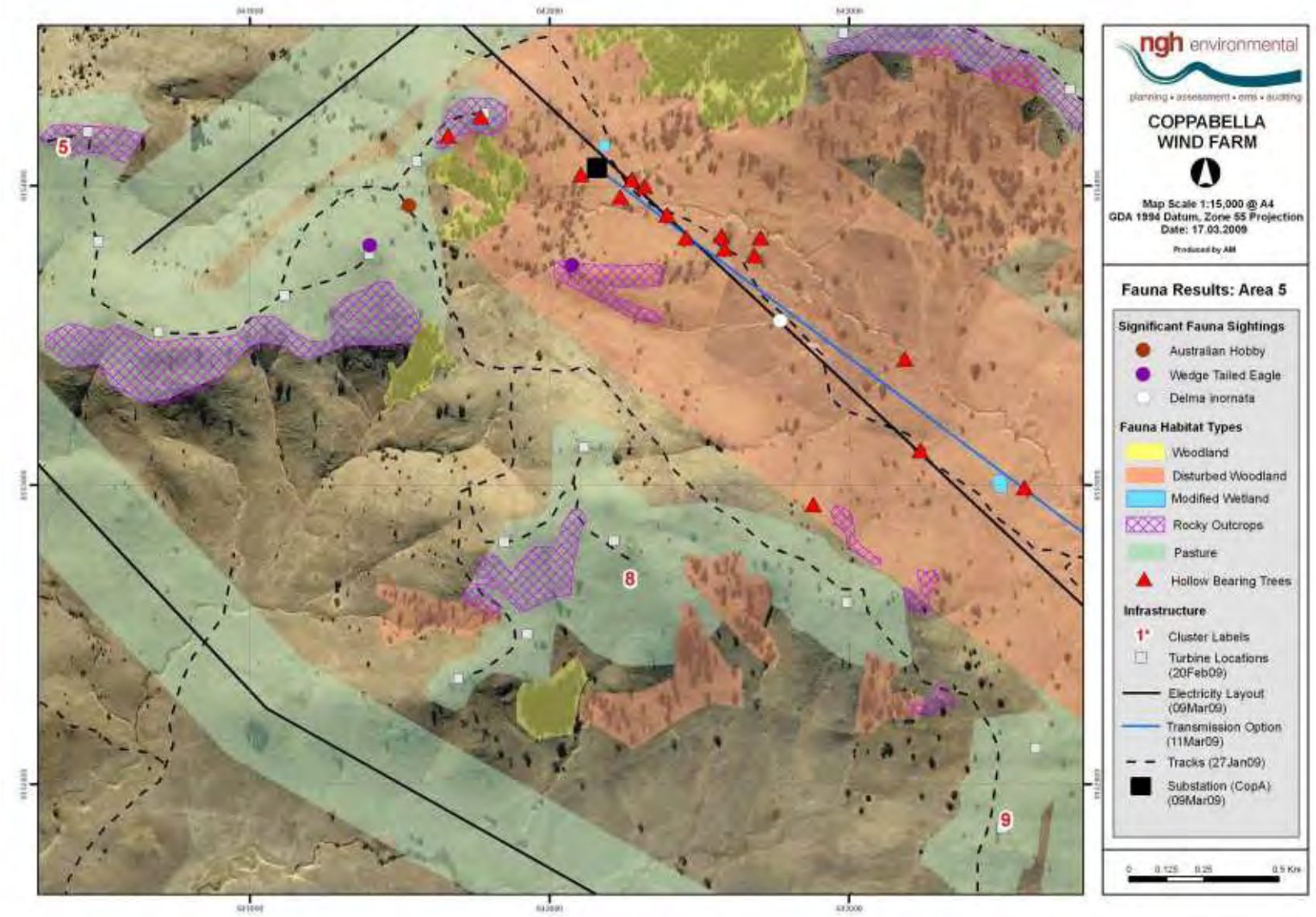
7a
5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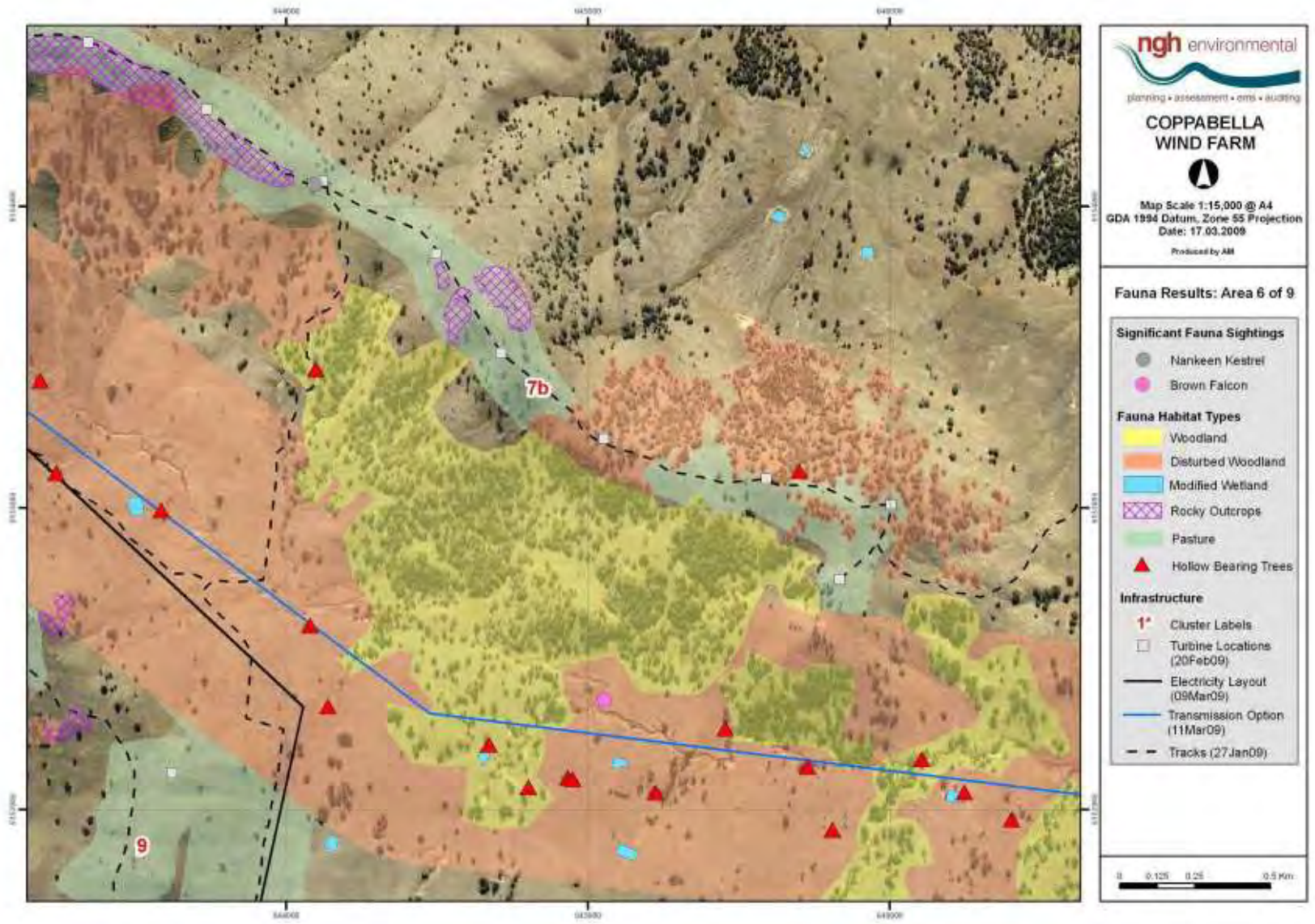
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 5
Significant Fauna Sightings
Australian Hobby
Wedge Tailed Eagle
Delma inornata
Fauna Habitat Types
Woodland
Disturbed Woodland
Modified Wetland
Rocky Outcrops
Pasture
Hollow Bearing Trees
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
Substation (CopA) (09Mar09)
0 0.125 0.25 0.5 Km
5
8
9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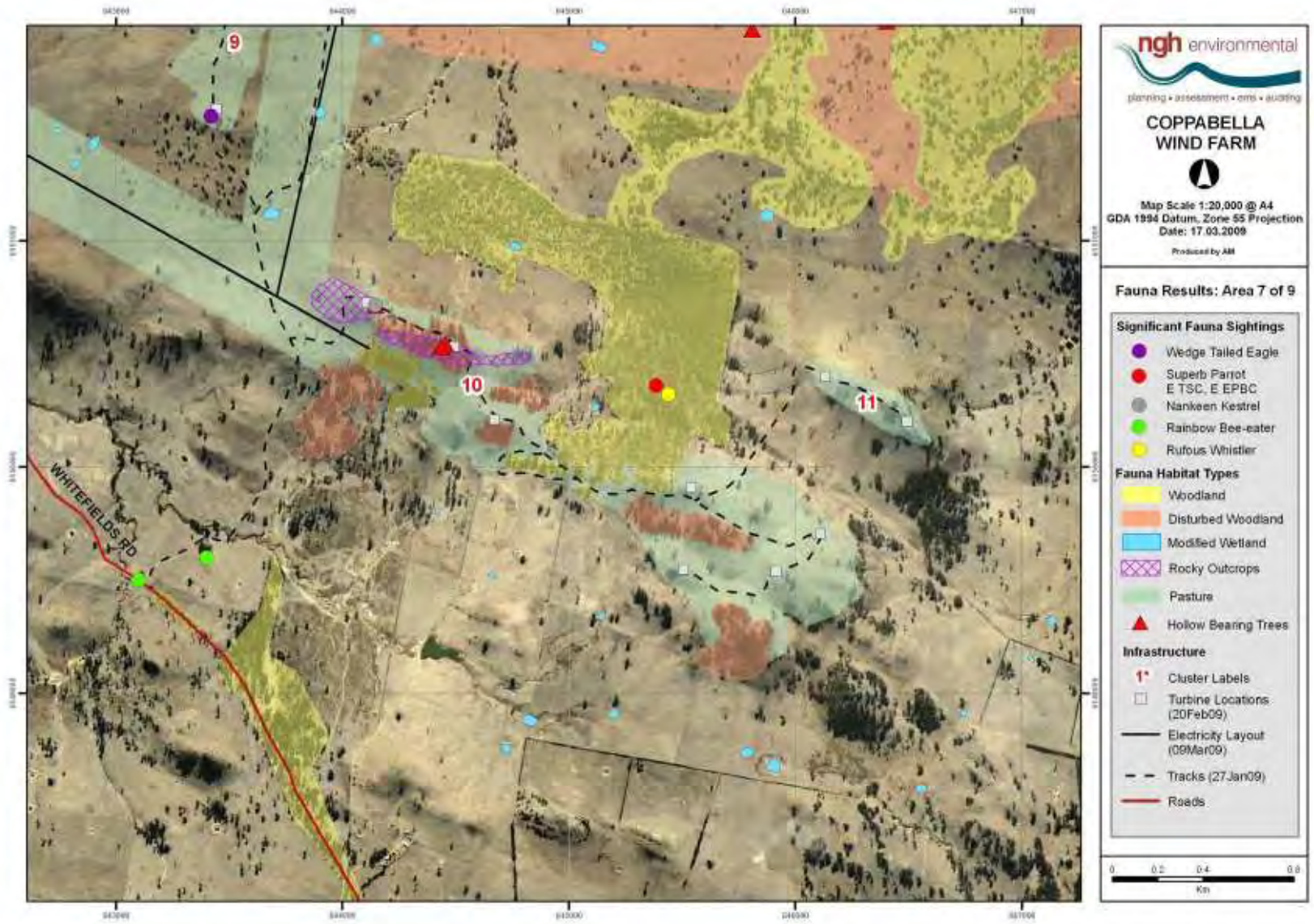
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 6 of 9
Significant Fauna Sightings
Nankeen Kestrel
Brown Falcon
Fauna Habitat Types
Woodland
Disturbed Woodland
Modified Wetland
Rocky Outcrops
Pasture
Hollow Bearing Trees
Infrastructure
1* Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
0 0.125 0.25 0.5 Km
7b
9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WHITEFIELDS RD
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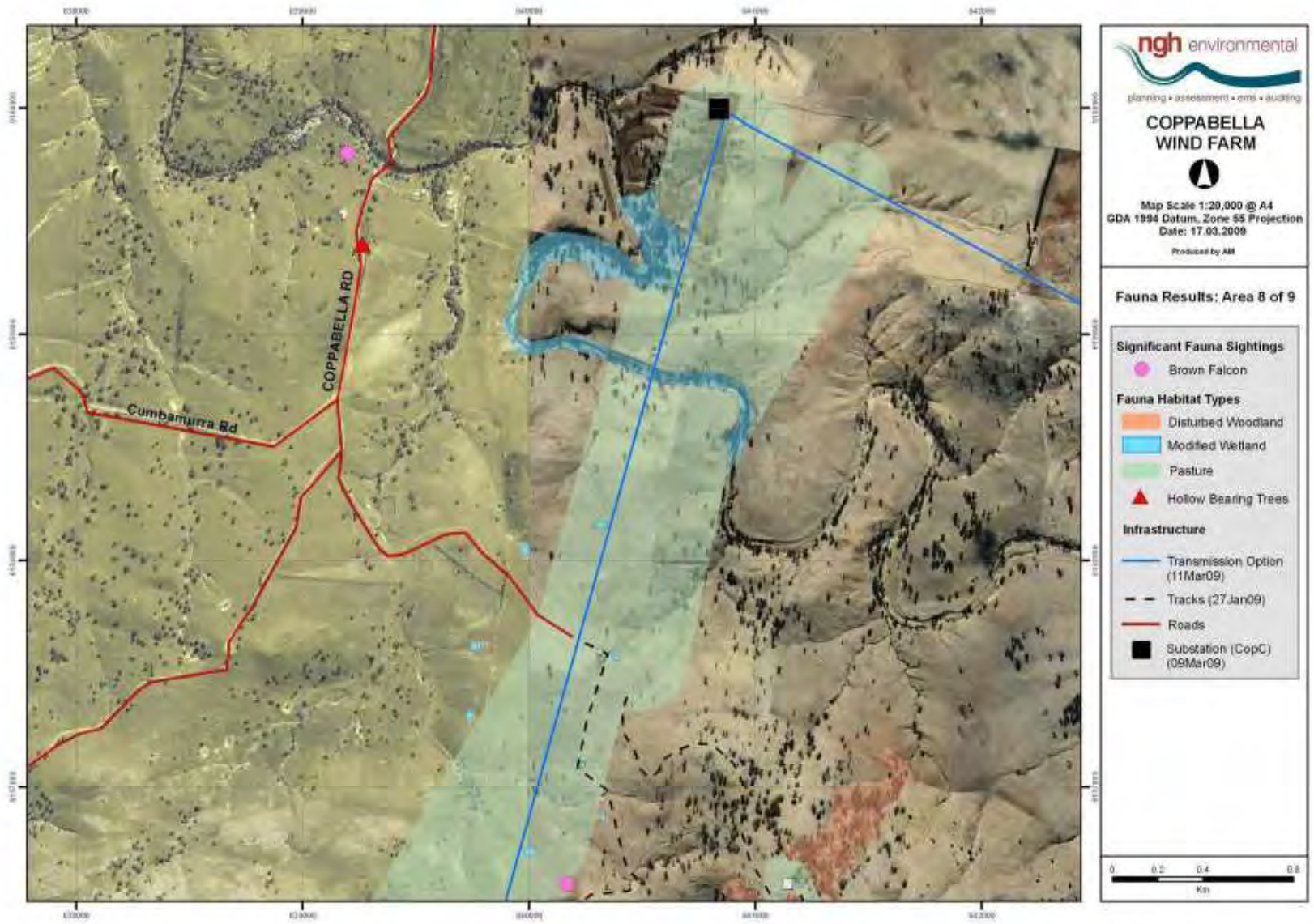
COPPABELLA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 7 of 9
Significant Fauna Sightings
Wedge Tailed Eagle
Superb Parrot
E TSC, E EPBC
Nankeen Kestrel
Rainbow Bee-eater
Rufous Whistler
Fauna Habitat Types
Woodland
Disturbed Woodland
Modified Wetland
Rocky Outcrops
Pasture
Hollow Bearing Trees
Infrastructure
1* Cluster Labels
Turbine Locations
(20Feb09)
Electricity Layout
(09Mar09)
Tracks (27Jan09)
Roads
0 0.2 0.4 0.8
Km


