

Biodiversity Assessment

LIVERPOOL RANGE WIND FARM – WIND FARM STUDY AREA



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ACRONYMS AND ABBREVIATIONS

AoS	Assessment of Significance
CMA	Catchment Management Authority
C'wth	Commonwealth Government of Australia
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
Durrigere SCA	Durrigere State Conservation Area
EEC	Endangered Ecological Community – as defined by either the NSW <i>Threatened Species Conservation Act 1995</i> or Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (C'wth)
ha	hectares
HBT	Hollow-bearing tree
km	kilometres
IBRA	Interim Biogeographic Regionalisation Australia
m	metres
MNES	Matters of National environmental significance under the EPBC Act
NPW Act	<i>National Parks And Wildlife Act 1974</i> (NSW)
NSW	New South Wales
OEH	(NSW) Office of Environment and Heritage, formerly Department of Environment, Climate Change and Water
POM	Plan of Management
SoC	Statement of Commitment
SIS	Species Impact Statement
sp/spp	Species/multiple species
TSC Act	<i>Threatened Species Conservation Act 1995</i> (NSW)
Turill SCA	Turill State Conservation Area

TERMINOLOGY USED IN THIS REPORT

~	Approximately.
Project Area	The entire proposal area: Defined by extent of landholder boundaries for the Wind Farm Study Area and extent of all infrastructure for the Transmission Line Study Area.
Development Area/Survey area	Development footprint plus a turbine buffer area (50m diameter) to allow for flexibility in the siting of infrastructure.
Development Footprint	The actual area that would be occupied by project infrastructure (i.e. not including the buffer).
Indicative layout	The infrastructure layout assessed in this report. While some minor adjustments are expected during the detailed design process, prior to construction, the indicative layout is considered typical of what is proposed and has been used to calculate impact areas to assist the impact assessment.
The Proposal	The proposed wind farm and transmission line, including approximately 288 turbines and their associated infrastructure, and up to 39 km of transmission line and the associated easement and infrastructure.
Wind Farm Study Area (WFSA)	Wind farm survey area which includes the northern section of the transmission line (subject of this report).
SoC	Statement of Commitment – commitments made by the proponent that would be implemented as part of the project, if approved.
Transmission Line Study Area (TLSA)	Transmission line survey area, includes the central and southern sections of the Transmission line, south of the Wind Farm Study Area (subject of a separate report).
Threatened entity	Refers to all units listed as threatened under the EPBC Act and/ or TSC Act including species, populations and ecological communities.

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1 INTRODUCTION

1.1 THE PROPOSAL

The proposed Liverpool Range Wind Farm project, incorporating the wind farm transmission line, ('the project') is located between the towns of Coolah and Ulan, approximately 370 km northwest of Sydney, on the Liverpool Range, central NSW (refer Appendix E.1 for Site Location Plan). The Project Area for the Liverpool Range Wind Farm, illustrated in Appendix E.1, would be located across the Warrumbungles, Upper Hunter, Liverpool Plains and Mid-Western Regional Local Government Areas (LGAs). The wind turbines would be primarily located in the Warrumbungles and Upper Hunter Regional LGAs. The Project Area is approximately 40 km (east-west) by 50 km (north-south) and occurs within three Catchment Management Authority (CMA) regions:

- 1) Central West CMA;
- 2) Hunter Central Rivers CMA; and
- 3) Namoi CMA.

The proposal would directly involve a large number of properties that are currently used for agriculture and grazing purposes.

The project includes the following infrastructure components:

- Up to 288 wind turbine generators including associated electrical generators (three blades mounted on a tubular tower (165 m);
- High voltage 33 kV transmission line and easement located between Ulan and Cassilis (easement is up to 30 m either side of the transmission line, and up to 38.2 km in length);
- Construction of substations and maintenance facilities;
- Creation of new access tracks and widening of existing tracks; and
- Upgrades to existing public roads.

The indicative infrastructure layout and survey area for the project are mapped in Appendix E.2.

The operational phase of the project would require site access for personnel by light truck or standard 4WD vehicles on a regular basis. A number of permanent onsite staff may be required. The operational life of the wind farm is 30 years, at which time the wind farm may be recommissioned (infrastructure upgraded) or decommissioned (removal of all above ground infrastructure).

The design and layout of the project has been refined based on the findings of the initial 2012 Biodiversity assessment as well as other considerations. These refinements include:

- Deletion of a number of proposed turbine locations in the far north-eastern corner of the Wind Farm due to identification of areas of high ecological significance.
- Identification of additional potential options (Appendix E) for location of the Transmission Line route in the southern part of the Project area:
 - Preferred route – the route that was surveyed in 2012
 - Alternative route – a potential route surveyed in 2013
 - 2nd Alternative route – a second potential route surveyed in 2013

1.2 OBJECTIVE OF THIS ASSESSMENT

A Biodiversity Assessment of the project has been completed by **ngh**environmental (this report). The assessment aims to provide an ecological impact assessment in accordance with the Director-General's Requirements (DGRs) and Environmental Assessment Requirements (EARs) for the Liverpool Range Wind Farm and NSW and Commonwealth legislation relating to threatened and protected species for the project. Specifically, the assessment:

- Identifies threatened species, populations and communities listed under NSW and Commonwealth legislation that have the potential to occur on site;
- Maps existing vegetation type and condition;
- Documents survey methods and effort;
- Demonstrates a design philosophy of impact avoidance, particularly on ecological values of high significance;
- Provides a worst case estimate of vegetation to be cleared, with a break down by vegetation type;
- Assesses the significance of proposed impacts to native vegetation, listed threatened species, populations and communities and their habitats, including consideration of habitat connectivity and wind-farm specific impacts such as blade-strike;
- Where required, includes details of how flora and fauna impacts would be managed during the construction and operation phases of the project;
- Demonstrates how the project achieves a biodiversity outcome consistent with “maintain or improve” principles;
- Addresses the risk of weed spread and identifies suitable mitigation measures to address the risk; and
- Determines the offsetting requirements and identifies suitable offset areas.

This report documents the findings of onsite ecological studies undertaken for the purposes of impact assessment. The report incorporates relevant information from the *Preliminary Ecological Investigation* (**ngh**environmental 2009) as well as providing an impact assessment pursuant to NSW and Commonwealth guidelines for threatened entities within the Project Area. A summary of relevant legislative considerations are given in Section 3.

1.3 APPROACH

1.3.1 Report Structure

This Biodiversity Assessment for the Liverpool Range Wind Farm project focussed on two broad areas:

- 1) All infrastructure associated with the wind farm area (Wind Farm Study Area); and
- 2) All infrastructure associated with the high voltage (33 kV) transmission line (Transmission Line Study Area).

Given the size of the Project Area, results and maps have been presented separately for the Wind Farm Study Area and the Transmission Line Study Area in this report, with the exception of *Section 7 Combined Results* which provides detailed microbat survey results and a discussion of the key ecological issues for the proposal as a whole. Additionally, the total vegetation clearance for the impact assessment has been calculated for each study area.

Interpretation of maps

Map sets presenting survey effort, survey results, and biodiversity constraints are provided for each study area. Each map set contains an overview map and a set of detailed maps. The overview map shows the order in which the detailed maps are referenced and their location within the study area. Each detailed map contains a grid reference which has been used to identify specific areas discussed within the body of the report.

When locations are referenced within the report, they are preceded by a code WF (Wind Farm) or TL (Transmission Line) to denote the relevant study area, then a number (denoting the map sheet), then the grid reference (denoting the exact location). For example, the reference 'WF3_A10' refers to the Wind Farm Study Area, map sheet 3, grid reference A10.

1.3.2 Guidelines and Approach for Assessment

The proposal will be assessed under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), in line with *State Environmental Planning Policy. (Major Projects) 2005*.

DGRs were issued on 31 March 2011 and supplementary DGRs were issued on 16 August 2011 by the NSW Department of Planning and Infrastructure. Recommended EARs were issued by Department for Environment, Climate Change and Water, now Office for Environment and Heritage (OEH) on 24 March 2011 (refer to Appendix A for a copy of the DGRs and EARs). Table 1-1 lists the DGRs and EARs relevant to the Biodiversity Assessment and references the section of this report where these have been addressed.

Table 1-1 Director-General's Requirements (OEH) and Environmental Assessment Requirements (Dept. of Planning) and corresponding report reference.

Director-General's Requirement (Dept. of Planning)	Report Reference
Identify threatened species, populations and communities listed under both State and Commonwealth Legislation with potential to occur on site.	Flora: Sections 5.2, 5.3 & 7.2, 7.4 Fauna: Sections 6.2 & 8.2 Threatened Species Evaluations: Appendix C
Map vegetation by community types and condition.	Map Sets: Appendix E
Mapping should include any Environmentally Sensitive Area Mapping held by the four LGAs.	Not Available from LGAs
Provide details of survey methodology, including survey effort.	Methods: Section 4.2 Survey Effort: Section 4.4
Demonstrate a design philosophy of impact avoidance on ecological values, in particular areas of high significance.	Recommendations: Section 12
Provide a worst case estimate of vegetation clearance (ha).	Impact Assessment: Section 10.3
Assess the significance of impacts to native vegetation, listed threatened species, populations, and communities and their habitats, with consideration for local connectivity and distribution of species.	Impact Assessment: Section 10 Significance of Impacts: Section 11 7 Part tests: Appendix D
Include details of how flora and fauna impacts would be managed during construction and operation including adaptive management, rehabilitation, regeneration measures and maintenance protocols.	Recommendations: Section 12

Demonstrate how the proposal achieves a biodiversity outcome consistent with 'maintain or improve' principles.	Recommendations: Section 12 7 Part tests: Appendix D Offset strategy: Appendix F
Address the risk of weed spread and identify mitigation measures.	Recommendations: Section 12
Environmental Assessment Requirement (OEH)	Report Reference
1) The EA should include a detailed Biodiversity Assessment	Entire Report
2) A field survey of the site should be conducted in accordance with the relevant guidelines (<i>Threatened Biodiversity and Assessment Guidelines for Developments and Activities</i>).	Methods: Section 4
3) Describe the potential nature of barotrauma impacts on threatened bat species and mitigation measures to avoid or mitigate these impacts	Impact Assessment: Section 10
4) The EA should contain the following:	
4a) The requirements set out in the <i>Guidelines for Threatened Species Assessment</i>	Methods: Section 4 Impact Assessment: Section 10 Significance of Impacts: Section 11 7-part tests: Appendix D
4b) Description and geo-referenced mapping of study area (survey locations, vegetation communities, key habitat, location of threatened species, populations and ecological communities present)	Map sets: Appendix E
4c) Description of survey methodologies used, including timing, location and weather conditions	Methods: Section 4 Map sets: Appendix E
4d) Qualifications and experience of Biodiversity Assessment team	Appendix G
4e) Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status	Flora: Sections 5.2, 5.3 & 7.2, 7.4 Fauna: Sections 6.2 & 8.2 Threatened Species Evaluations: Appendix C
4f) Description of likely impacts of the proposal on biodiversity and wildlife corridors (indirect, direct, construction, operational impacts)	Impact Assessment: Section 10 Significance of Impacts: Section 11 7-part tests: Appendix D
4g) Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to minimise impact	Impact Assessment: Section 10 Recommendations: Section 12 Offset Strategy: Appendix F
4h) Description of the residual impacts of the proposal. If the Proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected.	Offset Strategy: Appendix F
4i) Provision of specific Statement of Commitments relating to biodiversity	Recommendations: Section 12
5) An Assessment of Significance of direct and indirect impacts of the proposal	Impact Assessment: Section 10 Significance of Impacts: Section 11 7-part tests: Appendix D
6) Proposal of offset package should:	
6a) Meet DECCW's <i>Principles for the use of biodiversity offsets in NSW</i>	Offset Strategy: Appendix F
6b) Identify conservation mechanisms to ensure the long term protection and management of the offset sites	Recommendations: Section 12 Offset Strategy: Appendix F

6c) Include an appropriate management plan to be developed as a key amelioration measure to ensure offsets, management measures, monitoring programs are appropriately managed and funded	Recommendations: Section 12
7) Where appropriate, likely impacts on any adjoining and/or nearby DECCW estate reserved under the <i>National Parks and Wildlife Act 1974</i>	Impact Assessment: Section 10
8) Identification of any Matters of National Environmental Significance under the <i>Environment Protection and Biodiversity Conservation Act 1999</i>	EPBC Act: Section 3.6 Impact Assessment: Section 10 Significance of Impacts: Section 11 7 Part tests: Appendix D

Specific guidelines used in the preparation of this report include:

- *Draft Guidelines for Threatened Species Assessment* (DEC, 2005);
- *Biodiversity Offset Principles* (OEH);
- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities, Working Draft* (Department of Environment and Conservation NSW, November 2004);
- *National Wind Farm Development Guidelines – public consultation draft* (EPHC 2009); and
- *Australian Wind Energy Association Best Practice Guidelines* (AusWind 2006).

Specifically, this report includes consideration of:

- Impacts to native vegetation;
- Impacts of blade strike on birds and bats;
- Impacts associated with development near to National Parks or State Reserves;
- Management of identified impacts (including details of adaptive management protocols and ability to obtain achievable offsets); and
- Measures to avoid, mitigate and offset impacts, with the objective of ensuring an overall 'improve or maintain' environmental outcome for the proposal.

2 REGIONAL CONTEXT

The installation and operation of wind farms have the following characteristics that make it necessary to examine a broad environmental context when assessing their impact:

- Turbine arrays may cover multiple ridge tops in an area;
- Turbine arrays may interfere with migration paths / movement corridors of local and non-local birds and bats;
- The transmission easements required to connect the wind farms to the electricity grid can be long, potentially fragmenting areas of habitat for flora and fauna;
- Avoidance behaviours by birds may result in indirect loss of habitat if the entire wind farm envelope is avoided.

This information provided within this regional context section was considered in developing the survey plan for the Project Area, including which threatened or high-risk species and/or communities to target and the methods applied. The information has also been considered in the impact assessment in relation to how the potential impact from the proposal may affect important regional resources and the dispersal of native flora and fauna beyond the immediate impact area.

While outside of the scope of the Biodiversity Assessment, it should also be acknowledged that as a renewable energy project, the proposed development would address, to some extent, rising greenhouse gas emissions, and thereby the future impact of climate change, by providing a source of energy that is not dependent on the burning of fossil fuels. Therefore, long term outcomes of the proposal also have positive impacts on biodiversity in that reduction of fossil fuels aim to reduce change in community composition and species decline linked to climate change.

2.1 CMAS AND IBRA SUBREGIONS

The Interim Biogeographic Regionalisation Australia (IBRA) provides an Australia-wide regionalisation for patterns of biodiversity based on climate, geomorphology, landform, lithology and other characteristics (Environment Australia 2000). Each of the 89 IBRA regions is divided into subregions, which group biogeographic patterns at a higher resolution.

The wind farm lies within three Catchment Management Authorities (CMA) and three IBRA subregions. Wind farm:

- Hunter/Central Rivers CMA (Liverpool Range and Pilliga IBRA subregions)
- Central West CMA (Liverpool Range and Pilliga IBRA subregions)
- Namoi CMA (Liverpool Range IBRA subregion)

2.1.1 Hunter/Central Rivers CMA

The Kerrabee and Pilliga subregions of the Hunter/Central Rivers CMA include the sandstone of the Great Dividing Range, the open grasslands and woodlands of the Upper Hunter. In the Hunter-Central Rivers CMA region there are currently 313 entities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) plus 8 species listed on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Of the 313 NSW listings there are 178 vulnerable species, 69 endangered species, 12 critically endangered species, 13 endangered populations, 29 endangered ecological communities (EECs) and two vulnerable ecological communities. The Hunter-Central Rivers CMA is also subject to 35 key threatening processes.

2.1.2 Central West CMA

The Central West CMA covers a wide diversity of landforms and vegetation, with more than 550 vertebrate species recorded in the catchment, in 81 broad vegetation types, with 3183 species of plants. The soil and land types range from sandstones to granites and basalts.

Before European settlement the catchment supported a complex mosaic of forests, temperate and semi-arid woodlands, wetlands, shrub lands, heaths and grasslands. Clearing and subsequent degradation have reduced this natural vegetation cover to a large number of small, isolated remnants on the less fertile and productive soils. For example, the Box and Ironbark woodlands which originally occupied large parts of the slopes and plains have been reduced by as much as 90%, and are now among the most significantly altered plant communities in NSW.

In the Central West CMA region there are currently 154 entities listed under the TSC Act plus five species listed on the EPBC Act. Of the 154 NSW listings there are 93 vulnerable species, 40 endangered species, 3 critically endangered species, and 11 EECs. The Central West CMA Region is also subject to 33 key threatening processes.

2.1.3 Namoi CMA

The catchment is bounded by the Great Dividing Range in the east, the Liverpool Range and Warrumbungle Range in the south, and the Nandewar Range and Mt. Kaputar to the North. The catchment covers a wide diversity of landforms and vegetation, with 91 broad vegetation types, including EECs, such as Box Gum woodlands and native grasslands.

In the Namoi CMA region there are currently 150 entities listed under the TSC Act plus four species listed on the EPBC Act. Of the 150 NSW listings there are 85 vulnerable species, 27 endangered species, four critically endangered species, one endangered population, and 15 EECs. The Namoi CMA is also subject to 33 key threatening processes. In particular, the Pilliga region of the Namoi is also home to the largest population of Barking owls (listed as vulnerable) in Southern Australia. The Namoi is home to a large number of threatened woodland birds such as the endangered Regent Honeyeater and the vulnerable Grey-crowned Babbler.

2.2 LANDUSE AND ISSUES COMMON TO THESE CMAS

The Project Area is largely agricultural, characterised by intensively modified broad floodplains (cereal cropping and grazing) beneath broad basalt ridges (grazing). The midslopes contain the majority of the remnant native vegetation, from sparse to densely treed woodlands.

In particular, the composition and structure of vegetation types within the Project Area has been modified as a result of managed stock grazing as well as grazing by feral goats. Large numbers of feral goats, foxes and rabbits were observed in the Project Area and continue to have a deleterious effect on native vegetation. When goats, rabbits, and stock occupy the same area the resultant combined grazing pressure inhibits plant regeneration on a broad scale. The high abundance of foxes within the Project Area contributes to reduction of fauna biodiversity in an already compromised landscape.

Overall, key biodiversity issues in all CMAs include inappropriate grazing management, habitat degradation and fragmentation, increasing dryland salinity, loss of native vegetation (i.e. clearing of native woodlands and grasslands) and invasive pest species (foxes, goats, environmental, agricultural and noxious weeds), and conserving remnant vegetation on private lands (CMA 2012).

2.3 LOCAL COUNCILS

The Project Area covers four (LGAs): Warrumbungles; Upper Hunter; Liverpool Plains; and Mid-Western Regional.

In particular, Liverpool Plains Shire has endorsed a Biodiversity Strategy for the Liverpool Plains focusing on maintaining and improving biodiversity within the region (ELA 2010). The Liverpool Plains LGA is contained within the Namoi River Catchment, with a common boundary with the Upper Hunter. As the Liverpool Plains LGA is mostly agricultural with both cropping and grazing the need for conservation of natural landscapes is increasingly important.

Liverpool Plains Shire has a variety of biodiversity assets and supports 25 vegetation communities, of which eight are endangered under the TSC Act, and several threatened flora (2 TSC Act, 3 EPBC Act listed species) and fauna species (19 bird species, 20 mammal, 1 reptile species listed under the TSC Act). Of the vegetation communities recorded within the LGA, several fall into the category of the state and nationally EEC Box Gum Woodland which is also found within the Liverpool Range Wind Farm Project Area. This EEC includes White Box, Yellow Box and Blakely's Red Gum Woodland which are some of the most locally abundant vegetation types identified for the LGA covering 77, 900 ha (ELA 2010).

The biodiversity strategy identifies several threats to the LGA, the most serious threats include land clearing, weeds, feral animals, and inappropriate fire regimes. Land clearing, weed and feral animal proliferation is the most obvious threat associated with agricultural practices, especially within the Liverpool Range Wind Farm Project Area. In turn, there is opportunity for this proposal to play an active role in management of the above threats and for development to also result in a positive outcome.

2.4 PROTECTED AREAS

Coolah Tops National Park lies to the immediate east of the north-east corner of the wind farm.

Turrill State Conservation Area (SCA), Durridgere SCA, Goulburn River National Park (NP) and Munghorn Gap Nature Reserve occur between approximately 4 and 44 km to the south of the wind farm. These areas have environmentally important features, including providing habitat for several threatened species including nocturnal birds, woodland birds, and microchiropteran bats. The value of each protected area is provided in more detail below.

2.4.1 Coolah Tops National Park

Coolah Tops National Park lies approximately 2 km east of the wind farm survey area. The Park is one of a series of conservation reserves sampling the basalt country of the Mount Royal and Liverpool Range and is approximately 12 000 ha in area. Located at the junction of the Liverpool and the Warrumbungle Range, Coolah Tops provides a link between the more easterly basalt reserves and Warrumbungle National Park to the northwest.

The Coolah Tops National Park Plan of Management (POM) attributes the regional conservation significance of the park to the following reasons:

- It protects an area of tall montane forest on basalt;
- It lies on a westerly extension of the northern tablelands and thus supports different plant and animal communities to other basalt reserves in the region;

- It has small areas of old growth forest and extensive areas of structurally well-developed Snow Gum including the largest recorded individuals of this species;
- The endangered Grassy White Box Woodland community and the rare plants *Discaria pubescens* and *Teucrium* sp. are found in the park, and it has significant populations of the poorly reserved Silvertop Stringybark and Mountain Ribbon Gum;
- It provides optimum habitat for arboreal mammals, including large populations of The Greater Glider;
- The threatened Regent Honeyeater, Glossy Black Cockatoo, Powerful Owl, Barking Owl, Masked Owl, Common Bent-Wing Bat and Large Pied Bat are found in the park; and
- Many species of native animals are at or near the western limits of their distribution in the park and the park protects the headwaters of several major rivers and creeks (NSW National Parks and Wildlife Service, November 2002; Kavanagh 1995).

2.4.2 Goulburn River National Park and Munghorn Gap Nature Reserve

Goulburn River National Park lies approximately 1.5 km south-east of the transmission line easement. The Park covers approximately 70 100 ha. It extends along approximately 90 km of the Goulburn River. The Central Goulburn Valley group of land systems, of which Goulburn River National Park occupies a large proportion, is dominated by the Goulburn River and its headwaters. Munghorn Gap Nature Reserve lies approximately 4.5 km south of the transmission line easement. The Reserve lies approximately 34 kilometres north-east of Mudgee, adjacent to Goulburn River National Park. The reserve covers approximately 5 900 ha.

The national park and nature reserve are botanically significant as they form part of a transitional zone containing a mixture of plants from the south-east, north-west and western parts of the State; a variety of plant species endemic to the Sydney Sandstone reach their northern and western limits in the Park. Threatened fauna including the Brush-tailed Rock Wallaby, New Holland Mouse, Square-tailed Kite, Powerful Owl, Large Pied Bat, Common Bent-winged Bat, Swift Parrot, Turquoise Parrot, Painted Honeyeater, Glossy-black Cockatoo, Red-tailed Black, Cockatoo, Malleefowl, Regent Honeyeater and the Broad-headed Snake are thought to occur in the park (NSW National Parks and Wildlife Service, November 2002).

2.4.3 Durrigere State Conservation Area

Dependent on the final transmission line route, Durrigere State Conservation Area (Durrigere SCA) will either lie approximately 1.2 km east of the easement, or fall directly in the easement. The SCA was created in 2005 and covers approximately 5 463 ha. Durrigere SCA lies north of Ulan and east of Ulan Road. Durrigere SCA provides a link between the forested areas within private lands to the west and Goulburn River National Park to the south. Prior to its dedication as a state conservation area Durrigere was used as a state forest and heavily logged. As a consequence a mosaic of regrowth and more mature forest (including hollow-bearing trees) exist within the area.

The broad vegetation types of the Conservation Area include Dry Sclerophyll Forest, Grassy Woodlands, and Semi-arid Woodlands. The SCA is known to support several threatened birds (owls and woodland birds) and microbat species. Regularly recorded threatened birds include Varied Sittella, Speckled Warbler, Grey-crowned Babbler, Glossy Black-cockatoo and Barking Owl. As with Goulburn River NP, a

number of species endemic to the Sydney region reach their western limit here, a good example of which is the Rock Warbler (*Origma solitaria*).

2.4.4 Turill State Conservation Area

Turill SCA is found towards the northern end of the Transmission Line Study Area and south of the Wind Farm Study Area. It covers an area of approximately 996 ha, making it approximately 18% of the size of Durridgere SCA. The majority of Turill SCA consists of undulating Pilliga sandstone, although there is at least one area in the southwest corner where the underlying rock is basalt. The sandstone areas of the SCA are vegetated with Sandstone Forest communities consisting of Ironbarks and Cypress Pines, and where basalt is present, the vegetation becomes typical Box Gum Woodland. In the immediate vicinity of creeklines the vegetation becomes more of an open Riparian Woodland community containing Rough-Barked Apples (*Angophora floribunda*), Blakely's Red Gum (*Eucalyptus blakelyi*), and Yellow Box (*Eucalyptus melliodora*). The vegetation within Turill SCA is known to contain a number of flora species found at their eastern or western limits, and also provides habitat for a mix of coastal and inland bird species.

2.5 LANDSCAPE CONNECTIVITY

The term 'landscape connectivity' describes the broad spatial configuration of areas of vegetated lands and includes a consideration of barriers to connectivity such as roads, clearing and rows of turbines (Lindenmayer & Fischer 2006; Brett Lane & Associates 2009). Connectivity is maintained through intact forest and woodland, 'corridors' of vegetation and 'stepping stones' (i.e. scattered trees; or patches of shrubs or trees that act as stepping stones across an otherwise cleared landscape). Such connectivity may be used by fauna to traverse generally inhospitable landscapes, allowing for immigration and emigration from populations that may not otherwise occur. This may help to alleviate issues such as inbreeding depression and the effects of demographic stochasticity that can increase the risk of extinction for isolated or small populations. However, it has also been suggested that corridors may also transmit contagious diseases between habitat patches, expose native fauna to predators, exotic and domestic animals and poachers, and produce other negative effects (Simberloff & Cox 1987).

The Project Area comprises a series of broad ridges and valleys, within the Liverpool Range. Aerial imagery demonstrates the site itself varies between cleared and sparsely treed areas of vegetation. At a local scale the Project Area is densely treed to the north, north-east of the wind farm (Coolah Tops National Park and surrounding private landholdings) and at the southern end of the transmission line.

At a regional scale, the Project Area can be seen to be located with a loop of connecting woodland and forested habitat. Vegetation in the northern tip of the Project Area facilitates east-west linkages towards areas of forest to the east (Coolah Tops National Park). Vegetation in the southern sections of the Project Area facilitate east-west and southern connectivity to extensive areas of protected forest (Durridgere SCA, Goulburn River National Park and Wollemi National Park).

Between the Project Area and the additional forested areas to the east, vegetation is patchy. This pattern of habitat and connectivity, while patchy and therefore compromised in some locations, may allow for an increased level of fauna activity within the Project Area. Particularly for fauna, such as birds and bats, which are highly mobile and have large ranges, and which are tolerant of some level of disturbance (clearing and habitat modification).

3 STATUTORY CONSIDERATIONS

3.1 NSW ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The EP&A Act provides for a co-ordinated approach to development and includes the objective to encourage protection of the environment including threatened species, population and ecological communities listed under the TSC Act. Section 5A of the EP&A Act provides a list of factors that must be considered in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats. While not required for Part 3A assessments, they are a systematic and transparent means to characterise impacts, allowing for the development of mitigation measures to avoid a significant impact.

The proponent obtained DGRs to guide the assessment of impacts of the Liverpool Range Wind Farm, under Section 75F, Part 3A of the EP&A Act. Part 3A has since been repealed but transitional arrangements are in place to deal with such projects. It is understood that the submission will be assessed by the NSW Department of Planning and Infrastructure, under the provisions of Part 3A.

The recommendations in this report would form Statements of Commitment (SoCs), formulated to avoid impacts where possible, minimise where avoidance is not possible and offset residual impacts to ensure the 'improve or maintain' environmental outcome is met.

3.2 NSW THREATENED SPECIES CONSERVATION ACT 1995

The TSC Act lists threatened flora and fauna species, populations and ecological communities ('threatened entities') and key threatening processes in Schedules 1 through to 3. The TSC Act gives provisions for recovery plans, threat abatement plans and action statements. The Director-General (D-G) for the Office of Environment and Heritage (within the Department of Premier and Cabinet) must consider the effect of the proposal based on the factors listed in Section 94, which match those in Section 5A of the EP&A Act (assessment of significance). The D-G may grant a licence to harm threatened entities, which may include conditions.

This report considers threatened entities and critical habitat that may occur in the Project Area and the affect that the proposal may have upon them, including key threatening processes. Assessments of significance are undertaken in accordance with the *Threatened Species Assessment Guidelines: the assessment of significance* (DEC 2007).

3.3 NSW NATIONAL PARKS AND WILDLIFE (NPW) ACT 1974

The D-G for the Office of Environment and Heritage (within the Department of Premier and Cabinet) is the authority for the protection and care under the *NSW National Parks and Wildlife Act 1974* (NPW Act) of protected fauna (Part 7) and native plants (Part 8), including threatened entities (Part 8A). This report considers threatened fauna and flora that may occur in the Project Area and the affect that the proposal may have upon them.

The NPW Act also provides a mechanism for conservation on private land under Part 4 Division 69. A Conservation Agreement provides legally binding protection for private land, with conditions attached to the land title.

The proponent commits to securing a formal vehicle to manage an offset site in perpetuity; however a Property Vegetation Plan rather than a Conservation Agreement is proposed. Property Vegetation Plans are set up by catchment management authorities and are attached to the land title. The offset strategy outline is provided in Appendix C to ensure that an overall ‘maintain or improve’ outcome is met for the proposal.

3.4 NSW FISHERIES MANAGEMENT (FM) ACT 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve fish stocks and key fish habitats including threatened species, populations and ecological communities of fish and marine vegetation. The FM Act is administered by the D-G of the Department of Industry and Investment. There are a range of activities that may come under the jurisdiction of this act.

The FM Act covers freshwater and marine habitats and species. Freshwater includes any body of freshwater that is naturally or artificially stored. Any dredging or reclamations works (which includes removing material from land submerged by water, filling in or depositing any material onto land submerged by water or draining water to reclaim land) requires consideration under the FM Act, unless it is an artificial waterbody not connected to a natural waterbody.

Division 8 provides that the passage of fish must not be blocked by obstructions unless a permit under the Act has been obtained. This affects proposals that include water crossings.

Part 7A provides for the listing of threatened species, populations and ecological communities (threatened entities) and key threatening processes. Any development should consider harm to threatened entities as required by the EP&A Act.

3.5 STATE ENVIRONMENTAL PLANNING POLICY NO. 44 – KOALA HABITAT PROTECTION

This policy encourages the conservation and management of natural vegetation that provides habitat for Koalas. Koalas are listed under the TSC and EPBC Acts as a vulnerable species. Liverpool LGA is subject to this State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44); this LGA is the only shire of the four LGAs detailed on Schedule 1 of the Policy. Liverpool LGA cannot approve development in an area affected by the policy without an investigation of core koala habitat. SEPP 44 aims to identify areas of potential and core Koala Habitat. These are described as follows:

- **Potential Koala Habitat:** areas of native vegetation where the trees listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component; and
- **Core Koala Habitat:** an area of land with a resident population of Koalas, evidenced by attributes such as breeding females, and recent and historical records of a population.

This report considers whether any part of the Project Area could be described as potential or core koala habitat under SEPP 44.

3.6 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION (EPBC) ACT 1999 (CWTH)

The EPBC Act aims to conserve native flora and fauna species of national conservation significance including threatened and migratory species, communities and populations, termed ‘Matters of National Environmental Significance’ (MNES). If there is potential for a MNES to be impacted because of a proposed development, the nature and potential magnitude of impact must be characterised according to the *Significant Impact Guidelines* (2006). This will determine whether an action is likely to have a significant impact on MNES, in which case the proposal must be referred to the Federal Minister for assessment and approval.

A protected matters search was completed for MNES of which 26 threatened species, five vegetation communities, 14 migratory birds, and one wetland of international importance was returned (Hunter Estuary Wetlands). The Hunter Estuary Wetland is situated on the northern edge of Newcastle and is not considered further in this assessment as it will not be affected by the proposal. Threatened species evaluations were undertaken and are provided in Appendix C. The proposal was not considered to have a significant impact on any listed EPBC threatened species. There is potential for impact on one Critically Endangered Ecological Community (CEEC), Box Gum Woodland and further assessment was applied to this community (refer to Sections 10 and 11, Appendix D).

4 METHODS

4.1 DESKTOP ASSESSMENT

4.1.1 Background Research

Existing information relevant to the proposal was reviewed, including:

- Aerial imagery;
- DoE (formerly DSEWPac) website for Species Profiles and Threats (SPRATs), recovery plans, conservation advice and policy statements for nationally listed species and ecological communities;
- Birds Australia and Shorebirds 2020 websites; and
- Web-based literature, journal articles and other published information on bird migration patterns and bird collision risk associated with wind turbines (cited in the text where used).

This information was used to build a picture of:

- Native vegetation types within the Project Area and immediate surrounds;
- Previous survey effort in the area;
- Vegetation associations present (including associations of significance);
- Flora and fauna species (including species of national, state or local conservation significance) known or likely to occur in the area;
- Potential ecological constraints and opportunities for the proposal; and
- Key threatening processes (e.g. weeds, pest animals) that may require specific management.

4.1.2 Database Searches

A desktop assessment was undertaken involving database searches of NSW and Commonwealth listed entities. The desktop assessment included searches of the following databases:

- 1) *Atlas of NSW Wildlife database*, searched by the three CMAs (searched 3 October 2012, updated searches 5 November 2013). Database results returned: 46 flora species; four amphibian, 12 microbat, 54 bird, one invertebrate, 12 mammals (excluding bats), five reptile species, and six vegetation communities listed as threatened for the three CMAs.
- 2) EPBC Act *Protected Matters Search Tool*, using the Project Area boundary as the search area with a 10 km buffer (searched 3 October 2012, updated 5 November 2013). Database results returned included: 26 threatened species, five vegetation communities, 14 migratory birds, and one wetland of international importance.

The results of the above database searches were combined and are presented in Appendix C.

Other key web-based databases including NSW Threatened Species database, Birdlife Australia Birddata database and the Commonwealth Species Profile and Threats (SPRAT) were consulted in the preparation of this report.

Threatened Species, Populations, and Vegetation Communities Evaluations

A threatened species evaluation has been undertaken to evaluate the presence of habitat in the proposed wind farm and the likelihood of occurrence and impact from the proposal development for each species and community returned from database searches (NSW Wildlife Atlas and EPBC Protected Matters Search). The potential for these entities to occur on the wind farm site was evaluated following field work based on specific habitat preferences and site characteristics.

In the evaluation, the presence of habitat rated as either:

Present: Potential or known habitat is present within the Project Area.

Marginal: Habitat present is not typical but may be suitable, or habitat is typical but condition is poor or microhabitat requirements are not present.

Absent: No potential or known habitat is present within the Project Area.

There are four categories for likelihood of occurrence:

None: Species known or predicted to occur within the locality but no suitable habitat present within the Project Area.

Unlikely: Species known or predicted within the locality. Suitable habitat may be present in the Project Area but the proximity of nearest records suggests it is unlikely to occur.

Possible: Suitable habitat present and the species could occur in the Project Area based on the proximity of nearest records.

Present: Species was recorded during the field investigations.

Based on the habitat present and the likelihood of occurrence categories above, a threatened species will be placed into one of the four categories for potential for impact:

No: The proposal would not result in an impact to this species.

Low: The proposal is unlikely to result in an impact to this species. No Assessment of Significance (AoS) is considered necessary for this species.

Moderate: The proposal could impact this species or its habitats but risks are considered highly manageable. No Assessment of Significance (AoS) is considered necessary for this species. Management measures have been developed to address the risks.

High: The proposal is likely to impact this species or its habitats. An AOS has been applied to these entities to properly characterise the impact and provide information then used to either develop management measures to protect the entity or justify avoidance of the entity.

An assessment of significance was applied to those considered a Moderate or High risk (refer to Appendix C). Therefore evaluation of threatened entities has been undertaken at two points: evaluation of likelihood of occurrence and then evaluation of risk of impact. Recommendations (Section 12) have been formulated prior to final impact assessment. Finally, in Section 11 a conclusion is drawn about the significance of impacts under the EP&A Act and the need for a referral of the proposal to the Commonwealth under the EPBC Act. The conclusion assumes the effective implementation of the stated recommendations.

4.2 FIELD SURVEY METHODOLOGY – FLORA

4.2.1 Survey Personnel

Flora surveys in the wind farm project area were conducted by three botanists:

- Jackie Miles (JM);
- Brenton von Takach Dukai (BVT) and
- Kelly Simpson (KS).

4.2.2 Survey Effort (2012-2013)

The total survey effort completed for the Wind Farm Study Area is shown in Table 4-1. A total of 52.3 hours was spent in survey effort for flora within the WFSA.

Table 4-1 Wind farm flora survey effort summary.

Date	Method	Target Species	No. Surveys	Effort - Time			Effort - Area	
				Time Spent	No. People	Total (hrs)	Area Covered	Known Total (ha)
Oct 8-19 2012 Oct 1-9 2013	Random meanders (including targeted searches)	All flora species	79	30 mins ea.	1	39.5	50m X 50m	19.75 ha
	Inspection searches	All flora species	77	10 mins ea.	1	12.8	25x25 m	4.81 ha
						52.3 hrs		24.56 ha

4.2.3 Detailed Survey Methods

The flora assessment approach was designed to achieve suitable site coverage of the Wind Farm Study Area, as well as incorporate more specialised surveys to compile detailed species lists, collect data on structural and floristic characteristics and review significant flora species considered potential occurrences in the study area. The flora survey program developed for the site consists of a series of complementary assessment and survey techniques.

The majority of the flora survey program in the Wind Farm Study Area was completed in 2012 with additional areas surveyed in October 2013.

Prior to the commencement of the field survey program, a series of field maps were produced identifying:

- The proposed route options for the transmission line from Ulan in the south to the southern extent of the Wind Farm Study Area;
- Proposed areas suitable for locating turbines within the Wind Farm Study Area;
- Proposed locations of overhead powerlines, underground powerlines, substations and access tracks within the Wind Farm Study Area; and
- Recorded locations of threatened flora from the Atlas of NSW Wildlife.

This data was uploaded to field GPS units to allow for identification of proposed infrastructure locations in the field.

These maps were analysed to ensure that the field survey would include assessment of all vegetation types and a suitable distribution of survey effort across the site. The majority of areas subject to disturbance from powerlines and installation of turbines were surveyed by vehicle or on foot. Some sections of the Wind Farm Study Area could not be surveyed as a result of property access issues at the time of survey. For some areas, particularly on largely cleared and disturbed ridges of the wind farm, areas were surveyed visually from neighbouring ridges or roadways due to time constraints. The survey effort maps make clear which areas were inspected and to which areas results data was extrapolated based on these inspections.

Flora plot / random meanders

Formal random meanders (after Cropper 1993) of between 15 and 45 minutes duration (depending on the vegetation condition and patch size) and each covering up to 1 ha were undertaken at 79 sites within the Wind Farm Study Area, sampling each vegetation type occurring on the site. The random meander was used in preference to standard 0.04 ha quadrats because it maximises the opportunity to detect all the species present in a particular vegetation type at a particular location and improves opportunities for detecting significant or sparsely distributed plant species. Floristic, structural and physical data were recorded as for a quadrat. Cover abundance scores were recorded for the majority of sites according to a modified Braun-Blanquet cover abundance scale¹, with the score applying to general abundance in the area of the random meander. The flora plot field data sheet developed for the project is included in Appendix B.1.

Inspections and targeted searches

In addition, the majority of the study areas were inspected by vehicle to confirm vegetation types and assist with mapping the distribution of EECs. EECs and areas of natural vegetation in better condition were usually assessed by random meander, while more disturbed vegetation received only a short inspection. Dominant species occurring at the sites were recorded to adequately confirm the vegetation type and condition where necessary. Another 77 locations were assessed briefly in this way, making a total of 156 vegetation assessment locations within the Wind Farm Study Area.

Targeted searches for potential threatened flora species were undertaken within survey sites and areas of suitable habitat where access and time constraints permitted. Dedicated searches were not undertaken for threatened grass species during this survey, as most native grasses were not flowering and therefore not identifiable in the time frame of the surveys (October). In general the low habitat quality of the Wind Farm Study Area suggests that threatened flora would not be expected, due to the long grazing history of many parts of the site.

Not all of the proposed turbine ridges were accessible by vehicle. Two or three which appeared to be more heavily treed than average were walked to from nearby roads. Those which were lightly treed and appeared similar to those which had been more closely surveyed were merely viewed from a distance through binoculars and photographed. It is considered that this is not a significant limitation, since many of the ridges which were traversed were very similar in condition and species composition and extrapolation from these ridges is considered reliable and adequate.

Understorey condition assessment

Condition assessment was undertaken at all random meander and inspection points within the survey area. Vegetation across the broader site boundary has not been assigned a condition class as surveys of

¹ modified from that described by Mueller-Dombois and Ellenberg 1974

the detail necessary to ascertain condition were not undertaken in these areas. Vegetation condition was most closely assessed within the turbine envelopes.

Vegetation surveyed was rated according to a six-point condition class scale, focusing on floristic integrity in the understorey (Table 4-2).

Biometric assessment: condition categorisation

The Biobanking assessment pathway was not used for this assessment. However, the following text relates the vegetation condition classes used in this assessment to those defined under the NSW OEH Biometric guidelines (DECC 2008a) (outside of this section, all condition categories discussed are as defined in the first column of Table 4-1 and not the biometric condition classes).

Under the Biometric guidelines,

Native woody vegetation is in low condition if:

- The over-storey per cent foliage is <25% of the lower value of the over-storey per cent foliage cover benchmark for that vegetation type, AND
- <50% of vegetation in the ground layer is indigenous species or >90% ploughed or fallow

Native grassland or herbfield is in low condition if:

- <50% of vegetation in the ground layer is indigenous species or >90% ploughed or fallow.

If native vegetation is not in low condition then it is considered to be in moderate to good condition. Hence, for some open woodland communities, treeless native pasture derived from woodland and dominated by native grasses would be classed in 'moderate to good' condition under this categorisation (depending on the overstorey benchmark). Similarly, areas where the groundcover is exotic but suitable overstorey cover is present would also be classed in 'moderate to good condition'.

Application of condition ratings to current survey

Table 4-2, below, demonstrates how the two-class biometric condition classes relate to the six-point condition class scale used in this survey. The six-point scale was used to provide greater differentiation between condition classes, useful in considering the significance of impacts.

The six classes presented in Table 4-2 are most relevant for vegetation types with a grassy groundcover, such as Box Gum Woodland. They are less applicable to shrubby vegetation on sandstone in the transmission line part of the site, where virtually all of the vegetation is in 'good' condition in the sense that it is relatively undisturbed and free of exotic species. However, forest on low fertility sandstone derived soils tends to have few species in the groundcover and many shrubs, so in the above rating scheme it would be rated as only moderate-good at best. This is probably a reasonably accurate condition assessment as much of the forest has been logged and is regrowth. However, its condition was generally rated as good, unless it was clearly affected by grazing along edges or was young regrowth.

The wetter forest community occurring in the very highest part of the Wind Farm Study Area also is not dealt with adequately by this rating system. This forest type, dominated by Mountain Gum and Silvertop Stringybark, naturally has lower groundcover diversity than the grassy woodlands of the lower elevations. It was generally found to be in good condition wherever it occurs as intact stands, is relatively undisturbed and has few exotic species. Where the community occurs as scattered trees or clumps it is generally in poor condition, since pasture "improvement" was found to be more common in the higher, wetter parts of the site, and exotic grasses and legumes dominate the groundcover in these areas.

Table 4-2 Six-point condition class scale.

Condition class	Characteristics	CEEC	EEC	Biometric condition
Exotic	Groundlayer dominated by exotics, no native overstorey present.	No	No	Low
Poor	Trees absent to very sparse and groundlayer dominated by one or two native grass species, <5 native non-grass species OR native overstorey present and groundlayer dominated by exotics.	No	Yes	Low
Poor-moderate	Groundlayer dominated by native grasses, 5-11 native non-grass species present in very low numbers.	No	Yes	Moderate-Good
Moderate	Groundlayer dominated by native grasses, 5-11 native non-grass species present and common.	No	Yes	Moderate-Good
Moderate-good	Groundlayer dominated by native grasses with a diversity of native non grass (at least 12 native non-grass species).	Yes	Yes	Moderate-Good
Good	Groundlayer dominated by native grasses with a diversity of native non grass (at least 20 native non-grass species)	Yes	Yes	Moderate-Good

4.3 FIELD SURVEY METHODOLOGY - FAUNA

4.3.1 Survey Personnel

Fauna surveys in the Wind Farm Study Area were conducted by six field members:

- Mark Free (MF);
- Rena Gaborov (RG);
- Paul Shipway (PS);
- Frank Bird (FB);
- Deb Frazer (DF);
- Brenton von Takach Dukai (BVT)

4.3.2 Survey Effort

The total survey effort completed for the Wind Farm Study Area is shown in Table 4-1. A total of 259.2 hours was applied to survey effort for fauna in the Wind Farm Study Area. Generally, the number of hectares covered for the Wind Farm Study Area has been provided, however this was not possible for nocturnal survey effort.

Table 4-3 Wind farm fauna survey effort summary.

Date	Method	Target Species	No. Surveys	Effort - Time			Effort - Area	
				Time Spent /survey	No. People	Total (hrs)	Area Covered	Known Total (ha)
Oct 8-19 2012	Habitat assessment, including Hollow-bearing tree survey	All species	84	20 mins ea.	1	28	50x50 m	21
Oct 1-9 2013	Bird survey	All birds	85	10 mins ea.	1	13.2	50x50 m	21.25
	Herpetofauna search	All reptiles	79	10 mins ea.	1	13.2	50x50 m	21.25

Date	Method		Target Species	No. Surveys	Effort - Time			Effort - Area	
					Time Spent /survey	No. People	Total (hrs)	Area Covered	Known Total (ha)
	Bird utilisation survey		All birds	24	30 mins ea.	1-2	12 hrs	~100x100m	24
	Extended Herptofauna search		All species	11	30 mins ea.	1-2	5.5 hrs	50x50m	2.75
	Nocturnal Survey	Stagwatching / Evening listening	All nocturnal fauna, with focus on threatened species*	15	20 mins ea.	2	10hrs	N/A	N/A
		Spotlighting - On-foot	All nocturnal fauna, with focus on threatened species*	15	60 mins ea.	2	30hrs	N/A	N/A
		Spotlighting - Vehicle-based	All nocturnal fauna, with focus on threatened species*	13	30 mins ea.	2	13hrs	N/A	N/A
		Call Playback	All nocturnal fauna, with focus on threatened species**	13	30mins ea.	2	6.5hrs	N/A	N/A
		Anabat	Microchiropteran Bat species	16	8 hrs		128hrs	N/A	N/A
							259.2hrs		90.25 ha

- *Powerful owl, Barking owl, Masked owl, Squirrel glider, Brush-tailed phascogale, Koala, Grey-headed flying-fox, Bush stone-curlew, Yellow-bellied glider, Spotted-tailed quoll
- **Powerful owl, Barking owl, Masked owl, Squirrel glider, Koala

4.3.3 Detailed Survey Methods

Habitat assessment was the primary survey method for species with potential to be affected by the project. For the Wind Farm Study Area, targeted surveys focussed on fauna known to be most affected by wind farms, that is, fauna with potential for blade-strike impacts (birds and bats). Fauna effort is detailed in Section 4.3.2 and mapped in 'Fauna survey effort' in Appendix E.2.

The majority of the fauna survey program in the Wind Farm Study Area was completed in 2012 with additional some additional areas surveyed in October 2013. Additional areas surveyed in 2013 are shown on Survey Effort maps – Detailed – Maps 1, 2, 6 and 8 (Appendix E).

The fauna assessment approach was designed to achieve suitable site coverage of the Wind Farm Study Area, as well as incorporate more specialised surveys to target significant fauna species considered potential occurrences to gain a deeper understanding of the suite of vertebrate fauna occurring in the

area. The fauna survey program developed for the site consists of a series of complementary assessment and survey techniques:

Habitat assessment & fauna point surveys

Prior to the commencement of the field survey program, a series of field maps were produced identifying:

- The proposed route options for the transmission line from Ulan in the south to the southern extent of the Wind Farm Study Area;
- Proposed areas suitable for locating turbines within the Wind Farm Study Area; and
- Proposed locations of overhead powerlines, underground powerlines, substations and access tracks within the Wind Farm Study Area.

This data was uploaded to field GPS units to allow for identification of proposed infrastructure locations in the field.

These maps were analysed to ensure that the field survey would include assessment of all habitat types and a suitable distribution of survey effort across the site. The majority of areas subject to disturbance from clearing for the transmission line and other powerlines, installation of turbines or creation of access tracks were surveyed by vehicle or on foot. Some areas of the wind farm could not be surveyed as a result of land access issues at the time of survey. For some areas, particularly on largely cleared and disturbed ridges of the wind farm, areas were surveyed visually from neighbouring ridges or roadways due to time constraints.

At regular intervals along the transmission line and wind farm ridgelines, fauna point surveys were completed. These fauna point surveys consisted of:

- Completion of a Fauna Habitat Assessment data sheet, which involved an assessment of site habitat characteristics including abundance of mature trees, tree hollows and rock habitats, presence of waterbodies, dense groundcover and shrub layer and/or mistletoe and identification of microhabitats suitable for significant fauna species;
- A 10 minute bird census;
- A 5-10 minute herpetofauna search including lifting of fallen logs and surface rock; and
- A 5 minute tracks, scats and signs search for evidence of fauna use.

The fauna habitat assessment field data sheet is provided in Appendix B.1.

Targeted surveys

Targeted surveys included use of more “in-depth” survey techniques to target significant fauna species, fauna groups most at risk from “blade-strike” or barotrauma and nocturnal fauna. These specialised surveys include:

- Morning and dusk bird surveys. These surveys consisted of a minimum 0.5 hr bird survey at locations identified as having generally higher habitat values for bird species. Bird utilisation surveys including recording abundance and behaviour and classifying flight height of birds recorded. All bird surveys were carried out by very experienced bird observers using good quality high-powered binoculars;
- Herpetofauna surveys. These surveys consisted of a minimum 20 min active search for reptiles at locations identified as having generally higher habitat values for reptiles, particularly significant species.

- Microbat census using ‘Anabat’ ultrasonic microbat call detection recording equipment. Three Anabat units were used during the survey at different locations across the site. In all, 15 locations were surveyed for a total of 21 nights of Anabat recording. Anabat data was analysed by Dr Greg Richards following completion of the survey program; and
- Nocturnal surveys including call playback and spotlighting, focussing on threatened owls and mammals in suitable habitat. Call playback was undertaken following the methods of DEC (2004) and included a 10 minute initial listening period followed by broadcast of recorded calls of the Powerful Owl, Barking Owl, Masked Owl, Squirrel Glider and, in most cases, Koala. Each call was followed by a 5 minute listening period. Spotlighting surveys then consisted of survey of the call playback location and adjacent areas for generally 30 mins to 2 person hours on foot. Vehicle based spotlighting was used as a supplementary survey technique where possible.

In addition, opportunistic fauna sightings were recorded during the course of the survey program and the following were recorded by hand-held GPS to assist spatial analysis:

- All raptor sightings;
- All threatened species sightings; and
- All habitat features of importance.

Further details on fauna survey techniques utilised are discussed below.

Habitat assessment

The standard datasheets used recorded information about the vegetation structure and habitat components of a site, including leaf litter, fallen timber, hollow-bearing trees, rock features, presence of water and canopy connectivity. Habitat quality was classified as either absent, poor, average, good or excellent for various fauna groups. Fauna habitat quality² is rated on the presence of the following components:

- Diverse structure, that is, structural components at a range of stratum levels (understorey, midstorey, canopy) and age or size classes (trees of different ages, fallen timber of different sizes);
- Shelter and refuge, that is, low shrub or tussock, rocky outcrops, hollow logs (ground dwelling fauna);
- Mature trees, which are more likely to bear hollows and mature hollow-bearing trees, which are more likely to bear multiple hollows of a range of sizes, including those with large internal dimensions. Mature trees also produce more foraging resources for nectar and seed eating fauna;
- Habitat complexity, including ecotones³ between vegetation types, or areas with different management regimes, which produce a habitat mosaic. Within a habitat patch, there may be a recently disturbed area, as well as a mature area with little recent disturbance. This increases the range of foraging and shelter opportunities within a habitat; and

² Habitat ‘quality’ and vegetation ‘condition’ classes are not interchangeable, as different criteria are used to distinguish fauna and flora values.

³ Ecotones are transition zones, where one habitat element grades into another. These zones are usually more bio-diverse, as they contain resources used by a greater number of species, ie the pasture/forest edge is used by both pasture and forest species.

- Key habitat components such as hollow-bearing trees, Glossy Black-cockatoo feed trees and mistletoe.

Bird utilisation survey

- The area search method was used for bird surveys with 30 minutes duration;
- Birds were recorded by sight and vocalisations. Field guides were used for visual identification including Pizzey & Knight (2003) and Simpson and Day (1999). Song-based identification was based on Bird Observers Club of Australia recordings (1998);
- Species present within the search area, flying overhead and outside the search area were recorded; and
- As well as species observed, the following variables were recorded: number of individuals; distance from observer; flight height; and bird behaviour. Flight height was broken into four classes: 0-20 metres above the ground, 21-40 metres, 41-165 metres and greater than 165 metres above the ground. The third class (40-165 metres) represents the potential turbine blade-sweep area; a higher risk of collision is present for species flying at this height.

Herpetofauna search

- Depending on habitat extent and quality, searches varied between 15 and 45 minutes;
- One significant reptile species was targeted: Pink-tailed Worm-lizard (*Aprasia parapulchella*); and
- Active searching was undertaken in suitable habitat including rolling rocks, logs, and other debris. Rocks and logs were scanned for basking individuals prior to active searching. The species was targeted in rocky outcrops particularly those on slopes within grassland and woodland. The Pink-tailed Worm-lizard was targeted by rolling debris (rocks, logs, bark, etc.) in areas of potential habitat.

Microchiropteran bat surveys (Anabat)

Microchiropteran bats were surveyed using a ground-based Anabat detector (passive survey). The detector was left in place overnight in locations chosen to maximise the potential for detecting multiple species of bats, such as in likely flyways through vegetation, along drainage lines and near dams. Recording was typically from approximately 30 minutes before sunset to daybreak the following morning.

Nocturnal surveys (Evening listening and stagwatching; spotlighting; call playback)

Evening listening / stagwatching

Evening listening involved observing hollows and listening for fauna activity, particularly owls, for approximately 30 minutes before and after sunset.

Spotlighting

Foot-based and vehicle-based spotlighting was undertaken using an area search method searching for nocturnal, arboreal and scansorial vertebrate fauna along the edge and through the middle of patches of vegetation. Spotlighting was conducted using hand-held 12v 50w spotlights. Surveys were of variable duration from 15 minutes to two hours. The length of vehicle-based transects was determined by length of track suitable for spotlighting. Foot-based spotlight surveys were undertaken by one spotlight operator and vehicles-based surveys were undertaken by one to two spotlight operators (not including the driver).

4.4 WEATHER CONDITIONS DURING SURVEY PERIOD

Weather data for the field survey periods (8 – 20 October 2012 and 1 – 9 October 2013) has been taken from the nearest weather station, Merriwa station 061287, and is presented in Table 4-4. Both rainfall and temperature data is available from this station (Bureau of Meteorology 2012/2013).

Weather

Table 4-4 Weather data recorded at Merriwa weather station during the field week 8/10/12 – 20/10/12

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Direction of maximum wind gust	Speed of maximum wind gust (km/h)	Time of maximum wind gust	9am Temperature (°C)	9am relative humidity (%)	9am cloud amount (oktas)	9am wind direction	9am wind speed (km/h)	9am MSL pressure (hPa)	3pm Temperature (°C)	3pm relative humidity (%)	3pm cloud amount (oktas)	3pm wind direction	3pm wind speed (km/h)	3pm MSL pressure (hPa)
8/10/12	3.4	21.7	0	ESE	35	8:03	13.1	68		ESE	24	1016.1	20.9	31		NW	11	1011
9/10/12	1.5	22.4	0	WSW	43	14:08	12.7	65		WSW	9	1012.8	21	29	3	WSW	20	1009.7
10/10/12	2.1	25.7	0	NW	48	13:37	12	74		WSW	9	1012.7	24.8	27		WNW	24	1007.5
11/10/12	7.6	18.4	1.2	W	56	13:34	10.3	94	8	NNE	9	1005.9	16.7	40	3	W	28	1005.4
12/10/12	2.3	16.4	0.6	SW	56	13:19	8.3	74	8	WNW	33	1011.2	13.3	58	7	WSW	31	1013.5
13/10/12	4.9	20.7	0.8	WNW	37	11:29	12.3	57		W	17	1021.1	19.2	32	2	W	17	1018.8
14/10/12	2.8	21.1	0	ESE	28	12:33	10.4	81		W	6	1025.4	19.6	34		SE	13	1022.7
15/10/12	1.2	27.1	0	WNW	48	15:21	13.3	67		WNW	7	1026.8	26.3	19		W	15	1022.3
16/10/12	5.4	30.6	0	NNW	35	14:42	18	39		WSW	11	1022.5	30.2	17		NW	24	1017.4
17/10/12	14.9	31.2	0	WNW	46	12:50	23.5	34		WNW	24	1017	30.5	17		WSW	24	1014.9
18/10/12	11.3	26.9	0	ESE	35	7:07	16.6	70	8	E	20	1021.5	26.5	34		ESE	17	1017.6
19/10/12	8.3	33.7	0	NW	50	13:59	17.4	75		WSW	9	1017.8	32.9	18	2	NW	30	1012.9
20/10/12	11.5	33.1	0	WNW	54	11:11	26.5	34		WNW	20	1012.1	32.2	9		W	26	1011

Source of data: Bureau of Meteorology 2012 (www.bom.gov.au. Accessed 14/11/2012).

Merriwa, New South Wales, October 2012 Daily Weather Observations

Observations were drawn from Merriwa (Roscommon) {station 061287}.

Table 4-5 Weather data recorded at Merriwa weather station during the field week 1/10/2013 – 9/10/2013

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Direction of maximum wind gust	Speed of maximum wind gust (km/h)	Time of maximum wind gust	9am Temperature (°C)	9am relative humidity (%)	9am cloud amount (oktas)	9am wind direction	9am wind speed (km/h)	9am MSL pressure (hPa)	3pm Temperature (°C)	3pm relative humidity (%)	3pm cloud amount (oktas)	3pm wind direction	3pm wind speed (km/h)	3pm MSL pressure (hPa)
1/10/13	6.7	30.4	0	WNW	83	12:08	26.8	34		NNW	43	1008.6	17.2	80	8	WNW	24	1011.6
2/10/13	3.4	23.7	4	NW	41	14:10	15.9	43		N	7	1017.4	23.2	27		WNW	24	1011.6
3/10/13	10.1	17	0	SW	57	11:02	13.6	58	8	W	26	1013.9	15.3	37	1	WSW	35	1015
4/10/13	0.3	22	0.2	NNE	20	9:57	13	51		E	11	1022.8	20.8	28		SSE	11	1018
5/10/13	1.9	27.2	0	WNW	39	13:47	17.1	51		W	9	1018.8	26.3	20		W	19	1013.6
6/10/13	3.5	31.1	0	WSW	46	13:52	15.7	45		W	9	1013.6	29.9	12		W	28	1009
7/10/13	10.5	27.6	0	WNW	37	14:32	17.9	42		SW	19	1011.1	26.5	19		WNW	11	1008.1
8/10/13	5.1	24.9	0	SW	39	15:21	14.6	70		WNW	15	1015.4	22.1	25	2	S	22	1013.5
9/10/13	2.8	29.4	0	NNW	30	14:13	13.7	72		WSW	6	1021.5	27.8	15		WNW	17	1016.5

Source of data: Bureau of Meteorology 2013 (www.bom.gov.au. Accessed 17/10/2013).

Merriwa, New South Wales, October 2013 Daily Weather Observations

Observations were drawn from Merriwa (Roscommon) {station 061287}.

4.4.1 Limitations

Survey coverage

The turbine development envelope of the Wind Farm Study Area was generally surveyed in detail but the potential access tracks and all transmission line routes between the numerous ridges were not surveyed to the same detail, unless they were identified during desktop analysis as passing through woodland patches.

Coverage of the entire Project Area was not possible due to limited access constrained by impassable areas (i.e. steep slopes, rocky terrain, and areas with no access tracks), or land access permission constraints. Therefore due to the size of the survey area and access restrictions, not all vegetation patches within the Project Area could be searched in the time allowed, nor surveyed in detail for fauna. Instead, representative areas were surveyed, with most time spent in areas of good quality vegetation. Vegetation patches that could not be accessed were assessed from the roadside or nearest ridgeline where possible. Condition for these areas was extrapolated from other known areas of similar vegetation that had been surveyed in detail. The survey effort maps clearly illustrate the location of all survey and inspection points so it can clearly be seen for which areas assessment has been based on extrapolation.

The fauna survey utilised a combination of non-invasive survey techniques and fauna habitat assessment to identify areas that may support threatened species, rather than undertaking a comprehensive trapping program or using any invasive survey techniques. Night fauna work was targeted toward forest and woodland safely accessible at night. Some forested areas in the proposal area were not surveyed at night due to safety considerations. Detailed habitat assessments were generally undertaken in these areas during the day.

Field data collected during the Spring 2012 surveys, combined with database records, background research and aerial photography analysis, is considered to provide an adequately detailed assessment of the flora, fauna and their habitats that occur and are likely to occur within the Wind Farm Study Area.

Species detection

The October 2012 and 2013 survey corresponded with the peak flowering time for many plant species, however dry conditions were experienced at the time of the surveys and some plant species may have gone undetected, e.g. if they were dormant, inconspicuous or lacked distinguishable features such as flowers or seed. These limitations, whilst recognised, can be said for any chosen survey period.

In particular the dry conditions may have reduced the appearance of some spring flowering species such as orchids and lilies in some areas. The survey timing was too late in the year to detect threatened grass species known from previous records in the area and known to occur within Box Gum Woodland habitat. While spring-flowering exotic annuals such as Bromes (**Bromus* sp.), Barley Grass (**Hordeum* sp.) and Rye Grasses (**Lolium* sp.) were easy to identify in October, most of the native grasses were neither flowering nor carrying old seed heads from the previous season. The diversity of native grasses has therefore been underestimated, and the proportional cover of the different species at any site could not be determined. Given the degraded nature of most of the Project Area and the open understorey, it is considered most species would have been detected in the areas surveyed and the resultant flora species list is comprehensive, with the exception of native grass species. Recommendations provided in Section 12 advise pre-survey work for threatened native grasses within the final alignment to compensate for this limitation.

The information obtained from this survey and database records represent limited fauna survey effort over small snapshots in time. Additional species, such as migratory birds, could utilise or fly over the area that may not be captured by current records. It is likely that additional fauna species would be recorded at different times of the year. These limitations, whilst recognised, can be said for any chosen survey period.

Precautionary approach

Updated boundaries were received during and after the 2012 field surveys were undertaken, hence some of the survey results fell outside of the area assessed during the field survey. The 2013 survey within the wind farm project area addressed some of these information gaps. As it is difficult to rule out the presence of any particular species without extensive surveys, a precautionary approach has been adopted. That is, if suitable habitat is present and desktop assessment has determined the species could occur in the area, the species has been assumed to have potential to utilise habitat within the proposed Project Area.

Anabat results

The bat call identifications presented in this report are based on a combination of manual and automated methods using either reference calls from the region or from species calls recorded outside the region if they are likely to represent the calls from species in the survey region. Some bat species are readily identified via Anabat recordings, but several are not able to be distinguished by a call recording alone.

Anabat recordings alone may only represent a proportion of the bat species that are actually present. The number of bat calls recorded is not a measure of species' abundance as the calls could be from one bat or many bats. The recording of calls on any one night may be influenced by many factors including temperature, humidity, insect activity, wind and associated vegetation movement.

Anabat call analysis is affected by many factors these include: placement of detector (Anabats were located on the ground and not at flight height of several bats; the suite of species present in an area; the quality of calls recorded (equipment settings, microphone quality, background noise from wind, insects, echoes); and the quality of the reference call database for the region and the experience of the analyst.

4.5 GIS MAPPING & ANALYSIS

Figures have been produced using ArcView 10. Geo-referenced aerial imagery, development envelopes and infrastructure layout shapefiles were provided by Epuron.