COPPABELLA RD
Cumbamurra Rd
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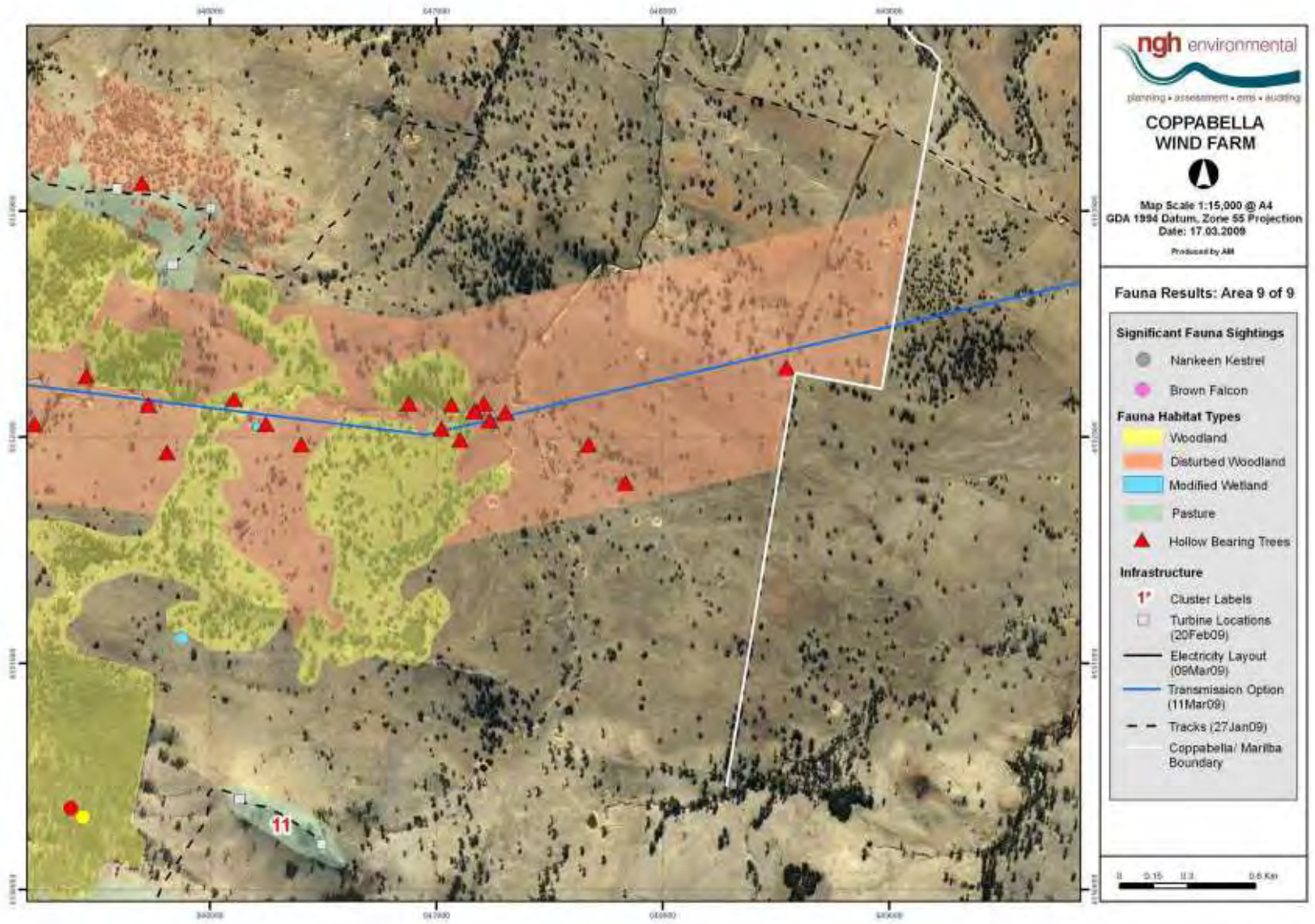
planning • assessment • ems • auditing
COPPABELLA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 8 of 9
Significant Fauna Sightings
Brown Falcon
Fauna Habitat Types
Disturbed Woodland
Modified Wetland
Pasture
Hollow Bearing Trees
Infrastructure
Transmission Option (11Mar09)
Tracks (27Jan09)
Roads
Substation (CopC) (09Mar09)
0 0.2 0.4 0.8
Km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COPPABELLA
WIND FARM
Map Scale 1:15,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 9 of 9
Significant Fauna Sightings
Nankeen Kestrel
Brown Falcon
Fauna Habitat Types
Woodland
Disturbed Woodland
Modified Wetland
Pasture
Hollow Bearing Trees
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (27Jan09)
Coppabella/ Marilba Boundary
11

Table 6-4 Summary of habitat types and condition in study area

DESCRIPTION	APPROX. EXTENT WITHIN THE DE (HA)	LOCATION WITHIN THE DE	VEGETATION TYPES	CONDITION AND DISTURBANCE	FAUNA HABITAT RESOURCES	THREATENED OR SIGNIFICANT SPECIES RECORDED IN THIS HABITAT TYPE
Woodland						
Remnant and regrowth Box-Gum Woodland and dry grass forest patches with a relatively continuous overstorey cover	241.37	**Clusters**: 3 and 10, and small areas on 7 **Transmission**: between 6 and 7a, and on the eastern slope of 3 **Transmission line**: in the western portion and along watercourses	Box-Gum Woodland and dry grass forest	Low grazing pressure and clearing and predominately native groundcover.	Box-Gum Woodland with native grass groundcover and occasional shrubs. High structural diversity with abundant fauna refuge sites	Superb Parrot, Red-capped Robin, Varied Sitella
Disturbed Woodland						
Cleared and fragmented woodland areas that are disturbed by grazing and often weed invasion	780.75	**Clusters:** small areas on 7a and 7b, 3, 6, 8 and 10 **Transmission:** between 6 and 7a and north of 3 **Access:** adjacent to Whitefields Road **Transmission line**: Spread all over the proposed route between areas of woodland and pasture	Box-Gum Woodland and dry grass forest	Cleared, grazed and fragmented woodland with variable groundcover composition	Mature and hollow-bearing trees on road-side remnants and edges of woodland, moderate structural diversity with some refuge sites	Superb Parrot, Dusky Woodswallow
Pasture						
Mixed native and exotic pasture with only scattered mature eucalypts	1,834.7	All Clusters, transmission envelopes and access routes	Derived Box-Gum Woodland and pasture	Extensively cleared grazed and modified pasture areas. Most Clusters are dominated by exotic species	Variable native and exotic grass and forb groundcover feed resources, some ground refuge opportunities and scattered mature paddock trees.	*Delma inornata*, Raptors seen from ridge sites and flying over cleared valleys

DESCRIPTION	APPROX. EXTENT WITHIN THE DE (HA)	LOCATION WITHIN THE DE	VEGETATION TYPES	CONDITION AND DISTURBANCE	FAUNA HABITAT RESOURCES	THREATENED OR SIGNIFICANT SPECIES RECORDED IN THIS HABITAT TYPE
Modified wetland habitat						
Small dams and watercourses	11.27 (only Jugiong Creek)	Existing and proposed access roads pass over small ephemeral creeks; Proposed power and transmission line easements intercept Jugiong Creek, transmission line follows Bushrangers Creek and a number of smaller tributaries	Riparian forest	Generally cleared of tree cover and heavily degraded by weeds, streambed erosion and sedimentation	Watering sources, small areas of aquatic and riparian vegetation	Waterbirds: ducks, teals, plovers Microbats: *Nyctophilus, Mormopterus*
Ridges and rocky outcrops						
Exposed ridges on steep side slopes featuring extensive volcanic rock outcrops. Features predominately pasture with occasional areas of disturbed woodland and woodland.	197.56	All ridge tops and side slopes within the development envelope	Exotic and native pasture with scattered trees/Box-Gum Woodland	Generally in low condition from extensive sheep grazing, weed invasion and clearing. Features only scattered trees with no shrub or small tree layer. Areas are very dry with little or no top soil	Refuge and basking opportunities for reptiles. Navigation and thermal currents for raptor flight. Prey for raptors during lambing	Raptors: Wedge-tailed Eagle, Nankeen Kestrel, Australian Hobby and CollaredSparrow-hawk

6.2.2 Species recorded at the site

In total, 94 exotic and native vertebrate species were recorded during the surveys. This comprised of 65 bird, 17 mammal, 8 reptile and 4 frog species. The highest fauna species richness was recorded from woodland habitats (45 species), followed by wetland habitats (40 species), disturbed woodland (39 species) and lastly, ridges (19 species) (Table 6-5). Most species were recorded a multiple habitat types.

Table 6-5 Species richness recorded across all habitat types (note most species occurred in multiple habitat types; both exotic and native species counted)

HABITAT TYPE	BIRDS	MAMMALS	REPTILES	AMPHIBIANS	TOTAL
Woodland	34	8	3	0	**45**
Disturbed woodland	32	6	0	0	**38**
Pasture	19	6	4	0	**29**
Wetland habitats	24	2	2	4	**38**
Ridges and rocky outcrops	15	2	3	0	**20**

Birds

The five general habitat types carried differing bird species including (but not limited to):

- Woodland: fantails, pardalotes, choughs, honeyeaters, gerygones, robins, thornbills, thrushes and treecreepers
- Disturbed woodland and on woodland edges: thornbills, parrots and rosellas, wattlebirds, currawongs, woodswallows and magpies
- Pasture with scattered trees on flats: open country species including pipits, parrots, galahs, cockatoos, swallows and tree martins
- Ridge top pasture areas with scattered trees: raptors and open country species
- Wetland habitats (dams and creeks): honeyeaters, cuckoos, and waterbirds including ducks, grebes, teals, plovers and Clamorous Reed Warbler

High avian species richness was recorded in woodland habitats (34 species), and particularly in the woodland remnant north of Cluster 10 (beyond the development envelope). Two threatened species were recorded in the study area: Superb Parrot (listed as Vulnerable on the TSC Act) was recorded flying in a flock of ten over the woodland patch to the north of Cluster 10. This species was also observed in disturbed road-side woodland remnants along Illalong Road, to the east of the site. Diamond Firetail was recorded in a flock of six feeding within a disturbed section of Bushranger's Creek along the proposed COP (A) Substation transmission line. One migratory bird species: Rainbow Bee-eater was observed on the site (listed on the EPBC Act) using burrows along the wooded banks of Bushranger's Creek.

Many of the woodland bird species recorded are specialist species and were not recorded in other habitats. Woodland bird species that have been listed as decliners in the wheat-sheep belt region of

NSW were identified on the site including Varied Sittella, Red-Capped Robin and Jacky Winter (all within woodland habitat) and Dusky Woodswallow (pasture and disturbed woodland).

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 omnipresent in cleared pasture areas over the entire site.

Fourteen bird species recorded from pasture and rock outcrops on ridge tops, which included the raptors: Australian Hobby, Brown Falcon, Collared Sparrow-hawk, Nankeen Kestrel and Wedge-tailed Eagle.

Nocturnal birds recorded include the Boobook Owl, which was heard in the woodland below turbine Cluster 7a and a Barn Owl, observed along Jugiong Creek on Whitefields road, north of the site.

Seven wetland bird species were observed in vegetation along creeks (Clamorous Reed Warbler) and within farm dams (Eurasian Coot, Hardhead, Grey Teal, Australian Wood-duck, Hoary-headed Grebe and Masked Lapwing). These species may be impacted by the disturbance or infill of dams on the site, however are relatively common and would be able to relocate in the face of disturbance.

Mammals

The site is highly fragmented and impacted by grazing, clearing and weed invasion. These factors limit the site's capacity to provide habitat for mammalian species. The site generally features a reduced groundcover due to heavy grazing by sheep and many areas are dominated by exotic forbs and mixed grasses. Connectivity between woodland patches is limited to only scattered paddock trees and eroded riparian lines.

Tree Elliot trapping surveys targeted arboreal, hollow-dwelling mammals. These were placed on mature trees on the edges of the woodland on the upper slope of 7a. No arboreal mammals were captured. The limited number of hollows in this area and the lack of connectivity to other mature woodland patches likely limits the abundance and diversity of arboreal mammals that the site is able to support. Only one ringtail possum was observed in continuous woodland habitat on the lower slopes below 7a, where as spotlight surveys identified a high abundance of Ringtail Possums (seven) and Brushtail Possums (eleven) in remnant mature woodland in roadside vegetation where there are higher numbers of hollows and greater east-west connectivity. The high abundance recorded on the roadside may also reflect the vehicle survey method as surveys were able to cover much larger distances than a survey by foot.

The highest quality ground-dwelling mammal habitat on the site is located on the south-facing slopes below 7a and 7b and within the large woodland patch north of Cluster 10. These areas are the largest remnants on the site and are the least impacted by grazing and weed invasion. They feature an intact understorey, extensive areas of refuge (fallen debris and occasional rocky areas) and occasional small hollows. Ground Elliot and Cage trapping were undertaken within these areas and targeted small and medium-sized ground-dwelling mammals. An additional fifteen trap nights was undertaken on the ridge on Cluster 6 among disturbed remnant White Box woodland. Cluster 6 has a highly disturbed understorey (dominated by European Nettle*), although carries many mature trees with hollows.

No mammals were captured during the ground-trapping survey (only Australian Magpie and Shingleback Lizard were captured in the cage traps). The null result is considered to reflect the disturbed and fragmented nature of the landscape. Fragmentation and grazing are known to reduce

the capacity for the landscape to support small mammals (for example Bennett 1990; Lindenmayer *et al.* 2000), and is also likely to have consequences for larger fauna that prey on these species such as forest owls, foxes and potentially quolls, if locally present.

Multiple species of macropod were observed onsite (Eastern Grey Kangaroo, Euro, Red-necked Wallaby and Swamp Wallaby). Only Eastern Grey Kangaroo was observed in pasture habitats. Swamp Wallaby was observed only in gully woodland habitat on Cluster 3, where there was a continuous canopy cover, abundant ground refuge (fallen logs) and low grazing.

Exotic species observed included the sheep and cow (grazing stock), Red Fox, European Hare and European Rabbit. Foxes and rabbits were observed within all habitat types, and hares were observed only in pasture although are likely to occur in other habitats.

Macro and microchiropteran bats

Six species of microbats were recorded on the site (see Appendix B for Anabat results). These were identified foraging in woodland, over dams and around isolated paddock trees from two sites: in the valley between Clusters 6 and 7, and from Jugiong Creek.

Microbats require specific foraging and roosting habitats, with many foraging in the forest canopy and using large hollow-bearing trees or caves for roosting (Pennay & Freeman 2005). Many microbat species also utilise multiple roosts to avoid predation and parasite loads (Kunz & Lumsden 2003 cited in Rhodes 2006).

Hollow-bearing paddock trees have been found to provide critical roosting and nesting resources for microbats (Gibbons and Boak, 2002; Manning et al., 2006). The site provides scattered hollow-bearing trees in paddocks and around the edges of larger patches. Hollows were observed on the northern end of Cluster 10 and 6, on the edges of woodland habitat on site 7a and b, as well as in road side remnants along Whitefields Road and along the proposed COP (A) Substation transmission line route.

Reptiles

Eight species of reptile were observed during the survey period.

Abundant volcanic rock outcropping is present on ridges and side slopes within the development envelope (discussed above). The quality of these habitats for reptiles is related to the extent of exotic grass and forb cover and grazing pressure (see example

Figure 6-2). These factors have been negatively correlated to reptile diversity on rock outcrops ecosystems in Australia (Fischer *et al.* 2004; Michael *et al.* 2008). Rocky outcrops on ridge tops and side slopes, in particular were the most heavily disturbed areas on the site.

Reptile searches (rock rolling) targeted rock outcropping on different aspects, and in different vegetation types and conditions. Searches on rocky ridges and slopes within the proposed development envelope identified only three individuals: Eastern Brown Snake, Shingleback Lizard and Cunningham's Skink (all basking on rocks). No small reptiles were identified on rocky outcrops despite the extensive survey effort (approximately 1078 rocks/logs rolled, Figure 5-1). The low reptile species richness recorded is likely to be related to the disturbed condition of the ridge tops and upper slopes within the development envelope.

Rock rolling revealed that black ants occurred under 5-40% of the rocks rolled, however there were no clear differences in the percentage of ants between the Clusters (Table 6-6), or between the different slope aspects.

Reptile searches were also undertaken in woodland, and anthropogenic habitats such as under tin, fence posts, tyres and other refuge. Eastern Bearded Dragon and *Delma inornata* were found around anthropogenic habitat on pasture flats. Copper-tailed Skink was uncovered under a rock in woodland habitat on the slope below 7b.

Table 6-6 Reptile survey summary

TURBINE CLUSTER/ LOCATION	AV. % ROCKS W/ BLACK ANTS	AV. NO. ROCKS, LOGS OR REFUGE ROLLED	NUMBER OF SURVEYS	EFFORT (ROCKS ROLLED)	REPTILE SPECIES OBSERVED, HABITAT TYPE AND OBSERVATION TYPE
1	15	45	1	45	Nil
3	23	41	6	246	Nil
4	15	63.5	2	127	Cunningham's Skink (rock outcrop on slope; basking)
6	15	75	1	75	Nil
7	19	33.6	5	168	Coppertail Skink (woodland on slope; under rock); Shingleback Lizard (rock outcrop on ridge; basking);
8	15	105	2	210	Nil
9	20	62	1	62	Nil
10	25	35	2	70	Eastern Brown Snake (rock outcrop on ridge; basking); Shingleback Lizard (woodland; cage trap); Bearded Dragon (woodland on flat; opportunistic record)
Flat (around habitation)	15	15	5	75	Bearded Dragon and *Delma inornata* (pasture)
Aquatic habitat	-	-	-	-	Red-bellied Black Snake (creek), Eastern Long-necked Turtle (dam)
Total	-	-	25	1078	8 species

Figure 6-2 Examples of reptile habitat available at Coppabella Hills Precinct. Clockwise from top left, Clusters 3, 4, and 7.

Amphibians

Four amphibian species were recorded at the site: Eastern Sign-bearing Froglet (*Crinia parinsignifera),* Common Eastern Froglet (*Crinia signifera),* Southern Banjo Frog or Pobblebonk *(Limnodynastes dumerilii)* and Spotted Marsh Frog *(Limnodynastes tasmaniensis*) in creek and dam (wetland) habitats. All these habitats were located on flats, except for one small drainage line on the southern end of Cluster 3. All species are common with apparent tolerance to disturbance from grazing, sedimentation and erosion of aquatic habitats. Amphibian species were generally not recorded in highly eroded habitats, or areas lacking aquatic vegetation. It is likely that a greater diversity of frogs would have been recorded during warmer weather or immediately after rainfall.

6.3 PROFILE OF POTENTIAL BIRD AND BAT IMPACTS

6.3.1 Potential fauna movements

Local and regional fauna movements are not known, however potential paths may be discerned from an assessment of topography, regional habitat provision, site connectivity and historical species

records. Locally, the ridges on the site may concentrate hunting and foraging behaviour of fauna species in a north-west to south-easterly direction.

This section provides a profile of potential fauna movements within the locality which informs the risk assessments completed for threatened and non-threatened fauna potentially at risk of wind farm development. The risk assessments determine the level of risk of potential impacts arising from the construction and operation of the proposed wind farm (see Section 6.4).

Woodland Species

The Yass region has been extensively cleared and fragmented for agriculture. Larger woodland and forest remnants (100-200 hectares) are rare within the district and these are only intermittently linked by roadside and riparian corridors, smaller 'stepping-stone' woodland patches, planted wind-breaks and scattered paddock trees. Faunal movements between larger woodland remnants across the region would be largely limited to highly mobile birds and bats, as well as some ground-dwelling mammals that are less sensitive to disturbance and are able to use linear corridors and habitat stepping stones to move through the landscape.

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 (Reid 1999). Many woodland birds that occur in the region are unlikely to venture far from large remnants and many more species, such as the Superb Parrot and Regent Honeyeater, rarely cross extensive open areas (Fischer and Lindenmayer 2002; Garnett and Crowley 2000).

The principal flight paths for woodland bird species are likely to follow slopes and lowland areas carrying remnant woodland and water sources. The Coppabella precinct area features 2 large woodland remnants which occur outside the development envelope:

- the long south west facing slope below Cluster 7 (approximately 124 hectares), and
- the flat north of Cluster 10 (approximately 100 hectares)

These woodland patches are likely to contribute to north-west to south-east fauna movement across the district. Only sparse, disturbed woodland remnants occur on the ridges where turbine Clusters have been proposed.

Intermittent woodland occurs along Jugiong Creek and its smaller tributaries which create a linear corridor to the Murrumbidgee River, and eventually to Lake Burrinjuck (approximately 25km from the site) and forest woodland reserves to the south. Whitefields Road roughly east-west on the southern edge of the subject site also carries intermittent woodland tree cover which could provide a dispersal path for woodland species. Birds and bats moving at tree canopy height through this corridor are unlikely to be affected by the wind turbines located on adjacent ridges.

Open country species, high-fliers and raptors

Open country and generalist species and raptors are potentially at higher risk of collision than woodland specialists as these species may utilise cleared ridge-top habitats.

Twelve of the 14 bird species recorded on ridge-top sites were observed at heights above 40m. These species are considered to be at risk of colliding with moving turbines blades which operate at 36m of the ground. High-flying bird species included the raptors as well as Australian Magpie, Australian

Raven, Brown Thornbill, Common Starling*, Crimson Rosella, Galah and Sulphur-crested Cockatoo. Raptor species with low fecundity that occur at low density in the landscape are particularly at risk from population-scale impacts as a result of collision mortalities. Such species include the Barking Owl, Square-tailed Kite, Brown Falcon, Nankeen Kestrel and Wedge-tailed Eagle. Night active birds, both hunting and migrating such as the Silvereye or owls are also considered to be at increased risk.

Other species observed flying above 40m in different habitat types (such as in woodland or on pasture flats) include Superb Parrot, Eastern Rosella, Crimson Rosella, Red-rumped Parrot, Silvereye, Australian Wood Duck, Laughing Kookaburra, Welcome Swallow, Dusky Woodswallow and Tree Martin. Many of these species are known to fly in flocks of greater than four and are therefore at risk of multiple collisions with turbine blades. Multiple collisions may result in impacts on a local population of the species.

Wetland birds

No wetlands occur within the study area. The closest large waterbodies include Lake Burrinjuck (25km to the south, Lake Bethungra (50km to the west) and Lake George (80km south-east). Local waterbodies include dams and creeks are small and largely ephemeral, and degraded by clearing, siltation and weeds. Given the absence of habitat, no large concentrations of migratory wetland species are expected to forage or breed in the local area.

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. 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. However given that large wetland habitats do not occur locally, bird movements across the site are likely to be diffuse and irregular, rather than concentrated and seasonal. Long-distance migratory birds are likely to have attained a travelling altitude greater than the turbine height.

Some water bird species, including Ibis, Herons, Egrets and ducks, are known to utilise smaller ephemeral farmland waterbodies such as dams, creeks and inundated pastures which occur on the site. However, water birds are likely utilise lowland habitats and river systems rather than ridges to move between water bodies, thereby reducing the risk of collision with turbines.

Microchiropteran bats

There have been few studies of wind farm impacts on microbat species. Comparing available data with that on bird mortality, bat mortality events appear to be greater in number. Migratory bats comprise the majority of bat mortalities in all wind farm studies to date (Barclay *et al.* 2007; Erickson *et al.* 2002, Arnett 2005). A review of 30 North America wind farm monitoring studies found a mean of 6 bat mortalities per turbine per year where turbines are greater than 65m high (10 sites) (Barclay *et al.* 2007). The review also showed that mortality rates are highly variable between sites (range 0-13.6 fatalities/turbine) (Barclay *et al.* 2007). This is supported by other studies which report mixed results (Erickson *et al.* 2002, Arnett 2005; Kunz et al 2007).

The entire study area is likely to provide foraging resources for insectivorous bats as there are few other areas locally with vegetated upper slopes and ridges, where insects are likely to rise to with thermals. Of most concern at this site is Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*), listed as a vulnerable species in the *TSC Act* and recorded during surveys (See Section 6.4 below).

6.4 THREATENED AND SIGNIFICANT FAUNA SPECIES

6.4.1 Threatened and Migratory Species

Two threatened fauna species: Superb Parrot, Diamond Firetail and one migratory species: Rainbow Bee-eater was identified on the site. Superb Parrot and Diamond Firetail are listed as Vulnerable on the TSC Act and the Commonwealth EPBC Act. Rainbow Bee-eater is listed as migratory on the EPBC Act.

Preliminary threatened species evaluation

A number of threatened and migratory fauna 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 D. A preliminary assessment was conducted as part of the evaluation to identify threatened and migratory species potentially at risk from impacts arising as a result of the wind farm development. Species with the potential to be present and determined to be at risk were then subject to Assessments of Significance pursuant to the TSC and EPBC Acts.

The assessment takes into account eight factors and assumes no mitigation measures are adopted. Potential impacts assessed include habitat removal and degradation, barotrauma and collision impacts. The following factors were considered:

1. The species is known to occur within the region
2. The species could breed onsite
3. Breeding habitat has the potential to be impacted
4. The species could forage onsite
5. Foraging habitat has the potential to be impacted
6. The species may fly at the height of the turbine blades (40m) and may therefore be at risk of collision or barotrauma
7. The species is a flocking or colonial species (individuals cluster in groups)
8. The species is migratory or nomadic

All factors were weighted equally, except for presence of local records (weighted 2 units) as this was considered to be important to filter out species for which their known distribution range does not include the study area. Species with preliminary impact factors greater than four were considered to have the potential to be impacted by the proposed development.

Based on the evaluation, 27 species were considered to have potential to be impacted by the proposed activity. Three additional species (White-bellied Sea-eagle, Little Whip Snake and Eastern False Pipistrelle) were included as a precautionary measure. The full preliminary evaluation is provided in Appendix D.

Assessments of Significance and risk assessment

To properly characterise the impact of the proposal on threatened and migratory fauna that have been evaluated as being potentially at risk from the proposal, an EPBC Act 'Assessment of Significance'

was conducted for migratory and threatened fauna listed on the EPBC Act and a TSC Act 'Assessment of Significance' was conducted on species listed under this act pursuant to the *NSW Environmental Planning and Assessment Act* and the Commonwealth *Environmental Protection and Biodiversity Conservation Act*. These assessments are provided in Appendix E.

A qualitative risk assessment was completed in conjunction with the Assessments of Significance to determine the 'assessed risk' of the relevant threatened and migratory fauna species. 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). The risk assessment takes into consideration the likelihood and consequence of habitat removal and collision or barotrauma impacts on a local population of the species. Likelihood incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and collision in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status.

The level of 'assessed risk' denotes the recommended degree of mitigation or further action required in order to ensure that the proposed wind farm development does not result in a significant impact on the species. The risk levels indicate:

- **Very low and low risk:** no further action required
- **Moderate risk:** mitigation measures should be applied
- **High risk:** further survey work required or avoidance of habitat

The potential impacts, preliminary impact factor, assessed risk and recommended mitigation measures for each threatened fauna species considered by the Assessments of Significance is summarised in Table 6-7 and discussed in Section 6.4.3.

Table 6-7 Summary of potential impacts, preliminary impact factor and assessed risk for threatened species with the potential to be impacted by the proposal

HABITAT AND DESCRIPTION ONSITE	POTENTIAL IMPACT	COMMON NAME AND CONSERVATION STATUS	PIF*	ASSESSED RISK (from Assessments of Significance Appendix E)		
				HABITAT REMOVAL	COLLISION/ BAROTRAUMA	MITIGATIONS (if risk greater than moderate)
COLLISION RISK WETLAND SPECIES						
Dams and adjacent pasture	Habitat removal and collision risk	Cattle Egret *Ardea ibis/ Bubulcus ibis* M EPBC CAMBA, JAMBA Marine overfly area	7	Very low	Low	-
AIRSPACE ONLY (no habitat available onsite)	Collision risk only	White-throated Needletail *Hirundapus caudacutus* M EPBC CAMBA JAMBA Marine overfly	6	Low	Low	-
		White-bellied Sea-Eagle *Haliaeetus leucogaster* M EPBC CAMBA Listed	4	Very low	Low	-
		Rainbow Bee-eater *Merops ornatus* M EPBC Marine overfly area	7	Low	Moderate	Target species for monitoring
		Blue-billed Duck *Oxyura australis* V TSC	5	Very low	Low	-
WOODLAND SPECIES						
Woodland	Habitat removal and collision impacts	Square-tailed Kite *Lophoictinia isura* V TSC	8	Low	Moderate	Target species for monitoring
		Painted Honeyeater *Grantiella picta* V TSC	6	Very low	Low	-
		Regent Honeyeater *Xanthomyza Phrygia* E TSC E EPBC M EPBC	7	Low	Low	-
		Brown Treecreeper (eastern subspecies) *Climacteris picumnus Victoriae* V TSC	5	Low	Very low	-

HABITAT AND DESCRIPTION ONSITE	POTENTIAL IMPACT	COMMON NAME AND CONSERVATION STATUS	PIF*	ASSESSED RISK (from Assessments of Significance Appendix E)		
				HABITAT REMOVAL	COLLISION/ BAROTRAUMA	MITIGATIONS (if risk greater than moderate)
Woodland and hollow-bearing trees	Habitat removal and collision impacts	Gang-gang Cockatoo *Callocephalon fimbriatum* V TSC	7	Low	Moderate	Target species for monitoring
		Swift Parrot *Lathamus discolour* E TSC E EPBC Marine overfly (may)	7	Low	Moderate	Target species for monitoring
		Turquoise Parrot *Neophema pulchella* V TSC	6	Low	Low	-
		Superb Parrot *Polytelis swainsonii* V TSC V EPBC	8	**High**	Moderate	**Avoid mature woodland and hollow-bearing trees** **Target species for monitoring**
		Barking Owl *Ninox connivens* V TSC	7	Low	Moderate	**Target species for monitoring**
Woodland and hollow-bearing trees	Habitat removal	Squirrel Glider *Petaurus norfolcensis* V TSC	6	Low	-	-
Woodland and adjacent grassy areas	Habitat removal	Diamond Firetail *Stagonopleura guttata* V TSC	7	Low	Low	-
		Hooded Robin (South eastern form)*Melanodryas cucullata cucullata* V TSC	6	Low	Very low	-
		Speckled Warbler *Pyrrholaemus saggitatus* V TSC	6	Low	Very low	-

HABITAT AND DESCRIPTION ONSITE	POTENTIAL IMPACT	COMMON NAME AND CONSERVATION STATUS	PIF*	ASSESSED RISK (from Assessments of Significance Appendix E)		
				HABITAT REMOVAL	COLLISION/ BAROTRAUMA	MITIGATIONS (if risk greater than moderate)
Woodland and paddock trees	Habitat removal	Koala *Phascolarctos cinereus* V TSC	6	Low	-	-
MICROBATS						
DAMS	Habitat removal, barotrauma and collision risks	Large-footed Myotis *Myotis adversus* V TSC	6	Low	Low	-
WOODLAND	Habitat removal, barotrauma and collision risks	Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis* V TSC	8	Low	**High**	**Further assessment in January** **Target species for monitoring**
		Little Pied Bat *Chalinolobus picatus* V TSC	8	Low	Low	-
		Eastern False Pipistrelle *Falsistrellus tasmaniensis* V TSC	4	Low	Mod	-
		Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* V TSC	6	Low	Low	-
ROCK OUTCROPS						
Rocky outcrops:	Habitat removal	Little Whip Snake *Suta flagellum* V TSC	4	Low	-	-
		Pink-tailed Legless Lizard or Worm Lizard *Aprasia parapulchella* V TSC V EPBC	6	Low	-	-
		Striped Legless Lizard *Delma impar* V TSC V EPBC	6	Low	-	-

*PIF = Preliminary Impact Factor

6.4.2 Non-listed species of concern

Research at wind farms across Australia and other parts of the world provide evidence to suggest non-threatened bird and bat species which may be at risk of collision and barotrauma impacts at wind farms (see Appendix G: *Windfarm Risks to Birds and Bats Addendum*).