Vegetation and habitat mapping have been hand-digitised by **ngh**environmental based on aerial imagery and field survey. Vegetation type and condition has been mapped for the survey area that was current at the time of the field survey. Vegetation types were unable to be mapped in the broader site boundary due to time constraints during the field survey work and limited access, especially within and across steep and rocky ridgetops.

No existing environmentally sensitive vegetation mapping data was available for any of the four LGAs which contain the project.

4.6 LANDSCAPE CONNECTIVITY ANALYSIS

A landscape connectivity analysis was undertaken with reference to aerial imagery, considering the spatial configuration of vegetation including percentage vegetation cover and connectivity across the

landscape. The field surveys also provided an opportunity to ground truth assumptions about local connectivity (refer to *Section 2.0 Regional Context*).

4.7 VEGETATION TYPE CLASSIFICATION & NOMENCLATURE

The identification of specific vegetation types is based on the NSW Vegetation Classification and Assessment developed for the South Western Slopes (Upper Slopes) Bioregion by Benson (2008) and Benson *et al.* (2010), which provides the most recent classification for the Project Area.

Botanical nomenclature follows Harden (1990-2002), except where recent taxonomic changes have occurred. Noxious weeds identified are those declared for the four LGAs control area under the *Noxious Weeds Act 1993*.

4.8 CONSTRAINTS ANALYSIS

A constraint, for the purposes of this assessment, is an ecological feature (or combination of features) that reduces the suitability of a site to accommodate the proposed development. Constraints mapping was undertaken at several stages throughout the project in order to guide the development of the infrastructure layout to minimise ecological impacts. Constraints were identified and assessed based on a combination of desktop assessment and field surveys, including aerial photo interpretation and GIS mapping. Aerial photo interpretation was used initially to allow interpretation in areas that were not directly assessed during field survey. Following the initial constraints analysis in 2012, and in response to constraints identified, the turbine layout was adjusted to remove proposed turbines from areas where potential impacts were considered to be of concern (namely the far north-east of the windfarm). The Wind Farm development envelope was also altered following constraints analysis to avoid impacts to an area of Box Gum Woodland EEC and CEEC in moderate-good condition. Additional field survey was undertaken in spring 2013 to allow further detailed survey of areas visited in 2012, as well as additional route options identified since the 2102 surveys.

This iterative process of constraints identification, design adjustments and follow up field survey has enabled impacts to be avoided so that the overall ecological impact of the windfarm on threatened entities is greatly reduced. Residual constraints (i.e. where impact could not be entirely avoided) are classified and mapped according to four constraint classes (Table 4-6). Constraints maps are provided in Appendix E.4.

The biodiversity constraints in the Project Area have been identified and assessed based on desktop assessment and field surveys, including aerial photo interpretation and GIS mapping. Aerial photo interpretation was used to extrapolate data in areas that were not directly assessed within the field. In this instance knowledge of the surrounding areas was considered adequate to make a judgement call on the constraint level applied. The result of the constraints analysis is provided in Section 9.2.3 and Appendix E.4.

Table 4-6 Constraint classes.

Level of Constraint	Description	Management Options
High	<ul style="list-style-type: none"> Impacts in these areas <u>are</u> significant. Impacts would be difficult, costly, or not able to be offset, and should be avoided. Approval is unlikely to be permitted in these areas. 	<ul style="list-style-type: none"> Avoid direct or indirect impacts in these areas
Moderate	<ul style="list-style-type: none"> Impacts have <u>potential</u> to be significant if not managed carefully. Further survey work to guide mitigation and management strategies. 	<ul style="list-style-type: none"> Mitigate through specific management actions (i.e. micro-siting, pre-clearance surveys for HBTs). Offsetting may require a larger offset ratio.
Low	<ul style="list-style-type: none"> Impacts <u>highly unlikely</u> to be significant in these areas. Infrastructure is most appropriately located in these areas. 	<ul style="list-style-type: none"> Standard mitigation actions required. Offset residual impacts (a lower offset ratio will apply).

5 WIND FARM FLORA RESULTS

5.1 VEGETATION COMMUNITIES

Nine vegetation types as defined by Benson *et al.* (2010), plus one exotic vegetation type, occur within the Wind Farm Study Area, including infrastructure such as roads and transmission lines which cross valley flats:

- Silvertop Stringybark – Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range (ID490);
- Brittle Gum - Silvertop Stringybark grassy open forest of the Liverpool Range (ID495);
- Silvertop Stringybark - Yellow Box – Norton’s Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488);
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483);
- Yellow Box grassy woodland on lower hillslopes and valley flats in the southern Brigalow Belt South bioregion (ID437);
- Rough-barked Apple – Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley flats (ID281);
- Derived Speargrass – wallaby grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region (ID395);
- River Oak – Rough-barked Apple – red gum – box riparian tall woodland (ID084);
- Bottlebrush riparian shrubland wetland (ID333); and
- Exotic Pasture and Crops (this is not native vegetation).

The vegetation code in parentheses corresponds to the classification used by Benson *et al.* (2010). These vegetation types are described briefly below. A full description extracted from Benson *et al.* (2010) is provided in Appendix B.3 along with representative photos from the field work. Vegetation types that do not represent a natural vegetation type (e.g. highly modified) have been given a generic name. The distribution of these communities is displayed on the maps in Appendix E.3. A species list for the site is provided as Appendix B.2. A summary of raw data collected at each flora plot and inspection point within the Wind Farm Study Area is provided in Appendix B.6.

Silvertop Stringybark / Forest Ribbon Gum Very Tall Moist Open Forest on Basalt Plateau on the Liverpool Range (ID490)

This community is found in the very highest parts of the Wind Farm Study Area and is characterised by the dominance or presence of Silvertop Stringybark (*Eucalyptus laevopinea*) and Mountain Gum (*E. dalrympleana* ssp. *heptantha*). Forest Ribbon Gum (*E. nobilis*), although a typical dominant of this community, was not found on the site. The understorey is open and grassy, with few shrubs, though this is likely to be an artefact of grazing, as stands within the adjacent Coolah Tops National Park have an open shrub layer which includes *Indigofera australis*. The ground cover is generally continuous and includes Bracken (*Pteridium esculentum*), which is absent from all other vegetation communities on the site. There is a modest range of grasses and forbs, of which the most distinctive species is the small daisy *Brachyscome sieberi*, which was also found in no other community. In fragmented stands with livestock access there is penetration of exotic pasture species such as clovers (**Trifolium* spp.) and Rye Grass (**Lolium* spp.) into the forest.

This community is considered to be of “least concern” by Benson *et al.* (2010), as most of its occurrence is within Coolah Tops National Park.

This community is mapped as Mountain Gum Silvertop Stringybark Forest in the vegetation maps provided in Appendix E.3.

Brittle Gum / Silvertop Stringybark Grassy Open Forest of the Liverpool Range (ID495)

This community occurs at slightly lower elevations than the preceding one, in the north-eastern part of the Wind Farm Study Area and is characterised by the dominance or presence of Silvertop Stringybark (*Eucalyptus laevopinea*) and Brittle Gum (*E. praecox*), with Yellow Box (*E. melliodora*) an occasional component. It appears to be a more open and grassy community than the preceding one, though this may be because all examples seen were disturbed. Shrubs are sparse to absent. In the one example found in good condition the only common shrub was *Daviesia genistifolia*. The ground cover is generally continuous and can have a high diversity of grasses and forbs. Grasses could not be identified with any certainty due to the timing of the survey, but forbs include Yam Daisy (*Microseris lanceolata*) and Scaly Buttons (*Leptorhynchos squamatus*) in the best quality remnant of this community, as well as the more widespread species found in most woodland remnants in the study area such as *Asperula conferta*, *Hydrocotyle laxiflora* and *Swainsona galegifolia*. In fragmented stands the groundcover is dominated by exotic pasture species such as clovers (**Trifolium* spp.) and Rye Grass (**Lolium* spp.).

This community is considered to be of “least concern” by Benson *et al.* (2010), as it is conserved within Coolah Tops National Park, although disturbed and semi-cleared stands were found to be reasonably common in the north-eastern corner of the Wind Farm Study Area. Despite one of its dominant trees being an indicator species for the listed EEC Box-Gum Woodland, Benson *et al.* (2010) do not identify this community as part of that EEC.

This community is mapped as Brittle Gum Stringybark Forest in the vegetation maps provided in Appendix E.3.

Silvertop Stringybark / Yellow Box / Norton’s Box Grassy Woodland on Basalt Hills mainly on northern aspects of the Liverpool Range (ID488)

This community occurs at slightly lower elevations than the preceding one, and is more widespread in the northern part of the Wind Farm Study Area. The dominant tree tends to be Norton’s Box or Mealy Bundy (*Eucalyptus nortonii*), with Silvertop Stringybark and Rough-barked Apple (*Angophora floribunda*) common and Yellow Box (*E. melliodora*) an occasional component. Occasional stands of regrowth are dominated by Yellow Box. Such stands were interpreted as being community 488 if they occurred in the typical landscape position of this community on upper slopes and mid-elevation ridges and if Norton’s Box was present nearby. Shrubs are sparse to absent, though in steep rocky sites there may be occasional patches of *Olearia elliptica*, *Notelaea microcarpa* and *Cassinia* spp. The ground cover is generally near-continuous except for rock outcrops and can have a high diversity of grasses and forbs. Grasses could not be identified with any certainty due to the timing of the survey, but forbs in the best quality remnant of this community included *Galium leptogonium*, *Senecio distalilobatus*, *Swainsona reticulata* and *Dichopogon strictus*, as well as the more widespread species found in most woodland remnants in the study area such as *Asperula conferta*, *Hydrocotyle laxiflora* and *Swainsona galegifolia*. In fragmented stands the groundcover is dominated by exotic pasture species such as clovers (**Trifolium* spp.) and Rye Grass (**Lolium* spp.).

This community is considered to be vulnerable by Benson *et al.* (2010), as substantial areas have been cleared and most are subject to grazing. The typical location of this community on steep slopes reduces

the impact of grazing relative to nearby ridge tops and valley flats, so it tends to be less degraded than the following communities found in those locations. Despite regarding this community as being vulnerable, and despite one of its dominant trees being an indicator species for the listed EEC Box-Gum Woodland, Benson *et al* (2010) do not identify this community as part of that EEC. It is not listed as an EEC.

This community is mapped as Norton's Box Woodland in the vegetation maps provided in Appendix E.3.

Grey Box / White Box Grassy Open Woodland on Basalt Hills in the Merriwa Region (ID483)

This community occurs on lower slopes in the northern part of the Wind Farm Study Area and onto the lower elevation ridge tops which occur in the southern part of the site. The dominant tree is White Box, which throughout the Wind Farm Study Area occurs as a hybrid with other box species (*E. X albens*), rather than as the more typical blue-foliaged and large-fruited form found on the nearby Liverpool Plains. Co-dominant may be Yellow Box (*E. melliodora*) and Blakely's Red Gum (*E. blakelyi*), although these are more typical of valley floor flats (see the following two communities). Occasional stands are dominated by Yellow Box. Such stands were interpreted as being community 483 if they occurred in the typical landscape position of this community on mid slopes and lower elevation ridges and if White Box was present nearby. Shrubs are generally absent, as this community is the most heavily subjected to grazing within the study site. The ground cover is generally near-continuous except for rock outcrops and usually has a low diversity of native grasses and forbs due to this grazing history. Native forbs are generally restricted to the more widespread and grazing tolerant species such as *Dichondra repens*, *Asperula conferta*, *Hydrocotyle laxiflora*, *Vittadinia* spp. and *Swainsona galegifolia*. In fragmented stands, particularly on ridge tops where grazing pressure is most intense the groundcover is dominated by exotic pasture species such as clovers (**Trifolium* spp.) and Rye Grass (**Lolium* spp.) and occasionally by weeds on stock camp areas. Typical species in the latter situation are the native Stinging Nettle (*Urtica incisa*) and exotics such as Horehound (**Marrubium vulgare*), Stinking Roger (**Tagetes minuta*) and thistles (**Silybum marianum*, **Carthamus lanatus*, **Cirsium vulgare*).

This community is considered to be critically endangered by Benson *et al* (2010), as substantial areas have been cleared and virtually all are subject to grazing. It is listed as an EEC under the TSC Act and a Critically Endangered Ecological Community (CEEC) under the EPBC Act (Box-Gum Woodland).

This community is mapped as White Box Woodland in the vegetation maps provided in Appendix E.3.

Yellow Box Grassy Woodland on Lower Hillslopes and Valley Flats in the Southern Brigalow Belt South Bioregion (ID437)

This community is dominated by Yellow Box (*Eucalyptus melliodora*) but may include Rough-barked Apple (*Angophora floribunda*) and is typically found on valley floor flats. It therefore does not intersect with turbine development envelopes and was consequently not sampled within the Wind Farm Study Area during the field work. Stands dominated by Yellow Box on low ridges and mid-slopes were interpreted as being community 483 as in most cases White Box was present nearby, or could reasonably be inferred to have been so prior to clearing. Shrubs are generally absent in this community. The ground cover is generally near-continuous except for rock outcrops and usually has a low diversity of native grasses and forbs due to the long grazing history of valley flats. In fragmented stands the groundcover is dominated by exotic pasture species such as clovers (**Trifolium* spp.) and Rye Grass (*Lolium* spp.) and occasionally by weeds in wetter areas such as creek banks.

This community is considered to be endangered by Benson *et al.*, as substantial areas have been cleared and virtually all are subject to grazing. It is listed as an EEC under the TSC Act and a CEEC under the EPBC Act (Box-Gum Woodland).

This community is mapped as Yellow Box Woodland in the vegetation maps provided in Appendix E.3.

Rough-barked Apple / Red Gum / Yellow Box Woodland on Alluvial Clay to Loam Soils on Valley Flats (ID281)

This community is dominated by Rough-barked Apple (*A. floribunda*) and Blakely's Red Gum (*E. blakelyi*) but may include Yellow Box (*E. melliodora*) and is typically found on valley floor flats. It therefore does not intersect with turbine development envelopes and was consequently not sampled within the Wind Farm Study Area during the field work. Occasional stands which included Rough-barked Apple or Blakely's Red Gum on low ridges and mid-slopes were interpreted as being community 483 as in most cases White Box was present nearby, or could reasonably be inferred to have been so prior to clearing. Shrubs are generally absent in this community. The ground cover is generally near-continuous except for rock outcrops and usually has a low diversity of native grasses and forbs due to the long grazing history of valley flats. In fragmented stands the groundcover is dominated by exotic pasture species such as clovers (**Trifolium* spp.) and Rye Grass (**Lolium* spp.) and occasionally by weeds in wetter areas such as creek banks.

This community is considered to be vulnerable by Benson *et al* (2010), as substantial areas have been cleared and virtually all are subject to grazing. However, these authors also identify it as being part of the listed EEC Box-Gum Woodland.

This community is mapped as Blakely's Red Gum Woodland in the vegetation maps provided in Appendix E.3.

Derived Speargrass / Wallaby Grass / Wire Grass Mixed Forb Grassland mainly in the Coonabarabran – Pilliga – Coolah Region (ID395)

This community is very extensive within the study area, particularly in the lower elevation southern part of the Wind Farm Study Area, where rainfall is lower than in the vicinity of Coolah Tops and pasture improvement with clovers and exotic annual pasture grasses appears to be less commonly practised. Shrubs are absent in this community, but there may be scattered eucalypts, Rough-barked Apple and Kurrajong (*Brachychiton populneus*) trees. The ground cover is generally near-continuous and usually has a low diversity of native grasses and forbs due to grazing history of the region. However, occasional sites were found on lower slopes where the native forb diversity was moderate (for example site AA17 near Cassilis Road). In this situation, and if grassy box-gum woodland occurs nearby, this community could be regarded as being part of that EEC, although it was identified as of "least concern" by Benson *et al.* (2010) It is common in the region and may be of value to native fauna as a largely native matrix within which higher quality patches of remnant woodland are embedded.

This community is mapped as Native Pasture in the vegetation maps provided in Appendix E.3.

River Oak / Rough-barked Apple / Red Gum Box / Riparian Tall Woodland (ID84)

This community is dominated by River Oak (*Casuarina cunninghamiana*) but may include Rough-barked Apple (*A. floribunda*) and various red gum or box species and is typically found on creek and river banks in valley floors. It therefore does not intersect with turbine development envelopes and was consequently only sampled in two locations within the Wind Farm Study Area during the field work. It may intersect with roads or transmission lines where these cross drainage lines. In the sampled locations it was found

to be in poor condition, with the understorey mainly composed of exotic species, due to relatively high soil moisture and nutrient levels, and livestock trampling pressure when they come to water to drink. It was identified as near threatened by Benson *et al.* (2010) but is not listed as an EEC under Federal or State legislation.

This community is mapped as River Oak Woodland in the vegetation maps provided in Appendix E.3.

Bottlebrush Riparian Shrubland Wetland (ID333)

This riparian community is dominated by a Bottlebrush (*Callistemon sieberi*) which grows to about 5 metres high, forming a dense, low canopy, through which emergent eucalypts may protrude. It is typically found on small, boggy upper drainage lines in the higher north-eastern part of the Wind Farm Study Area. This community does not intersect with turbine development envelope and was only sampled in one location within the Wind Farm Study Area during the field work, though it may intersect with roads or transmission lines where these cross drainage lines. It has a groundcover of native grasses such as *Poa labillardierei*, sedges and rushes, with a variable component of exotic pasture species. It was identified as vulnerable by Benson *et al.* (2010) but is not listed as an EEC under Federal or State legislation.

This community was not mapped within the Wind Farm development area.

Exotic Pasture and Crops

Exotic pasture in the northern part of the Wind Farm Study Area consists of clovers (**Trifolium* spp.) and pasture grasses such as Rye Grass (**Lolium* spp.), Phalaris (**Phalaris aquatica*), Cocksfoot (**Dactylus glomerata*), bromes (**Bromus* spp.) and Barley Grass (**Hordeum* spp.). Areas with this type of groundcover and very sparse trees were also mapped as exotic pasture. In stock camp areas on top of ridges the pasture composition often comprised Barley Grass and weeds such as thistles and Horehound (**Marrubium vulgare*). Cropping paddocks are confined to river flats in the Wind Farm Study Area, and as such do not intersect with turbine envelopes. They may occasionally intersect with roads and transmission line routes.

This community is mapped as Exotic Pasture in the vegetation maps provided in Appendix E.3.

Table 5-1 Conservation status of natural vegetation types in the Wind Farm Study Area.

Vegetation Type	Pre-1750 Extant (ha)	Extant Area (ha)	Total Area Reserved or Protected (ha)	Conservation Status (Benson <i>et al</i> 2010)	EEC (yes / no)
Silvertop Stringybark-Mountain Gum tall wet forest (ID 490)	25,000 ha	18,000 ha	8370 ha	Least concern	No
Brittle Gum – Silvertop Stringybark grassy open forest (ID495)	300 ha	250 ha	50 ha	Least concern	No
Silvertop Stringybark - Yellow Box – Norton’s Box grassy woodland (ID488)	3000 ha	1500 ha	50 ha	Vulnerable	No
Rough-barked Apple – Red Gum – Yellow Box woodland on valley flats (ID 281)	150,000 ha	50,000 ha	1000 ha	Endangered	Yes
Grey Box x White Box grassy open woodland on basalt hills (ID483)	20,000 ha	2000 ha	0	Critically endangered	Yes

Vegetation Type	Pre-1750 Extant (ha)	Extant Area (ha)	Total Area Reserved or Protected (ha)	Conservation Status (Benson <i>et al</i> 2010)	EEC (yes / no)
Yellow Box grassy woodland on lower hillslopes and valley flats (ID437)	35,000 ha	8000 ha	0	Endangered	Yes
Derived Speargrass – wallaby grass – wire grass grassland (ID395)	100 ha	10,000 ha	730 ha	Least concern	Yes if adjacent to EEC.
River Oak – Rough-barked Apple – red gum – box riparian tall woodland (ID084)	20,000 ha	12,000 ha	1300 ha	Near threatened	No
Bottlebrush riparian shrubland (ID333)	4000 ha	1200 ha	5 ha	Vulnerable	No

5.2 ENDANGERED ECOLOGICAL COMMUNITIES

Of the vegetation that occurs in the survey area, one community that would meet the definition of a listed Endangered Ecological Community occurs:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland

Depending on condition, this vegetation type could qualify as an EEC under both NSW and Commonwealth legislation, as discussed below.

5.2.1 NSW Endangered Ecological Community (EEC)

The White Box, Yellow Box, Blakely's Red Gum Woodland EEC listed under the NSW *Threatened Species Conservation Act 1995* includes:

- Woodland areas mapped as White Box, Yellow Box or Blakely's Red Gum Woodland in poor to good condition (with or without native understorey); and
- Grasslands and pastures dominated by native grasses that are derived from these communities.

Areas of vegetation located within the Wind Farm development area which meet the definition of White Box, Yellow Box, Blakely's Red Gum Woodland EEC are mapped in Appendix E.5.

5.2.2 Commonwealth Critically Endangered Ecological Community (CEEC)

The EPBC Act sets more stringent criteria for the recognition of the Box Gum Woodland Critically Endangered Ecological Community (CEEC) listed under that Act.

Under the EPBC Act, Box Gum Woodland remnants belong to the CEEC if:

- One of the most common overstorey species is/was Yellow Box, Blakely's Red Gum or White Box; AND
- The understorey is predominantly native; AND
- The patch is greater than 0.1 ha; 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 Commonwealth Government); OR
- The patch is greater than 2 ha with an average of 20 or more mature trees per hectare, or natural regeneration of the dominant overstorey eucalypts is present.

Based upon the condition thresholds any areas of Box Gum Woodland in 'moderate-good or good' condition would correspond to this community. No areas of moderate-good or good condition Box Gum Woodland EEC were recorded within the Wind Farm development area (refer to Section 5.2.4 below).

5.2.3 Vegetation Types Recorded within the Wind Farm Study Area and EEC Status

As the Wind Farm Study Area is located on fertile basalt-derived soils Box Gum Woodland is the principal vegetation community present, except at the highest elevations above about 950m at the northern end of the site. Areas dominated by either White Box, Yellow Box or Blakely's Red Gum are likely to fall within the above definition of the Box Gum Woodland EEC, although there are some exceptions. Yellow Box is also a component of ID488 (Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland) and although in less disturbed stands it tends to be a minor component, clearing may change the proportions of the various tree species in regrowth stands so that Yellow Box becomes dominant. In these instances Yellow Box has been considered as belonging to community 488, and therefore is not considered part of the EEC. Yellow Box can also occur in ID 495 (Brittle Gum – Silvertop Stringybark grassy open forest) and so may appear as paddock trees within areas derived from clearing of this type of forest. Again, in this situation these trees were not assumed to be indicators of the presence of Box-Gum Woodland EEC.

River Oak – Rough-barked Apple – Red Gum Box - Riparian Tall Woodland (ID 084) occurs on creeks and river banks in the valleys between the turbine ridges, where it may merge into remnant stands of Rough-barked Apple – Red Gum – Yellow Box Woodland on valley flats (ID 281) or Yellow Box Grassy Woodland (ID437) on lower hillslopes and valley flats. Any of these areas could be regarded as belonging to Box Gum Woodland EEC if one or more of the three principal tree species is dominant, although pure stands of River Oak on creek banks are not part of the EEC. These EECs, occurring as they do on valley floors, will only intersect with the proposed development along transmission line easements and access roads.

Grey Box x White Box Grassy Open Woodland on basalt hills (ID483), which may include or be locally dominated by Yellow Box, is the dominant vegetation type of ridges and upper slopes below about 950m elevation, and is present on most of the proposed turbine envelopes, though often occur only on the upper slopes rather than on the flat ridge crests

Derived Speargrass – Wallaby Grass – Wire Grass Grassland (ID395) is common in the southern part of the Wind Farm Study Area. The higher ridges at the northern end are much more likely to carry "improved" pasture dominated by exotic grasses and clovers. While Benson *et al.* (2010) regarded this as a community of least concern, under the Scientific Determination it could be part of the Box Gum Woodland EEC if it once comprised White Box/Yellow Box/Blakely's Red Gum woodland, regardless of its current condition. Areas of Native Pasture which are considered to constitute the EEC are mapped in Appendix E.5.

5.2.4 Vegetation Condition of EEC Recorded within the Wind Farm Study Area

Since Box Gum Woodland habitat coincides with prime farmland, this community has been heavily impacted by clearing, grazing, cultivation and the introduction of weed and pasture species. The impact of this depletion is compounded by the severe fragmentation and continuing degradation of remaining stands. In particular, at higher elevations where most of the pasture is exotic, EEC stands are generally in

poor condition. Some lower elevation stands are classed as being in moderate condition on the basis of having 5-11 non-grass native groundcover species. One location surveyed in 2012 (Flora survey ID AA21) recorded Box Gum Woodland EEC and CEEC in mod-good condition based on there being more than 11 native non-grass species. The Wind Farm development envelope has subsequently been altered in this area to avoid this stand of EEC/CEEC. No areas of moderate-good or good condition Box Gum Woodland EEC were recorded within the Wind Farm development area and hence no areas of Box Gum Woodland EEC meet the condition thresholds required for CEEC classification. Areas of EEC are mapped in Appendix E.5.

5.3 CONSERVATION SIGNIFICANT FLORA SPECIES

The Commonwealth and State online database searches and NSW Wildlife Atlas threatened species records indicated 46 recorded or potential presence of numerous threatened species which could occur in the wider study area (including nominated species). Because the Project Area is close to the boundary of several CMA subregions and three IBRA Bioregions a lengthy list of threatened species was generated for the region. On closer review the threatened species evaluation in Appendix C.1 concluded that four threatened species have at least moderate potential to be present on parts of the Wind Farm Study Area, based on site quality, disturbance history, known distribution ranges and the results of the field survey (Table 5-2). All have similar habitat requirements of grassland or grassy woodland, preferably with a relatively low level of grazing pressure.

White Box or Yellow Box Woodland would be the most likely vegetation type to provide habitat for these species; however it is considered unlikely that the threatened flora are present in high numbers due to the level of degradation by grazing and/or conversion to exotic pasture. Native groundcover is higher within scattered rock outcrops, which provides some protection from grazing. The probability of threatened flora being found in this community is considered to be low, although the grasses Bluegrass (*Dichanthium setosum*), Lobed Bluegrass (*Bothriochloa biloba*) and Finger Panic Grass (*Digitaria porrecta*) have the potential to occur on heavy clay basalt-derived soils. There are areas on the side slopes, which could be traversed by access roads, which may still be in sufficiently good condition to harbour some of these species, although the majority of these access roads are located along existing cleared tracks which would require minimal clearing. The most appropriate time to search for these species would be after the location of proposed access roads on the side slopes has been determined. A pre-clearance survey should be undertaken and if found infrastructure should be micrositied around populations if they are found.

Austral Toadflax (*Thesium austral*) is dependent on the presence of Kangaroo Grass (*Themeda australis*), on which it is a partial root parasite. Kangaroo Grass is sensitive to prolonged heavy grazing and tends to persist only in areas where grazing is intermittent. Only one area was found where Kangaroo Grass appeared to be a dominant grass, at the north-eastern end of the study area. The vegetation in this location belongs to the Brittle Gum – Silvertop Stringybark Grassy Woodland community, and was found in 2012 to have a high diversity of native non-grass groundcover species (31 species), including species which are rare in grazed situations such as Yam Daisy (*Microseris lanceolata*) and Scaly Buttons (*Leptorhynchos squamatus*). This area could provide habitat for Austral Toadflax as well as the threatened Silky Swainson-pea (*Swainsona sericea*). Based upon the quality of habitat in this area, it has subsequently been removed from the proposed development. Areas of better quality Box Gum Woodland in the southern part of the study area may also provide suitable habitat for the Silky Swainson-pea which can tolerate some degree of grazing as was observed along the Transmission Line Study Area.

Table 5-2 Threatened flora species with potential to occur within the Wind Farm Study Area.

Species	Status	Habitat
Bluegrass <i>Dichanthium setosum</i>	V TSC V EPBC	Woodland or native pasture on basalt soils, most likely in areas with low grazing pressure
Finger Panic Grass <i>Digitaria porrecta</i>	E TSC E EPBC	Woodland or native pasture on basalt soils, most likely in areas with low grazing pressure
Lobed Blue-grass <i>Bothriochloa biloba</i>	V EPBC	Woodland or native pasture on basalt soils, most likely in areas with low grazing pressure
Silky Swainson-pea <i>Swainsona sericea</i>	V TSC	Grassy woodland and secondary grassland in areas with low grazing pressure

KEY: TSC Act – Threatened Species Conservation Act 1995; EPBC – Environment Protection and Biodiversity Conservation Act 1999; V – Vulnerable; E – Endangered

5.4 VEGETATION CONDITION

Vegetation condition varies considerably throughout the Wind Farm Study Area and includes a small amount of relatively undisturbed forest at the highest elevations, fragmented forest to which livestock have access which varies from moderate-good to poor condition, woodland in poor to good condition, native pasture with scattered retained or regrowth trees, and exotic pasture, with or without scattered trees. There are also cropping paddocks on valley flats which may be traversed by transmission lines or roads.

Generally woodland condition is best on steeper slopes where livestock pressure is lower. Where such stands were included within the survey area they were found to have the highest diversity of non-grass native groundcover species, though none with tree regeneration were seen. Groundcover condition is also better in areas with rock outcrops, since these provide some protection from grazing. Many of the native species recorded in the site surveys were recorded only or mainly in small patches of rock, with adjacent pasture being principally exotic. Since the rocky areas were targeted in vegetation surveys, this can give an inflated impression of the site quality. At most ridge top sites, native non-grass species were reduced to a few grazing tolerant species such as Kidney Weed (*Dichondra repens*), Stinking Pennywort (*Hydrocotyle laxiflora*) and Fuzzweed (*Vittadinia*) species, as well as *Swainsona galegifolia*, the latter presumably toxic or unpalatable or both.

Many of the better quality remnants, being located on side slopes are not Box Gum Woodland EEC, but vegetation community ID488, dominated by Norton's Box, which tends to occupy the steeper slopes.

Box Gum Woodland EEC remnants range from poor (with an exotic groundcover) to, rarely, moderate condition.

5.5 NOXIOUS WEEDS

A total of nine weeds listed as Noxious in the Mid-Western Regional and Warrumbungle Council control areas were seen in the Project Area. All of these are listed as noxious in class 4 ("the growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction"). They are the shrubs Boxthorn (**Lycium ferocissimum*), Blackberry (**Rubus fruticosus* sp. agg.), Sweet Briar (**Rosa rubiginosa*) and Prickly Pear (**Opuntia* sp.), the trees Tree of Heaven (**Ailanthus altissima*) and Broad-leaf Privet (**Ligustrum lucidum*), the climber Bridal Creeper (**Asparagus*

asparagoides) and forbs St John's Wort (**Hypericum perforatum*) and Bathurst Burr (**Xanthium spinosum*). Of these, only Sweet Briar (**Rosa rubiginosa*) and St John's Wort (**Hypericum perforatum*) are common in parts of the Wind Farm Study Area. Sweet Briar was noted as being common at one survey location, to the west of Pandora Pass, where Blackberry and St John's Wort are also common. The presence of large numbers of goats, either semi-feral or domestic, over much of the site probably helps to keep the numbers of woody weeds low. St John's Wort is the most widespread noxious weed, being present at many sites at low to moderate density, with high density infestations visible on nearby side slopes. Prickly Pear and Bathurst Burr are sparsely scattered over the Wind Farm Study Area.

Recommendations have been provided in Section 11 for the management of noxious weed species.

6 WIND FARM FAUNA RESULTS

6.1 HABITAT TYPES AND CONDITION

Habitat in the Project Area can be broken into six fauna habitat types (excluding exotic pasture):

- Open pasture with scattered trees;
- Open woodland;
- Forest;
- Hollow-bearing trees;
- Rocky habitats; and
- Aquatic areas / riparian areas

In general, these habitat types favour wide ranging, highly mobile fauna (birds and bats). However, smaller ranging, ground-dwelling fauna, including amphibians, would find quality patches of habitat in rocky outcrops, connected areas of woodland and riparian corridors.

6.1.1 *Open Pasture with Scattered Trees*

Open pasture (exotic or native) with a very low density of scattered trees (less than 3%) occurs predominantly on the majority of ridges as well as in flood plain valleys, the latter being extensively modified for agricultural use. In some locations, scattered trees included mature and hollow-bearing trees.

6.1.2 *Woodland*

Open woodland remnants and regenerated patches of woodland occur throughout the Project Area. Agricultural activities have simplified the structural and floristic diversity of this habitat type and this reduces the range of species likely to occur. Tree cover can range from low to quite dense. Woodland trees included mature and hollow-bearing trees. Mistletoe was observed in several areas. In general, lower slopes were the least treed (and most extensively modified for agriculture), followed by the ridges.