A qualitative risk assessment for non-listed birds and bats of concern has been completed using the same risk assessment model, combining assessments of likelihood and consequence, used for the evaluation of threatened and migratory fauna. The risk assessment focuses on bird groups which have been shown to be at particular risk in studies at other wind farms (raptors, waterbirds, migratory species), as well as bats that were identified on the site. It assesses the potential impacts of collision and barotrauma on these species at a population level.

These species are not considered to be rare or threatened within the region and therefore are less likely to be at risk of population-scale impacts than listed species. A high to low risk rating for non-listed species indicates:

- **Very low and low risk:** no further action required
- **Moderate risk:** target monitoring of this species
- **High risk:** target monitoring and species-specific mitigation recommended.

Table 6-8 presents the summarised risk assessment results for populations of bird species considered to be of concern. The assessment, including details of relevant behavioural ecology and potential impacts of the wind farm proposal, is included as Appendix F.

Table 6-8 Summary of risk assessment for non-threatened species of concern

SPECIES	LIKELIHOOD	CONSEQUENCE	RISK (POP)
BIRDS			
Wedge-tailed Eagle *Aquila audax*	Possible	Moderate	High
Nankeen Kestrel *Falco cenchroides*	Possible	Insignificant	Low
Brown Falcon *Falco berigora*	Possible	Insignificant	Low
Australian Hobby *Falco longipennis*	Possible	Minor	Moderate
Black-shouldered Kite *Elanus axillaris*	Possible	Insignificant	Low
Black Kite *Milvus migrans*	Possible	Insignificant	Low
Whilstling Kite *Haliastur sphenurus*	Possible	Insignificant	Low
Swamp Harrier *Circus approximans*	Very rare	Insignificant	Low
Brown Goshawk *Accipiter fasciatus*	Rare	Insignificant	Low
Barn Owl *Tyto alba*	Possible	Minor	Moderate
Tawny Frogmouth *Podargus strigoides*	Very rare	Insignificant	Low
Peregrine Falcon *Falco peregrinus*	Possible	Minor	Moderate
White Ibis *Threskiornis molucca*	Rare	Minor	Low
White-winged Triller *Lalage tricolor*	Rare	Minor	Low
Australian Magpie *Gymnorhina tibicen*	Possible	Insignificant	Low

SPECIES	LIKELIHOOD	CONSEQUENCE	RISK (POP)
Silvereye *Zosterops lateralis*	Possible	Minor	Moderate
Galah *Cacatua roseicapilla*	Possible	Insignificant	Low
Sulphur-crested Cockatoo *Cacatua galerita*	Possible	Insignificant	Low
Crimson Rosella *Platycercus elegans*	Rare	Insignificant	Low
BATS			
Recorded bats *Chalinolobus gouldii* *Mormopterus* sp 4 *Nyctophilus* spp *Scotorepens balstoni* *Vespadelus* spp	Rare	Minor	Low

6.4.3 Conclusion

High risk

Threatened and migratory species

The above risk assessment conducted for threatened and migratory (Assessments of Significance, Appendix E) identified two threatened species as having high risk rating: **Superb Parrot** (key threat: habitat removal), **Eastern Bent-wing Bat** (key threat: barotrauma / collision).

Superb Parrots are known to nest locally in open Box-Gum Woodland or isolated paddock trees. Habitat removal, particularly the removal of hollow-bearing trees in mature woodland remnants, is considered to be a high risk for this species.

The study area is located c.45km (straight line distance) from a known maternity cave for Eastern Bent-wing Bats, near Wee Jasper. This maternity colony is thought to be the source population for the Murrumbidgee, Lachlan and parts of the Southern Rivers catchments (Dwyer 1968). Potential population-scale impacts from barotrauma and collision may occur during foraging while the species is at the maternity cave. 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).

Further assessment and habitat avoidance measures should be conducted for these species to ensure that they are not significantly impacted by the proposal (discussed in Section 8.2.2 and 8.2.3 below).

Non-listed species

The above risk assessment for non-listed species of concern identified one species: **Wedge-tailed Eagle** (key threat: collision) as being at high risk of collision impacts during the operational phase of the development. Operational monitoring should target this species and species-specific mitigation measures should be implemented to reduce the risk to acceptable levels (see Section 8.2).

Moderate risk

No species were categorised as being at moderate risk from habitat removal.

Threatened and migratory species categorised as having a moderate risk from collision and barotrauma are:

Threatened and migratory:	**Rainbow Bee-eater, Square-tailed Kite, Gang-gang Cockatoo, Swift Parrot, Superb Parrot and Barking Owl**
Non-listed species:	**Australian Hobby, Barn Owl, Peregrine Falcon and Silvereye**

The proposal is not expected to significantly affect moderate or low-risk populations. Bird and bat monitoring should be undertaken to manage and mitigate against collision and barotrauma impacts. Monitoring should specifically target high and moderate risk species (see Section 8.2).

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. Based on the survey findings and evaluation, the key biodiversity constraints that occur within the development envelope are summarised below and illustrated on Figure 7-1. The biodiversity constraints operating at the Coppabella Hills Precinct 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. A summary of constraints is provided in Table 7-2.

Table 7-1 'Traffic light' constraints approach and recommended mitigation measures

LEVEL OF CONSTRAINT	COLOUR	RECOMMENDED MITIGATION MEASURES
High constraint	Red	Impacts on these areas and habitat resources are impossible or very 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 specific 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 Coppabella Hills Precinct, 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, electricity transmission easements, turbines and the substation.

7.2.1 Constraining values

Biodiversity values that constrain the suitability of the Coppabella Hills Precinct for wind farm development and which have been included in the constraints mapping include woodland, pasture, wetland or riparian habitats and rocky outcrops. These are described below.

Woodland

Approximately 983 hectares of treed Box-Gum Woodland and Dry Shrub Forest occur within the development envelope, based on an indicative layout. Both these communities are listed as Box-Gum Woodland Endangered Ecological Community under the TSC Act. Of this total, approximately 265 hectares features high to moderate groundcover species diversity dominated by several native grass species, with some forb species present (good, moderate to good and moderate condition patches).

These areas are considered to be of higher conservation significance than the poor and poor-moderate treed areas.

Within the development envelope, good to moderate condition woodland occurs on Cluster 10, on the south facing slope below 7a and 7b, within saddles and east of the northern part of Cluster 3, within the proposed electricity envelope between Clusters 5, 6 and 7a, and on patches on the south facing slope of Cluster 3. Approximately 15 hectares of this community also falls under the EPBC Act listed Critically Endangered Ecological Community (in the valley between Clusters 6 and 7a and in the saddle on Cluster 10).

Woodland vegetation provides important habitat for woodland flora and fauna species, including the threatened Yass Daisy and Superb Parrot (recorded on the site).

All areas of moderate, moderate-good and good condition woodland EEC, and 'woodland' fauna habitat and hollow-bearing trees (threatened species habitat) that occur within the proposed development area are considered to be a high constraint for the proposed development and should be avoided.

Woodland EEC in poor and moderate to poor condition, or 'disturbed woodland' fauna habitat are considered to be a moderate constraint for the proposed development. Disturbance will require mitigation.

Pasture

Flora and ecological communities

Areas of pasture dominated by native grasses and a moderate diversity of forbs are likely to come under the TSC Act listed EEC definition. Areas of native pasture are irregularly interspersed between extensive areas of exotic dominated pasture. Native pasture EEC is considered to be a moderate constraint for the proposal, requiring mitigation.

The most disturbed and exotic-dominated areas tended to occur on the highest points (ridge crests). Surveyed areas that were dominated by exotics, and therefore of low development constraint include: all surveys on Clusters 1 (Figure 5-4), 2 (Figure 5-5) and 4, parts of 5 and 6 upper slope, parts of 7a and 7b ridge and upper slope; 3a upper slope; and parts of 10.

The composition of pasture areas is highly variable between sites and within small areas (Figure 5-2, Figure 5-3), and is likely to change over time depending on season, water availability and grazing pressure. To account for this spatial and temporal variability, native pasture areas and exotic pasture areas have been mapped as a single vegetation type 'pasture'. Although low diversity native pasture is included in the EEC definition (listed under the TSC Act), it is locally abundant, highly disturbed by grazing and weed invasion and is unlikely to have significant natural recovery potential. Therefore cleared pasture areas on the site are considered to be of relatively low conservation value and have been assessed as posing a low constraint for the proposed development.

Fauna

All pasture areas were heavily grazed at the time of the survey. Pasture areas provide only moderate to low quality habitat for fauna species. Fauna resources within cleared pasture habitats include rocky outcrops (discussed below), scattered paddock trees and standing and fallen dead timber. Scattered paddock trees and standing dead trees provide important habitat resources in modified landscapes.

Habitat resources (such as fallen timber or rocks) within these areas should be avoided or relocated in nearby similar habitats if they overlap the development footprint.

Disturbed wetland and riparian habitats

Although of poor quality, dams and creeks within the development envelope provide a habitat resource for aquatic and wetland species, a foraging resource for bats and a watering source for native fauna and domestic stock. These habitats are considered to be moderate constraints for the proposal.

Rocky habitats and ridge tops

Extensive rocky outcrops occur on all ridge tops and side slopes within the development envelope, however these areas are highly disturbed by grazing and weed invasion. The proposal has the potential to introduce a hazard to aerial habitat above the ridges, in the form of collision and barotrauma risk for bird and bat species. Ground debris such as fallen and standing dead timber is present on ridges. For rock outcrop and ridge-top specialists, development of these habitats may reduce areas of habitat; however given the extent of this habitat on the site, the removal of this habitat at the construction phase is not likely to affect the viability of local populations. These areas therefore represent a low development constraint.

Table 7-2 Constraints summary

HABITAT OR HABITAT FEATURE THAT OCCURS WITHIN THE DEVELOPMENT ENVELOPE	EXTENT WITHIN DE (ha)	LOCATION WITHIN DE	CONSTRAINT
Woodland EEC in moderate, moderate-good and good condition	265.2	**Clusters:** 10, north west and central; 8, 6 slope and small areas on 5; southern edge of Cluster 7; 3 north and central north **Transmission:** gullies between 6 and 3, 6 and 7a, and between 5 and 7a; 3 east and north **Access:** adjacent to Whitefields Road	**High**
Woodland EEC in poor and poor-moderate condition	717.9	**Clusters:** 10 north west, central west and central east, 6 ridge, 7b far south east,7a far north west, 3 north and central **Transmission envelopes**: between 6 and 7a, below 10, north and east of 3 **Access:** along Whitefields Road	**Moderate**
Woodland fauna habitat (threatened species habitat)	241.4	**Clusters**: 3 and 10, and small areas on 7 **Transmission**: between 6 and 7a, and on the eastern slope of 3	**High**
Disturbed woodland fauna habitat	780.8	**Clusters:** small areas on 7a and 7b, 3, 6, 8 and 10 **Transmission:** between 6 and 7a and north of 3 **Access:** adjacent to Whitefields Road	**Moderate**
Pasture	1834.7	All cleared areas on the site	**Low**
Modified wetland habitats (creeks and dams)	11.27 (only Jugiong Creek)	Dams, creek crossing and Jugiong Creek	**Moderate**

HABITAT OR HABITAT FEATURE THAT OCCURS WITHIN THE DEVELOPMENT ENVELOPE	EXTENT WITHIN DE (ha)	LOCATION WITHIN DE	CONSTRAINT
Rocky outcrops	197.6	All ridge tops and side slopes within the development envelope	**Low**
Hollow-bearing trees and mature paddock trees	18 locations	Clusters 10, 3 north and 6; in paddock trees in low lying areas within transmission envelopes; and also adjacent to Whitefields Road	**High**
Threatened species habitat	-	Two threatened species were observed on the site: • Superb Parrot in woodland and mature road-side habitats • Yass Daisy in good condition Box-Gum Woodland	**High**

7.2.2 Biodiversity constraint mapping

The constraint classes have been mapped for the subject site, together with most recent wind farm infrastructure layout to show areas of potential impact. The biodiversity constraint class maps are provided in Figure 7-1. Constraint areas based on vegetation type and condition class have been extrapolated from survey plot data and air photographs. Note: This finalised infrastructure layout has undergone several revisions, based on the provision of constraints mapping, as discussed in Section 8.

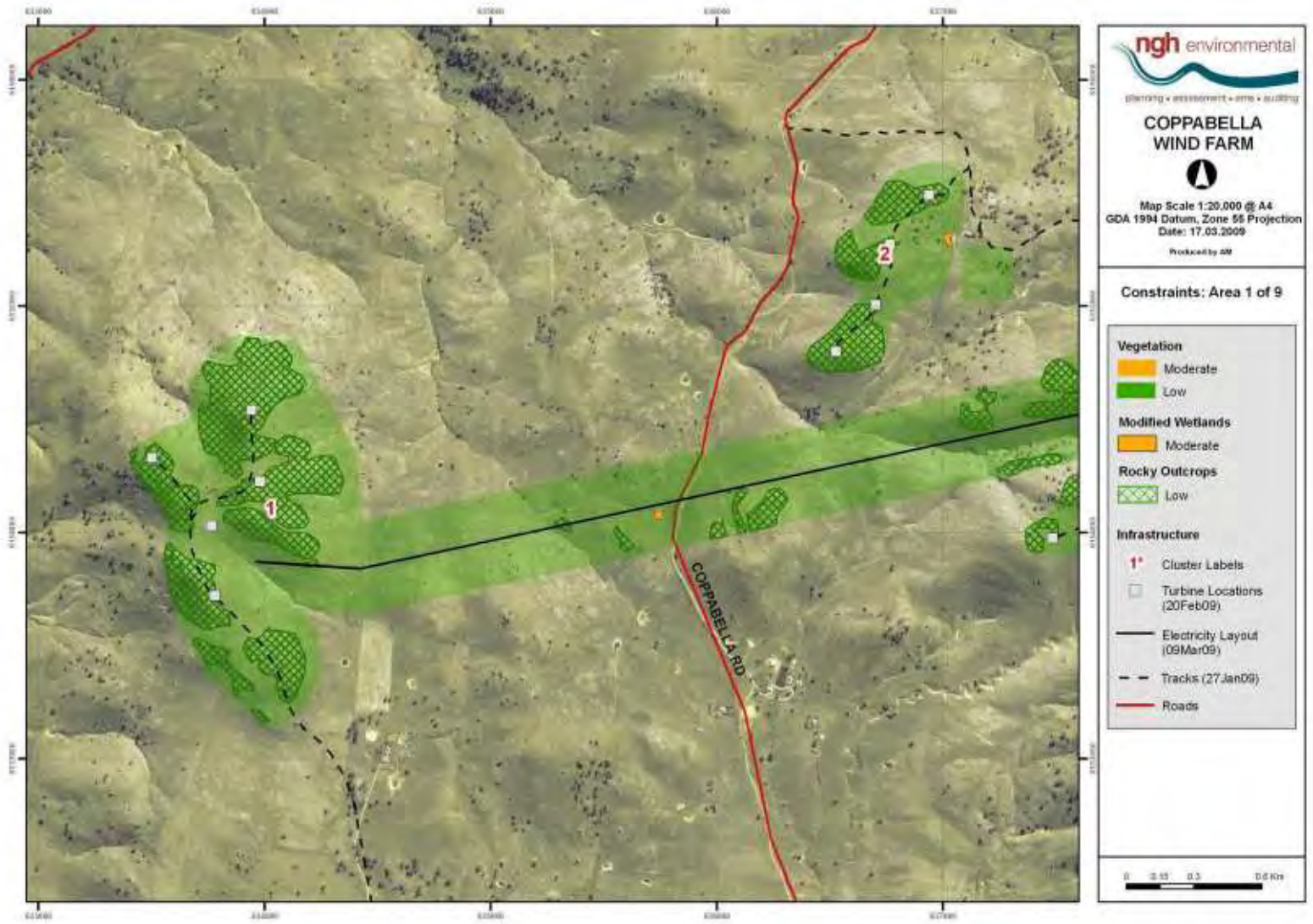
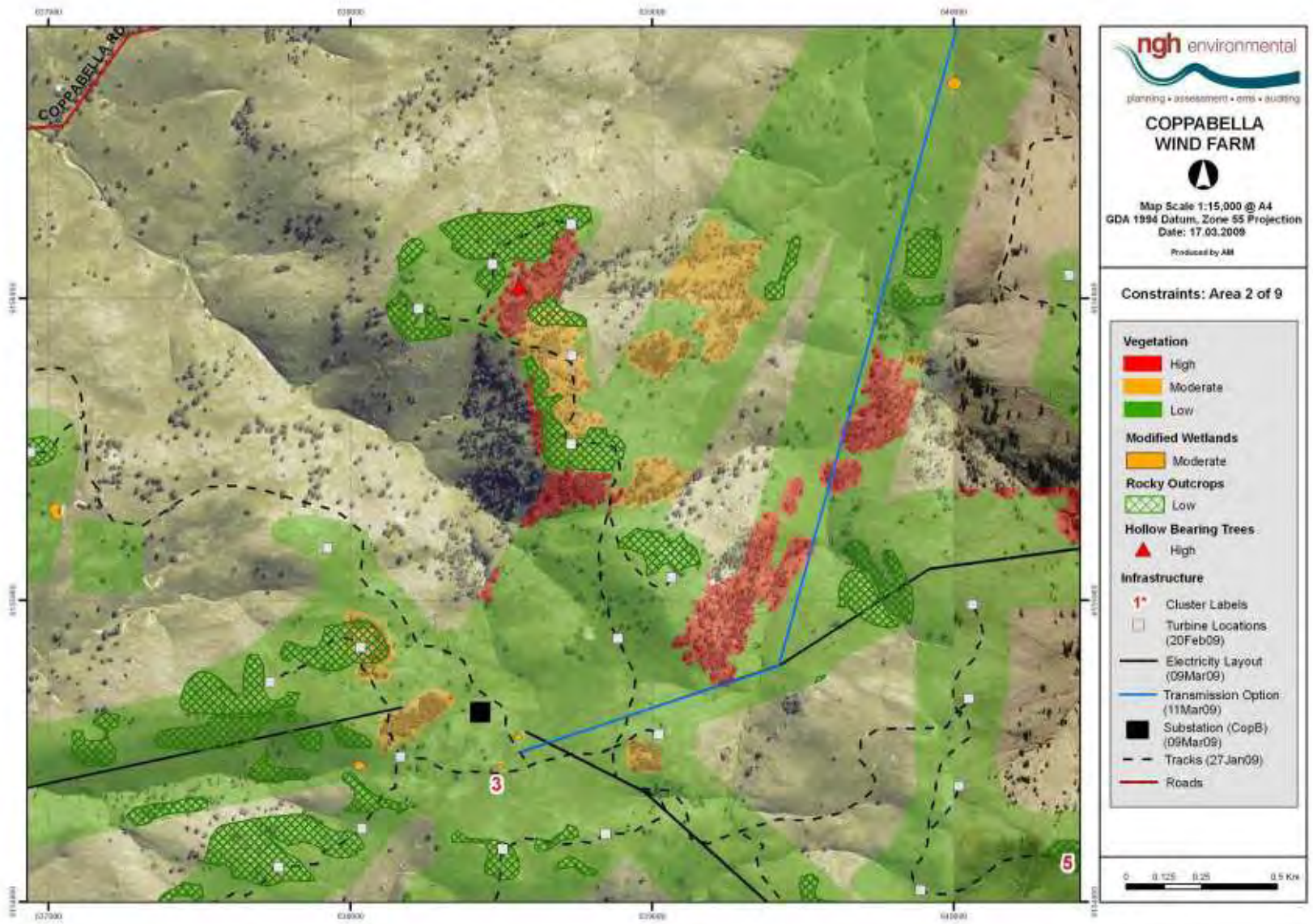