The mid slopes contained the highest tree density and most connected and structurally diverse habitat (including fallen timber). More densely treed areas are also associated with creeks and drainage lines. The north-east of the Wind Farm Study Area contains more dense vegetation than the remainder of the site.

Woodland remnants provide habitat for a diversity of fauna species. Important factors in influencing localised diversity including the distance between trees (particularly for gliders, other arboreal mammals and smaller birds), presence of a shrub layer and proximity to large tracts of native vegetation, particularly Coolah Tops National Park.

6.1.3 *Forest*

The Wind Farm Study Area contains few areas of forest vegetation, with areas of forest generally confined to the north-eastern corner of the Wind Farm Study Area where they occur adjacent to areas of woodland.

6.1.4 Aquatic / Riparian Areas

Aquatic areas are habitat for fish, frogs and waterbirds. Any water source is generally an important habitat component for all fauna, including microchiropteran bats. Dams provide habitat for species with capacity to disperse between the water bodies. Dams and watercourses generally occur outside of the turbine development envelope at lower elevations. Dams in the Wind Farm Study Area vary in condition from poor to moderate in habitat quality for amphibians and water birds. Dams in poor condition are in areas currently being grazed, where sheep and cattle accessing the dam trample vegetative growth and stir up sediments. However, being a small water body the quality of habitat offered by a farm dam is transient, changing with the grazing regime and seasonal rainfall.

Minor creeks occur in the valleys between ridges and usually feature river polished stones in the creek bed. These often had good canopy connectivity, were flanked by large River Sheoaks, but had variable water quality, due to stock access and low rainfall. Riparian woodland included a dense shrub layer of *Callistemon*. These areas are likely only to be affected by the development of access tracks or other infrastructure, being located in the valleys and flats.

Threatened fish listed under the FM Act are not anticipated in the minor creeklines of the Wind Farm Study Area. The development is not expected to have an adverse impact on riparian habitats; however recommendations to design creek crossings in accordance with NSW Fisheries Policy and Guidelines for Fish Friendly Waterway Crossings (2003) are provided in Section 12.

No groundwater dependent ecosystems occur within the Wind Farm Study Area or will be affected by the proposal.

6.1.5 Habitat Features

Hollow bearing trees

Hollow-bearing trees generally occurred as scattered mature trees over pasture and through woodland and forest. Table 6-1 shows that tree hollows were common in 35% of the sites assessed and were generally poor to average in quality (Table 6-2). In general, the majority of hollows were of small to medium hollow entrance size, most likely to be utilised by small to medium birds and microchiropteran bats, rather than owls and gliders. However, the north-eastern section of the Wind Farm Study Area was noted as supporting a greater density of larger hollows in better-quality forest; understorey diversity increased in this area in comparison to the rest of the site. Overall, connectivity between hollow bearing trees is low given the clearing and fragmentation for agricultural practices within the Wind Farm Study Area.

Rocky outcrops

Basalt outcrops were common on the ridges and slopes, but were usually limited in spatial extent and included predominantly small rocks. Generally, they occur with limited habitat connectivity between rock outcrops and limited vegetative cover.

Areas of scattered surface rock are common, including on many exposed ridge tops (Table 6-1). Surface rock is variable in size and typically embedded into the soil layer. These areas often include fallen timber but vegetation cover is often very sparse and there is a general lack of leaf litter.

Table 6-1 Habitat features present in each fauna plot habitat assessment site of the Wind Farm Study Area (2012-2013 data).

Habitat Type	Absent (No. sites)	Scattered (No. sites)	Common (No. sites)	Abundant (No. sites)	Relative Importance Score*
Tree hollows	9	45	17	13	1.40
Mature trees	11	30	13	30	1.74
Leaf litter	28	46	10		0.79
Fallen logs <50cm	10	34	34	5	1.41
Fallen logs >50cm	27	40	15	2	0.90
Mistletoe	62	18	2	1	0.30
Rock outcrop	56	9	13	6	0.63
Small surface rock	14	32	23	15	1.46
Large surface rock	44	22	14	3	0.71
Cliffs	83	1	0	0	0.01

Table 6-2 Value of habitat features for fauna groups at each habitat assessment site of the Wind Farm Study Area (2012-2013 data).

Fauna Group	Absent	Poor	Average	Good	Excellent	Relative Importance Score*
Hollow dependent fauna	5	28	23	20	3	1.85
Rock dependent fauna	9	33	22	12	2	1.55
Log dependent fauna	7	32	21	17	7	1.82
Small birds	18	45	14	5	2	1.14
Waterbirds	72	8	3	1	0	0.20

*Note. A relative importance score has been applied to the habitat assessment data recorded during the field surveys to collate qualitative data on the relative abundance and value of fauna microhabitats (Table 6-1) and the relative abundance and value of fauna microhabitats for specific fauna groups (Table 6-2). The raw data is provided in Appendix B.5. The relative importance score is arrived at by assigning a value of 0 for sites where the value of the habitat is absent, 1 where it is considered Poor, 2 where it is considered Average, 3 where it is considered Good and 4 where it is considered Excellent. This total is then divided by the number of sites where a value has been recorded.

6.2 CONSERVATION SIGNIFICANT FAUNA SPECIES

6.2.1 Database Searches

The Commonwealth and State online database searches and NSW Wildlife Atlas threatened species records indicated 88 recorded or potential presence of threatened species which could occur in the wider study area (including nominated species). Because the Project Area is close to the boundary of several CMA subregions and three IBRA Bioregions a lengthy list of threatened species was generated for the

region. The threatened species evaluation presented in Appendix C.3 determined that 31 threatened species have at least moderate potential to be present on parts of the Wind Farm Study Area, based on site quality, disturbance history, known distribution ranges and the results of the field survey (Table 6-3).

Table 6-3 Threatened or migratory listed species that could occur (possible) in the Wind Farm Study Area.

Species	Status	Habitat
Reptiles		
Pink-tailed Legless Or Worm Lizard <i>Aprasia parapulchella</i>	V TSC V EPBC	Open woodland with predominantly native grasses and natural temperate grasslands on well-drained slopes with scattered, partially-buried rocks.
Birds		
Speckled Warbler <i>Chthonicola sagittata</i>	V TSC	Habitats typically are structurally diverse with a grassy understorey, a sparse shrub layer and an open canopy.
Brown Treecreeper (eastern subspecies) <i>Climacteris picumnus victoriae</i>	V TSC	Occurs in eucalypt woodlands, mallee and drier open forest of eastern Australia, preferring woodlands lacking dense understorey.
Varied Sittella <i>Daphoenositta chrysoptera</i>	V TSC	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands.
Regent Honeyeater <i>Anthochaera Phrygia</i>	E TSC E EPBC M EPBC	Most records are from box-ironbark eucalypt associations and it appears to prefer wetter fertile sites within these associations.
Scarlet Robin <i>Petroica boodang</i>	V TSC	In NSW it occupies open forests and woodlands from the coast to the inland slopes. Scarlet robins breed in dry eucalypt forests and temperate woodland.
Grey-crowned Babbler <i>Pomatostomus temporalis temporalis</i>	V TSC	Prefers Box Gum Woodlands although also inhabits open forests, scrub lands, even farmlands and suburbs.
Little Lorikeet <i>Glossopsitta pusilla</i>	V TSC	Forages primarily in the canopy of open <i>Eucalyptus</i> forest and woodland, yet also finds food in <i>Angophoras</i> , <i>Melaleucas</i> and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity.
Glossy Black-cockatoo <i>Calyptorhynchus lathami</i>	V TSC	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species, particularly Black She-oak (<i>Allocasuarina littoralis</i>), Forest She-oak (<i>A. torulosa</i>) or Drooping She-oak (<i>A. verticillata</i>) occur
Turquoise Parrot <i>Neophema pulchella</i>	V TSC	Occurs in grassy woodland and open forest carrying a mixed assemblage of White Box, Yellow Box, Blakely's Red Gum, Red Box and Red Stringybark.
Square-tailed Kite <i>Lophoictinia isura</i>	V TSC	Occurs primarily in coastal and sub-coastal open forest, woodlands and mallee. It has been recorded inland along timbered watercourses and adjacent areas.
Little Eagle <i>Hieraetus morphnoides</i>	V TSC	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.
Grey Falcon <i>Falco hypoleucos</i>	E TSC	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.
Spotted Harrier <i>Circus assimilis</i>	V TSC	The Spotted Harrier occurs in a variety of habitats including grassy open woodland and riparian woodland.

Species	Status	Habitat
Barking Owl <i>Ninox connivens</i>	V TSC	Occurs in dry box-dominated forest and woodlands and roosts in dense foliage of <i>Acacia</i> , <i>Casuarina</i> or <i>Eucalyptus</i> species. It nests in large hollows (20-46 cm diameter) of large, old eucalypts including River Red Gum, White Box, Red Box and Blakely's Red Gum.
Powerful Owl <i>Ninox strenua</i>	V TSC	This species occurs primarily in tall, moist productive eucalypt forests of the eastern tableland edge and the mosaic of wet and dry sclerophyll forests occurring on undulating, gentle terrain nearer the coast.
Masked Owl <i>Tyto novaehollandiae</i>	V TSC	Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m.
White-throated Needletail <i>Hirundapus caudacutus</i>	M EPBC	Recorded in the airspace above woodlands, forests and farmlands. Often seen 'patrolling' favoured feeding grounds above ridges and hilltops. This species migrates to Australia from mid-October and is a regular summer migrant until April when it returns to breed.
White-bellied Sea-eagle <i>Haliaeetus leucogaster</i>	M EPBC	This species occurs around coastal areas, islands and estuaries, but is also found in inland areas around large rivers, wetlands and reservoirs.
Mammals		
Squirrel Glider <i>Petaurus norfolcensis</i>	V TSC	Mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest.
Koala <i>Phascolarctos cinereus</i>	V TSC V EPBC	Occurs in woodland communities, coastal forests, woodlands of the tablelands and western slopes and the riparian communities of the western plains.
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	V TSC V EPBC	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. It roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin.
Little Pied Bat <i>Chalinolobus picatus</i>	V TSC	Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, bimbil box.
Little Bentwing-bat <i>Miniopterus australis</i>	V TSC	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.
Eastern Bentwing-bat <i>Miniopterus schreibersii oceanensis</i>	V TSC	This species roosts and raises its young in caves and mine tunnels. The species appears to forage above the forest canopy in a diverse range of forest types.
Corben's Long-eared Bat <i>Nyctophilus corbeni</i>	V TSC V EPBC	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species.
Yellow-bellied Sheath-tail-bat <i>Saccolaimus flaviventris</i>	V TSC	It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.
Eastern Cave Bat <i>Vespadelus troughtoni</i>	V TSC	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW.
Eastern False Pipistrelle <i>Falsistrellus tasmaniensis</i>	V TSC	Found in wet sclerophyll forest and coastal mallee. It appears to prefer wet sclerophyll forest although also utilises open forest at lower altitudes.

Species	Status	Habitat
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i>	V TSC	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.
Greater Long-eared Bat <i>Nyctophilus timoriensis</i>	V TSC V EPBC	Inhabits a variety of vegetation types, including mallee, bullock but more commonly box/ironbark/cypress-pine communities that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.

KEY: TSC Act – Threatened Species Conservation Act 1995; EPBC – Environment Protection and Biodiversity Conservation Act 1999; V – Vulnerable; E – Endangered; M – Migratory.

6.2.2 Koala – SEPP 44

Schedule 2 of SEPP 44 lists Koala feed tree species to be considered under the SEPP. One of these species, White Box (*Eucalyptus albens*), occurs on the Wind Farm Study Area, where it occurs as a hybrid with other box species, usually hybridising with Grey Box. It is present on the lower slopes of ridgelines in the northern part and lower elevation ridgetops in the southern part of the Wind Farm Study Area.

In some locations, this White box hybrid constitutes over 15% of the tree canopy, indicating that “potential koala habitat” as defined by SEPP 44 is present. The fauna survey program completed as part of this assessment (including call playback) did not record any Koalas or evidence of Koala use and this, together with analysis of database records, suggests that the Wind Farm Study Area does not provide any areas of “core koala habitat” as defined by SEPP 44.

6.3 FAUNA SPECIES RECORDED DURING FIELD SURVEYS

A range of fauna species were recorded across the Project Area (Wind Farm & Transmission Line Study Area), including:

- 26 species of herpetofauna (reptiles and amphibians);
- 38 species of mammal (including 16 microchiropteran bats and 9 exotic species); and
- 128 species of bird.

Refer to Appendix B.3 for a full species list.

6.3.1 Feral Species

Several feral species were observed regularly during the field work within the Wind Farm Study Area including Goats (*Capra hircus*), European Rabbit (*Oryctolagus cuniculus*) and Red Fox (*Vulpes vulpes*). Goats were widespread and in high abundance throughout the Wind Farm Study Area and Red Foxes were observed readily during day and night field work. The grazing impact of Goats is having an adverse effect on regeneration and recruitment of native vegetation and is contributing to the lack of understorey present within remnant stands of woodland or forest in the area. The impact of Goats coupled with stock grazing has been a large contributor to the low vegetation condition ratings applied to much of the vegetation within the Wind Farm Study Area.

6.3.2 Threatened Species

Specific threatened species that were identified within the Wind Farm Study Area included two species of bird, one arboreal mammal, and four microchiropteran bat species (Table 6-4); locations of observations are shown in the maps in Appendix E.3.

Table 6-4 Threatened species recorded during field surveys within the Wind Farm Study Area.

Name	Status	Observation Location
Birds		
Scarlet Robin <i>Petroica boodang</i>	V TSC	NE corner of Wind Farm Study Area: WF3_B7
Varied Sittella <i>Daphoenositta chrysoptera</i>	V TSC	Ridgetop in eastern part of study area: WF6_G9
Arboreal Mammals		
Squirrel Glider <i>Petaurus norfolcensis</i>	V TSC	Along creek line near to substation location: WF6_B16
Microchiropteran bats		
Eastern Bentwing-bat <i>Miniopterus schreibersii oceanensis</i>	V TSC	Various locations.
Corben's Long-eared Bat <i>Nyctophilus corbeni</i>	V TSC V EPBC	Various locations.
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	V TSC V EPBC	Various locations.
Eastern Cave Bat <i>Vespadelus troughtoni</i>	V TSC	Various locations.

KEY: TSC Act – Threatened Species Conservation Act 1995; EPBC – Environment Protection and Biodiversity Conservation Act 1999; V – Vulnerable.

7 MICROCHIROPTERAN BAT RESULTS

This section provides a summation of microbat results for the Project Area. These topics were better represented as a combined analysis rather than being reviewed in isolation for each study area.

7.1 DETAILED MICROBAT ANALYSIS

7.1.1 Species Recorded

Fourteen bat species were recorded in the Wind Farm Project Area (Table 7-1), four of which are listed under the NSW TSC Act, and one also listed under the EPBC Act.

Table 7-1 Species recorded during bat detection surveys at the proposed Liverpool Range Wind Farm

Species	Common Name	TSC Act	EPBC Act
<i>Austronomus australis</i>	White-striped Freetail Bat	-	-
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	-
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	-	-
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	-	-
<i>Miniopterus schreibersii</i>	Eastern Bentwing Bat	V	-
<i>Mormopterus ridei</i>	Eastern Freetail Bat	-	-
<i>Mormopterus</i> sp. 4	Southern Freetail Bat	-	-
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	V	V
<i>Nyctophilus</i> spp.	Long-eared Bats	-	-
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	-	-
<i>Vespadelus darlingtoni</i>	Large Forest Bat	-	-
<i>Vespadelus regulus</i>	Southern Forest Bat	-	-
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-
<i>Vespadelus vulturnus</i>	Little Forest Bat	-	-

KEY: For clarity, the taxonomy of *Miniopterus* follows Richards et al (2012), though *M. schreibersii* has been considered as *M. orianae* (Churchill 2008).

7.1.2 Threatened Species

Although records of threatened microbat species were quite widespread in the Wind Farm Study Area, relative activity levels were quite low. Table 7-2 shows the number of calls identified during the bat survey (including both Wind Farm and Transmission Line Study Areas). Over 11,000 call files were recorded; 104 calls of threatened species constitute less than 1% of the total activity recorded.

Table 7-2 Occurrence of threatened species in the Project Area, based on the number of calls recorded.

Species	Definite Identification	Probable Identification	Total Calls
<i>Chalinolobus dwyeri</i>	8	1	9
<i>Miniopterus schreibersii</i>	57	0	57

<i>Nyctophilus corbeni</i>	17	0	17
<i>Saccolaimus flaviventris</i>	0	1	1
<i>Vespadelus troughtoni</i>	20	0	20
			104

7.1.3 Threatened Species Habitat Preference

The detailed habitat identifications from the vegetation surveys were condensed to a smaller set for the purposes of bat utilisation patterns. It is well known that bats respond to habitat structure, rather than species composition, especially where some species have evolved to occupy cluttered habitats, others to open habitats, and others to airspace free of obstacles. There is some relationship between understorey type and wooded habitats such as forest or woodland, where a different community structure can be found in those with different types of understorey.

7.1.4 Wind Farm Study Area

Table 7-3 shows that the Large-eared Pied Bat appeared to prefer dense and open woodland. Eastern Bentwing Bat utilised all habitats except pasture with scattered trees and exposed ridgetops with sparse trees. Corben's Long-eared Bat showed a distinct preference for *Casuarina* along creeklines, open forest without understorey and dense woodland, supporting the concept that all long-eared bats prefer cluttered habitats. Eastern Cave Bat was only recorded in woodland and forest patches. Yellow-bellied Sheath-tail Bat was not recorded within the Wind Farm Study Area.

Table 7-3 Habitat utilisation by threatened species in the Wind Farm Study Area

Habitat	No. of Sites in Habitat	<i>Cdwy</i>	<i>Msch</i>	<i>Ncor</i>	<i>Sfla</i>	<i>Vtro</i>	Total Listed Species
<i>Casuarina</i> on creeklines	2	-	4	6	-	-	2
Forest patches	2	-	3	-	-	6	2
Open forest, no understorey	1	-	6	1	-	-	2
Pasture with scattered trees	3	-	-	-	-	-	0
Woodland – dense	2	1	3	1	-	-	3
Woodland – open	6	1?	2	-	-	-	1 or 2
Woodland – patchy	2	-	1	-	-	1	2
Sparse trees on exposed ridgetop	0	-	-	-	-	-	0
Site occurrence for each species		2	6	3	0	2	
Mean calls per site		1.0	3.2	2.7	0	3.5	

KEY: Species mnemonics are as follows: *Cdwy* = *C. dwyeri*, *Msch* = *M. schreibersii*, *Ncor* = *N. corbeni*, *Sfla* = *S. flaviventris* and *Vtro* = *V. troughtoni*. The number of calls recorded is shown in cells.

Table 7-4 Comparison between Wind Farm and Transmission Line habitat utilisation patterns

Species	Number of Habitats Utilised		Mean Calls / Night	
	WF	TL	WF	TL
<i>Chalinolobus dwyeri</i>	2	4	1.0	1.8
<i>Miniopterus schreibersii</i>	6	3	3.2	11.3
<i>Nyctophilus corbeni</i>	3	2	2.7	1.5
<i>Saccolaimus flaviventris</i>	0	1	0	1?
<i>Vespadelus troughtoni</i>	2	2	3.5	6.5

Note: Total vegetation types recorded: (WF = 8, TL = 4). Total Anabat sites (WF = 16, TL = 12)

7.1.5 Non-threatened Species

Analysis of the habitat utilisation of non-threatened species was only carried out for the Wind Farm Study Area. When the wind farm is operational, experience shows that some non-threatened species may negatively interact with turbines. Species such as White-striped Freetail Bat and Gould's Wattled Bat are known to rate highly in the number of fatalities caused by collision and barotraumas associated with wind farms. Of the eight broad habitat types in the Wind Farm Study Area, two are most likely to have turbines ('pasture with scattered trees' and 'sparse trees on exposed ridgetops') but these have lower utilisation by non-threatened bats than the others (Table 7-5). Of note, White-striped Freetail Bat and Gould's Wattled Bat were not recorded on exposed ridgetops.

Table 7-5 Site records for each non-threatened bat species recorded in the Wind Farm Project Area.

Habitats	No. of Sites	Aaus	Cgou	Cmor	Mrid	Morm4	Nyct	Sbal	Vdar	Vreg	Vvul
Casuarina on creekline	2	2	2	1		2	2	2	2		2
Forest patch with dam	1	1	1	1	1	1	1	1	1	1	1
Pasture with scattered trees	2	1	1		1	1	1		1	1	
Sparse trees on exposed ridgetop	1					1					
Sparsely wooded slopes	2			1			2		2		
Woodland - dense	1	1							1		
Woodland - open	5	2	3	3	3	2	2	1	4	1	1
Woodland - patchy	2			1	1	1			2	2	
Site records for each species		7	7	7	6	8	8	4	13	5	4
Total sites	16										
Proportion of sites utilised		0.44	0.44	0.44	0.38	0.50	0.50	0.25	0.81	0.31	0.25

KEY: Species mnemonics are as follows: Aaus = *A. australis*, Cgou = *C. gouldii*, Cmor = *C. morio*, Mrid = *M. ridei*, Morm4 = *Mormopterus sp.4*, Nyct = *Nyctophilus* spp (either *N. geoffroyi* or *N. gouldi*), Sbal = *S. balstoni*, Vdar = *V. darlingtoni*, Vreg = *V. regulus* and Vvul = *V. vulturnus*. The 'pasture with scattered trees' and 'sparse trees on exposed ridgetops' habitat types are those that are most likely to have turbines. A "site record" is the occurrence of a species at a site, irrespective of the number of calls recorded.

8 KEY ECOLOGICAL ISSUES

8.1.1 Wind Farm Study Area Key Ecological Issues

The following are the key flora issues for the Wind Farm Study Area:

- The presence of a small area of non-EEC woodland in good condition which contains a high diversity of native groundcover species and also has some potential as threatened flora habitat (located within the north-east section of the Wind Farm Study Area near general location WF3_A6);
- The potential for three threatened grass species to be present in less heavily grazed areas such as side slopes which may be traversed by roads and transmission lines;
- The presence of Box-Gum woodland EEC in poor-moderate and moderate condition across the study area, primarily within the southern section.

The following are the key fauna issues for the Wind Farm Study Area:

- The presence of two threatened bird species (Scarlet Robin and Varied Sittella);
- The potential occurrence of additional threatened bird species that may occur in woodland and forest habitats and may be impacted to various degrees by clearing of native vegetation;
- The presence of four threatened microchiropteran bat species (Eastern Bentwing Bat, Corben's Long-eared Bat, Large-eared Pied Bat, Eastern Cave Bat) and an additional 10 microchiropteran bat species returned from database searches that may be impacted by operation of turbines;
- The presence of the threatened Squirrel Glider, a hollow-dependent arboreal mammal that is sensitive to impacts including loss of tree hollows and fragmentation of habitat;
- The presence of hollow-dependent species including arboreal mammals, microchiropteran bats and a range of bird species that may be impacted to various degrees by clearing of native vegetation;
- The presence of scattered surface rock and fallen timber on higher elevation ridgetops that provides high quality habitat for reptiles and other species;
- The presence of riparian habitats, including rocky drainage lines;
- The presence of an area containing a large population of Greater Gliders, a preferred prey species of the threatened powerful owl;
- The presence of non-threatened raptor species, Wedge-tailed Eagles and Brown Falcons, that may be impacted by operation of turbines; and
- The proposed location of turbines and other infrastructure in proximity to Coolah Tops National Park, a large conservation reserve that provides known habitat for a range of fauna species.

8.1.2 Relationship of Key Ecological Issues to the Constraints Analysis

As summarised in Section 4.8, a constraints analysis was applied to the Project Area and was based on three constraint classes; High, Moderate and Low. The above key ecological issues within the Project Area were used to inform the constraints analysis and the impact assessment. The key ecological issues relate to the presence of an EEC, threatened flora and fauna habitat, landscape connectivity (potential to create a barrier effect), as well as threatened and 'high risk' fauna species (with regard to potential wind farm

impacts). Table 8-1 details the application of the above ecological issues into a constraint class, where such issues can be mapped. The implications of the development on these ecological issues are further investigated in the impact assessment section of this report (Section 9), with recommendations provided in Section 11.

Table 8-1 Identified ecological issues for the Wind Farm Study Area and their constraint class.

Constraining Value	Constraint	Description
EEC : Box-gum Woodland		
<ul style="list-style-type: none"> Poor, poor-moderate, or moderate quality. Some of these areas in moderate condition have some marginal potential to support threatened native grass species. 	Moderate	<ul style="list-style-type: none"> Throughout Wind Farm Project Area
Mature / good quality habitat and vegetation		
<ul style="list-style-type: none"> Mature habitat supporting hollow-bearing trees in moderate-good or good condition 	Moderate	<ul style="list-style-type: none"> Moderate-good and good condition habitat includes approximately 200ha of Norton's Box Woodland and Mountain Gum Silvertop Stringybark Forest within the northern section of the WF study area. Approximately 20ha of this would be directly impacted.
Landscape connectivity		
<ul style="list-style-type: none"> Fragmentation or barrier effect for patches of vegetation which may be critical for threatened fauna mobility 	Moderate	<ul style="list-style-type: none"> North-east corner and eastern boundary of Wind Farm close to Coolah Tops National Park.
<ul style="list-style-type: none"> General 	Moderate	<ul style="list-style-type: none"> Intact vegetation, corridors, patches and scattered paddock trees throughout Project Area.
Sensitive features		
<ul style="list-style-type: none"> Hollow-bearing trees 	Moderate	<ul style="list-style-type: none"> Included in mapping of mature / good quality habitat.
<ul style="list-style-type: none"> Riparian areas and drainage lines 	Moderate	<ul style="list-style-type: none"> Throughout the Project Area and would require micro-siting around these areas, or minimising impacts through specific management controls.
<ul style="list-style-type: none"> Rocky outcrops 	N/A	<ul style="list-style-type: none"> Throughout the Wind Farm Project Area and unable to be mapped, but would require micro-siting of turbines in significant areas.

9 IMPACT ASSESSMENT

9.1 APPROACH TO IMPACT ASSESSMENT

The following impact assessment section has been divided into:

- 1) General information relating to the types of impacts associated with wind farms with reference to available research and its application to the Liverpool Range wind farm site, where relevant (Section 9.2); and
- 2) Detailed information on the specific impacts of the proposal for vegetation clearing and associated fauna impacts from habitat loss and collision or barrier effects within the construction or operational phase of the wind farm (Section 9.3).

The calculation of estimated impact area includes the following infrastructure and associated buffers:

- 288 proposed turbines with a 25m radius turbine buffer
- 60m wide buffer along the Transmission Line (33 kV) within the Wind Farm Study Area.
- Substation buffers approximately 600m in diameter
- 60m wide buffer along proposed overhead powerlines
- 20m wide buffer along proposed underground powerlines
- 20m wide buffer along proposed and existing tracks

The infrastructure layout includes an alternative option in the north-western corner of the Wind Farm Study Area where an alternative sub-station location (and associated variation in the alignment of the transmission line corridor in this area) has been identified.

Section 9.3.1 provides further detail on how to interpret the calculations within the impact assessment tables.

9.2 TYPES OF IMPACT – BACKGROUND INFORMATION

There are three primary adverse effects of wind farms upon biodiversity (Macintosh and Downie 2006):

1. Habitat loss (vegetation clearance) – relevant to Wind Farm and Transmission Line Study Areas and considered in terms of cumulative impact where appropriate;
2. Blade-strike (bird and bat collision with turbines and barotrauma) – Wind Farm Study Area; and
3. Alienation or barrier effects (behaviour change in fauna) – Wind Farm Study Area.

9.2.1 Direct Habitat Loss (Vegetation Clearance)

Considering the scale of the development, the level of clearing associated with a wind farm development is considered relatively low, as the towers occupy a vertical plane. During construction, the majority of clearing occurs through supporting infrastructure such as tracks and transmission lines (addressed in a separate report); however turbine footings, crane hard stands and crane operational areas may be substantial for turbines located in vegetated areas. Across a broad area, key issues are effects upon landscape connectivity for fauna and impact upon over-cleared vegetation communities, such as EEC. Furthermore, with clearing comes impacts including vegetation and soil compaction, erosion and sedimentation risks, weed spread and others.

9.2.2 Blade-strike/Collision Risk

A range of direct and indirect impacts of wind farms on birds and bats have been recognised in recent years, with mortality via direct collision with moving turbine rotors being an obvious impact (Madders and Whitfield 2006; Smales 2006).

Collision risk can be defined as the likelihood of individual species migrating, feeding or roosting in the proximity of a wind farm which may lead to collisions with wind turbines and other infrastructure (Drewitt and Langston 2006). The species present, number and behaviour of birds, topography, seasonal weather conditions, turbine design, and the specifications and layout of the wind farm are all factors influencing collision risk (Smales 2006; Drewitt and Langston 2006; Bull *et al.* 2013). Collision with rotor blades generally occurs when birds are approaching the rotor with a tail-wind, which reduces their ability to take evasive action. Mortality or injury can also result from birds being driven down to the ground by the force of the wake behind the rotor (Sharp 2010).

Industry research reveals that the species that appear to be most susceptible to population scale impacts due to blade-strike are common species (i.e. not listed as threatened in state or Commonwealth legislation). However, evidence shows that operational impacts affect particular species disproportionately, compared to habitat loss or stationary elevated structures (Willis *et al.* 2010). While research on Australian wind farms is lacking, evidence to date suggests the species most affected by collision mortality fall into the following groups (MacMahon 2010, Roaring 40s Renewable Energy 2010, Smales 2006):

- Large sedentary raptors;
- Fast high flying microchiropteran bats; and
- Fast high flying non-passerines.

Available data from operational wind farm monitoring (i.e. carcass searches) at Australian wind farms is presented in Table 9-1. Based on the data in this table below, carcass searches at operational wind farms have found an average mortality of 0.71 birds and 0.55 bats per turbine per year, although these rates are imperfect given the limited datasets. Table 9-1 also shows that although a range of species have been recorded from carcasses searches, four species are disproportionately represented (shaded grey in Table 9-1): White-throated Needletail, Wedge-tailed Eagle, White-striped Freetail Bat and Gould's Wattled Bat.

Collision risk modelling has been developed for birds and involves the use of avoidance rates for each species modelled based on observed flights around turbines, with most species assumed to have an avoidance rate of 98-99%. This means that out of 100 flights near a turbine, an individual bird would take avoidance action to avoid the turbine and rotors 98 or 99 times (i.e. 1 in 100 likelihood of collision with turbine rotors). These avoidance rates are generally considered to be accurate for the majority of bird species (Biosis Research 2009), but Wedge-tailed Eagles have a considerably lower avoidance rate at between 90% and 95% (Smales 2009, MacMahon 2010). This is supported by carcass search data presented in Table 9-1. If Elmoby Ecology (2012) data is excluded for species analysis (as small sample size skews fine analysis), the figures in the table provide an average of 0.05 Wedge-tailed Eagle, 0.03 White-throated Needletail and 0.09 Gould's Wattled Bat deaths per turbine per year.

Table 9-1 Collisions per turbine per year from five Australian wind farms.

Species	Elmoby Ecology 2012 (2 turbines, 6 mths)	Hydro Tasmania 2012 (62 turbines, 1 yr)	Roaring 40s 2011 (62 turbines, 1 yr)	Roaring 40s 2012 (62 turbines, 1 yr)	nghenvironmental (unpubl.) (15 turbines, 2 yrs)	Av.
Brown Falcon	1	0	0	0.03	0	
Silvereye	0	0.02	0	0	0	
Australian Pelican	0	0.02	0	0	0	
White-throated Needletail	0	0.02	0.02	0.08	0	
Wedge-tailed Eagle	0	0	0.02	0.05	0.13	
Swamp Harrier	0	0	0	0.011	0	
Pied Currawong	0	0	0	0	0.03	
Australian Magpie	0	0	0.35	0	0.003	
Other bird species	0		0.4	0.35		
ALL BIRDS	2	0.05	0.79	0.52	0.2	0.71
White-striped Freetail Bat	1	0	0	0	0.27	
Gould's Wattled Bat	0	0.05	0.15	0.11	0.07	
Large Forest Bat		0	0	0	0.03	
Other bat species				0.02	0.03	
ALL BATS	2	0.05	0.15	0.13	0.4	0.55

Raptors

Raptors are generally considered the most vulnerable group of birds in Australia (Roaring 40s Renewable Energy 2010), particularly the Wedge-tailed Eagle (as well as the White-bellied Sea-eagle, however this species is uncommon or rare in the Project Area). Particular bird groups, such as raptors and waterbirds are considered at greater risk of collision because of their flight heights, size and behaviour. A review of avian collision mortality in the United States by Erickson *et al.* (2001) found that most avian fatalities were nocturnal migrant passerines.