Figure 7-1 Constraints mapping, map set (9 maps in total)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Moderate
Low
Modified Wetlands
Moderate
Rocky Outcrops
Low
Hollow Bearing Trees
High
Infrastructure
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Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Substation (CopB) (09Mar09)
Tracks (27Jan09)
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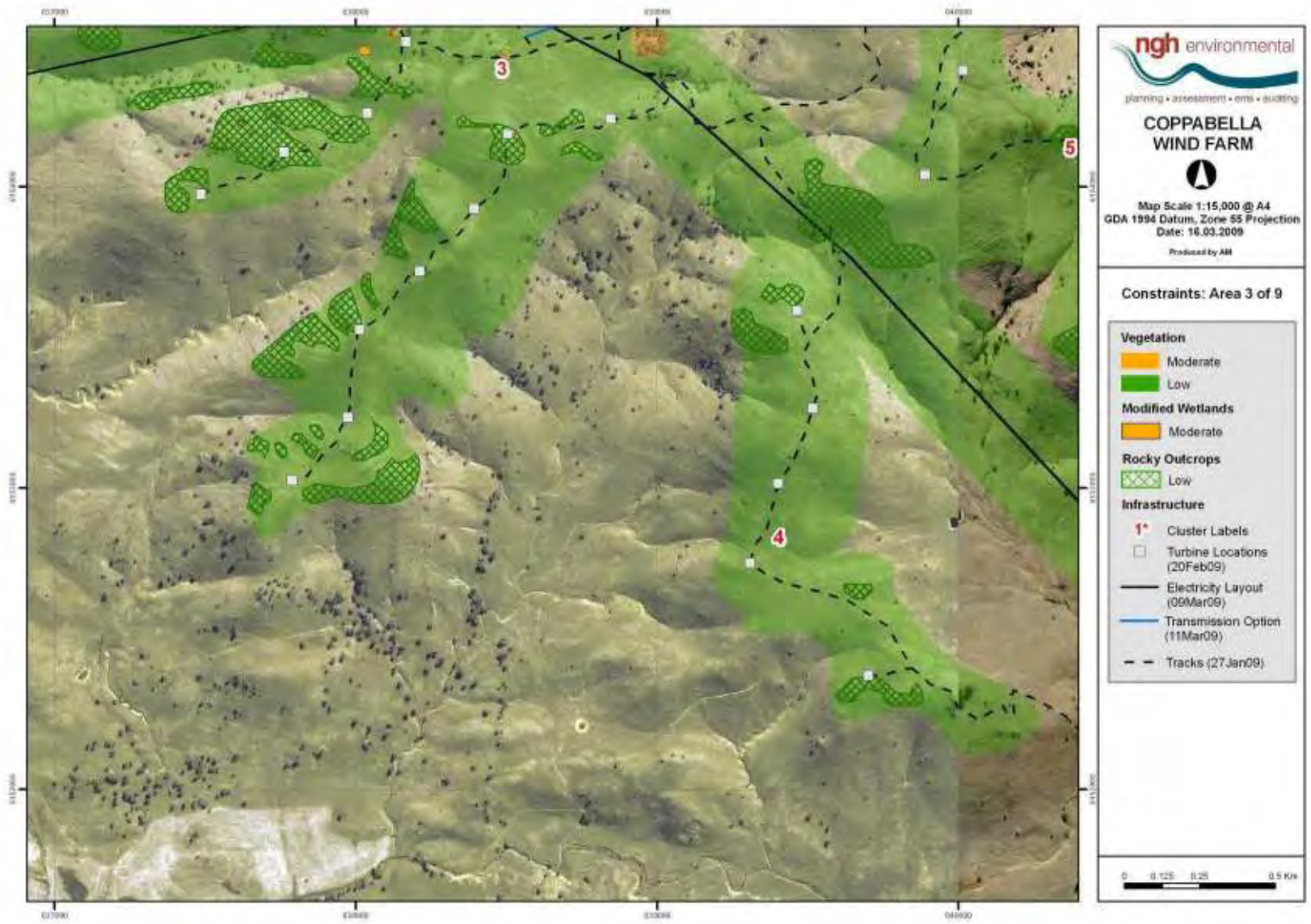
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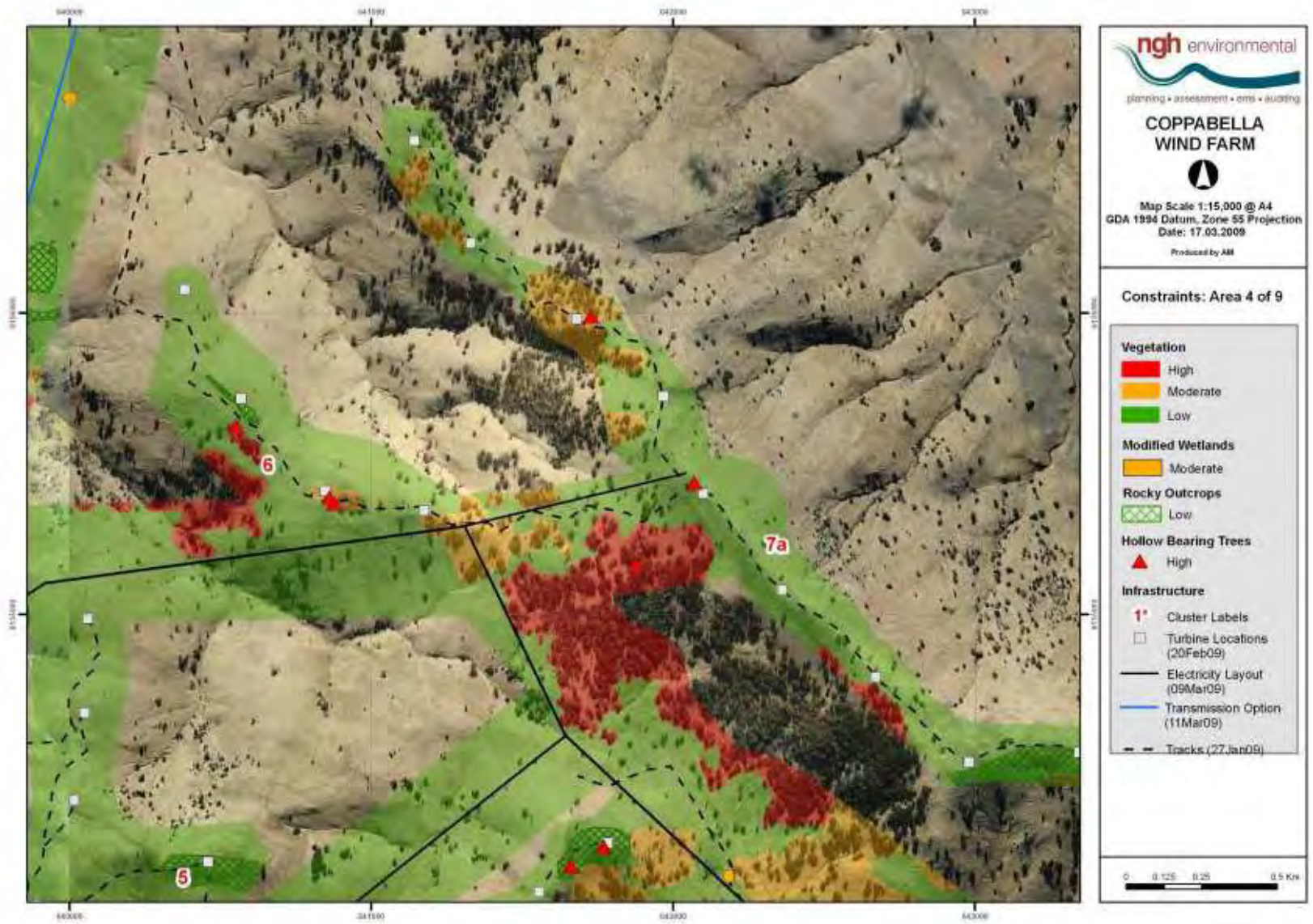
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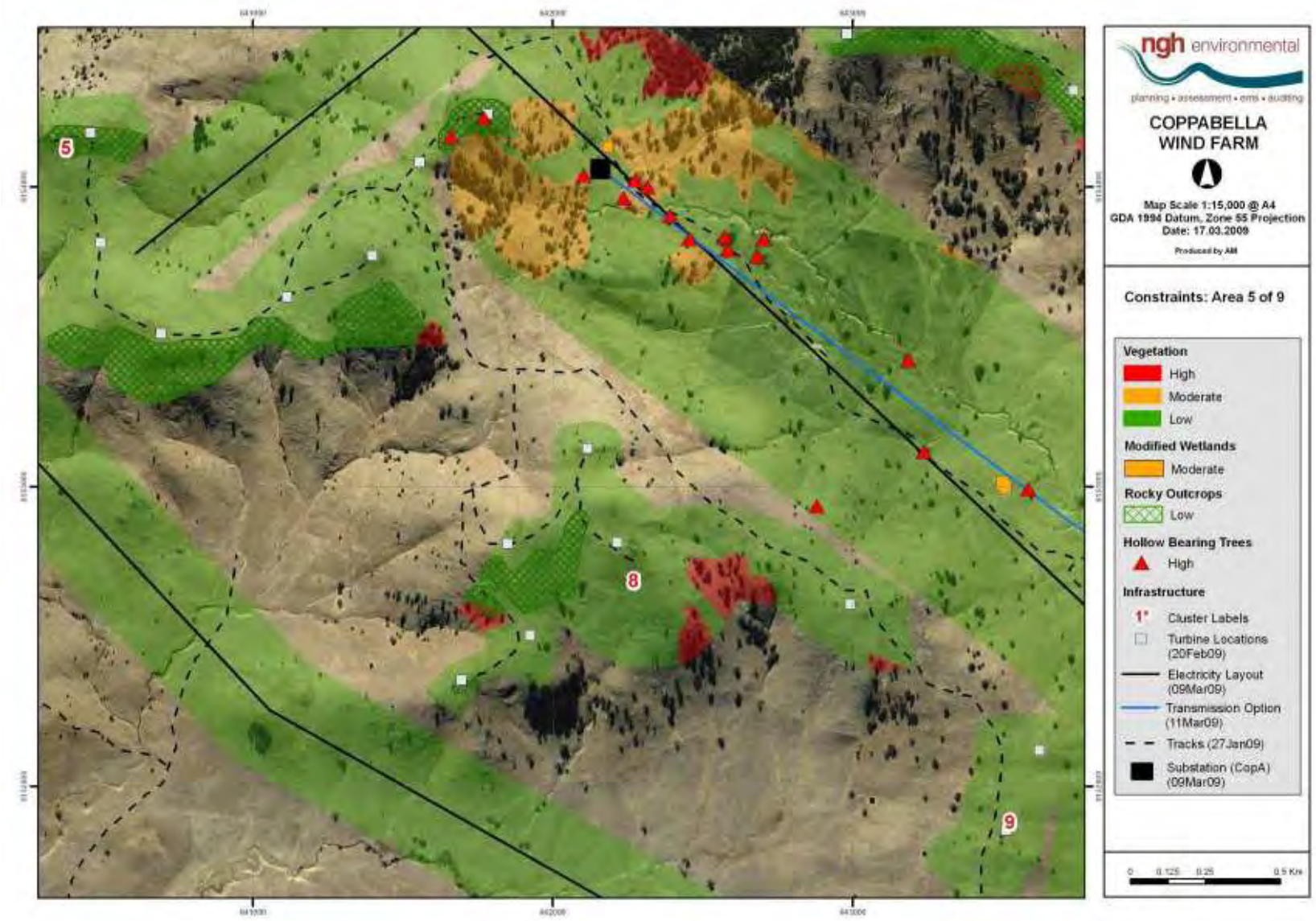
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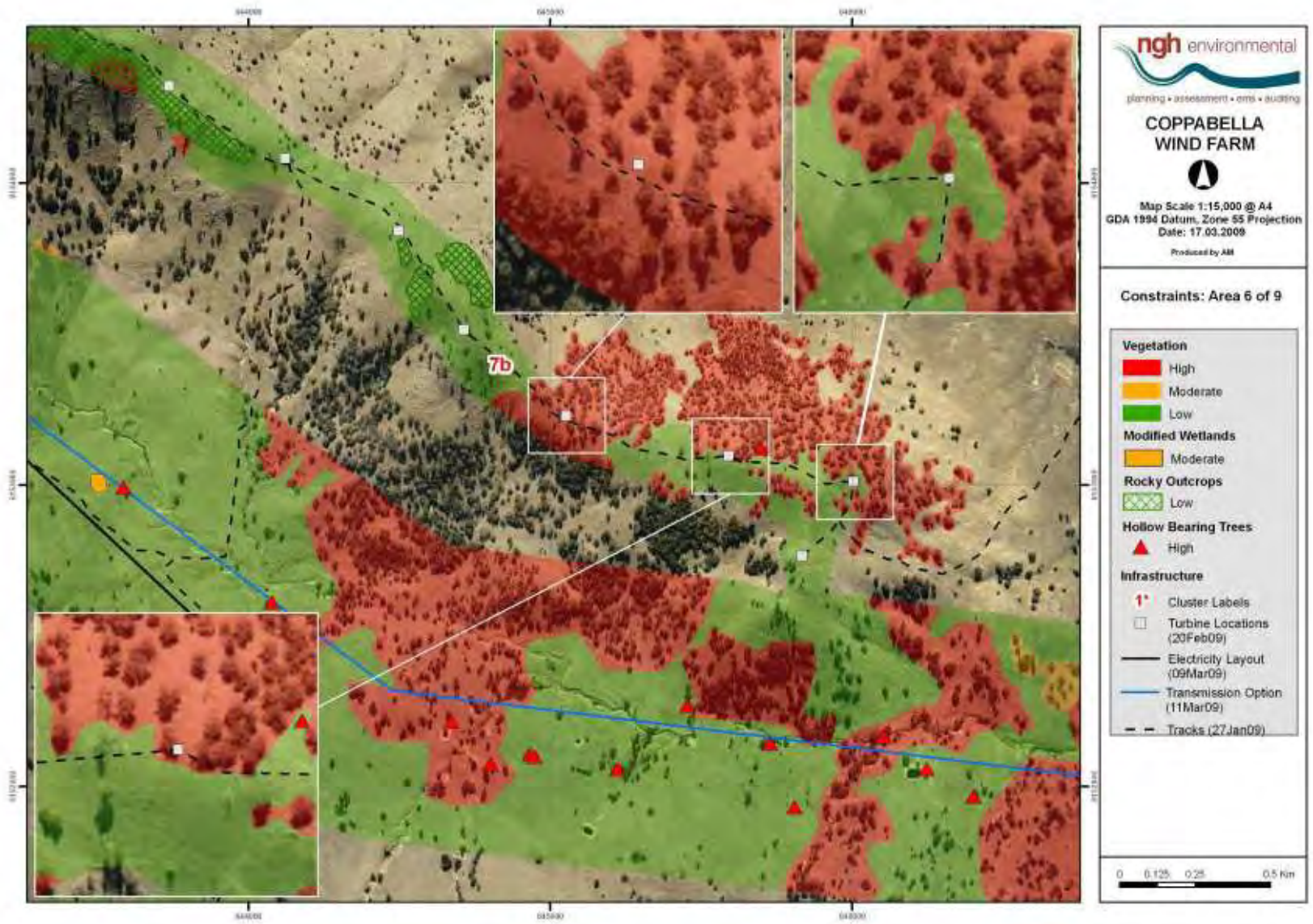
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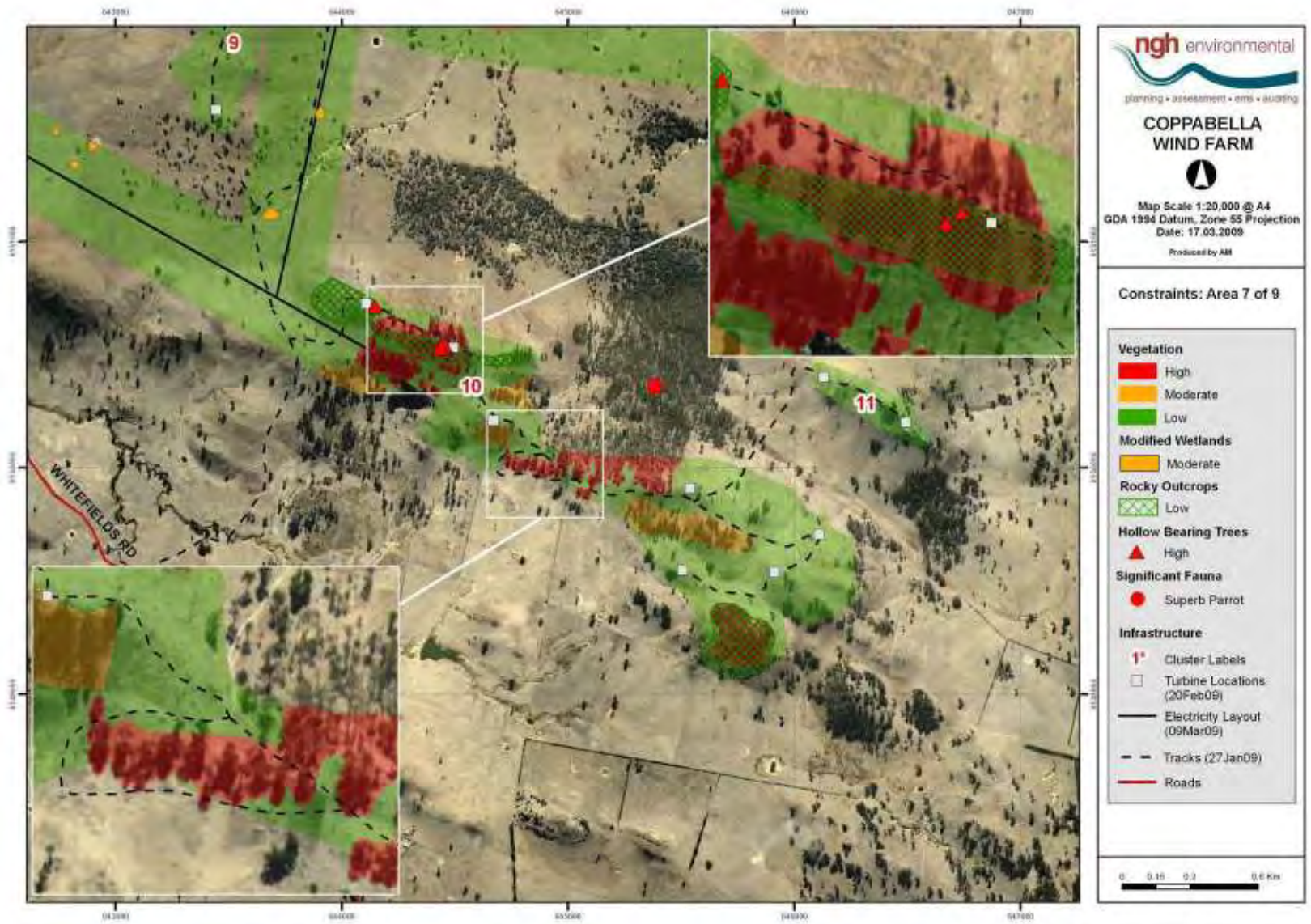
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Moderate
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Modified Wetlands
Moderate
Rocky Outcrops
Low
Hollow Bearing Trees
High
Significant Fauna
Superb Parrot
Infrastructure
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Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (27Jan09)
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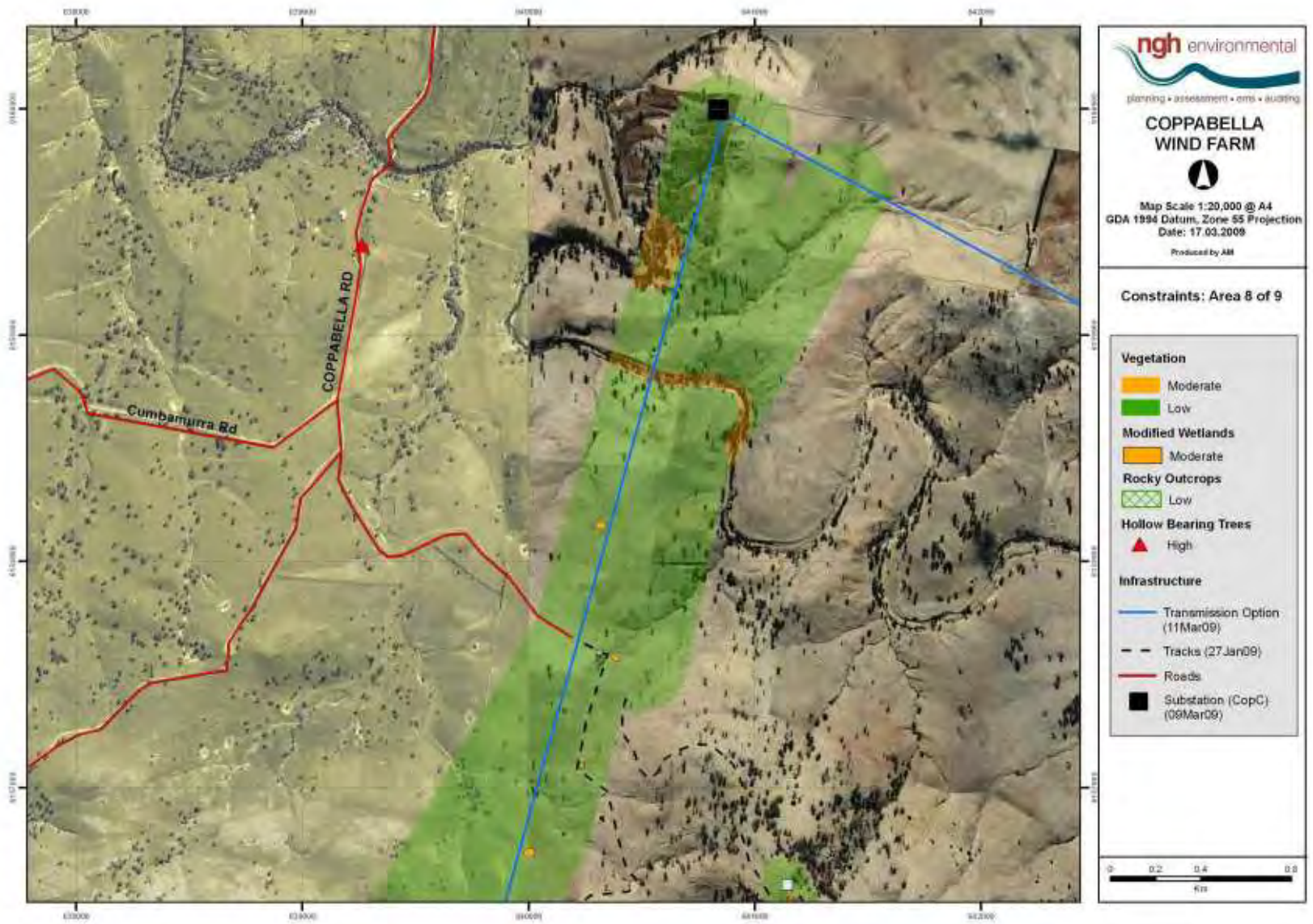
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Low
Modified Wetlands
Moderate
Rocky Outcrops
Low
Hollow Bearing Trees
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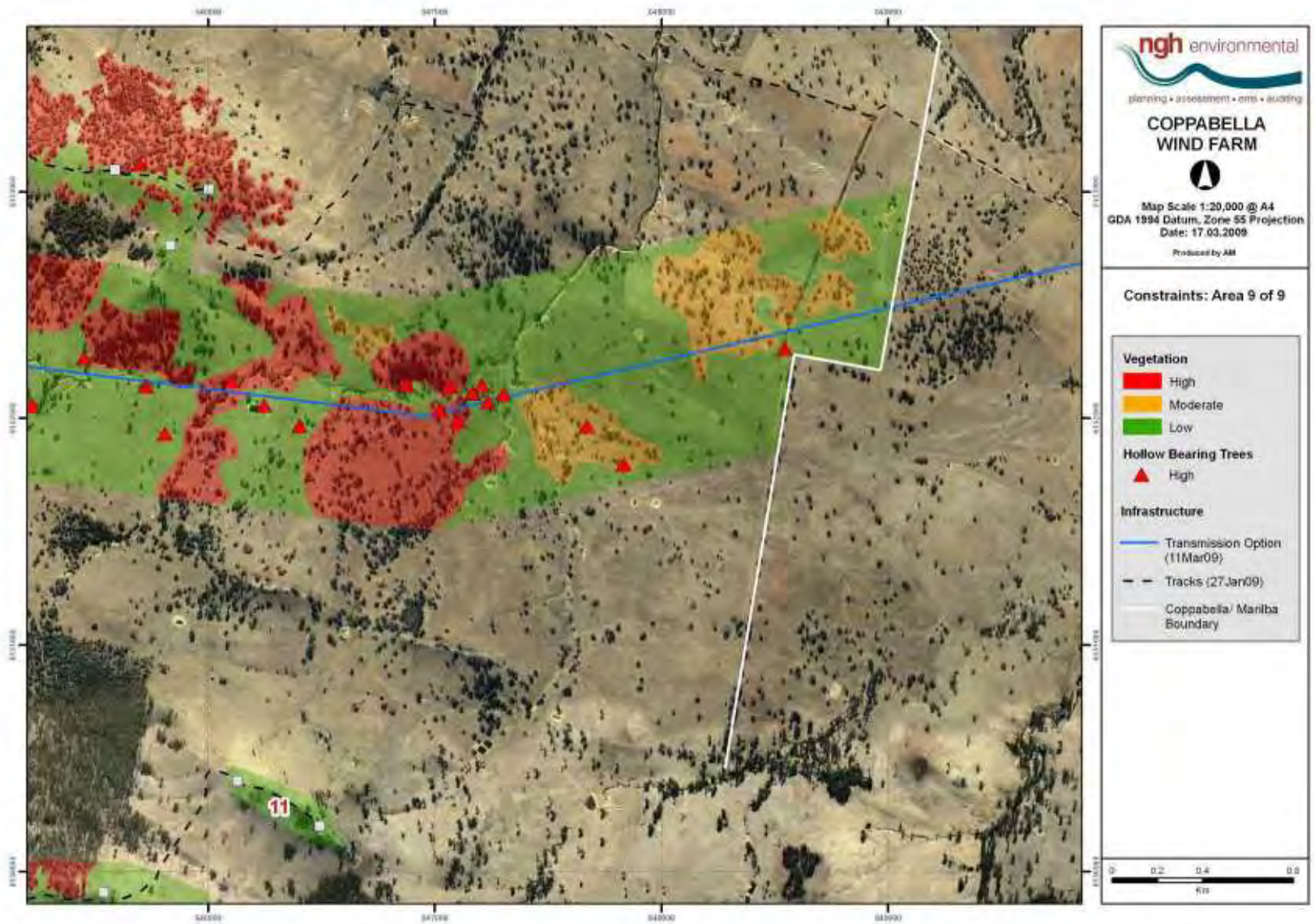
Km