The flying heights of bird species varies considerably; many birds rarely, if ever, reach rotor-swept height, while others do so routinely and some frequently fly above that height (Sharp 2010). In relation to the Liverpool Range wind farm proposal, the highest tip of the blade is at 165 m and the lowest point of the blade to the ground will be 28 m. At risk flight heights (i.e. within the rotor-swept area) are therefore between 28 m and 165 m. The tips of turbine rotors generally travel at speeds of between 200 and 300 km/h (Smales 2006).

Different types of flight, such as hovering, circling, vertical and horizontal flights made by different species of birds, and by birds engaged in different activities, may pose quite different risks of collision (Smales 2006). Collision risk may vary within the same bird species; depending on the bird's age, behaviour and stage of annual cycle, e.g. a Wedge-tailed Eagle when searching for food to support its young. Weather conditions (e.g. fog, rain and wind) and the time of day or night also have an influence on collision risk (Drewitt and Langston 2006; Smales 2006). Overall, a species presence on site can be a poor indicator of collision risk. There is evidence that particular morphological, ecological and behavioural factors are associated with a species' vulnerability to colliding with wind turbines (Hull *et al.* 2013).

Microchiropteran Bats

Bat-strike interactions are likely during the operation of proposed wind turbines in the Project Area. Although it is not exactly known which species may fly within the rotor-swept area, it is expected that several species may have interactions with turbines. Little is known about the effect of operating turbines on bat behaviour, whether bats avoid turbines or not, and the actual number of bat-strikes that have been caused by operational wind farms in Australia. Some recent wind farm studies overseas have suggested that bats may be impacted by a sudden change in localised air pressure created by turbines, after bats had been found with fatal injuries consistent with Barotrauma (Baerwald *et al.* 2008). Barotrauma is likely to be caused by the sudden air pressure change at turbine blades to which microchiropteran bats are more susceptible than birds (Baerwald *et al.* 2008).

In Europe and North America, migrating bats are most susceptible to collision with high numbers of fatalities during migration periods (Cryan and Barclay 2009). Horn *et al.* (2008) studied bat activity around wind turbines at a facility in Virginia USA, where hundreds of migrating bats had collided with turbines. The turbines were located along a heavily forested ridge, and activity was monitored with thermal imaging cameras. Out of 998 bat observations of bats interacting with turbines, 41 avoidances (4.108%) were observed and five collisions (0.501%) were recorded. In the remaining 952 observations, bats flew around the blades or investigated them. Whether or not these figures would apply to an Australian situation is unknown, an extrapolation of the US activity may give the only possible indication of the potential for fatalities at the proposed Liverpool Range Wind Farm proposal.

In Australia, there are relatively few migrating bats. However, evidence from carcass searches suggests that even when microchiropteran bats are using echolocation for moving through their environment certain species are still at risk of collision with turbine rotors. In terms of blade-strike, Australian species that appear to be most at risk are those that forage above canopy (i.e. in open areas) and move through their environment at high speeds, such as the White-striped Freetail Bat and Gould's Wattled Bat. These species are more likely to travel at blade-sweep height and either fail to detect the moving blades, or are less able to quickly manoeuvre around them (this is discussed in more detail in Section 9.3.4). Species such as the Large Forest Bat fly in the mid-storey, away from vegetation, and are likely to occasionally fly higher, within the risk zone (Hull and Cawthen 2013). A study in Tasmania found that bat mortalities predominantly occurred in autumn, and that tree roosting species with high wing aspect ratios that forage in the open air at high altitude appear to be susceptible (Hull and Cawthen 2013).

9.2.3 Indirect Habitat Loss

Alienation involves changes in behaviour (such as avoiding nesting or foraging resources) and habitat utilisation (such as diverging around the broad area where turbines are located). This can result in indirect habitat loss if birds ultimately avoid and entire wind farm development area that they utilised prior to construction of the wind farm. A barrier effect may cause birds and microchiropteran bats to alter their flight pathways to avoid the wind farm area, i.e. the ridgelines and hilltops where the turbines are located. Barrier effects may affect local sedentary birds in their daily traverses for foraging, roosting and breeding sites or may cause migratory birds to shift migratory flyways. Alienation of hunting habitat for raptors such as Wedge-tailed Eagle may be of particular concern (Smales 2006). Siting and configuration of turbines is the primary issue; inappropriate layout (such as lines of turbines between important habitat features) can create a 'barrier effect', resulting in habitat loss or fragmentation (Brett Lane and Associates 2009). In Tasmania, Hull and Muir (2013) found that there was a change in the avoidance patterns of eagles from no avoidance at the control site, to an increasing avoidance from the commissioning stage to the operational stage. While such a response is likely to be species or site-

specific, it does indicate that the construction and operation of a wind farm does not necessarily result in a large-scale alienation effect (Hull and Muir 2013).

Although the zone of disturbance around individual turbines can be relatively small, the cumulative area of this zone around large wind farms such as that proposed has the potential to be substantial (Sharp 2010). Turbines are generally placed to maximise wind values and to minimise turbulence from topographic features and other turbines. In practice, this means there are usually large and variable spaces between turbines (Smales 2006). Rows of turbines throughout the Project Area could in effect act as multiple barriers to the movement of birds and bats. Birds and bats may be forced to change their flight behaviour to avoid collisions with turbines, subsequently impacting on their breeding and foraging success (Drewitt and Langston 2006).

9.3 SPECIFIC PROPOSAL IMPACTS – WORST CASE SCENARIO

9.3.1 Interpretation of Impact Assessment Tables

The impact assessment tables (Table 9-2 to Table 9-6) show what is considered to be the worst case scenario impact areas for the Wind Farm Study Area. That is they consider the actual area of impact plus a generous buffer width.

The following provisions apply to Table 9-2:

- The **Total Vegetation Clearance rows** (shaded grey) for the Wind Farm Study Area is an *overestimation* of total clearance as some areas still include buffer zones or are larger than required. These include the overhead powerline cabling / easement, substations, and new tracks. Clearing calculations for underground powerlines and tracks have used a 20 m buffer (10m either side) when in fact the actual clearing is likely to be substantially less than that. Area calculations will be refined in relation to the final alignment and infrastructure layout.
- The **Total Survey Area rows** (shaded grey) for the Wind Farm Study Area have been calculated using GIS mapping software and has excluded areas in which infrastructure overlaps.
 - The vegetation clearance hectare totals are also presented for each infrastructure type and can therefore be read in isolation.
- For the Wind Farm Study Area, vegetation clearance has been calculated per turbine footing (288 turbines) for each vegetation type based on the indicative turbine locations.
- Unknown: these are areas not surveyed during the field work, or for which vegetation mapping cannot be confidently extrapolated. Constraints analysis has been extrapolated to these areas (refer Section 4.8) using a precautionary approach.
 - Within the Wind Farm Study Area the main areas unknown include: minor areas of proposed underground powerline and proposed tracks within northern sections of the wind farm.

9.3.2 Habitat Loss (Vegetation Clearing)

At the time of this assessment, the proposal included scope for the development of up to 288 turbines. This may be reduced, however the calculations for magnitude of impact remain based on the worst-case scenario (288 turbines) and associated infrastructure. The proposal would result in the removal of vegetation within the development footprint, including:

- 1) turbine towers, surrounding hardstand and crane operation areas, substations, control building, access tracks and overhead powerlines; and
- 2) the section of the 330kV transmission line within the Wind Farm Study Area. Electrical cabling would be installed adjacent to disturbed areas for the access tracks where possible.

Estimates of permanent habitat loss for each of the affected vegetation types are presented in the tables below (Tables 9-2 to 9-4). As mentioned, overall impact areas have been determined based on worse case (maximum) infrastructure footprints as provided by the proponent.

Non-threatened Vegetation Types

The survey area for the Wind Farm covers a total of 6,999.9 ha. The bulk of vegetation clearance within the defined impact area affects exotic vegetation (737.7 ha). Within the Wind Farm development footprint Norton's Box Woodland supports a total of 11.5 ha good or 9.5 ha of moderate-good condition vegetation, which is substantially higher than any other vegetation type. This represents a total of 16% and 8% of good and moderate-good condition Norton's Box Woodland mapped across the Wind Farm survey area. This community is considered to be 'vulnerable' by Benson *et al* (2010), as substantial areas have been cleared or subject to grazing. The typical location of good quality vegetation of this community was on steep slopes, therefore limiting grazing impacts. These areas are more likely to be affected by clearing associated with access tracks and powerlines rather than clearing for turbines. However, despite regarding this community as being vulnerable, and despite one of its dominant trees being an indicator species for the listed EEC Box Gum Woodland, Benson *et al* (2010) does not identify this community as part of that EEC.

Other areas of good condition vegetation were found in Brittle Gum Stringybark Woodland and Mountain Gum / Silvertop Stringybark Forest within the north-eastern section of the wind farm in 2012. These areas have been removed from the development footprint as part of the revised design. No other vegetation communities in good or moderate-good condition are located within the Wind Farm development footprint.

Box Gum Woodland EEC/CEEC

Table 9-6 provides details on the extent of Box Gum Woodland EEC and CEEC to be cleared as a result of the proposed development. These calculations are expressed for the entire project area including the Wind Farm Study Area and the Transmission Line Study Area in order to assess a cumulative impact to this EEC. Calculations have been determined for the three infrastructure layouts so comparisons may be made. Under the TSC Act areas of degraded native pasture which once comprised Box Gum Woodland canopy species may still be considered part of the EEC. The extent of native pasture which would be included within the definition of Box Gum Woodland EEC is also provided in Table 9-6, however the discussion below of the condition classes is limited to areas comprising a native tree component.

Poor-moderate and moderate condition areas

The EEC over the vast majority of the Entire Project Area is characterised by low diversity native pasture in poor or poor-moderate condition. Within the Entire Project Area (~7920 ha), the estimated amount of EEC to be cleared is approximately 199.8 ha (preferred option), 209.8 ha (alternative option) or 210.5 ha (2nd alternative option). The majority of this (95% for the preferred, 84% for the alternative and 90% for the 2nd alternative) is in poor or poor-moderate condition.

This vegetation is widespread in farmland throughout the region, and particularly within lower elevation areas on the ridgetops of the Wind Farm Study Area. The long history of grazing, fertiliser use and weed

invasion means that the potential for natural regeneration is likely to be very low. Given the low viability of this vegetation and its condition, its importance to the persistence of the EEC in the locality is not high. Combined with the abundance of this vegetation type in the district and the highly localised and limited impacts associated with the proposal, impacts to poor-moderate and moderate condition Box Gum Woodland are not expected to be significant.

Where occurrences of EEC are along established roads or tracks it may be possible to further avoid or minimise impacts in these areas. Impacts to areas in transmission line clearing corridors of the study areas may also have the potential to be avoided or minimised by micro-siting infrastructure with input from an ecologist. Where new tracks, turbines or other infrastructure are placed within identified areas of EEC impacts are unavoidable and offsetting these impacts would be required. Higher offset ratios apply to higher value habitat, providing an incentive throughout the construction process to minimise impacts in high value areas.

Moderate-good and good condition areas

Only 2% (preferred), 0% (alternative) and 7% (2nd alternative) of the total EEC recorded across the entire project area was found to be in good or moderate-good condition. No such areas are located within the wind farm study area.

Habitat Loss (Hollow-bearing Trees and Landscape Connectivity)

Proposed development within the Wind Farm Study Area has been calculated as resulting in the loss of up to 310.4 ha of woodland or forest vegetation types (or 304.2 ha with the adoption of the alternative infrastructure layout). This is considered to be a worst case scenario or an upper limit to the likely clearing, as micro-siting of infrastructure can substantially reduce tree loss in most circumstances. Of this 310.4 ha of woodland or forest vegetation types, 48.3 ha is in moderate or better condition. This condition type is a good reflection of fauna habitat qualities including presence of mature trees, tree hollows, fallen timber and structural complexity.

Hollow-bearing trees are present across the Project Area, and although concentrated in areas of better condition, may occur in all habitat types and condition classes. In general, the majority of hollows were of small to medium hollow entrance size, most likely to be utilised by small to medium birds and microchiropteran bats, rather than owls and gliders. However, the north-eastern section of the Wind Farm Study Area was noted as supporting a greater density of larger hollows in better-quality forest; understorey diversity increased in this area in comparison to the rest of the Project Area. These hollows have the potential to support larger birds such as the Glossy Black-cockatoo, or arboreal mammals such as the Squirrel Glider. Overall, connectivity between hollow-bearing trees is low given the clearing and fragmentation for agricultural practices within the Project Area, but increases in the areas identified above due to their proximity to better-quality vegetation within nearby protected areas.

Recommendations have been made to the proposal in order to avoid impact upon fauna connectivity and habitat patch size and integrity, as well as hollow-bearing trees, where possible. Refer to Section 10.3.2 – landscape connectivity and protected areas for more detail on the value of these areas.

Table 9-2. Preferred Infrastructure Layout: Estimated impact area of the development by vegetation type based on the worst case scenario within the Wind Farm Study Area

Infrastructure Type (Preferred Option)	Quantity	Width (m)	Length (km)	Total Area (ha)	ROG (ha)	RRG (ha)	NP (ha)	YBW (ha)	WBW (ha)	NBW (ha)	MGST (ha)	BGW (ha)	Ex (ha)	Un (ha)
Individual turbines (footings – 25m radius)	288.0	25 radius		56.3			8.5		9.5	8.9	0.1	0.6	28.7	
Substation and control buildings	7.0			233.1	2.4	20.5	34.4		10.2	5.8			159.8	
Overhead powerline cabling / easement		60.0	52.7	318.2	9.0	12.0	66.8	3.6	35.2	29.4			162.2	
Underground powerline cabling		20.0	204.5	406.8			50.4		41.0	43.0	0.9	1.4	258.3	11.7
Transmission line infrastructure (330kV) (northern section within Wind Farm Study Area)		60.0	56.1	342.6	6.3	22.8	70.4		45.4	24.7			172.9	
Tracks including existing and proposed new tracks (permanent formed width)		10.0	282.5	561.2	0.2	0.3	55.6		46.3	46.2	0.0	3.2	278.4	131.1
TOTAL Vegetation clearing				1404.0	15.7	45.1	224.4	3.6	136.1	105.5	1.0	3.7	737.7	131.2
TOTAL Wind Farm Survey Area				6999.9	46.3	77.6	956.1	6.0	1035.4	841.0	35.9	114.4	3755.8	131.3

KEY:

WOODLAND/FOREST VEG TYPES

BGW Brittle Gum Stringybark Woodland (ID495)
YBW Yellow Box Woodland (ID437)
WBW White Box Woodland (ID483)
NBW Norton's Box Woodland (ID488)
MGST Mountain Gum / Silvertop Stringybark Forest (ID490)

RIPARIAN VEG TYPES

RRG Riparian Red Gum (ID281)
ROG River Oak Woodland (ID84)

GRASSLAND

NP Native Pasture (ID395)
Ex Exotic Pasture

OTHER

Un Unknown

Table 9-3 Preferred Infrastructure Layout - Permanent habitat loss of vegetation types by condition based on the worst case scenario⁴ within the Wind Farm Study Area

Liverpool Range Wind Farm							
Vegetation types	Vegetation clearing within each condition class						
NGH Condition Class	Good	Moderate-Good	Moderate	Poor-Moderate	Poor	Exotic	Total
[Biometric condition class]	Moderate-Good				Low		
Riparian Red Gum Woodland (ID281)					45.1		45.1
Yellow Box Woodland (ID 437)					3.6		3.6
White Box Woodland (ID 483)			5.2	27.7	103.2		136.1
Norton's Box Woodland (ID 488)	11.5	9.5	20.3	26.1	37.9		105.3
Brittle Gum Stringybark Woodland (ID 495)			1.8		1.8		3.6
Mountain Gum / Silvertop Stringybark Forest (ID 490)					1.0		1.0
River Oak Woodland (ID 084)					15.7		15.7
Native Pasture (ID 395)			167.0	17.6	39.8		224.4
Exotic Pasture						737.7	737.7
Unknown							(131.2)
TOTAL	11.5	9.5	194.3	71.4	248.1	737.7	1272.5

⁴ All of the condition classes in Table 9-3 (good, mod-good, moderate, poor-moderate and poor) excluding the 'exotic' class would equate to the 'moderate to good' definition specified within the Biometric Guidelines due to the dominance of native vegetation in the groundlayer or having a native overstorey with a per cent foliage cover greater than 25% of the lower value of the over-storey per cent foliage cover benchmark of that vegetation type. Exotic dominated vegetation would equate to 'low' condition.

Table 9-4 Alternative Infrastructure Layout⁵: Estimated impact area of the development by vegetation type based on the worst case scenario within the Wind Farm Study Area

Infrastructure Type (Alternative Option)	Quantity	Width (m)	Length (km)	Total Area (ha)	ROG (ha)	RRG (ha)	NP (ha)	YBW (ha)	WBW (ha)	NBW (ha)	MGST (ha)	BGW (ha)	Ex (ha)	Un (ha)
Individual turbines (footings – 25m radius)	288	25 radius		56.3			8.5		9.5	8.9	0.1	0.6	28.7	
Substation and control buildings	8			265.3	8.1	20.5	34.4		7.1	5.8			189.4	
Overhead powerline cabling / easement		60.0	52.9	319.5	7.7	12.0	66.8	3.6	33.5	29.4			166.5	
Underground powerline cabling		20.0	204.5	406.8			50.4		41.0	43.0	0.9	1.4	258.3	11.7
Transmission line infrastructure (330kV) (northern section within Wind Farm Study Area)		60.0	54.1	324.6	6.3	22.7	70.1		40.9	24.7			159.9	
Tracks including existing and proposed new tracks (permanent formed width)		10.0	282.5	561.2	0.2	0.3	55.6		46.3	46.2	0.0	3.2	278.4	131.1
TOTAL Vegetation clearing				1404.8	18.9	44.4	224.1	3.6	127.4	105.5	1.0	3.7	745	131.2
TOTAL Wind Farm Survey Area				6975.2	48.4	77.1	955.0	6.0	1020.5	841.0	35.9	114.4	3745.6	131.3

KEY:

WOODLAND/FOREST VEG TYPES

BGW Brittle Gum Stringybark Woodland (ID495)
YBW Yellow Box Woodland (ID437)
WBW White Box Woodland (ID483)
NBW Norton's Box Woodland (ID488)
MGST Mountain Gum / Silvertop Stringybark Forest (ID490)

RIPARIAN VEG TYPES

RRG Riparian Red Gum (ID281)
ROG River Oak Woodland (ID84)

GRASSLAND

NP Native Pasture (ID395)
Ex Exotic Pasture

OTHER

Un Unknown

⁵ The alternative infrastructure layout option differs from the preferred only slightly in that it includes one additional substation, 2km less Transmission Line infrastructure (33 kV) and 200m additional overhead powerline. This is shown on the figures in Appendix E.1.

Table 9-5 Alternative Infrastructure Layout - Permanent habitat loss of vegetation types by condition based on the worst case scenario⁶ within the Wind Farm Study Area

Liverpool Range Wind Farm (Alternative Infrastructure layout)							
Vegetation types	Vegetation clearing within each condition class						
NGH Condition Class	Good	Moderate-Good	Moderate	Poor-Moderate	Poor	Exotic	Total
[Biometric condition class]	Moderate-Good				Low		
Riparian Red Gum Woodland (ID281)					44.4		44.4
Yellow Box Woodland (ID 437)					3.6		3.6
White Box Woodland (ID 483)			5.2	27.3	95.0		127.4
Norton's Box Woodland (ID 488)	11.5	9.5	20.3	26.1	37.9		105.3
Brittle Gum Stringybark Woodland (ID 495)			1.8		1.8		3.6
Mountain Gum / Silvertop Stringybark Forest (ID 490)					1.0		1.0
River Oak Woodland (ID 084)					18.9		18.9
Native Pasture (ID 395)			167.0	17.6	39.5		224.1
Exotic Pasture						745	745
Unknown							131.2
TOTAL	11.5	9.5	194.3	71	242.1	745	

Table 9-6 Clearing of TSC Act EEC and EPBC Act CEEC based on the worst case scenario across the entire project area including both the Wind Farm Study Area and the Transmission Line Study Area.

Condition Class	CEEC ¹	EEC ²	Biometric Condition	Vegetation Clearance (ha) Preferred Infrastructure Layout		Vegetation Clearance (ha) Alternative Infrastructure Layout		Vegetation Clearance (ha) 2 nd Alternative Infrastructure Layout	
				EEC (with native tree component)	EEC (native pasture) ⁷	EEC (with native tree component)	EEC (native pasture)	EEC (with native tree component)	EEC (native pasture)
Poor	No	Yes	Low	161.2	39.3	146.8	35.9	156.1	36.2
Poor-Moderate	No	Yes	Moderate-Good	29.5	43.3	34.8	40.1	35.2	56.8
Moderate	No	Yes	Moderate-Good	5.2	159.3	5.2	159.3	5.2	159.3
Moderate-Good	Yes	Yes	Moderate-Good	2.6		23.0		8.7	
Good	Yes	Yes	Moderate-Good	1.3				5.3	
Subtotal				199.8	241.9	209.8	235.3	210.5	252.3
Total				441.7		445.1		462.8	

KEY:

CEEC¹ EPBC Act Critically Endangered Ecological Community

EEC² TSC Act Endangered Ecological Community

⁷ It is unlikely that native pasture areas will require substantial modification, as there is no, or very little, overstorey requiring clearing, and the impact footprint of most infrastructure relating to the project is relatively small. These numbers are thus likely to be exaggerated beyond the true impact.

9.3.3 Blade-strike (High Risk Raptor Species)

Based on Australian collision monitoring data (Table 9-1), ecological traits and local wind farm experience, the following raptor species are most likely to be at high risk from operational impacts at Liverpool Range wind farm:

- Wedge-tailed Eagle;
- Little Eagle; and
- Brown Falcon.

Wedge-tailed Eagle

Although the Wedge-tailed Eagle is not a listed threatened species on mainland Australia, it is recognised as an at risk and flagship raptor species in relation to wind farm developments. Juvenile eagles, specifically recently fledged individuals, are considered the most vulnerable of the raptors, due to “inexperience and being relatively weak flyers” (EBS Ecology 2012 p.73). **ng**h environmental have been involved in operational monitoring of a NSW wind farm and collation of Wedge-tailed Eagle data. Data shows attempted breeding by a Wedge-tailed Eagle two years in a row (using different nests within the same territory) with nests within 300 m of operational turbines. At least one breeding attempt appears to have failed following the blade-strike death of one recently fledged and one adult eagle, found under the turbine closest to the nest. Similar reports are emerging in other parts of Australia. At Cape Jervis, South Australia, at least two fledgling Wedge-tailed Eagles have been killed by collision with a wind turbine within 200 m of a nest site (EBS Ecology 2012).

Based on the evidence, it appears prudent to situate turbines a safer distance from known Wedge-tailed Eagle nests. Recommended buffer distances vary from 500 metres on mainland Australia (EBS Ecology 2012) to 1000m in Tasmania, where the species is endangered (Hydro Tasmania Consulting 2010). No Wedge-tailed Eagle nests were located during the Spring sampling in close proximity to the turbine envelopes; however buffer zones should be considered if they are located in further assessments.

As mentioned, Wedge-tailed Eagles exhibit a lower collision avoidance rate than other species of birds. Reasons for this including size, manoeuvrability and hunting style are discussed in the literature. In large part the higher risk seems attributable in part to flight behaviour and the use of territories. If turbines are placed within the core territory of an individual Wedge-tailed Eagle, for example, then the likelihood of a collision is greatly increased for this individual due to the high proportion of flights made within the rotor-swept area by the species and their regular use of updraughts in certain landscape positions (often coinciding with turbine placements).

Brown Falcon and Little Eagle

Although the Brown Falcon does not have a rating under legislation, it is often an at risk raptor species in relation to wind farm developments. Brown Falcons are likely to be resident to the area. They use the stick nests of other birds, usually a raptor or raven species, with peak breeding time being between August-November. Little Eagles are rated as vulnerable under the TSC Act, but have not been recorded in the Australian carcass search literature cited above.

Both species are a medium sized raptor with similar soaring and prospecting foraging behaviour (Aumann 2001c) as the Wedge-tailed Eagle and may be similarly at risk from turbines in certain landscape positions. As for Wedge-tailed Eagles, juvenile Little Eagles or Brown Falcons with turbines near nests would be most at risk.

Based on the collision risk modelling research presented in Table 9-1 suggesting birds avoid turbines 98-99% of the time, with the exception of Wedge-tailed Eagles which have an avoidance rate of 90-95%, it is considered that the proposal will not have an adverse effect on these raptor species. Additionally, these species were not recorded in high abundance during the field survey, especially Brown Falcons and the management measures suggested in Section 12 are considered adequate to manage these species. However, the implementation of an adaptive bird and bat management plan with focus on these raptor species will provide detail on habitat utilisation and foraging patterns. Additionally, spacing of the turbines at no less than 300 m apart will reduce the risk of collision and blade strike.

9.3.4 Habitat Loss and Blade-Strike (Microchiropteran Bats)

Habitat Clearance

Loss of foraging habitat and roost sites (hollow-bearing trees) through clearance associated with construction of a wind farm has the ability to incur some impact on microbat populations. Notably, two habitats where turbines are most likely to be located, pasture with scattered trees and exotic pasture, were not shown to be utilised by any threatened species within the Wind Farm Study Area, however this is not evidence to suggest they do not use the area, but could suggest that abundance and activity levels within these areas could be less compared to woodland or forested areas.

Some habitats supported two or three threatened species, including *Casuarina* riparian habitat on creeklines, forest patches, and woodland vegetation. Of the four threatened species recorded in the Wind Farm Study Area, Corben's Long-eared Bat can roost in hollows, (as can the Yellow-bellied Sheath-tail Bat, recorded only in the Transmission Line Study Area) while Eastern Bentwing Bat, Eastern Cave Bat, and Large-eared pied Bat roost in caves and are unlikely to be adversely affected by hollow-bearing tree loss (roost sites). It is assumed that, as with most forest bats, Corben's Long-eared Bat and Yellow-bellied Sheath-tail Bat colonies utilise a number of alternative roosts in the landscape (Richards *et al* 2012).

Blade-strike

It can be expected that some bat fatalities will occur during the operation of the wind farm, and until deterrence systems are developed these would be impossible to mitigate. Current and unpublished studies at the Capital Wind Farm (Bungendore, NSW) indicate that for every fatality there has been much higher activity near the turbine: that is, not every bat that flies near a turbine will be killed.

Considering the threatened species known from the Project Area, Yellow-bellied Sheath-tail Bat is renowned as a high flying species and can fly within the rotor-swept area, but data from the survey indicates that very few (if any) utilise habitats on the site. Eastern Bentwing Bat is known as a sub- and over-canopy feeder, so the majority of foraging would be below the rotor-swept area; however, they do have the ability to forage within the rotor-swept area. Based on their wing aspect ratio (an indicator of foraging style) the same would probably apply to the Eastern Cave Bat. Corben's Long-eared Bat forages below the canopy or low to the ground in open areas, and is therefore considered unlikely to encounter turbines. The TSC Act assessment of significance has been applied to threatened microbat species with the potential to fly within the rotor-swept area including: Eastern Bentwing Bat; Yellow-bellied Sheath-tail Bat; and Eastern Cave Bat (Appendix D).

Two non-threatened species detected during this biodiversity assessment, the White-striped Freetail Bat and Gould's Wattled Bat, are high flyers and forage above the canopy. Carcasses of these species have been found at a number of monitored wind farms in NSW and Victoria (Richards, unpublished). Anabat

results suggest these non-threatened species were more likely to be recorded within forest patches with dams (*Casuarina*-lined creeks and Open woodland remnants). These species are discussed in further detail below.

High Risk Bat Species

White-striped Freetail-bat

The foraging and flight behaviour of White-striped Freetail Bat makes them a high-risk species. The White-striped Freetail Bat is a relatively large microbat that pursues prey in open air above canopy height (around 50m above ground – within RSA) at high speed (up to 60 km per hour). Due to speed and wing structure, they are not a highly manoeuvrable bat (Churchill 2008). Observations show that the species is a relatively straight path flier and appear to have limited ability to turn (McKenzie et al 2002). The echolocation call design of the White-striped Freetail Bat, which provides individuals with information to navigate through their environment, is a slow low frequency pulse which provides a low resolution picture (Herr 1998). Its echolocation call design is used for target detection of prey rather than navigating cluttered environments, hence the species' utilisation of open habitat (Rhodes 2006). The characteristics of its echolocation calls as well as flight and wing design mean White-striped Freetail Bat have a poor ability to detect and avoid obstacles (such as rotors) during pursuit flight. While White-striped Freetail Bats occupy a wide range of habitats including woodland, forest, agricultural land and grasslands (Churchill 2008), habitat preferences are correlated with open areas in canopy gaps and along the edge of vegetation and it is more active on upper slopes (Lloyd *et al.* 2006).

Gould's Wattled Bat

Like White-striped Freetail Bat, the Gould's Wattled Bat is a relatively large microbat and a fast, high flier with restricted manoeuvrability (Herr 1998). The Gould's Wattled Bat also have an echolocation call design which provides a low resolution image of its environment ideally suited to fast flying in open areas (Herr 1998) meaning this bat too has a poor ability to detect and avoid obstacles while pursuing prey, particularly mobile ones such as rotors. This species hunts most in the sub-canopy and along flyways, particularly on upper slopes (Lloyd *et al.* 2006), so turbines located between closely linked patches of bush or within patches are likely to present the highest risk to Gould's Wattled Bat.

9.3.5 Alienation or Barrier Effects (Susceptible Fauna Species)

As the development envelope lies largely within a highly disturbed and fragmented agricultural landscape, there is limited opportunity for the turbine layout to sever movement corridors for fauna species. One area in the far north-east section of the wind farm was identified in 2012 as a posing a potential barrier to the movement of threatened owls and microchiropteran bats, given its close proximity to Coolah Tops National Park. In response to concerns the about collision risk, 130 turbines have now been removed from this area and the area will not be developed.

The most obvious approach to mitigate the risks posed by a wind farm on bird movements and behaviour would be to space turbines at a distance that allow birds to fly between them. There are no generally accepted minimum separation distances for turbines. Within the proposed layout the turbines will be placed around 300-600 m apart. There is no evidence to suggest that this spacing is sufficient to manage the risk of potential bird strike, but it is generally considered that the greater the distance allowed between turbines, the lower the risk of collision.

In general the turbines are between 350m and 600m apart. The closest 2 turbines are 338m apart, while the most common separation distance is around 380m (this applies to approximately half of the turbines).

This separation distance is likely to allow for safe passage between turbines for birds and bats, without creating a barrier effect. However, within areas of intact woodland or forest the greater the turbine spacing (i.e. 600m apart) the better.

In general however, it is considered best to avoid placing turbines between core areas of habitat (e.g. between the large blocks of intact vegetation), to reduce the potential impact on bird (and bat) movements between habitat patches.

Landscape Connectivity and Protected Areas

Coolah Tops National Park

Threatened fauna recorded in Coolah Tops National Park includes:

Owls	Parrots	Woodland Birds	Bats
Powerful Owl	Glossy Black-Cockatoo	Diamond Firetail	Eastern False Pipistrelle
Masked Owl	Little Lorikeet	Flame Robin	Eastern Bentwing Bat
		Scarlet Robin	
		Varied Sittella	
		Speckled Warbler	

The siting of turbines close to this habitat is considered a high operational risk for fauna species (i.e. blade-strike). Operational impacts to the Powerful Owl or microchiropteran bats are most noteworthy. The Powerful Owl is likely to forage outside the National Park into forested areas of the wind farm and has the ability to fly within the rotor-swept area of turbines and is therefore subject to blade-strike.

A high density of Greater Gliders, a known food resource for the Powerful Owl, were detected within the turbine development area directly adjacent the National Park and within Brittle Gum Stringybark Woodland or Silvertop Stringybark Forest. These records are consistent with Kavanagh's (1995) research on nocturnal and mammal fauna within the National Park in which he recorded a very high density of Greater Gliders in Silvertop Stringybark Forest. On average Kavanagh recorded 1.9 animals per ha in elevations above 700-800m; Greater Glider distribution and abundance are strongly related to higher elevations. Given the habitat connectivity and similar vegetation type and elevation of the Wind Farm Study Area within this area to the National Park, it is possible Powerful Owls move through this area of the wind farm to forage on this resource. It is for this reason that 130 turbines have been removed from the layout in the north-eastern extent of the wind farm, which will not be developed.