ngh environmental
planning • assessment • ems • auditing
COPPABELLA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Constraints: Area 9 of 9
Vegetation
High
Moderate
Low
Hollow Bearing Trees
High
Infrastructure
Transmission Option (11Mar09)
Tracks (27Jan09)
Coppabella/ Manilba Boundary
0 0.2 0.4 0.8
Km
11

8 IMPACT ASSESSMENT AND MITIGATION STRATEGIES

8.1 CONSTRUCTION PHASE

Loss of habitat and habitat modification for the turbine towers and surrounding hardstand areas, control building, substation, new and widened access tracks and power-line poles are the key direct impacts of the construction phase. This vegetation would be removed for the life of the wind farm (up to 30 years). As set out in Section 3.2, the permanently removed development footprint of the proposed wind farm has been estimated as 70 hectares; additionally 29.04 would be maintained in transmission easements and 24.26 hectares could be rehabilitated post construction. The impact of this loss of habitat would be dependent on the type, quality and use of the habitat to be removed or modified.

The power-line 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 power-line, and the poles would permanently displace a small area of ground layer vegetation at their base. The power-line would require a cleared easement of 20 metres and would be located to minimise clearing of trees. Where possible, the power-line route would avoid remnant Box-Gum Woodland, particularly large paddock trees and linear remnants beside roads and watercourses.

Grass cover may be restored over much of the permanent access routes running between the turbines to assist track stability and reduce runoff. Low gradient sections of the inter-turbine access tracks may be reinstated with grass cover following the works to reduce runoff and improve long term stability. Mitigation has been developed specific to the need to retain some flexibility in the final route location.

Additional indirect impacts from construction may arise as a result of erosion and sedimentation of waterways and adjacent habitats, weed establishment, noise and other disturbances associated with the construction phase.

8.1.1 Specific habitat types

Estimates of vegetation loss for each of the affected vegetation types and condition classes are presented in

Table 8-1 and 8-2. Estimates of woodland vegetation loss have been derived from the final infrastructure layout provided by the Proponent. They are based on a worst-case scenario and assume total loss of vegetation within the turbine footprint and crane operation area for all turbine locations within 50 metres of vegetation type, with no mitigation measures applied.

According to Tables 8-1 and 8-2, the works would permanently remove approximately 11.32 hectares of Box-Gum Woodland EEC, 0.59 hectares of which is considered to be high constraint woodland. Additionally, 53.44 hectares of native and exotic pasture, less than 0.01 hectares of Riverian River Red Gum forest (poor condition) and 5.15 hectares of rocky outcrops would be impacted by the proposal.

Table 8-1 Maximum impact areas within each vegetation community. Calculations are based on the indicative infrastructure layout provided by the proponent.

Coppabella Hills Precinct									
Infrastructure	**Quantity**	**Width (m)**	**Length (m)**	**Area (ha)**	**P**	**BGW**	**DSGF**	**RRGF**	**RO**
Turbine footing [a]	86.00	25.00	25.00	**5.38**	3.63	0.50	0.06	0.00	1.19
Crane hardstand [c]	86.00	22.00	40.00	**7.57**	5.11	0.70	0.09	0.00	1.67
Crane operation area (includes footing and hardstand) [c]	86.00	50.00	50.00	**21.50**	14.50	2.00	0.25	0.00	4.75
Tracks [a]	1.00	8.00	67063.65	**53.65**	42.67	6.95	0.07	0.00	3.96
Underground powerlines onsite [c]	1.00	2.00	21905.29	**4.38**	3.45	0.77	0.03	0.00	0.13
Overhead powerline cabling / easement [b]	1.00	20.00	14517.82	**29.04**	13.27	15.27	0.36	0.14	0.00
Overhead power pole footings [a]	145.18	1.00	1.00	**0.01**	0.01	0.01	0.00	0.00	0.00
Substation and control bldg [a]	3.00	2.00	18330.43	**11.00**	7.14	3.86	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
Construction compound, staging and storage [c]	1.00	300.00	100.00	**3.00**	3.00	0.00	0.00	0.00	0.00
Development envelope (DE)				**2829.10**					
Percentage of DE permanently removed				**2.48**					
Breakdown by impact type:									
a Permanent habitat loss (includes all footings and tracks)				**70.04**	53.44	11.32	0.13	0.00	5.15
b Habitat modification (transmission easement maintenance)				**29.04**	13.27	15.27	0.36	0.14	0.00
c Temporary habitat loss (areas that can be rehabilitated post construction)				**24.26**	18.08	2.27	0.22	0.00	3.69

P: Pasture, BGW:Box Gum Woodland, DSGF: Dry Shrub/Grass Forest, RRGF: Riparian River Red Gum Forest, RO: Rocky Outcrops

Table 8-2 Maximum impact areas on each woodland vegetation condition class and on high and moderate constraint Box Gum Woodland EEC[10].

Coppabella Hills Precinct							
Woodland vegetation types	**Permanent habitat loss [a] within each condition class**						**Total of each vegetation type within DE**
	Good	**Moderate / good**	**Moderate**	**Poor / moderate**	**Poor**	**Total**	
Box Gum woodland	0.17	0.17	0.21	2.95	7.84	**11.34**	892.11
Long-leaved box Dry Grass Forest	0.00	0.04	0.00	0.04	0.06	**0.13**	91.01
Riparian River Red Gum	0.00	0.00	0.00	0.00	0.00	**0.00**	11.27

Coppabella Hills Precinct		
Endangered Ecological Community (EEC)	**Permanent habitat loss [a] within each class**	
	High constraint EEC	**Moderate constraint EEC**
Box Gum Woodland EEC	0.59	2.99
Total area within the DE	**265.24**	**717.88**

[10] Endangered Ecological Community (EEC) Box-Gum Woodland includes both box-gum woodland and long-leaved box dry grass forest treed remnants. EEC of high conservation value are woodland remnants in good, moderate to good, and moderate condition. EEC of moderate conservation value are woodland remnants in poor to moderate and poor condition.

Woodland and threatened species habitat

Removal of moderate to good condition woodland EEC and mature forest patches with hollow-bearing trees has the potential to result in significant loss of habitat for Superb Parrot, Yass Daisy and for the EEC Box-Gum Woodland, (see Appendix E for detail).

Of particular concern are areas of suitable Superb Parrot habitat (mature woodland remnants with hollow-bearing trees) including:

- Road-side remnants adjacent to Whitefield's Road
- In the saddle and north west crest on Cluster 10
- In the transmission easement on the south-facing slope and saddle between Clusters 6 and 7a
- In hollow-bearing paddock trees and woodland that occur within the valley between Clusters 5 and 7a

Areas of high constraint moderate to good condition EEC including:

- Within the transmission envelope between Clusters 6, 5 and 7a
- Remnants on Cluster 10
- the woodland below Cluster 7b near the proposed turbine access track

Areas of Yass Daisy habitat including:

- On the steep slopes within the transmission easement between Clusters 6 and 7a
- Within the Box-gum Woodland remnant beginning in the centre of Cluster 10 and stretching to the north

Works in these areas should be avoided, or micro-sited with the assistance of an ecologist to avoid impacts on standing live and dead trees. Hollow-bearing trees should not be removed in these areas. A buffer should be established on large woodland remnants to ensure indirect impacts (such as noise and dust) are minimised.

Given the disturbed and fragmented nature of the site, and the extent of similar woodland vegetation of equal and greater conservation value, the removal of moderate constraint woodland habitat associated with the proposed development is not considered likely to result in significant impacts on flora, fauna or ecological communities within the locality, provided that the recommended mitigation measures outlined in Section 8.1.5 below are effectively implemented.

Pasture with scattered trees

Given the disturbed condition of the surveyed pasture areas, the majority of the impact area within pasture habitats is likely to be within exotic dominated pasture, with only occasional small removal of native pasture. Pasture habitat is not high quality and is abundant throughout the district. Removal of this vegetation and fauna habitat type as a result of the proposal is not likely to result in significant impacts on flora and fauna or ecological communities.

Existing groundcover may be retained over flatter sections of the route, although soils and vegetation would be locally affected by the passage of heavy vehicles. Disturbed areas would be revegetated with native grass species. Where possible, turbine sites would be located away from mature paddock trees.

Disturbed wetland and riparian habitats

There is not likely to be permanent impacts on modified wetland habitats within the locality. Impacts may occur for the construction and upgrade of creek crossings across the site. Erosion and hydrological issues should be considered when developing creek crossings, tracks and when disturbing soils for construction, including installing appropriate drainage systems, sediment traps, and revegetating disturbed areas with native species.

Should dams be required to be removed during site development, alternative watering points should be established to compensate for their loss.

Rocky habitats and ridge tops

Approximately 5.15 hectares of rocky outcrops would be removed by the construction of turbines and the access tracks. Disturbed rocks and woody debris should be relocated to nearby similar habitats to ensure suitable micro-habitat resources are maintained. Turbine sites should be micro-sited to avoid standing live and dead trees as far as is possible. Impacts on rock outcrops within high constraint woodland areas should be avoided. If avoidance is not possible, preclearance surveys should be undertaken in rock outcrops in high constraint areas prioir to disturbance.

8.1.2 Fragmentation

The proposed works are unlikely to result in fragmentation of woodland habitats given that the site is already highly fragmented and disturbed from grazing and clearing. Permanent habitat removal for wind turbines would occur primarily within marginal ridge-top woodland. Access to the turbine Clusters is via existing tracks and roads, along the edges of woodland habitats or within cleared and disturbed areas. Track and road widening would not dissect continuous patches, however may result in the reduction of habitat 'stepping stones' for use by mobile fauna. This is not considered likely to result in significant impacts on fauna in the locality given the limited extent of woodland habitat removal in relation to the extent of woodland that occurs on the site.

8.1.3 Indirect impacts

Dust, noise and vibration

The installation of tracks, turbines, cable laying and associated infrastructure would generate temporary impacts. The dust, noise, vibration and activity associated with the construction phase may affect the foraging behaviour of local fauna species, particularly birds and macropods.

Pasture areas contain livestock and their current management involves the operation of machinery and vehicles in largely cleared areas. The increased noise, vehicle emissions and dust expected during the construction phase are not anticipated to be cause for concern for fauna onsite. Temporarily de-stocking areas where construction works are underway would reduce potential for injury to stock during the construction phase. Adhering to predetermined access routes and low speeds (max. 40km/hr) would reduce the risk of vehicles colliding with stock or native fauna onsite.

Weed invasion

The invasion of native vegetation by exotic perennial grass has the potential to occur following the construction phase. The Box-Gum Woodland EEC in particular is vulnerable to the introduction and

spread of perennial grasses such as African Love Grass, Serrated Tussock, Phalaris, Cocksfoot, Yorkshire Fog and Paspalum. Machinery and vehicles should be washed down before being brought onto the site and unnecessary soil disturbance should be avoided, to minimise the risk of exacerbating weed invasion in the EEC remnants.

Other 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 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 to 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 construction period. The limited duration of dust deposition is not expected to significantly affect vegetation or fauna or flora populations that occur at the site.

8.1.4 Offsetting

Under the Native Vegetation Act 2003, clearing of remnant vegetation or protected regrowth can only be approved when the clearing will improve or maintain environmental outcomes and ensure that there is no net loss of biodiversity values. To achieve this outcome an 'Offset Plan' can be developed which would specify offset targets to be managed for conservation outcomes in perpetuity. Offsetting is not a requirement for Part 3A Major Projects but would help to reduce the impacts associated with vegetation clearing for the proposal and also have beneficial outcomes through the conservation and ongoing management of existing woodland areas.

Offsetting targets must be met within the same vegetation type that would be cleared (Box-Gum Woodland and derived Box-Gum Woodland) and preferably within the locality (10-20km from the site). Further survey work would need to be undertaken once the final turbine layout has been determined in order to calculate offset targets for derived Box-Gum Woodland native pasture. Targets should be defined in order to preserve, and if possible, improve habitat connectivity across the locality. Dependant on the land tenure, it may be possible to achieve some of the offsetting within the woodland patch north of Cluster 10 and along the south west slope of the main ridge 7, for example.

8.1.5 Recommended management measures for construction phase

Planning and mitigation measures recommended for potential impacts during the construction phase are set out in Table 8-3 below.