Operational impacts to the other threatened species identified within Coolah Tops National Park are considered manageable or unlikely to occur.

Goulburn River National Park and Durrigere State Conservation Reserve

The Transmission Line Study Area lies nearby or traverses Goulburn River National Park and Durrigere SCA. Threatened flora and fauna species recorded within or nearby these protected areas include:

Owls	Parrots	Woodland Birds	Bats	Flora
Powerful Owl	Glossy Black-Cockatoo	Diamond Firetail	Corben's Long-eared Bat	Ausfeld's Wattle
Barking Owl		Flame Robin	Eastern Bentwing Bat	

Hooded Robin
Brown Treecreeper
Varied Sittella
Speckled Warbler
Grey-crowned Babbler

The TSC Act Assessment of Significance has also been applied to several of the above species and the conclusions have informed the management strategies to be developed and incorporated in to the proposal (Appendix D).

9.3.6 Buffers for Birds and Bats

A review of bat deaths at wind farms in Germany revealed turbine placement as a key factor in the mortality of bats. A total of 89 % of all bat fatalities were found to be near turbines that were within 100 m of a wooded area (Durr and Bach 2004). Bird and bat activity levels are generally concentrated around areas of vegetation. A minimum buffer of 100 m from the turbine blades is recommended for areas of high habitat value for birds and bats. The activity of the majority of bat species utilising the Project Area is likely to be highest in moderate or moderate-good quality wooded areas (i.e. Mountain Gum Silvertop Stringybark Forest, Brittle Gum Stringybark Woodland or Box Gum Woodland of moderate, moderate-good condition). Refer to Appendix E.3 for condition of vegetation recorded within the Project Area.

Wooded areas are more likely to be used for foraging and roosting by a greater abundance and diversity of birds than areas supporting degraded woodland over pasture, or those absent of trees. A buffer around areas of high habitat value will reduce the potential for ongoing risks to birds and bats (e.g. collision, disturbance and barotrauma) during the operational phase of the proposal. Limited open water surfaces were present within the Project Area; however any present could also be buffered. If turbines are placed within this buffer zone, the risk of bird and bat interactions with turbines increases.

Nest sites are focus areas for bird activity including behaviour which has potential to represent a risk to birds where turbines are located, such as display flight and juvenile birds learning to fly. A standard prescription is to apply a 50 – 100 m buffer around nest sites for key fauna and to avoid locating turbines in these areas. It is considered that tracks and other infrastructure can be micro-sited to avoid impacting such features.

While no Wedge-tailed Eagle nests were identified during the survey, further survey work may reveal nest sites. Given the activity of Wedge-tailed Eagles during the survey it is expected breeding pairs utilise habitat within the Project Area, or close to the area. If further survey work reveals active nests, it is recommended that consideration of a buffer greater than 100 m is applied due to larger size and habitat utilisation differences of this bird. Therefore a minimum of 100 metre buffer is recommended, with preference for up to 500 m (if possible).

9.3.7 Indirect and Peripheral Impacts

As well as direct clearing impacts, quantified in Section 10.3.2, vegetation surrounding the development footprints would be affected by vehicle access and parking, materials laydown and stockpiles. Peripheral impacts may include smothering of vegetation, soil compaction and erosion. Compaction of soil can impede vegetative growth and the successful re-establishment of groundcover in disturbed areas. The works have the potential to introduce and spread weed species. Common pasture weeds are widespread

across the site however; listed noxious weeds are not in high abundance and generally limited in their distribution. With the implementation of specific weed control measures, the risk of spreading and introducing additional weed species is considered to be manageable.

Pollution risks are associated with the use of concrete, fuels and lubricants and construction chemicals. These risks are considered manageable with appropriate safeguards. Dust would be generated from the excavation and building activities at the construction sites, and by traffic using unsealed access routes. Dust deposition is not expected to significantly affect the habitat values of the site. Noise, vibration and activity during construction phase may disturb fauna during nesting, foraging and migration periods. This disturbance is likely to be of low magnitude temporally and spatially, considering the dispersed pattern of infrastructure proposed.

9.4 THREATENED SPECIES / COMMUNITIES WITH POTENTIAL FOR IMPACT

A threatened species evaluation has been undertaken to evaluate the potential for threatened species that are present or potentially occur to be impacted by the proposal. This evaluation is presented in Appendix C. In the evaluation, one of four categories was assigned to each of the listed threatened or migratory species in terms of risk of impact, as outlined below:

No: The proposal would not result in an impact to this species.

Low: The proposal is unlikely to result in an impact to this species. No Assessment of Significance (AoS) is considered necessary for this species.

Moderate: The proposal could impact this species or its habitats but risks are considered highly manageable. No Assessment of Significance (AoS) is considered necessary for this species. Management measures have been developed to address the risks.

High: The proposal is likely to impact this species or its habitats. An AOS has been applied to these entities to properly characterise the impact and provide information then used to either develop management measures to protect the entity or justify avoidance of the entity.

Based on the categories described above, threatened or migratory listed species that are considered to have a moderate or high risk of impact are given in Table 9-7. Impacts to moderate risk species are considered manageable without the need for an Assessment of Significance. Species that are considered to have a high risk of impact have been subject to an Assessment of Significance and are discussed in Appendix D, with conclusions presented in Section 10. In Section 11 recommendations are given for managing risk, which may be included as statements of commitment to be undertaken pending proposal approval.

Table 9-7 Species with a moderate risk of impact from the proposal, and identification of impact types.

Common Name	Species Name	Impact Type	WF Risk	Identified during Survey	AoS
Ecological Community					
Box Gum Woodland		Vegetation clearing	High	✓	✓
Flora					
Bluegrass	<i>Dichanthium setosum</i>	Vegetation clearing	Mod		✓
Finger Panic Grass	<i>Digitaria porrecta</i>	Vegetation clearing	Mod		✓
Lobed blue-grass	<i>Bothriochloa biloba</i>	Vegetation clearing	Mod		✓
Woodland Birds					
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Vegetation clearing (habitat loss, connectivity)	Mod	✓	✓
Regent Honeyeater	<i>Anthochaera phrygia</i>	Vegetation clearing (habitat loss, connectivity)	Low		✗
Black-chinned Honeyeater	<i>Melithreptus gularis gularis</i>	Vegetation clearing (habitat loss, connectivity)	Mod	✓	✓

Common Name	Species Name	Impact Type	WF Risk	Identified during Survey	AoS
Hooded Robin	<i>Melanodryas cucullata cucullata</i>	Vegetation clearing (habitat loss, connectivity)	Low		✗
Scarlet Robin	<i>Petroica boodang</i>	Vegetation clearing (habitat loss, connectivity)	Mod	✓	✓
Flame Robin	<i>Petroica phoenicea</i>	Vegetation clearing (habitat loss, connectivity)	Low		✗
Diamond Firetail	<i>Stagonopleura guttata</i>	Vegetation clearing (habitat loss, connectivity)	Mod		✓
Parrots and Cockatoos					
Little Lorikeet	<i>Glossopsitta pusilla</i>	Habitat loss, blade-strike	High	(off-site only)	✓
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Habitat loss	Low		✗
Turquoise Parrot	<i>Neophema pulchella</i>	Habitat loss, blade-strike	Mod		✗
Raptors					
Square-tailed Kite	<i>Lophoictinia isura</i>	Habitat loss, blade-strike	Mod		✓
Little Eagle	<i>Hieraaetus morphnoides</i>	Blade-strike	High		✓
Grey Falcon	<i>Falco hypoleucos</i>	Blade-strike	Low		✓
Spotted Harrier	<i>Circus assimilis</i>	Blade-strike	Low		✗
Nocturnal Birds					
Barking Owl	<i>Ninox connivens</i>	Habitat loss, blade-strike	High		✓
Powerful Owl	<i>Ninox strenua</i>	Habitat loss, blade-strike	Mod		✓
Masked Owl	<i>Tyto novaehollandiae</i>	Habitat loss, blade-strike	Mod		✓
Mammals (bats)					
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Habitat loss	Mod	✓	✗
Little Pied Bat	<i>Chalinolobus picatus</i>	Habitat loss	Low		✗
Little Bentwing-bat	<i>Miniopterus australis</i>	Habitat loss	Low		✗
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	Blade-strike	High	✓	✓
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	Habitat loss	Low		✗
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	Habitat loss	Mod	✓	✓
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	Blade-strike	High	(TL only)	✓
Eastern Cave Bat	<i>Vespadelus troughton</i>	Blade-strike	High	✓	✓
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	Habitat loss	Low		✗
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	Habitat loss	Low		✗
Greater Long-eared bat	<i>Nyctophilus timoriensis</i>	Habitat loss	Low		✗

Common Name	Species Name	Impact Type	WF Risk	Identified during Survey	AoS
Mammals (excluding bats)					
Squirrel Glider	<i>Petaurus norfolcensis</i>	Habitat loss	Mod	✓	✓
Koala	<i>Phascolarctos cinereus</i>	Habitat loss	Low		✗
Reptiles					
Pink-tailed Legless Lizard	<i>Aprasia parapulchella</i>	Vegetation clearing (construction impacts)	Low		✗

10 SIGNIFICANCE OF IMPACTS

10.1 ASSUMPTIONS

The impact assessment, including Assessments of Significance for communities and species listed under TSC and EPBC Acts, is based on the following assumptions:

- The Assessments of Significance have been undertaken based on the specifics of the proposal, known impact types of wind farms and the ecology of the species; and
- Recommendations given herein would form part of SoCs for the proposal.

The full Assessments of Significance pursuant to NSW and Commonwealth guidelines are presented in Appendix D. A summary of assessment outcomes is provided below.

10.2 FLORA AND VEGETATION COMMUNITIES

An Assessment of Significance for the Wind Farm Study Area has been undertaken for the following entities:

- Box Gum Woodland
- *Dichanthium setosum*
- *Digitaria porrecta*
- *Bothriochloa biloba*
- *Swainsona sericea*

10.2.1 Summary of Assessment Outcomes

Swainsona sericea

Suitable habitat is widespread throughout the region for this species, however previous clearing and disturbances have reduced population sizes and extents to small areas. Due to this, no particularly suitable habitat for the species is expected to be permanently removed, although some may be temporarily disturbed. Three individuals of this species were observed during the surveys, at one location in the Transmission Line Study Area, but are unlikely to be impacted by the works, particularly as there will be protections put in place prior to the commencement of works to ensure they are not impacted in any manner. Clearing for the easement will result in the temporary loss of potential future habitat for the expansion of the local population of *Swainsona sericea*. Following construction the easement will provide suitable habitat. Grazed grassland and patchy woodland habitat, similar to that where this species was recorded, is widespread in the vicinity and wider locality.

The habitat to be removed or modified is not considered important to the long-term survival of the species in the locality, due to the limited occurrence of the population, and the widespread availability of similar habitat. As a result, it is unlikely that the proposed development would result in a significant impact on this species should it occur in the Project Area.

Digitaria porrecta

Digitaria porrecta was not recorded within the Wind Farm or Transmission Line Study Area. If this species occurs within the project area it is likely to be confined to basalt-derived soils in the Wind Farm Study Area. As the majority of groundcover vegetation within the nominated survey envelope will not be

impacted by the development of the wind farm, the area will continue to provide potential marginal habitat for this grass. It is unlikely that the proposed development would result in a significant impact on this species should it occur in the Project Area.

Dichanthium setosum* and *Bothriochloa biloba

Neither *Dichanthium setosum* nor *Bothriochloa biloba* were recorded within the Wind Farm or Transmission Line Study Area. Both are considered possible occurrences in the Wind Farm Study Area. The majority of groundcover vegetation within the Wind Farm survey envelope will not be impacted by the development of the wind farm and will continue to provide potential marginal habitat for these grasses. It is unlikely that the proposed development would result in a significant impact on these grass species should they occur in the Project Area.

White Box Yellow Box Blakely's Red Gum Woodland (TSC Act)

The majority of the Box Gum Woodland vegetation on the site is in a degraded state due to past and present agricultural practices. Box Gum Woodland covers up to 462.8 ha within the study area, of which approximately 61.4% is in poor or poor-moderate condition. However, given that (1) the total extent of the community present in the region is likely to be far more extensive than the amount being cleared, (2) the proposed infrastructure has such a small footprint, (3) most of the EEC proposed for clearing is of poor quality, and (4) it is likely that most understorey species will be retained, it is concluded that there is unlikely to be a significant impact on this community as a result of the proposed works.

Other areas of higher quality remnants exist within the site boundary and provide good opportunities for offsetting and maintaining or improving biodiversity values of these areas. The proponent commits to offsetting vegetation of appropriate type to achieve at minimum a 'like for like' offset.

An assessment of significance (Appendix C) concluded that the removal of up to 462.8 ha of this community is not considered to be significant for the Box Gum Woodland EEC with respect to its generally degraded state and the extent of similar vegetation in the locality.

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Grassland (EPBC Act)

No areas of CEEC were located within the Wind Farm survey area based upon the revised infrastructure layout. One small area of CEEC quality was identified in the 2012 survey, however the project has been redesigned to avoid this area. Within the Transmission Line Study Area, there is between 3.9 ha (preferred route) and 23 ha (alternative route) of CEEC Box Gum Woodland present, depending on the chosen alignment. The proposed works are not expected to impact habitat critical to the survival of the CEEC, not considered likely to substantially alter hydrological patterns necessary for the community's survival, and are unlikely to cause a substantial change in species composition in areas of CEEC. Due to these and other factors, it is considered that there is unlikely to be a significant impact on CEEC Box Gum Woodland as a result of the proposed development.

10.3 FAUNA

Assessments of significance for the Wind Farm Study Area have been undertaken for:

Woodland Birds

- Speckled Warbler
- Brown Treecreeper
- Diamond Firetail
- Varied Sittella

- Painted Honeyeater
- Black-chinned Honeyeater
- Grey-crowned Babbler
- Scarlet Robin
- Turquoise Parrot
- Little Lorikeet
- Glossy Black-cockatoo

Raptors

- Little Eagle
- Square-tailed Kite

Nocturnal Birds

- Powerful Owl
- Masked Owl
- Barking Owl

Mammals (excluding bats)

- Squirrel Glider

Bats

- Eastern Bentwing-bat
- Yellow-bellied Sheath-tail-bat
- Eastern Cave Bat
- Corben's Long-eared Bat
- Large-eared Pied Bat

10.3.1 Summary of Assessment Outcomes

Conclusions

Eight threatened smaller woodland/forest bird species were recorded within the Transmission Line and/or Wind Farm Study Areas; the Speckled Warbler, Brown Treecreeper, Varied Sittella, Painted Honeyeater, Black-chinned Honeyeater, Grey-crowned Babbler, Diamond Firetail and the Scarlet Robin. A ninth species, the Little Lorikeet, was recorded to the north of the study area during the survey period. These species are unlikely to occur in the majority of the Wind Farm Study Area due to the fragmentation and open nature of habitats in this area.

Glossy Black-cockatoos and evidence of foraging were recorded in several locations in larger tracts of Sandstone Forest in the Transmission Line Study Area. Of the *Casuarina* and *Allocasuarina* species recorded during the present study, two species - *Allocasuarina diminuta* and *A. gymnanthera* – are known to be preferred feed trees for the Glossy Black-cockatoo. Both these species are present throughout areas of Sandstone Forest in the Transmission Line Study Area, with *A. gymnanthera* the more common. Neither of these species is common within the Wind Farm Study Area.

The Powerful Owl was recorded within the Transmission Line Study Area in the 2013 survey and both the Masked and Barking Owls are considered possible occurrences, based on local records and habitat characteristics. These owls may be impacted by loss of habitat, including potential roost hollows and loss of habitat affecting the prey base for these species (primarily arboreal mammals for the Powerful Owl, smaller terrestrial mammals for the Masked Owl and arboreal and terrestrial mammals as well as birds for the Barking Owl). There is also some potential for direct mortality of owls, particularly Powerful Owls,

as a result of blade strike. Results of 2012 surveys and the recognition of a habitat link between Coolah Tops NP into forested areas in the north-eastern section of the Wind Farm Study Area providing a potential flight path for this species, the turbine layout was amended to remove the array of turbines from the north-east corner. Furthermore, all three owl species are recommended to be considered as part of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

The threatened raptor species Little Eagle and Grey Falcon are considered 'possible' and 'possible but unlikely' occurrences, respectively. Operational impacts (blade-strike) have potential to affect these species, as well as the Square-tailed kite recorded in the Transmission Line Study Area in the 2013 survey. As no active nests of these species were found in the Wind Farm Study Area or considered likely within 100 metres of surveyed proposed turbine locations, the risk to fledging Little Eagles and Square-tailed kites is considered low to moderate. The Grey Falcon is unlikely to nest in the locality. Adult birds, including raptors, have generally shown an ability to habituate to the turbines by taking avoidance action around rotors or by modifying their behaviour (such as approach a route at the head of a gully from below rather than above – EBS Ecology 2012). Further, the collision monitoring results reviewed (Table 9-1) suggest common species are most at risk of colliding with turbines. Thus on the basis of probability it appears unlikely that a viable local population of Little Eagle, Square-tailed kite or Grey Falcon would be placed at risk of extinction from the wind farm proposal. However, these species should be focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

A single Squirrel Glider was recorded during the 2012 survey program, in open woodland vegetation along a valley floor within the Wind Farm Study Area. This species was recorded again in the Transmission Line Study Area during the 2013 survey. Squirrel Gliders are unlikely to occur on higher elevation ridges to be affected by any tree removal for turbine location or ridgetop tracks. There will be some tree removal for access tracks, powerlines and associated infrastructure in lower elevation parts of the Wind Farm Study Area. This tree removal is unlikely to contribute substantially to fragmentation of habitat for the Squirrel Glider.

The Threatened microchiropteran Eastern Bentwing Bat, Eastern Cave Bat and Yellow-bellied Sheath-tail Bat (Transmission Line Study Area only) were all recorded during the Anabat survey program. The Eastern Bentwing Bat was recorded from 6 sites within the Wind Farm Study Area. The Eastern Cave Bat was recorded from 2 sites within the Wind Farm Study Area. The only call attributed to the Yellow-bellied Sheath-tail bat was from Sandstone Forest on the Transmission Line Study Area. The Eastern Bentwing Bat and Eastern Cave Bat roost in caves and will therefore not be affected by loss of tree hollows. No roost or maternity caves are known to occur nearby the Project Area. Given that these threatened species are flexible in foraging habitat selection and that very large areas of Sandstone Forest occur, it is not expected that there would be adverse impacts to resident populations from habitat loss *per se*.

These microchiropteran bats should be focal species of an adaptive Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty. A pre-construction base line survey to compare species composition and activity of microchiropteran bats is recommended in Section 12.

The pattern of development proposed would be comprised of a series of sparsely distributed discrete footprints (turbines, substations and control buildings) and narrow linear footprints (transmission line and tracks). Considering the habitat within these areas and that surrounding them, and considering the ecological characteristics of the subject species considered, with the implementation of recommendations, including further surveys and micro-siting, the overall magnitude of impacts upon

subject species is likely to be low to moderate and unlikely to lead to a significant population scale impact.

For fauna species considered in this assessment, impacts are unlikely to:

- Adversely affect lifecycle to the extent that a local population would be placed at risk of extinction.
- Fragment or isolate habitat.

In addition to the design measures already implemented, a number of recommendations are given to minimise and offset the impacts of the proposal upon the species. With implementation of recommendations, the proposal is considered generally consistent with recovery objectives and would not exacerbate existing key threatening processes.

10.3.2 Conclusion

Presently, the majority of the land in the Project Area is farm land being used for production and therefore there are currently no measures in place to specifically improve biodiversity resources in the long term. The management measures and offsets presented here provide an opportunity to arrest existing pressures in the Project Area such as feral goats and weeds, and conserve a portion of land for biodiversity outcomes.

Based on assessments of significance, impacts arising from the proposal upon the threatened community and species known and likely to occur in the Project Area are manageable and unlikely to be significant. Therefore a Referral to the Commonwealth government under the EPBC Act is not considered necessary.

Impacts have been avoided where possible through design changes based on information and constraints provided by **ngh**environmental (2012). Recommendations have been provided to minimise and manage impacts both during the construction and operational phases of the wind farm and the transmission line.

11 RECOMMENDATIONS

11.1 MEASURES TO AVOID IMPACT

11.1.1 Amendments to layout

The design of the proposal has been refined in response to the results of the 2012 survey and an initial biodiversity constraints analysis. The proposal has been refined in the following ways:

- The total number of turbines has been reduced from 417 to 288 by removing 130 turbines from the far north-eastern section of the wind farm adjacent Coolah Tops National Park. This area was identified in the 2012 assessment as highly constrained in that it posed a potential barrier to the movement of threatened owls and microchiropteran bats, a potential collision risk and given its close proximity to Coolah Tops National Park. The change ensures biodiversity values are maintained in this important area. Specifically this has:
 - Reduced potential impact on Powerful Owls
 - Removed turbines in close proximity to Coolah Tops National Park
- Turbine spacing has been maximised so that, in general, the turbines are between 350 m and 600 m apart. Approximately a quarter of the turbines are more than 500 m apart. This will allow birds and bats greater opportunity to pass between turbines, thereby reducing collision risk.
- Avoidance of moderate-good or good quality EEC within the Wind Farm Study Area; An area surveyed in 2012 (Flora survey ID AA21) recorded Box Gum Woodland EEC and CEEC in mod-good condition based on there being more than 11 native non-grass species. The Wind Farm development envelope has subsequently been altered in this area to avoid this stand of EEC/CEEC. No areas of moderate-good or good condition Box Gum Woodland EEC were recorded within the Wind Farm development area and hence no areas of Box Gum Woodland EEC meet the condition thresholds required for CEEC classification.

11.1.2 Measures to be undertaken prior to construction

- Conduct searches for grasses Bluegrass (*Dichanthium setosum*), Lobed Bluegrass (*Bothriochloa biloba*) and Finger Panic Grass (*Digitaria porrecta*) which have the potential to occur on heavy clay basalt-derived soils on the wind farm site. The most appropriate time to search for these species would be after the location of proposed access roads on the side slopes has been determined. A pre-clearance survey should be undertaken and if found infrastructure should be micrositied around populations if they are found.
- Develop of SoCs for moderate-high constraint areas or other areas where development has the potential to result in a significant impact. The aim of these commitments is to ensure a significant impact is avoided. In particular, these areas include:
 - Eastern section of Wind Farm Study Area (nearby Coolah Tops National Park);
 - Areas of moderate quality EEC located within the Wind Farm development footprint; and
 - Areas with the potential to support hollow-bearing trees or threatened grass species.

- Additional measures to avoid impact to areas supporting threatened species, good quality habitat, Box Gum Woodland or hollow bearing trees during the design phase of the proposal are highlighted within Table 11-1. Table 11-1 details the area of interest, the target species / vegetation communities of concern, and recommendations to avoid potential impact.

Table 11-1 Design measures to avoid impacts for the Liverpool Range Wind Farm

MEASURES TO AVOID IMPACTS					
Item	Area	Target Species	Objective	Timing	Recommendation
Design Phase					
Threatened Native Grasses	Wind Farm Study Area: areas of moderate condition Box Gum Woodland EEC.	Finger Panic Grass, Lobed Blue-grass and Bluegrass	Pre-clearance survey in better quality Box-Gum Woodland	After final alignments / development envelopes confirmed	– A Pre-clearance survey is to be conducted for Finger Panic Grass, Lobed Blue-grass and Bluegrass within better quality Box-Gum Woodland EEC during flowering season from mid-January to late February. If found, turbines and infrastructure are to be micro-sited to avoid areas of at least moderate quality condition of these species in this vegetation type.
Threatened Reptiles	Wind Farm Study Area	Pink-tailed Worm-lizard	Pre-clearance survey in good quality Box-Gum Woodland (CEEC)	After final alignments / development envelopes confirmed	– Turbines and infrastructure would be micro-sited to avoid rocky outcrops in this habitat.
Hollow-bearing Trees	Wind Farm Study Area within moderate or moderate-good quality Box Gum Woodland	Focus species: Squirrel Glider, microchiropteran bats. Other species: other threatened hollow dependent fauna considered to be at moderate risk from development (i.e. woodland birds).	Targeted HBT survey to accurately record the number of hollows to be cleared.	After final alignments / development envelopes confirmed	<ul style="list-style-type: none"> – Pre-clearance survey within final development envelope and alignment for HBTs – Infrastructure micro-sited to avoid HBT, where possible. – Ideally, construction and any required tree clearance should avoid the peak breeding time for fauna and nesting time for birds (e.g. spring-summer). – In particular, clearance of HBT trees potentially suitable for Squirrel Gliders should not be undertaken within a 100 m radius over the breeding season in the latter half of the year for Squirrel Gliders. – For HBTs to be cleared a management plan should be prepared by an ecologist detailing: procedures to minimise impacts to, and relocate resident fauna; timing of works to avoid breeding periods; number and type of HBT to be removed and offset (to be included in Flora & Fauna Mgt Plan). – Where HBT are to be cleared a standard pre-clearance survey, such as that described in <i>Biodiversity Guidelines</i> (ngn environmental / RTA 2011), should be undertaken and details of HBTs cleared including number and size of hollows and number of hollow-bearing trees recorded.

11.2 MEASURES TO MINIMISE IMPACT

Measures to minimise impact during the design, construction and operational phase of the wind farm proposal are highlighted in Table 10-2 adopts the same rationale as Table 11-1 to ensure potential impacts are minimised at: 1) a broad level in which general management or control measures can be applied to the entire proposal; or 2) at a defined level in which management or control measures can be applied to particular areas, individual species, faunal groups, or communities.

In particular, a flora and fauna management plan as well as an adaptive bird and bat management plan should be prepared prior to construction. These management plans would focus on migratory and at risk bird and bat species, and any threatened flora species found during further survey work, as mentioned in Section 9.4 or discussed in Section 11 (Assessments of Significance). Particularly, the latter is required to address inherent uncertainty related to bird and bat collision risks at this site. The construction footprint should be kept to a minimum for least impact on flora and fauna. The proponent commits to upfront offset ratios before clearing proceeds which is an incentive to achieve 'minimal clearance' during the detailed design and construction phases. Management strategies for the construction phase of the proposal need to be developed and incorporated into the flora and fauna management plan. Prescriptions for inclusion in the plan are set out in the tables below. These measures are required to ensure a significant impact is avoided.

11.3 MEASURES TO OFFSET IMPACT

Measures to offset impacts are provided within Table 10-3 to ensure that an overall 'maintain or improve' outcome is met for the proposal; where impacts cannot be avoided, or sufficiently minimised, the residual impact will be offset in perpetuity. Appendix F details the biodiversity offset principles developed by the former DECCW (now OEH) and how these guide the identification and management of the offset site. Appendix F also details how offsets are best identified, managed, and the offset ratios to be applied.

No sites have been highlighted as offset areas at the time of writing, however potential offset areas identified during the field work include:

- Within the southern half of the Transmission Line Study Area good quality Sandstone Forest was identified. Offsetting any areas of Sandstone Forest will aid to protect a patch of forest of better quality that also provides threatened species habitat;
- Within the Wind Farm Study Area Brittle Gum Stringybark Woodland or Mountain Gum Silvertop Stringybark Forest was identified. In particular Mountain Gum Silvertop Stringybark Forest community is considered to be vulnerable by Benson *et al.* (2010) as substantial areas have been cleared and most are subject to grazing. However, within this area the typical location on steep slopes reduces the impact of grazing relative to nearby ridge tops and valley flats and the community was found to be less degraded than other communities; therefore offsetting this area will aid to protect a patch of forest of better quality than surrounding locations. This area also butts onto Coolah Tops National Park providing a strong movement corridor for fauna through this location. It was also found to support several hollow-bearing trees and a high density of Greater Gliders, a known food resource for Powerful Owls;
- In general, most of the Wind Farm Study Area, particularly the northern half, supports a high density of Goats. A management plan for the control of Goats could be considered as

a way to improve the biodiversity value of the Project Area. Reducing grazing pressure by Goats would promote regeneration and recruitment of Box Gum Woodland EEC within the area, which would not otherwise occur if Goats remain at current densities within the landscape. Reducing grazing pressure has several benefits and would indirectly contribute to the conservation of other flora and fauna species; and

- The majority of the Wind Farm Study Area supports Box Gum Woodland and other areas of good quality remnants are expected within the Project Area site boundary and would provide opportunities for offsetting and maintaining, or improving biodiversity values of these areas. With the correct implementation and management of an offset plan the proposal has the potential to contribute to the following;
 - Increasing protection of sites in good condition.
 - Increasing landscape functionality of the ecological community through management and restoration of degraded sites.
 - Increasing transitional areas around remnants and linkages between remnants.
 - Bringing about enduring changes in participating land manager attitudes and behaviours towards environmental protection and sustainable land management practices to increase extent, integrity and function of Box Gum Woodland.

Table 11-2 Design, construction and operational measures to minimise impacts for the Liverpool Range wind farm proposal.

MEASURES TO MINIMISE IMPACTS					
Item	Area	Target Species	Objective	Timing	Recommendation
Design Phase					
General Measures	Wind Farm Study Area	High risk birds and bats	Turbine infrastructure design to minimise operational impacts on birds and bats	Prior to operation	<ul style="list-style-type: none"> – Turbines and infrastructure would be micro-sited to avoid rocky outcrops in this habitat. – Red flashing lights should be fitted to turbine towers to reduce insect attraction and potentially night-flying birds. – No guy lines to be fitted to turbine towers. – Flags and/or marker balls to be fitted to wind monitoring mast guy lines – Turbines (e.g. nacelles) should minimise perching opportunities.
Construction Phase					
Box Gum Woodland and good quality fauna habitat	Wind Farm Study Area	Box Gum Woodland areas and threatened species	Prevent unauthorised clearance Minimise track and transmission line impacts in areas of high conservation value	During construction	<ul style="list-style-type: none"> – Clearly demarcate works areas nearby or within Box Gum Woodland areas to strictly define permitted clearance zone. – Minimise track width to the minimum required for safe access and operation – Install the 330kV powerlines (co-aligned with roads) as underground, where possible – Removal of topsoil and subsoil for trenching to be replaced and revegetate disturbed areas with local native grasses (i.e. Kangaroo Grass, Wallaby Grass or Spear Grass).

MEASURES TO MINIMISE IMPACTS					
Item	Area	Target Species	Objective	Timing	Recommendation
General Measures	Project Area	All species and vegetation communities	Minimise clearance and disturbance	During construction and as required	<ul style="list-style-type: none"> – Clearly demarcating works areas and restricting impacts to these. Including vehicle and equipment parking and access routes. – Co-locating underground and overhead 33kV powerlines with the track network to minimise additional impact area, where possible. – Establish construction compound in a disturbed area. – Use disturbed areas for vehicle and machinery access, materials laydown, stockpiling of cleared vegetation and deposition and retrieval of spoil, wherever practicable. – Fill in trenches as soon as possible. Trenches left open overnight to be inspected at first light for trapped fauna. Trapped fauna to be released appropriately in a nearby location. – HBTs and sensitive features to be retained to be communicated to staff via inductions and other methods.
Riparian Area Mgt	Project Area	All species and vegetation communities	Minimise clearance and disturbance	During construction	<ul style="list-style-type: none"> – Creek crossing to be designed in accordance with: NSW Fisheries Policy and Guidelines for Fish Friendly Waterway Crossings (2003). – Creek works not to be undertaken when heavy rain is forecast and should be avoided when there is flow. – Implement sedimentation and erosion controls in accordance with best practice guidelines.
General Habitat Mgt	Project Area	All species and vegetation communities	Minimise disturbance		<ul style="list-style-type: none"> – Bird and bat activity levels are generally concentrated around areas of vegetation. A buffer of 100 m from the turbine blades is recommended for areas of high habitat value for birds and bats. – Fallen timber > 50cm to be left in place or moved to a nearby area to retain fauna habitat. – Where rocky outcrops cannot be avoided, replace rock in nearby areas in consultation with an ecologist.

MEASURES TO MINIMISE IMPACTS					
Item	Area	Target Species	Objective	Timing	Recommendation
Weed Mgt	Project Area	All species and vegetation communities	Pre-construction inspection for noxious weeds within Project Area Prevention of spread of weeds and pathogens Weed monitoring	Before commencement of works and as required Monitoring – late spring / early summer after construction	<ul style="list-style-type: none"> – Control noxious weeds in works area according to plans and control measures of the LGAs – Control invasive but unlisted species such as African Lovegrass and Galenia where they occur on or adjacent to the site to prevent their spread into uninfested areas – Minimise use and adhere to best practice guidelines for herbicide treatment in environmentally sensitive areas (i.e. Box Gum Woodland) – Establish hygiene plan to ensure vehicle and machinery is absent of organic matter pre- and post-site access – Sign environmentally sensitive areas (i.e. CEEC areas) and designate clean-down area for entry / exit points into these areas. – Monitoring and weed control in areas of known noxious or invasive species. – Understorey vegetation in easements should be managed to maintain composition and quality to prevent weed invasion
Pollution Prevention	Project Area	All species and vegetation communities	Prevention of contaminants and erosion outside works zones	As required	<ul style="list-style-type: none"> – Establish a spill plan to prevent chemicals or pollutants from having an adverse effect on the environment. – Backfill cable trench where cement is used; at least 20 cm of cement free topsoil to be replaced as the top layer in the back fill. – Establish an erosion and sediment control plan so appropriate controls are in place prior to commencement of works.
Site Mgt	Project Area	All species and vegetation communities	Stabilisation of soil, rehabilitation and revegetation to be undertaken progressively to re-establish ground cover	As required	<ul style="list-style-type: none"> – Lightly mulch exposed soils with chipped vegetation or sterile hay in areas dominated by exotic groundcover species. Sow with an appropriate cover crop in consultation with land owners. – Lightly mulch exposed soils with chipped vegetation or sterile hay in areas dominated by native grasses using local provenance species. – Fertiliser should not be used to promote revegetation in areas dominated by native grasses.
Operational Phase					

MEASURES TO MINIMISE IMPACTS					
Item	Area	Target Species	Objective	Timing	Recommendation
Flora & Fauna Mgt Plan	Project Area	All species and vegetation communities	To avoid significant impact to flora and fauna outside of the accepted clearance boundaries and prevent 'unassessed' impacts occurring.	Implement prior to construction.	<ul style="list-style-type: none"> – An ecological professional to develop and implement a Flora and Fauna Management Plan to report on and manage impacts. – The management plan should highlight ecological important areas (vegetation communities and threatened fauna species habitat) and their management. – Specific areas requiring monitoring or management should be highlighted as well as timing for monitoring. – Weed species should be highlighted along with prescriptions for their management.
Adaptive Bird & Bat Mgt Plan	Wind Farm Study Area	High risk raptors and bats (species identified within Section 9.3.3 and 9.3.4 Threatened Owls (Powerful Owl, Masked Owl, Barking Owl)	Development of an 'insurance' monitoring program to address uncertainty inherent in the assessment.	Implement prior to construction. Survey and monitor during 'high risk' periods, when species may be moving through or foraging in the area	<ul style="list-style-type: none"> – An ecological professional to develop and implement a Bird and Bat Monitoring Program to report on, and manage impacts with potential to be significant – Monitoring surveys should include an understanding of breeding activity (i.e. nest locations) and foraging movements. – Baseline (pre-construction) and operational collision and abundance data would be collected, focused on higher risk species and higher risk locations in order that actions can be taken to address unforeseen impacts, should they occur. – Mgt Plan methods would utilise AusWEA (2006) best practice guidelines. – Mgt Plan should include mgt response options (i.e. restriction of lambing on ridges with high raptor activity to reduce collision risks) to be implemented where significant impacts are anticipated.

MEASURES TO MINIMISE IMPACTS					
Item	Area	Target Species	Objective	Timing	Recommendation
Habitat Connectivity	Transmission Line Easement	All common species, as well as threatened fauna, particularly owls, gliders and bats	Minimise fragmentation of landscape connectivity	After construction	<ul style="list-style-type: none"> – Promote growth of vegetation under the transmission line to the maximum allowable height to maintain fauna habitat connectivity. – Understorey vegetation in easements should be managed to maintain composition and quality to prevent weed invasion. – Install gliding poles for glider species, particularly the Squirrel Glider, if clearing for the transmission line easement exceeds 40m in areas of habitat for this species. – Near areas of intact woodland or forest a spacing of 600m should be considered for turbines.

Table 11-3 Offset measures to maintain or improve biodiversity for the Liverpool Range wind farm proposal.

OFFSET MEASURES TO MAINTAIN OR IMPROVE BIODIVERSITY					
Item	Area	Target Species	Objective	Timing	Recommendation
Construction Phase					
Development of offset strategy and offset plan	Project Area	Box Gum Woodland, Hollow-bearing trees, Threatened species habitat	Proponent will develop an offset plan to offset all permanent native vegetation removal to maintain or improve biodiversity in the longer term	Prior to construction	<ul style="list-style-type: none"> – Develop an offset strategy with input from OEH, the CMA and an ecological professional which will be finalised prior to any construction impacts an ecological professional, in accordance with Appendix F – Develop an offset plan with input from OEH and the CMA prior to operation, demonstrating the suitability of the final offset site and providing detailed management actions specific to the site. – Ensure the offset strategy complies with the <i>Principles for the use of biodiversity offsets in NSW</i> guidance document. – The offset ratio will be determined with reference to: the conservation status of the vegetation, the condition of the vegetation, and the actual threatened species habitat value lost (i.e. known threatened species habitat, not potential habitat). – The project offset plan includes suggested ratios but that these would be determined in consultation with OEH as part of the finalisation of the offset strategy.

11.4 DECOMMISSIONING

Biodiversity investigations would be required prior to decommissioning, to update the knowledge of site attributes and evaluate specific impact types (given the life span of the proposal is in the order of 30 years). The flora and fauna management plan for the project as well as results from the adaptive bird and bat management plan would inform the investigations. New measures to avoid and mitigate impacts may be required depending on: 1) the results of the investigation; and 2) outcomes of the monitoring programs implemented during the operational phase of the proposal.

12 CONCLUSION

12.1 PROJECT DESCRIPTION

The Liverpool Range wind farm covers an area of approximately 40 km (east-west) by 50 km (north-south). This Biodiversity Assessment includes assessment of the following infrastructure components:

- Up to 288 wind turbine generators including associated electrical generators (three blades mounted on a tubular tower (165 m).
- High voltage 33 kV transmission line and easement located between Ulan and Cassilis (Up to 60 m by 38.2 km easement).
- Construction of substations and maintenance facilities.
- Creation of new access tracks and widening of existing tracks.
- Upgrades to existing public roads.

12.2 REGIONAL VALUES AND EXISTING ENVIRONMENT ONSITE

The Project Area is largely agricultural, characterised by intensively modified broad floodplains (cereal cropping and grazing) beneath broad basalt ridges (grazing). The midslopes contain the majority of remnant native vegetation, from sparse to moderately treed woodlands. In particular, the composition and structure of vegetation types within the wider region has been modified as a result of managed stock grazing as well as grazing by feral goats. Large numbers of feral goats, foxes and rabbits were observed in the Project Area and continue to have a deleterious effect on native vegetation. Some better quality forested areas exist within the wider area on private lands, but are generally confined within protected areas (National Parks and state Reserves). Better quality forest was largely recorded within the southern half of the Transmission Line Study Area which is known to support several threatened fauna species, particularly woodland birds, forest owls, and microchiropteran bats.

A variety of biodiversity assets are supported within the region and most noteworthy is the state and nationally endangered community, Box Gum Woodland EEC. This EEC includes White Box, Yellow Box and Blakely's Red Gum Woodland which were recorded during this survey. While this community is endangered, it is also some of the most locally abundant vegetation type identified within the LGAs of the Project Area.

Overall, key biodiversity issues in all CMAs relevant to the Project Area include inappropriate grazing management, habitat degradation and fragmentation, increasing dryland salinity, loss of native vegetation (i.e. clearing of native woodlands and grasslands) and invasive pest species (foxes, goats, environmental, agricultural and noxious weeds), and conserving remnant vegetation on private lands (CMA 2012).

Impacts on National Parks / Reserves

Coolah Tops and Goulburn River National Parks are present nearby the Project Area, as well as State Conservation Reserves, including Munghorn Gap Nature Reserve and Durridgere SCA.

- Coolah Tops NP is approximately 2 km east of the Wind Farm Study Area;
- Goulburn River NP is approximately 1.5 km south-east of the Transmission Line Study Area;

- Munghorn Gap Nature Reserve is approximately 4.5 km south of the Transmission Line Study Area at its nearest point;

Therefore, no direct impacts are expected within the National Parks and/or reserves. Some alignment options of the transmission line traverses Durridgere SCA and have the potential to fragment the area. If these alignment options are considered further, follow-up survey work has been recommended within Durridgere SCA before development of these areas to provide more detail on their biodiversity value and quantify the potential impacts of the proposal. All other protected areas are considered to be located far enough away from the development to incur any indirect impacts associated with the proposal. However, with the implementation of the management controls recommended in Section 12, no indirect impacts are expected within these areas.

Impacts on Habitat Connectivity

The site comprises a series of broad ridges and valleys, within the Liverpool Range. Aerial imagery demonstrates the site itself varies between cleared and sparsely treed areas of vegetation. At a local scale the Project Area is densely treed to the north, north-east of the wind farm (Coolah Tops National Park and surrounding private landholdings) and at the southern half of the transmission line.

At a regional scale, the Project Area can be seen to be located with a loop of connecting woodland and forested habitat. Vegetation in the northern tip of the Project Area facilitates east-west linkages towards areas of forest to the east (Coolah Tops National Park). Vegetation in the southern sections of the Project Area facilitate east-west and southern connectivity to extensive areas of protected forest (Durridgere SCA, Goulburn River National Park and Wollemi National Park).

Between the Project Area and the additional forested areas to the east, vegetation is patchy. This pattern of habitat and connectivity, while patchy and therefore compromised in some locations, may allow for an increased level of fauna activity within the Project Area. Particularly for fauna, such as birds and bats, which are highly mobile and have large ranges, and which are tolerant of some level disturbance (clearing and habitat modification).

The proximity of Coolah Tops NP and Durridgere SCA provide habitat connectivity to forested areas within the development envelope and are known to support mobile threatened fauna species. Further survey work in these areas have been recommended to determine the value of this habitat for threatened fauna species and as a movement corridor, particularly woodland birds, forest owls and microchiropteran bats.

Significance of Impacts on Entities Listed as Threatened

The key biodiversity risks identified within this assessment were Box Gum Woodland, woodland birds, forest owls and microchiropteran bats. The proposal was considered to potentially result in a high risk to the Box Gum Woodland and 18 fauna species and an assessment of significance was applied to these species. These species included the: Speckled Warbler, Brown Treecreeper, Varied Sittella, Painted Honeyeater, Black-chinned Honeyeater, Grey-crowned Babbler, Scarlet Robin, Little Lorikeet, Glossy Black-cockatoo, Powerful Owl, Masked Owl, Barking Owl, Little Eagle, Grey Falcon, Squirrel Glider, Eastern Bentwing Bat, Yellow-bellied Sheath-tail-bat, and Eastern Cave Bat.

The proposal was considered to affect one state and nationally listed endangered community, Box Gum Woodland; however, the areas to be cleared are predominantly in poor condition and only a small area of moderate-good condition EEC could potentially be affected. The EEC and CEEC affected by the proposal would be included within the offset plan for the proposal. In particular the offset plan would include

provisions for offsetting Commonwealth listed CEEC to demonstrate compliance with the Commonwealth offset policy.

The conclusion of the Assessment of Significance revealed there is potential for the proposal to result in a significant impact for the Powerful Owl, Squirrel Glider and some microchiropteran bats in particular areas if they are developed. To avoid significant impact to these species recommendations for follow up survey work has been prescribed before any development occurs within these areas. With the implementation of the controls and recommendations of this report the proposal is therefore considered unlikely to have a significant impact on threatened fauna species or the Box Gum Woodland EEC / CEEC.

Maintain or Improve Environmental Outcome

The proposal has been developed with input from a biodiversity constraints analysis to assist in avoiding biodiversity impacts as a starting point. Detailed mitigation prescriptions have been developed to address the remaining risks, aimed at avoiding a significant impact on any listed threatened entity. The development of an offset site to be managed for biodiversity conservation in perpetuity forms part of this proposal.

The objective of the offset plan, which would be developed in detail prior to construction, is to ensure that an overall ‘maintain or improve’ outcome is met for the proposal. It would protect important habitat types to be affected by the development.

Another aspect of the ‘maintain or improve’ outcome is the monitoring of operational risk; bird and bat collisions. While this assessment demonstrates that significant impact is not anticipated for any listed species, an ‘insurance’ monitoring program is proposed so that the uncertainty inherent in the assessment can be addressed. Baseline (pre-construction) and operational collision and abundance data would be collected, focused on higher risk species and higher risk locations in order that actions can be taken to address unforeseen impacts, should they occur.

Context of Climate Change

There is evidence that modification of the environment by humans may result in climate change (DECC 2007). *Anthropogenic Climate Change* has been listed as a Key Threatening Process by the NSW Scientific Committee.

Major changes in vegetation composition are expected through shifts in rainfall patterns and will favour the establishment of woody vegetation and encroachment of unpalatable woody shrubs in many areas (Australian Greenhouse Office 2003). Species at particular risk from the effects of climate change include those species with long generations, poor mobility, narrow ranges, specific host relationships, isolated and specialised species and those with large home ranges (Hughes & Westoby 1994, cited in DECC 2007). Pest species may be advantaged by climate change.

As a renewable energy project, the proposed development would address, to some extent, rising greenhouse gas emissions, and thereby the future impact of climate change, by providing a source of energy that is not dependent on the burning of fossil fuels.

Conclusion

The pattern of development proposed would be comprised of a series of sparsely distributed discrete footprints (turbines, substations and control buildings) and narrow linear footprints (transmission line and tracks). Considering the habitat within these areas and that surrounding them, and considering the ecological characteristics of the Project Area, the impacts identified appear able to be managed such that significant impacts can be avoided and such that a maintain or improve outcome can be met for the

proposal. On balance, the impacts are considered acceptable. The proposal would have benefits as the development of this large scale renewable energy project would address, to some extent, rising greenhouse gas emissions, which stands to have broader adverse ecological impacts.

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APPENDIX A DIRECTOR GENERAL REQUIREMENTS



Planning

Contact: James Archdale
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Mr Andrew Durran
Executive Director
Epuron Pty Ltd
Level 11
75 Miller Street
NORTH SYDNEY NSW 2060

Our ref.: 10/23653

Dear Mr Durran

Subject: Director-General's Requirements for Liverpool Range Wind Farm (MP 10_0225)

The Department has received your application for the above project.

I have attached a copy of the Director-General's Requirements (DGRs) for the preparation of an Environmental Assessment for the project. These requirements have been prepared in consultation with relevant government authorities. I have also attached a copy of the government authorities' comments for your information.

The DGRs have been prepared based on the information you have provided to date. Please note that under section 75F(3) of the *Environmental Planning and Assessment Act 1979*, the Director-General may alter these requirements at any time. If you do not submit an Environmental Assessment for the project within 2 years, the DGRs will expire.

Prior to exhibiting the Environmental Assessment that you submit for the project, the Department will review the document to determine if it adequately addresses the DGRs. The Department may consult with other relevant government authorities in making this decision. Please provide 6 hard copies and 6 electronic copies¹ of the Environmental Assessment to assist this review.

If the Director-General considers that the Environmental Assessment does not adequately address the DGRs, the Director-General may require you to revise the Environmental Assessment. Once the Director-General is satisfied that the DGRs have been adequately addressed, the Environmental Assessment will be made publicly available for at least 30 days.

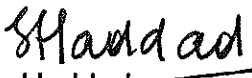
If your project is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Department of Sustainability, Environment, Water, Population and Communities to determine

¹ File parts must be no greater than 5Mb each. File parts should be logically named and divided.

if an approval under the EPBC Act is required for your project (<http://www.environment.gov.au> or 6274 1111).

Your contact officer for this proposal, James Archdale, can be contacted on 9228-6236 or via email at James.Archdale@planning.nsw.gov.au. Please mark all correspondence regarding the proposal to the attention of the contact officer.

Yours sincerely,



Sam Haddad
Director-General
Department of Planning

31/3/2011

ATTACHMENT 1
Director-General's Requirements
Section 75F of the *Environmental Planning and Assessment Act 1979*

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Project	Construction and operation of a new wind farm and associated infrastructure located across 4 shires on the New England Tableland region of New South Wales. The project is proposed to comprise approximately 550 turbines and a new transmission line connecting the wind farm to Transgrid's 330kV Wollar to Wellington transmission line located 30-40 kilometres south of the site.
Site	A development area covering approximately 40km (east to west) by 50km (north to south) in the New England Tableland region of New South Wales. The site is primarily located in the Warrumbungle & Upper Hunter Shires, between the township of Coolah and Cassilis approximately 370km north of Sydney. Additional turbines would be located in the Liverpool Plains Shire, with transmission line connections south of the site located in the LGA of Mid Western Regional Council.
Proponent	Epuron Pty Ltd
Date of Issue	####
Date of Expiration	####
General Requirements	<p>The Environmental Assessment (EA) must include:</p> <ul style="list-style-type: none"> • an executive summary; • a detailed description of the project (both the wind farm and associated infrastructure) including: <ul style="list-style-type: none"> → construction, operation and decommissioning details; → the location and dimensions of all project components including the wind turbines (including map coordinates and AHD heights), underground/ overhead cabling between turbines, electrical substation and transmission line linking the wind farm to the grid, temporary concrete batching plant(s), construction compounds, access roads/road upgrades (including internal access tracks) and obstacle lighting; → a timeline identifying the proposed construction and operation of the project components including staging, their envisaged lifespan and arrangements for decommissioning; → supporting maps/plans clearly identifying existing environmental features (e.g. watercourses, vegetation), infrastructure and landuse (including nearby residences and approved residential developments or subdivisions, if any) and the location/ siting of the project including associated infrastructure in the context of this existing environment; and → resourcing requirements (including, but not limited to, water supply and gravel). • consideration of any relevant statutory provisions including the consistency of the project with the objects of the <i>Environmental Planning and Assessment Act 1979</i> (i.e. Section 5 of the Act) and any relevant development control plans; • an assessment of the key issues outlined below, during construction, operation and decommissioning (as relevant). The Environmental Assessment must assess the worst case as well as representative impact for all key issues; • consideration of any cumulative impacts as relevant, taking note of proposed wind farms in the locality; • demonstration that the wind farm will be capable of meeting relevant Building Code of Australia (BCA) standards and other relevant codes / manufacturers' specifications for the construction of wind farms; • a draft Statement of Commitments detailing measures for environmental mitigation, management and monitoring for the project; • a conclusion justifying the project taking into consideration the environmental, social and economic impacts of the project; the suitability of the site; and the public interest; and • certification by the author of the EA that the information contained in the Assessment is neither false nor misleading.

	<p>The EA should present, with respect to each relevant transmission line impact, a considered overview of potential impacts along the length of the line, to identify areas of potentially significant impact for further, more detailed assessment. In addition to detailed assessment of areas of potentially significant impact, other areas along the length of the line should be assessed in a more general manner, with a particular focus on the development of frameworks for the mitigation, management and monitoring of more minor and generic environmental issues.</p>
Key Assessment Requirements	<p>The EA must include assessment of the following key issues for both the wind farm and transmission line:</p> <ul style="list-style-type: none"> • Strategic Justification - the EA must: <ul style="list-style-type: none"> → include a strategic assessment of the need, scale, scope and location for the project in relation to predicted electricity demand, predicted transmission constraints and the strategic direction of the region and the State in relation to electricity supply, demand and electricity generation technologies, and its role within the Commonwealth's Renewable Energy Target Scheme. The EA must clearly demonstrate that the existing transmission infrastructure has sufficient capacity to accommodate the project; → include a clear demonstration of quantified and substantiated greenhouse gas benefits, taking into consideration sources of electricity that could realistically be replaced and the extent of their replacement, with reference to the Department of Environment, Climate Change and Water <i>NSW wind farm greenhouse gas savings tool</i> (http://www.environment.nsw.gov.au/climatechange/greenhousegassavingstool.htm); → include an analysis of the suitability of the project with respect to potential land use conflicts with existing and future surrounding land uses (including rural residential development, building entitlements and subdivision potential, land of significant scenic or visual value, land of high agricultural value, mineral reserves (particularly Petroleum Exploration Licence 433 held by Eastern Star, Petroleum Exploration Licence 456 held by Santos/ApolloGas/Dart, mining lease A286 held by Industry and Investment and Exploration Licence 7597 held by Australian Bauxite), forestry, Crown land and conservation areas including Coolah Tops and Goulburn River National Parks), taking into account local and strategic landuse objectives and the potential for social and economic impacts on the local community. In particular justification should be provided regarding the suitability of the transmission line route through Durridgere State Conservation Area. Consideration should be given to any potential conflicts with the proposed Coolah to Newcastle gas pipeline and any operating or proposed extractive industries. The analysis of site suitability shall consider any Environmentally Sensitive Area Mapping held by Liverpool Plains Shire Council, Warrumbungle Shire Council, Upper Hunter Shire Council and Mid-Western Regional Council; and → describe the alternatives considered (location and/or design) for all project components, and provide justification for the preferred project demonstrating its benefits on a local and strategic scale and how it achieves stated objectives and any measures to offset residual impacts (for example community enhancement programmes). • Visual Impacts - the EA must: <ul style="list-style-type: none"> → provide a comprehensive assessment of the landscape character and values and any scenic or significant vistas of the area potentially affected by the project, including an assessment of the significance of landscape values and character in a local and regional context. This should describe community and stakeholder values of the local and regional visual amenity and quality, and perceptions of the project based on surveys and consultation; → assess the impact of shadow "flicker", blade "glint" and night lighting from the wind farm; → identify the zone of visual influence of the wind farm including consideration to night lighting (no less than 10 kilometres) and assess the visual impact of all project components on this landscape; → include an assessment of any cumulative visual impacts from transmission line

infrastructure;

- include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points, and provide a clear description of proposed visual amenity mitigation and management measures for both the wind farm and the transmission line. The photomontages must include representative views of turbine night lighting if proposed; and
- provide an assessment of the feasibility, effectiveness and reliability of proposed mitigation measures and any residual impacts after these measures have been implemented.

- **Noise Impacts** - the EA must:

- include a comprehensive noise assessment of all phases and components of the project including: turbine operation, the operation of the electrical substation, corona and / or aeolian noise from the transmission line, construction noise (focusing on high noise-generating construction scenarios and works outside of standard construction hours), traffic noise during construction and operation, and vibration generating activities (including blasting) during construction and/ or operation. The assessment must identify noise/ vibration sensitive locations (including approved but not yet developed dwellings), baseline conditions based on monitoring results, the levels and character of noise (e.g. tonality, impulsiveness, low frequency etc) generated by noise sources, noise/ vibration criteria, modelling assumptions and worst case and representative noise/ vibration impacts;
- in relation to wind turbine operation, determine the noise impacts under operating meteorological conditions (i.e. wind speeds from cut in to rated power), including impacts under meteorological conditions that exacerbate impacts (including varying atmospheric stability classes and the van den Berg effect for wind turbines). The probability of such occurrences must be quantified;
- include monitoring to ensure that there is adequate wind speed/profile data and ambient background noise data that is representative for all sensitive receptors;
- provide justification for the nominated average background noise level used in the assessment process, considering any significant difference between daytime and night time background noise levels at background noise levels higher than 30 dB(A);
- identify any risks with respect to tonal, low frequency or infra-noise;
- clearly outline the noise mitigation, monitoring and management measures that would be applied to the project. This must include an assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts after these measures have been incorporated;
- if any noise agreements with residents are proposed for areas where noise criteria cannot be met, provide sufficient information to enable a clear understanding of what has been agreed and what criteria have been used to frame any such agreements; and
- include a contingency strategy that provides for additional noise attenuation should higher noise levels than those predicted result following commissioning and/or noise agreements with landowners not eventuate.

The assessment must be undertaken consistent with the following guidelines:

- Wind Turbines - the South Australian Environment Protection Authority's *Wind Farms - Environmental Noise Guidelines* (2003);
- Substation – *NSW Industrial Noise Policy* (EPA, 2000);
- Site Establishment and Construction – *Interim Construction Noise Guidelines* (DECC, 2009);
- Traffic Noise – *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999); and
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006).

- **Ecological Impacts** – the EA must include an ecological assessment considering terrestrial and aquatic ecosystems (as relevant), including groundwater dependent ecosystems, consistent with *Guidelines for Threatened Species Assessment* (DEC, 2005); The EA must:
 - identify threatened species, populations and communities listed under both State and Commonwealth legislation that have the potential to occur on site;
 - map existing vegetation by vegetation/ community type and include details on existing site conditions, including whether the vegetation comprises a highly modified or over-cleared landscape and the types and quality of habitat resources available. Vegetation mapping should consider any Environmentally Sensitive Area Mapping held by Liverpool Plains Shire Council, Warrumbungle Shire Council, Upper Hunter Shire Council and Mid-Western Regional Council.
 - provide details of the survey methodology employed including survey effort and representativeness for each species targeted and clear justification for species that were discounted from requiring field surveys or further assessment;
 - demonstrate a design philosophy of impact avoidance on ecological values, and in particular, ecological values of high significance;
 - provide a worst case estimate of vegetation to be cleared (in hectares), including quantifying impacts (in hectares) by vegetation type and threatened species habitat (as relevant);
 - assess the significance of impacts to native vegetation, listed threatened species, populations and communities and their habitats with consideration to local and region-based ecological implications, including habitat connectivity and distribution of species. The assessment must consider impacts to in-stream and riparian ecology from works close to waterways and/ or waterway crossings. In addition, impact of the project on birds and bats from blade strikes, low air pressure zones at the blade tips (barotrauma), and alteration to movement patterns resulting from the turbines must be assessed, including demonstration of how the project has been sited to avoid and/ or minimise such impacts;
 - include details of how flora and fauna impacts would be managed during construction and operation including adaptive management, rehabilitation/ regeneration measures and maintenance protocols;
 - demonstrate how the project (with the incorporation of all proposed measures to avoid, mitigate and/ or offset impacts) achieves a biodiversity outcome consistent with "maintain or improve" principles. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project and to secure these measures in perpetuity; and
 - address the risk of weed spread and identify mitigation measures.
- **Heritage Impacts** – the EA must include an assessment of impacts on Aboriginal and historic heritage. The EA must:
 - include sufficient information to demonstrate the likely impacts of the project on Aboriginal heritage values/items (archaeological and cultural) and outline proposed mitigation measures (including consideration of the effectiveness and reliability of the measures) in accordance with the Draft *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005). The assessment must be undertaken by suitably qualified heritage consultants and demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, developing options and selecting options and mitigation measures (including the final proposed measures); and
 - provide sufficient information to demonstrate the likely impacts of the project on historic heritage values (including heritage vistas) and, where impacts to State or local historic heritage items are proposed, outline proposed mitigation and management measures (including consideration of the effectiveness and reliability of the measures) generally consistent with the guidelines in the NSW Heritage Manual. Where impacts to State or local historic heritage items are

proposed, a statement of heritage significance must be included.

- **Traffic and Transport** – the EA must assess the construction and operational traffic impacts of the project including:
 - details of traffic volumes (both light and heavy vehicles) and transport routes during construction and operation;
 - assess the potential traffic impacts of the project on road network function (including intersection level of service) and safety;
 - assess the capacity of the existing road network to accommodate the type and volume of traffic generated by the project (including over-dimensional traffic) during construction and operation, including full details of any required upgrades to roads, bridges, site access provisions (for safe access to the public road network) or other road features;
 - details of measures to mitigate and/or manage potential impacts, including construction traffic control, road dilapidation surveys and measures to control soil erosion and dust generated by traffic volumes;
 - details of access roads within the site including how these would connect to the existing public road network (i.e. site access) and ongoing operational maintenance requirements for on-site roads; and
 - consideration of relevant Council traffic/road policies.
- **Hazard/Risks**– the EA must include an assessment of the potential impacts on aviation safety, including the need for aviation hazard lighting, considering nearby aerodromes and aircraft landing areas, defined air traffic routes, aircraft operating heights, approach/departure procedures, radar interference, communication systems, and navigation aids. Aerodromes within 30km of the turbines should be identified and impacts on obstacle limitation surfaces addressed. In addition, the EA must assess the impact of the turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the turbines and transmission line. Possible effects on telecommunications systems must be identified. Potential hazards and risks associated with electric and magnetic fields and bushfires/use of bushfire prone land must also be assessed.
- **Water Supply, Water Quality and Hydrology** – The EA must:
 - identify water demands, and determine whether an adequate and secure water supply is available for the project;
 - identify water sources (surface and groundwater), water disposal methods and water storage structures in the form of a water balance;
 - include the statutory (licensing) context of the water supply sources;
 - assess potential environmental impacts associated with the use of the identified water sources including impacts on groundwater and implications for existing licensed users/basic landholder rights;
 - assess the potential to intercept groundwater, including predicted dewatering volumes, zone of drawdown and associated impact, water quality and disposal methods;
 - where the project involves crossing or works close to waterways, identify likely impacts to the waterways, how the waterways are proposed to be crossed and be designed in accordance with the NSW Office of Water Guidelines for Controlled Activities (August 2010);
 - describe the measures to minimise hydrological, water quality, aquatic and riparian impacts;
 - identify how works within steep gradient land or highly erosive soil types will be managed during construction and operation; and
 - consideration is to be given to water sharing plans and ground water and surface water access embargoes, as relevant.
- **Waste** – The EA must identify, quantify and classify the likely waste streams to be generated during construction and operation, and describe the measures to be implemented to manage, reuse, recycle and safely dispose of this waste.

	<ul style="list-style-type: none"> • General Environmental Risk Analysis – notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project, proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of the additional key environmental impact(s) must be included in the EA.
Consultation Requirements	<p>The Proponent must undertake a consultation programme as part of the environmental assessment process, including consultation with, but not necessarily limited to, the following parties:</p> <ul style="list-style-type: none"> • Liverpool Plains Shire Council; • Warrumbungle Shire Council; • Upper Hunter Shire Council; • Mid-Western Regional Council; • Department of Environment, Climate Change and Water; • NSW Office of Water; • Industry and Investment NSW; • NSW Roads and Traffic Authority; • NSW Rural Fire Service; • Land and Property Management Authority; • Central West Catchment Management Authority; • Hunter Central Rivers Catchment Management Authority; • Namoi Catchment Management Authority; • Commonwealth Department of Defence; • Civil Aviation Safety Authority; • Airservices Australia; • Aerial Agricultural Society of Australia; • relevant service providers; • relevant minerals stakeholders (including exploration and mining title holders); and • the local community and landowners (including "associated" and "non-associated" properties). <p>The consultation process shall include measures for disseminating information to increase awareness of the project as well as methods for actively engaging stakeholders on issues that would be of interest/concern to them. The EA must:</p> <ul style="list-style-type: none"> → demonstrate effective consultation with stakeholders, and that the level of consultation with each stakeholder is commensurate with their degree of interest/concern or likely impact; → clearly describe the consultation process undertaken for each stakeholder/group including details of the dates of consultation and copies of any information disseminated as part of the consultation process (subject to confidentiality); and → describe the issues raised during consultation and how and where these have been addressed in the EA.

Relevant Guidelines - For Reference

General

Wind Energy Facilities draft Environmental Impact Assessment Guidelines (Planning NSW, June 2002)

Draft EIS Guideline "Network Electricity Systems and Related Facilities" (Planning NSW, February, 2002)

Best Practice Guidelines for Implementation of Wind Energy Projects in Australia (Auswind, 2006)

Visual

Wind Farms and Landscape Values: National Assessment Framework (Australian Wind Energy Association and Australian Council of National Trust, June 2007).

Ecology

Cumulative Risk for Threatened and Migratory Species (Commonwealth Department of Environment and Heritage, March 2006).

Wind Farms and Birds: Interim Standards for Risk Assessment, (Auswind, July 2005).

Assessing the Impacts on Birds – Protocols and Data Set Standards (Australian Wind Energy Association).

Threatened Biodiversity Survey and Assessment – Guidelines for Developments and Activities (Working Document) (DEC, 2004).

Aviation Hazard

Advisory Circular 139-18(0) Obstacle Marking and Lighting of Wind Farms (Civil Aviation Safety Authority, July 2007). Note: this advisory is currently withdrawn however a replacement has to date not been issued.

Windfarm Policy (Aerial Agricultural Association of Australia, December 2009)

Powerlines Policy (Aerial Agricultural Association of Australia, December 2009)

Information Sheet – Airport Related Development (AirServices Australia)

Water Quality

National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000).

The NSW State Groundwater Quality Protection Policy (DLWC, 1998).

The NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002).