Table 8-3 Planning and mitigation measures during construction

Risk	Recommendation
A. Habitat loss and modification	
A.1 High constraint areas	i. Infrastructure should avoid the high constraints identified in Figure 7-1. ii. Areas of particular concern are: • Suitable Superb Parrot habitat (mature woodland remnants with hollow-bearing trees) including: ○ Roadside remnants adjacent to Whitefield's Road ○ In the saddle and north west crest on Cluster 10 ○ In the transmission easement on the south-facing slope and saddle between Clusters 6 and 7a ○ In hollow-bearing paddock trees and woodland that occur within the valley between Clusters 5 and 7a • High constraint moderate to good condition EEC including: ○ Within the transmission envelope between Clusters 6, 5 and 7a (also listed under the EPBC Act) ○ Remnants on Cluster 10 ○ The woodland below Cluster 7b near the proposed turbine access track • Suitable Yass Daisy habitat including: ○ On the steep slopes within the transmission easement between Clusters 6 and 7a ○ Within the Box-gum Woodland remnant beginning in the centre of Cluster 10 and stretching to the north Works in these areas should be avoided, or micro-sited to avoid impacts on continuous woodland and standing live and dead trees. Hollow-bearing trees should not be removed in these areas. iii. Specific measures to avoid high constraint areas should include: ○ Road widening within mature woodland (moderate condition) on Whitefields Road is not recommended. ○ The proposed transmission corridor and access track in the valley between Clusters 5 and 7a should be micro-sited further south west to avoid intact

Risk	Recommendation
	Box-Gum Woodland. ○ The proposed transmission corridor between Clusters 6 and 7a should be micro-sited further north (to be on the saddle rather than slopes) to avoid intact Box-Gum Woodland. ○ Tracks and turbines on Cluster 10 should be micro-sited to avoid impacts on high constraint woodland. iv. Works should be sited outside known Yass Daisy population areas and Commonwealth-listed CEEC areas identified on Figure 5-6. v. A buffer on protected areas should be established to ensure indirect impacts (such as noise and dust) are minimised. An appropriate buffer width would be twice the tree drip line, for example. vi. A final site inspection should be carried out after road and electricity easements are finalised, to ensure that threatened species habitat and high constraint EEC vegetation has been avoided or that impacts are manageable. vii. Power-line and access track routes and turbine sites should be selected to avoid woodland remnants and individual mature and hollow-bearing trees in other areas, which provide habitat for threatened fauna and potential seed sources for future site rehabilitation.
A.2 Moderate and low constraint areas	i. Infrastructure should be confined to cleared areas, sparsely vegetated areas, and edges of woodland as much as possible. Installation of new access tracks through continuous woodland would not be appropriate. ii. Hollow-bearing and mature trees should not be removed where possible, particularly in areas adjacent to woodland patches (such as on Cluster 10, in the valley between 5 and 7a, and within the proposed transmission between 6 and 7a). If removed, they should be replaced with nest boxes. iii. Standing dead trees, stumps and woody debris should be avoided where possible. Where they require removal to allow for the tracks and hardstand areas, they should be placed adjacent to the impact areas, to retain these refugia in the immediate area. iv. Clusters of rocks and boulders should be avoided where possible. Where rocks and boulders cannot be avoided, they should be placed directly adjacent to the works area to preserve the availability of refuge. Where rocks are to be removed, pre-clearance for threatened reptiles should be undertaken by experienced personnel. v. Should dams be required to be removed during site development, alternative watering points should be established to compensate for their loss.

Risk	Recommendation
B. Indirect impacts	
B.1 Weed invasion and sediment erosion	i. Weed and sediment erosion controls should be implemented to prevent onsite habitat degradation during and following the proposed works. A Construction Environmental Plan would be the appropriate vehicle for these controls. This plan should include, but not be limited to: ○ Machinery and vehicles should be washed down before being brought onto the site and unnecessary soil disturbance should be avoided, to minimise the risk of exacerbating weed invasion in the EEC remnants. ○ All areas of disturbed soil should be rehabilitated progressively as soon as practicable after disturbance, in order to resist erosion and colonisation by weeds. Design and implementation of specific erosion and sediment controls will be required to ensure that landforms are not destabilised and erosion is not increased onsite. This may rely on physical controls such as netting to stabilise slopes. Landforms in many areas are steep and unstable. Means to trap soil and moisture and stabilise slopes will provide the best potential for natural regeneration in the long-term. ○ Site stabilisation, rehabilitation and revegetation will be undertaken without delay. ○ 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.
B.2 Other indirect impacts	i. A buffer should apply to mature hollow-bearing trees to ensure indirect impacts (such as noise and dust) are minimised where practical. An appropriate buffer width would be twice the tree drip line, for example. ii. Additional risks to fauna may arise from collisions with construction and

Risk	Recommendation
	maintenance vehicles. Adhering to predetermined access routes and low speeds (max. 40km/hr off the public roads) would reduce the risk of vehicles colliding with stock or native fauna onsite. iii. Appropriate fire fighting equipment will be held on site when the fire danger is very high to extreme, and a minimum of one person on site will be trained in its use.
C. Offsetting	
	i. On finalisation of the development layout, an 'Offset Plan' should be developed in consultation with DECC and the CMA which would specify offset targets to be managed for conservation outcomes in perpetuity. ii. Further survey work would need to be undertaken once the final development layout has been determined in order to calculate offset targets for derived Box-Gum Woodland native pasture. iii. Appropriate areas for offsetting would carry the same vegetation (box-gum woodland) and ideally be within the locality (10-20km from the site) and contribute to woodland connectivity. Potential areas on the site include the woodland patch north of Cluster 10 and along the south west slope of the main ridge 7.

8.2 OPERATIONAL PHASE

8.2.1 Collision, barotrauma and avoidance impacts

The key operational impacts of wind farms have most relevance to species which fly in the path of operational turbines. There are three key impact types:

1. Collision with wind turbines: Within this investigation, 'collision' refers to mortality caused by direct collision with turbine blades or towers. The significance of the mortalities is species-specific. If the species is at low density in the landscape or susceptible to multiple collision events (such as for flocking species), collisions may threaten a local population. If the species is a top order predator or key stone species, there may be ecological ramifications of ongoing mortalities for other species.
2. Sudden decompression (barotrauma): Rapid or excessive air-pressure change near moving turbine blades has been linked to bat fatalities as a result of a haemorrhaging of the lungs (pulmonary barotrauma) (Baerwald *et al.* 2008). This is most relevant to bats.
3. 'Avoidance' behaviour caused by the presence of the turbines and associated infrastructure. Depending on where the turbines are located, this may affect foraging patterns, nesting, roosting or movements around the site. It equates to a loss of habitat, if

areas carrying infrastructure are avoided altogether, and therefore can have resultant impacts on the carrying capacity of the site.

The potential bladesweep area of the turbines range from approximately 44 (min) to 156 (max) metres above the ground. Raptors, migratory birds (such as Regent Honeyeater, Silvereye, Satin Flycatcher and Rufus Fantail), nocturnal species and bats are most at risk from these impacts, due to foraging behaviour, flocking or colonial movements, awkward flight characteristics, susceptibility to air pressure change, or night activities (Meredith *et al.* 2002; Airiola 1987 cited in Canada Bird Studies, 2001). These species may also utilise ridge systems for navigation and gliding and are therefore at increased risk of encountering wind turbines.

A literature review of collision and barotrauma impacts on birds and bats and potential mitigation and management options has been undertaken in Appendix G: *Windfarm Risks to Birds and Bats Addendum*. This resource has been used to evaluate species-specific impacts to threatened fauna and within Assessments of Significance (Section 6.4, Appendices D and E), and the non-listed fauna risk assessment (Section 6.4.2, Appendix F).

The risk assessment conducted for threatened and migratory (Assessments of Significance, Appendix E) identified one species: Eastern Bent-wing Bat as being at high risk from collision and barotrauma impacts during the operation of the wind farm.

The proposal has the potential to result in **significant** population-scale impacts from collision and/or barotrauma on the Eastern Bent-wing Bat. Further assessment has been recommended to be undertaken in **January**, coinciding with the peak activity at the Wee Jasper Eastern Bent-wing Bat maternity roost, to determine whether the site is used as a foraging area for the Eastern Bent-wing Bat. This assessment would aim to determine the significance of the risk to the survival of the local population and to develop appropriate risk mitigation measures to manage this risk. The results of this assessment would be documented in a separate report.

The risk assessment conducted for non-threatened species considered that the Wedge-tailed Eagle was at high risk from collision and barotrauma impacts. Species-specific mitigation measures should be implemented to reduce the risk to acceptable levels. This should include:

- Controlling food sources around the turbines. In particular, all carcasses of native, pest and domestic fauna within 200m of each turbine should be removed regularly.

Listed and non-listed species categorised as having a moderate risk from collision and barotrauma are:

Threatened and migratory:	**Rainbow Bee-eater, Square-tailed Kite, Gang-gang Cockatoo, Swift Parrot, Superb Parrot and Barking Owl**
Non-listed species:	**Australian Hobby, Barn Owl, Peregrine Falcon and Silvereye**

High and moderate risk species would be targeted for operational bird and bat monitoring (Section 8.2.2).

8.2.2 Bird and bat monitoring

A Bird and Bat Monitoring Plan would be developed in consultation with biodiversity and engineering consultants. This plan should be implemented prior to commencement of the operation phase and continue for the life of the proposed wind farm. The plan should be developed in coordination with other monitoring plans for the other two Yass Valley wind farm precincts and with other wind farms within the locality (see Section 8.4). The monitoring plan should aim to:

i. Ensure specific recommended mitigation measures outlined in this report are implemented and their effectiveness reviewed and adapted as necessary.

ii. Specify on-going monitoring procedures for the assessment and documentation of all collision and barotrauma-related injuries or mortalities, focusing in particular on moderate and high risk species. Timing for monitoring should be specific to the most at-risk target species.

iii. Specify procedures to investigate and implement adaptive measure to reduce impacts should injury or mortality be found to occur. Injury, mortality and habitat avoidance thresholds should be developed and used to trigger specific management responses to mitigate impacts. Thresholds should be developed with regard to having regard to species reproductive potential, conservation status and experiences at other Australian wind farms.

iv. Ensure that all injuries and mortalities of any threatened or migratory species are reported to DECC.

v. Ensure that all injured fauna are transported from the site and cared for by a suitably trained and experience wildlife carer, such as WIRES.

vi. Specify procedures to review adaptive mitigation measures to ensure their effectiveness at reducing collision and barotrauma related mortality.

vii. Coordinate the monitoring and adaptive actions for all wind farms within the regions to ensure cumulative impacts are appropriately documented and managed.

viii. Develop a standardised and publicly available database to increase the knowledge base on this subject.

Management responses to monitoring threshold exceedance would be dependent on the cause and the impact, but could include:

- Further research and consultation
- Detailed risk modelling and population assessments
- Adjustments or enhancements to turbines and associated infrastructure / implementing deterrents from the rotor impact zone. Examples may include:
    - Flight diversion or deterrent structures, lights, audio or sonar transmitters
    - Blade painting (refer Hodos *et al.* 2001)
    - Modifying habitat around turbines (removing water sources such as dams)
    - Removing local food sources (particularly carcasses) or insect attracting light sources
    - Compensatory off-site habitat protection or enhancement
    - Nest site protection

- Sponsoring the care of injured birds
- The periodic shutdown of one or more turbines to avoid high activity periods such as:
  - Outside of seasonal migration times and high activity seasons
  - in low wind (below 50km/h)
  - during the night (when nocturnal species are active)

8.2.3 Recommended management measures for operational phase

Planning and mitigation measures recommended for potential impacts during the operation phase are set out in Table 8-4.

Table 8-4 Planning and mitigation measures during the operational phase

Risk	Recommendation
A. High risk species	
A.1 Threatened species: Eastern Bent-wing Bat	i. The proposal has the potential to result in **significant** population-scale impacts from collision and/or barotrauma on the Eastern Bent-wing Bat. Further assessment on the Coppabella precinct has been undertaken in January 2009 during peak use of the maternity roost to determine the abundance of the Eastern Bent-wing Bat on the site. The results of the January report would be documented as a separate report. Its recommendations would be supplimentry to the recommendations of this report. ii. Monitoring should target impacts on this species and ensure that that mitigation measures are effective for reducing Eastern Bent-wing Bat mortalities.
A.2 Non-listed species: Wedge-tailed Eagle	i. Potential Wedge-tailed Eagle food sources around the turbines should be controlled. In particular, all carcasses of native, pest and domestic fauna within 200m of each turbine should be removed as often as possible. This could be done in conjunction with bird and bat monitoring, maintenance and general farm activities. ii. Monitoring should target impacts on this species and ensure that that carcass removal is effective for reducing Wedge-tailed Eagle mortalities.
B. Bird and bat monitoring	
	i. A Bird and Bat Monitoring Plan would be developed in consultation with biodiversity experts. This plan should be implemented prior to commencement of the operation phase and continue for the life of the proposed wind farm. The plan should be developed in coordination with other monitoring plans for the local wind farms. Potential aims of this plan are outlined above (Section 8.2.2). ii. Potential management responses to monitoring thresholds are discussed above (8.2.2).

Risk	Recommendation
C. General recommendations	
	i. Infrastructure placement should avoid the constraints identified in Figure 7-1. ii. Marker lights, if required should be minimised in number and fitted to reduce their ability to attract migrating birds and insects. Red lights are preferred, with the least number of flashes per minute. Cowls may also shield the light when viewed from the ground and reduce potential to attract wetland birds taking off at dusk. It is understood that CASA requirements will prevail. iii. Guy lines should not be fitted to towers or associated structures, where possible. iv. The turbine towers should not provide perching opportunities. v. Electrical connection lines should be installed underground where possible. vi. Power poles would be designed to minimise perching and roosting opportunities where practical. vii. Power poles and overhead transmissions would be designed to reduce impacts on birds (for example by using flags or marker balls, large wire size, wire insulation, wire and conductor spacing) in areas of elevated risk of bird strike.

8.3 DECOMMISSIONING PHASE

Decommissioning impacts would be similar but not as extensive as construction impacts. The area of impact would be reduced because underground footings and cabling would not be removed from the site. Access tracks would be upgraded as required. 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.

8.3.1 Recommended management measures for the decommissioning phase

Planning and mitigation measures recommended for potential impacts during the construction phase are set out in Table 8-5.

Table 8-5 Planning and mitigation measures during decommissioning phase

Risk	Recommendation
Decommissioning	i. A flora and fauna assessment should be undertaken prior to decommissioning to identify biodiversity constraints and develop specific impact mitigation measures. ii. Weed and sediment erosion control principles should be developed and implemented. iii. Disturbed ground should be stabilised and rehabilitated as soon as practicable after works.

8.4 CUMULATIVE IMPACTS

The Coppabella Hills Precinct forms part of the Yass Valley Wind Farm proposal involving two other project sites; Marilba Hills c. 5 kilometres to the east and Carroll's Ridge c.20 kilometres to the south-east. Together, these three precincts total up to 185 turbines, 109.22 kilometres of transmissions and 129.3 kilometres of access tracks. The impacts associated with these projects have been assessed separately in Biodiversity Assessments for each precinct.

There are several other wind farms proposed and operating in the region. Most of these are well to the east of the subject site, located near Gunning, Crookwell and Lake George.

The operational and proposed wind farm localities in the district may involve overlapping raptor territories and bird and bat migration routes. Continuing losses of some raptor species with low reproductive rates (such as Wedge-tailed Eagles) could represent a 'mortality sink' which has the potential to affect region-level populations (Jonzen et al. 2005).

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 impacted. 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 will 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 presence of the turbines and transmission easements would provide additional obstacles and hazards to birds and bats. Existing hazards include electricity transmission lines, and air, rail and road traffic. The ongoing monitoring and assessment of the operational impacts of wind farms operating in the region should be consistent, centrally analysed and published to ensure cumulative impacts remain within acceptable limits.

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 needs to be avoided. The location of the proposed wind farm turbines on a largely cleared ridgetop sites, and avoiding impacts to natural woodland communities and habitats, should restrict the potential to affect declining woodland or wetland species. Via the offset plan, there is scope to secure and improve some of these habitats on private property.

8.4.1 Recommended management measures for cumulative impacts

Planning and mitigation measures recommended for potential impacts for managing cumulative impacts are set out inTable 8-6.

Table 8-6 Planning and mitigation measures for managing cumulative impacts

Risk	Recommendation
Cumulative impacts	i. Bird and Bat Monitoring should be consistent for all proposed and existing wind farms within the region, centrally analysed and published to ensure cumulative impacts remain within acceptable limits. ii. Approval of any proposed wind farms should take into account the impacts of existing operational wind farms as well as the potential impacts of other proposed in the district.