Department of Water and Energy's Guidelines for Controlled Activities (February 2008):

- Watercourse Crossings;
- Instream Works;
- Laying Pipes and Cables in Watercourses;
- Outlet Structures; and
- Riparian Corridors.

Managing Urban Stormwater: Soils and Construction, Volume 1, 4th edition (Landcom, 2004).

Managing Urban Stormwater: Soils and Construction, Volume 2C Unsealed roads (DECC).

APPENDIX B SPECIES LISTS AND HABITAT ASSESSMENT DATA

B.1 FIELD DATA SHEETS

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

FLORA SURVEY DATA SHEET

Project: Liverpool Wind Farm

Survey date: _____ **Personnel initials:** _____

Flora Survey ID: _____ **RM duration:** _____

GPS Location (GDA94): _____ E _____ N **WP:** _____

Location/Brief site description: (eg current landuse, soil, geology, slope, aspect, topographic position)

Structure and dominants (within representative patch) (refer to reference sheet)

Stratum	Height	Foliage cover (%)*	Dominant 1	Dominant 2	Dominant 3
Tree					
Small tree					
Shrub 1					
Shrub 2					
Groundcover					

Benson Vegetation Community (please tick)

Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone (ID480);		Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest (ID481);	
Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills (ID479);		Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone (ID478);	
Narrow-leaved Ironbark - Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills (ID468);		Grey Box x White Box grassy open woodland on basalt hills (ID483);	
Planted Vegetation (windbreaks)		Exotic Pasture and Crops	
Derived Speargrass – wallaby grass – wire grass mixed forb grassland (ID395)		Other: (specify)	

Age class, condition and disturbance (including average dbh, hollows, fire, grazing, introduced fauna, clearing/logging, soil disturbance/loss, salinity, weeds, dieback) Refer to condition classes ref sheet.

Exotic ☐ Poor ☐ Poor -Moderate ☐ Moderate ☐ Moderate-Good ☐ Good ☐

Noxious weeds (note species and abundance) refer to list.

Threatened species and communities (if present, note pop. size/area, structure, reproductive status, habit, habitat, threats, photos, condition, native regen (refer to condition classes and note canopy cover)). Comments on whether further survey is required.

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

Species recorded (include cover/abundance score)

1 (uncommon <5%)

2 (common <5%)

3 (6-20% cover)

4 (21-50% cover)

5 (51-75% cover)

6 (76-100% cover)

[illegible]

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

FAUNA HABITAT ASSESSMENT LOCATION

Date & time		GPS location WP	
Personnel			
F.H.A.L. No. (eg: B3 FA, B4 FA etc)			
Correlates with veg No.			
Location description			
Habitat description			
Fauna Observed			

Quadrat size	20m x 20m			
Disturbances				
Grazing Pressure (circle)	Absent	Low	Medium	High
Waterbodies				
Tree height (average and tallest trees)				
Tree hollows (incl. no. of HBT and total no. of trees in quadrat eg. 2 of 7)				

Habitat features

	ABSENT	SCATTERED	COMMON	ABUNDANT
Small hollows				
Large hollows				
Mature trees				
Leaf litter				
Fallen trees & branches (<50cm diameter)				
Fallen trees & branches (>50cm diameter)				
Mistletoe				
Rock outcrop				
Small surface rock				
Large surface rock				
Cliffs and overhangs				
Tussock forming grasses				

Habitat quality for

	ABSENT	POOR	AVERAGE	GOOD	EXCELLENT	NOTES
Koala (presence of food trees)						
Small black ant tunnels?						
Log dependent fauna						
Small birds						
Waterbirds						
Glossy black-cockatoo feed trees						

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

NOCTURNAL SURVEY DATA SHEET

Survey details

Date & time		GPS location & WP	
Personnel			
Location description			
Habitat description (incl HBT)			

Weather details

Wind		Cloud	
Temp		Rain	

Survey effort (time)

Listening period		Call playback	
Spotlighting		Stag watch	

Call playback

Species	Time played	Species	Time played

Observations

Species	No.	Microhabitat	Obs type	Notes (incl confidence)

Description of spotlighting transect/location

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LIVERPOOL WIND FARM SURVEY OCTOBER 2013

ANABAT SURVEY DATA SHEET

[illegible]

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

HERPETOFAUNA SURVEY DATA SHEET

Survey details

Date & time		GPS location & WP	
Personnel			
Location description			
Habitat description			

Weather details

Wind		Cloud	
Temp		Rain	

Survey effort (time and description)

Reptile search	
Amphibian search	

Observations

[illegible]

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

DIURNAL BIRD SURVEY DATA SHEET

Survey details

Date & time		GPS location & WP	
Personnel			
Location description			
Habitat description			

Weather details

Wind		Cloud	
Temp		Rain	

Survey effort (time and description)

Observations

[illegible]

LIVERPOOL WIND FARM SURVEY OCTOBER 2013

OPPORTUNISTIC FAUNA RECORDS

[illegible]

B.2 FLORA

*Introduced species are preceded by an asterisk.

Where uncertainty exists, the taxon name is preceded by a question mark (?).

Species in **bold** are listed threatened species.

Relative abundance is given by a cover abundance scale (modified Braun-Blanquet):

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

Species Name	Common Name	Family Name	Abundance Score
Native Species			
Trees			
<i>Acacia implexa</i>	Lightwood or Hickory	Fabaceae	1
<i>Angophora floribunda</i>	Rough-barked Apple	Myrtaceae	0-3
<i>Callistemon sieberi</i>	River Bottlebrush	Myrtaceae	0-4
<i>Casuarina cunninghamiana</i>	River Oak	Casuarinaceae	0-3
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum	Myrtaceae	0-3
<i>Eucalyptus dalrympleana</i> ssp <i>heptantha</i>	Mountain Gum	Myrtaceae	0-2
<i>Eucalyptus laevopinea</i>	Silvertop Stringybark	Myrtaceae	0-3
<i>Eucalyptus melliodora</i>	Yellow Box	Myrtaceae	0-3
<i>Eucalyptus nortonii</i>	Mealy Bundy	Myrtaceae	0-3
<i>Eucalyptus praecox</i>	Brittle Gum	Myrtaceae	0-2
<i>Eucalyptus X albens</i>	White Box hybrids	Myrtaceae	0-3
Shrubs			
<i>Amyema pendulum</i>	a mistletoe	Loranthaceae	1
<i>Cassinia arcuata</i>	Sifton Bush	Asteraceae	0-3
<i>Cassinia hewsoniae</i>	Dogwood	Asteraceae	1
<i>Daviesia genistifolia</i>	Broom Bitter Pea	Fabaceae	1
<i>Dodonaea viscosa</i> ssp <i>angustifolia</i>	Hopbush	Sapindaceae	1
<i>Hibbertia obtusifolia</i>	Guineaflower	Dilleniaceae	1
<i>Hovea heterophylla</i>		Fabaceae	1
<i>Melicytus dentatus</i> (<i>Hymenanthera dentata</i>)	Tree Violet	Violaceae	1
<i>Muellerina eucalyptoides</i>	a mistletoe	Loranthaceae	1
<i>Notelaea microcarpa</i> ssp <i>microcarpa</i>		Oleaceae	1
<i>Notothixos cornifolius</i>	Kurrajong Mistletoe	Viscaceae	0-2
<i>Olearia elliptica</i>	Sticky Daisy Bush	Asteraceae	1
<i>Pimelea glauca</i>	Shrubby Rice-flower	Thymeleaceae	1
<i>Rubus parvifolius</i>	Small-leaved Bramble	Rosaceae	1
Ferns			
<i>Asplenium flabellifolium</i>	Necklace Fern	Aspleniaceae	1
<i>Cheilanthes distans</i>	Bristly Cloak Fern	Sinopteridaceae	1

Species Name	Common Name	Family Name	Abundance Score
<i>Cheilanthes sieberi ssp sieberi</i>	Rock or Mulga Fern	Sinopteridaceae	1
<i>Pellaea falcata</i>	Sickle Fern	Pteridaceae	1
<i>Pteridium esculentum</i>	Bracken	Dennstaedtiaceae	0-3
Vines & Twiners			
<i>Clematis aristata</i>	Old Man's Beard	Ranunculaceae	1
<i>Convolvulus graminetinus</i>	Bindweed	Convolvulaceae	1
<i>Eustrephus latifolius</i>	Wombat Berry	Luzuriagaceae	1
<i>Glycine ?clandestina</i>	Twining Glycine	Fabaceae	1
<i>Glycine tabacina</i>		Fabaceae	1
<i>Hardenbergia violacea</i>	Native Sarsaparilla	Fabaceae	1
Forbs			
<i>Acaena novae-zelandiae</i>		Rosaceae	0-2
<i>Acaena ovina</i>		Rosaceae	0-2
<i>Acaena sp.</i>		Rosaceae	0-2
<i>Ajuga australis</i>	Austral Bugle	Lamiaceae	1
<i>Arthropodium milleflorum</i>	Pale Vanilla Lily	Anthericaceae	1
<i>Arthropodium minus</i>		Anthericaceae	1
<i>Asperula conferta</i>	Common Woodruff	Rubiaceae	0-2
<i>Atriplex suberecta</i>		Chenopodiaceae	1
<i>Boerhavia dominii</i>	Tar Vine		1
<i>Bossiaea prostrata</i>		Fabaceae	1
<i>Brachyscome ciliaris var. subintegrifolia</i>		Asteraceae	1
<i>Brachyscome sieberi</i>		Asteraceae	1
<i>Bulbine bulbosa</i>	Bulbine Lily	Asphodelaceae	1
<i>Calandrinia eremaea</i>		Portulacaceae	1
<i>Calotis cuneifolia</i>	Purple Burr-daisy	Asteraceae	0-2
<i>Calotis lappulacea</i>	Yellow Burr-daisy	Asteraceae	0-3
<i>Chrysocephalum apiculatum</i>	Yellow Buttons	Asteraceae	1
<i>Cotula australis</i>	Carrot Weed	Apiaceae	1
<i>Crassula sieberiana</i>	Australian Stonecrop	Crassulaceae	0-2
<i>Cymbonotus sp.</i>	Bear's Ear	Asteraceae	1
<i>Cynoglossum australe</i>	Hound's Tongue	Boraginaceae	1
<i>Daucus glochidiatus</i>		Apiaceae	0-2
<i>Desmodium brachypodium</i>	Large Tick Trefoil	Fabaceae	1
<i>Desmodium gunnii</i>	Southern Tick Trefoil	Fabaceae	1
<i>Desmodium varians</i>	Slender Tick Trefoil	Fabaceae	1
<i>Dichondra repens</i>	Kidney Weed	Convolvulaceae	0-3
<i>Dichondra sp A</i>		Convolvulaceae	0-2
<i>Dichopogon strictus</i>	Chocolate Lily	Anthericaceae	1
<i>Diuris sulphurea</i>	Tiger Orchid	Orchidaceae	1
<i>Einadia nutans ssp nutans</i>		Chenopodiaceae	1
<i>Epilobium billardierianum ssp cinereum</i>	Willow Herb	Onagraceae	1
<i>Erodium crinitum</i>	Blue Storksbill	Geraniaceae	1
<i>Galium ?ciliare</i>			1
<i>Galium gaudichaudii</i>		Rubiaceae	1
<i>Galium leptogonium</i>		Rubiaceae	0-2
<i>Geranium retrorsum</i>		Geraniaceae	1

Species Name	Common Name	Family Name	Abundance Score
<i>Geranium solanderi</i> var. <i>solanderi</i>		Geraniaceae	0-3
<i>Geranium</i> sp.		Geraniaceae	0-3
<i>Goodenia pinnatifida</i>		Goodeniaceae	1
<i>Haloragis heterophylla</i>		Haloragaceae	1
<i>Hydrocotyle laxiflora</i>	Stinking Pennywort	Apiaceae	0-2
<i>Leptorhynchus squamatus</i> ssp. <i>squamatus</i>	Scaly Buttons	Asteraceae	1
<i>Mentha</i> ? <i>satureoides</i>	Native Mint	Lamiaceae	0-3
<i>Microseris lanceolata</i>	Murnong, Yam Daisy	Asteraceae	1
<i>Oxalis</i> sp.		Oxalidaceae	1
<i>Picris angustifolia</i>		Asteraceae	1
<i>Pimelea curviflora</i> var. <i>sericea</i>		Thymeleaceae	1
<i>Plantago hispida</i>		Plantaginaceae	1
<i>Plantago varia</i>		Plantaginaceae	1
<i>Podolepis hieracioides</i>		Asteraceae	1
<i>Poranthera microphylla</i>		Euphorbiaceae	1
<i>Pratia</i> ? <i>concolor</i>	Poison Pratia	Lobeliaceae	1
<i>Pratia</i> ? <i>puberula</i>	Trailing Pratia	Lobeliaceae	1
<i>Ranunculus</i> ? <i>amphitrichus</i>		Ranunculaceae	1
<i>Ranunculus</i> ? <i>collinus</i>	Hill Buttercup	Ranunculaceae	1
<i>Ranunculus lappaceus</i>	Common Buttercup	Ranunculaceae	0-2
<i>Rumex brownii</i>	Native Dock	Polygonaceae	1
<i>Scutellaria humilis</i>	Dwarf Skullcap	Scrophulariaceae	0-2
<i>Senecio bathurstianus</i>			1
<i>Senecio distalilobatus</i>		Asteraceae	1
<i>Senecio microbasis</i>		Asteraceae	1
<i>Senecio quadridentatus</i>	Cotton Fireweed	Asteraceae	1
<i>Sida corrugata</i>		Malvaceae	1
<i>Sigesbeckia australiensis</i>		Asteraceae	1
<i>Solanum cinereum</i>	Narrawa Burr	Solanaceae	1
<i>Stellaria pungens</i>	Prickly Starwort	Caryophyllaceae	1
<i>Swainsona galegifolia</i>		Fabaceae	0-2
<i>Swainsona queenslandica</i>		Fabaceae	1
<i>Swainsona reticulata</i>		Fabaceae	1
<i>Triptilodiscus pygmaeus</i>	Austral Sunray	Asteraceae	1
<i>Urtica incisa</i>	Stinging Nettle	Urticaceae	0-4
<i>Veronica calycina</i>	Hairy Speedwell	Scrophulariaceae	1
<i>Veronica plebeia</i>	Common Speedwell	Scrophulariaceae	1
<i>Viola betonicifolia</i>	Narrow-leaved Violet	Violaceae	1
<i>Vittadinia</i> ? <i>cervicularis</i> var. <i>subcervicularis</i>	Rough Fuzzweed	Asteraceae	1
<i>Vittadinia</i> ? <i>cuneata</i> var. <i>cuneata</i>	Fuzzweed	Asteraceae	1
<i>Vittadinia</i> ? <i>pterochaeta</i>	Fuzzweed	Asteraceae	0-2
<i>Vittadinia muelleri</i>		Asteraceae	1
<i>Wahlenbergia communis</i>	Tufted Bluebell	Campanulaceae	0-2
<i>Wahlenbergia</i> sp.		Campanulaceae	0-2
<i>Wahlenbergia stricta</i>	Tall Bluebell	Campanulaceae	0-2
<i>Wurmbea biglandulosa</i>	Early Nancy	Colchicaceae	1
Grasses			

Species Name	Common Name	Family Name	Abundance Score
<i>Aristida ramosa</i> var. <i>ramosa</i>	Wire Grass	Poaceae	0-3
<i>Austrodanthonia penicillata</i>	Wallaby Grass	Poaceae	1
<i>Austrodanthonia racemosa</i> var. <i>racemosa</i>	Wallaby Grass	Poaceae	1
<i>Austrostipa ?rudis</i>		Poaceae	1
<i>Austrostipa aristiglumis</i>	Plains Grass	Poaceae	0-5
<i>Austrostipa scabra</i> ssp <i>falcata</i>	Corkscrew Grass	Poaceae	0-3
<i>Austrostipa verticillata</i>	Bamboo Grass	Poaceae	0-4
<i>Bothriochloa ?macra</i>	Red-stem Grass	Poaceae	0-4
<i>Chloris truncata</i>	Windmill Grass	Poaceae	1
<i>Chloris ventricosa</i>	Tall Windmill Grass	Poaceae	0-2
<i>Cymbopogon refractus</i>	Barbed Wire Grass	Poaceae	1
<i>Cynodon dactylon</i>	Couch Grass	Poaceae	1
<i>Dichelachne micrantha</i>	Common Plume Grass	Poaceae	1
<i>Echinopogon ovatus</i>	Hedgehog Grass	Poaceae	0-2
<i>Elymus scaber</i>	Common Wheat Grass	Poaceae	1
<i>Joycea pallida</i>	Robust Wallaby Grass	Poaceae	1
<i>Microlaena stipoides</i>	Weeping Grass	Poaceae	0-4
<i>Panicum effusum</i>	Hairy Panic	Poaceae	1
<i>Poa ?sieberiana</i> var. <i>sieberiana</i>		Poaceae	1
<i>Poa labillardierei</i>	Silver or Poa Tussock	Poaceae	0-4
<i>Themeda australis</i>	Kangaroo Grass	Poaceae	0-4
Graminoids			
<i>Carex appressa</i>	Tall Sedge	Cyperaceae	0-4
<i>Carex breviculmis</i>		Cyperaceae	1
<i>Juncus ?usitatus</i>	Common or Tussock Rush	Juncaceae	1
<i>Juncus</i> sp.		Juncaceae	1
<i>Lepidosperma laterale</i>	Variable Sword-sedge	Cyperaceae	1
<i>Lomandra confertifolia</i> ssp <i>pallida</i>		Lomandraceae	0-3
<i>Lomandra filiformis</i> ssp <i>coriacea</i>		Lomandraceae	0-4
<i>Lomandra filiformis</i> ssp <i>filiformis</i>		Lomandraceae	1
<i>Lomandra longifolia</i> ssp. <i>longifolia</i>	Spiny Matrush	Lomandraceae	0-3
<i>Lomandra multiflora</i> ssp. <i>multiflora</i>		Lomandraceae	1
<i>Luzula meridionalis</i> var. <i>flaccida</i>		Juncaceae	1
<i>Schoenus apogon</i>	Common Bog-rush	Cyperaceae	1
Exotic Species			
Forbs			
* <i>Acetosella vulgaris</i>	Sheep Sorrel	Polygonaceae	1
* <i>Anagallis arvensis</i>	Scarlet Pimpernel	Primulaceae	1
* <i>Arctotheca calendulacea</i>	Capeweed	Asteraceae	0-4
* <i>Arenaria leptoclados</i>		Caryophyllaceae	1
* <i>Arenaria serpyllifolia</i>	Thyme-leaved Sandwort	Caryophyllaceae	1
* <i>Arenaria</i> sp.	Sandwort	Caryophyllaceae	1
* <i>Argemone ochroleuca</i>	Mexican Poppy	Papaveraceae	1
* <i>Capsella bursa-pastoris</i>	Shepherd's Purse	Brassicaceae	0-3
* <i>Carduus pycnocephalus</i>	Slender Thistle	Asteraceae	0-2
* <i>Carthamus lanatus</i>	Saffron Thistle	Asteraceae	0-2
* <i>Centaurea melitensis</i>	Maltese Cockspur	Asteraceae	1

Species Name	Common Name	Family Name	Abundance Score
* <i>Centaurium</i> sp.	Centaury	Gentianaceae	1
* <i>Cerastium</i> sp.	Chickweed	Caryophyllaceae	1
* <i>Chondrilla juncea</i>	Skeleton Weed	Asteraceae	1
* <i>Cirsium vulgare</i>	Black or Spear Thistle	Asteraceae	0-2
* <i>Conyza sumatrensis</i>	Tall Fleabane	Asteraceae	0-2
* <i>Echium plantagineum</i>	Paterson's Curse	Boraginaceae	0-3
* <i>Erodium cicutarium</i>	Common Storksbill	Geraniaceae	1
* <i>Galium aparine</i>	Cleavers	Rubiaceae	0-2
* <i>Geranium molle</i>		Geraniaceae	1
* <i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton-bush	Euphorbiaceae	1
* <i>Hypericum perforatum</i>	St John's Wort	Clusiaceae	0-3
* <i>Hypochaeris glabra</i>		Asteraceae	1
* <i>Hypochaeris radicata</i>	Cat's Ear, Flatweed	Asteraceae	0-2
* <i>Lactuca</i> sp.	Prickly Lettuce	Asteraceae	1
* <i>Lepidium africanum</i>	Peppergrass	Brassicaceae	1
* <i>Malva parviflora</i>	Small-flowered Mallow	Malvaceae	1
* <i>Marrubium vulgare</i>	Horehound	Lamiaceae	0-4
* <i>Medicago arabica</i>	Black Medic	Fabaceae	1
* <i>Medicago</i> sp.	Black Medic	Fabaceae	1
* <i>Modiola caroliniana</i>	Orange Flowered Mallow	Malvaceae	1
* <i>Paronychia brasiliensis</i>	Brazilian Whitlow	Caryophyllaceae	1
* <i>Petrorhagia nanteuilii</i>	Proliferous Pink	Caryophyllaceae	1
* <i>Plantago lanceolata</i>	Ribbed Plantain	Plantaginaceae	0-2
* <i>Polycarpon tetraphyllum</i>	Four-leaved Allseed	Caryophyllaceae	1
* <i>Polygonum aviculare</i>	Wireweed	Polygonaceae	1
* <i>Salvia verbenaca</i>	Wild Sage	Lamiaceae	0-3
* <i>Silybum marianum</i>	Variegated Thistle	Asteraceae	0-4
* <i>Sisymbrium officinale</i>	Hedge Mustard	Brassicaceae	0-2
* <i>Solanum nigrum</i>	Black Nightshade	Solanaceae	1
* <i>Sonchus oleraceus</i>	Sow Thistle	Asteraceae	1
* <i>Stellaria media</i>	Common Chickweed	Caryophyllaceae	1
* <i>Tagetes minuta</i>	Stinking Roger	Asteraceae	0-3
* <i>Taraxacum officinale</i>	Dandelion	Asteraceae	0-2
* <i>Tragopogon</i> sp.		Asteraceae	1
* <i>Trifolium arvense</i>	Hare's Foot Clover	Fabaceae	1
* <i>Trifolium campestre</i>	Hop Clover	Fabaceae	0-2
* <i>Trifolium dubium</i>	Suckling Clover	Fabaceae	1
* <i>Trifolium glomeratum</i>	Ball Clover	Fabaceae	1
* <i>Trifolium repens</i>	White Clover	Fabaceae	0-2
* <i>Trifolium subterraneum</i>	Sub Clover	Fabaceae	0-4
* <i>Urtica urens</i>	Stinging Nettle	Urticaceae	1
* <i>Vicia sativa</i>	Vetch	Fabaceae	1
* <i>Vicia</i> sp.	Vetch	Fabaceae	0-3
* <i>Xanthium spinosum</i>	Bathurst Burr	Asteraceae	1
Grasses			
* <i>Avena</i> sp.	Wild Oats	Poaceae	1
* <i>Briza minor</i>	Shivery Grass	Poaceae	1

Species Name	Common Name	Family Name	Abundance Score
* <i>Briza</i> sp.	Quaking Grass	Poaceae	1
* <i>Bromus ?molliformis</i>	Soft Brome	Poaceae	1
* <i>Bromus catharticus</i>	Prairie Grass	Poaceae	1
* <i>Bromus diandrus</i>	Giant Brome	Poaceae	1
* <i>Bromus inermis</i>		Poaceae	1
* <i>Cynosurus echinatus</i>	Dog's Tail Grass	Poaceae	1
* <i>Dactylis glomerata</i>	Cocksfoot	Poaceae	0-3
* <i>Ehrharta erecta</i>	Panic Veldt Grass	Poaceae	1
* <i>Eleusine tristachya</i>		Poaceae	1
* <i>Festuca ?bromoides</i>	Rat's Tail Fescue	Poaceae	1
* <i>Hordeum</i> sp.	Barley Grass	Poaceae	0-5
* <i>Lolium perenne</i>	Perennial Ryegrass	Poaceae	0-4
* <i>Phalaris aquatica</i>	Phalaris	Poaceae	0-3
* <i>Poa annua</i>	Winter Grass	Poaceae	1
* <i>Rostraria cristata</i>	Cat's Tail Grass	Poaceae	1
* <i>Vulpia</i> sp.	Rat's Tail Fescue	Poaceae	1
Shrubs			
* <i>Prunus cerasifera</i> ?	Plum	Amygdalaceae	1
* <i>Rosa rubiginosa</i>	Sweet Briar	Rosaceae	0-3
* <i>Rubus fruticosus</i> spp. agg.	Blackberry	Rosaceae	1
Trees			
* <i>Salix</i> sp.	Willow	Salicaceae	1

B.3 VEGETATION DESCRIPTIONS (BENSON *et al.* 2009) AND PHOTOS

Common Name: Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion

Scientific Name: *Eucalyptus laevopinea* - *Eucalyptus nobilis* - *Eucalyptus dalrympleana* subsp. *heptantha*-*Acacia melanoxylon* / *Acacia dealbata* - *Hibbertia obtusifolia* - *Smilax australis* - *Leucopogon lanceolatus* var. *lanceolatus* / *Pteridium esculentum* - *Poa sieberiana* var. *sieberiana* - *Hydrocotyle laxiflora* - *Acaena novae-zelandiae*

Veg. Comm. ID.: 490

Characteristic Trees: *Eucalyptus laevopinea*; *Eucalyptus nobilis*; *Eucalyptus dalrympleana* subsp. *heptantha*; *Acacia melanoxylon*; *Eucalyptus pauciflora*; *Eucalyptus stellulata*; *Eucalyptus melliodora*; *Eucalyptus bridgesiana*.

Shrubs/Vines/Epiphytes: *Acacia dealbata*; *Hibbertia obtusifolia*; *Eustrephus latifolius*; *Smilax australis*; *Leucopogon lanceolatus* var. *lanceolatus*; *Bursaria spinosa* subsp. *spinosa*; *Hibbertia acicularis*; *Indigofera australis*; *Pittosporum undulatum*; *Daviesia genistifolia*; *Pimelea curviflora* var. *curviflora*; *Acrothamnus hookeri*; *Xanthorrhoea glauca* subsp. *glauca*.

Groundcover: *Poa sieberiana* var. *sieberiana*; *Pteridium esculentum*; *Hydrocotyle laxiflora*; *Acaena novae-zelandiae*; *Dichondra repens*; *Viola betonicifolia*; *Desmodium varians*; *Glycine clandestina*; *Microlaena stipoides* var. *stipoides*; *Wahlenbergia stricta* subsp. *stricta*; *Austrodanthonia laevis*; *Austrodanthonia racemosa* var. *racemosa*; *Austrodanthonia pilosa*; *Dichelachne micrantha*; *Echinopogon ovatus*; *Echinopogon caespitosus* var. *caespitosus*; *Austrostipa rudis* subsp. *nervosa*; *Brachyscome microcarpa*; *Senecio diaschides*; *Adiantum aethiopicum*; *Calochlaena dubia*; *Luzula flaccida* form A; *Galium ciliare*; *Senecio biserratus*; *Lagenifera stipitata*; *Polystichum fallax*; *Cynoglossum australe*; *Epilobium billardioreanum* subsp. *cinereum*; *Ranunculus lappaceus*; *Clematis aristata*; *Asperula conferta*; *Ajuga australis*; *Swainsona galegifolia*; *Senecio quadridentatus*; *Arthropodium minus*; *Lomandra longifolia*; *Themeda australis*.

Vegetation Description: Very tall open forest to closed forest dominated by Silvertop Stringybark (*Eucalyptus laevopinea*) with Forest Ribbon Gum (*Eucalyptus nobilis*), Mountain Gum (*Eucalyptus dalrympleana* subsp. *heptantha*) and less commonly Snow Gum (*Eucalyptus pauciflora*) and Black Sallee (*Eucalyptus stellulata*). Blackwood (*Acacia melanoxylon*) is scattered through the forest. The shrub layer is sparse to very sparse with the most common species being Silver Wattle (*Acacia dealbata*) that grows above Bracken Fern (*Pteridium esculentum*). Other shrubs include *Hibbertia obtusifolia*, *Leucopogon lanceolatus* and *Bursaria spinosa* subsp. *spinosa*. Vines include *Eustrephus latifolius* and *Smilax australis*. The ground cover is dense. Grass species include *Poa sieberiana*, *Microlaena stipoides*, *Austrodanthonia pilosa*, *Dichelachne micrantha*, *Echinopogon ovatus* and *Austrostipa rudis* subsp. *nervosa*. The mat-rush *Lomandra longifolia* is often present along with the rush *Luzula flaccida*. Forb species include *Hydrocotyle laxiflora*, *Acaena novae-zelandiae*, *Dichondra repens*, *Viola betonicifolia*, *Brachyscome microcarpa*, *Senecio diaschides*, *Galium ciliare*, *Senecio biserratus*, *Lagenifera stipitata*, *Cynoglossum australe*, *Epilobium billardioreanum* subsp. *cinereum*, *Ranunculus lappaceus* and *Wahlenbergia stricta*

subsp. *stricta*. The scramblers *Desmodium varians* and *Glycine clandestina* are abundant. Bracken Fern (*Pteridium esculentum*) is dominant. Other ferns include *Adiantum aethiopicum*, *Calochlaena dubia* and *Polystichum fallax*. Occurs on chocolate loamy soils derived from basalt in mountains or plateau landscapes mostly over 1000 m altitude on the Liverpool Range including in Coolah Tops National Park in the southern Brigalow Belt South Bioregion. Similar forest occurs in Ben Halls Gap NP and Barrington Tops NP to the east but often with Messmate (*Eucalyptus obliqua*) which does not occur on the Liverpool Range west of Murrurundi. Heavily logged in the past with young regrowth in most areas but now well protected in reserves and generally in good condition.

Threat Category: Least Concern



Silvertop Stringybark and Mountain Gum dominate this example of vegetation community 490. Forest Ribbon Gum was not found on the site.

This community is found only in the highest, wettest parts of the wind farm site, close to Coolah Tops National Park.

Common Name: Brittle Gum - Silvertop Stringybark grassy open forest of the Liverpool Range, BBS Bioregion

Scientific Name: *Eucalyptus praecox* - *Eucalyptus laevopinea* / *Acacia dealbata* - *Hibbertia obtusifolia* - *Bursaria spinosa* subsp. *spinosa* / *Acaena novae-zelandiae* - *Poa labillardierei* var. *labillardierei* - *Hydrocotyle acutiloba* - *Desmodium varians*

Veg. Comm. ID.: 495

Characteristic Trees: *Eucalyptus praecox*; *Eucalyptus laevopinea*.

Shrubs/Vines/Epiphytes: *Hibbertia obtusifolia*; *Acacia dealbata*; *Bursaria spinosa* subsp. *spinosa*.

Groundcover: *Acaena novae-zelandiae*; *Poa labillardierei* var. *labillardierei*; *Hydrocotyle laxiflora*; *Poa sieberiana* var. *sieberiana*; *Stellaria pungens*; *Asperula conferta*; *Pratia purpurascens*; *Dichondra repens*; *Lomandra longifolia*; *Brachyscome microcarpa*; *Euchiton involucratus*; *Echinopogon ovatus*; *Pteridium esculentum*; *Dichelachne micrantha*; *Geranium solanderi* var. *solanderi*; *Oxalis perennans*; *Cynoglossum australe*; *Veronica calycina*; *Senecio diaschides*; *Desmodium varians*; *Glycine clandestina*; *Microlaena stipoides*

Vegetation Description: Mid-high to tall open forest dominated by Brittle Gum (*Eucalyptus praecox*) with Silvertop Stringybark (*Eucalyptus laevopinea*). The shrub layer is very sparse and includes *Hibbertia obtusifolia*, *Acacia dealbata* and *Bursaria spinosa* subsp. *spinosa*. The ground cover is dense to mid-dense and contains grasses such as *Poa labillardierei* var. *labillardierei*, *Poa sieberiana* var. *sieberiana*, *Microlaena stipoides* and *Dichelachne micrantha*. The mat-rush *Lomandra longifolia* is usually present. Forbs include *Pratia purpurascens*, *Dichondra repens*, *Acaena novae-zelandiae*, *Brachyscome microcarpa*, *Geranium solanderi* var. *solanderi*, *Oxalis perennans* and *Veronica calycina* and *Senecio diaschides*. Scramblers include *Desmodium varians* and *Glycine clandestina*. Occurs on dark brown clay to loam soil on basalt hillcrests and upper steep hillslopes on the Liverpool Range generally east of Coolah Tops National Park. Very restricted in extent. A sub-type to the more widespread ID490 on the Liverpool Range.

Threat Category: Least Concern.



This site is the best example of vegetation community 495 which was assessed. Although it is semi-cleared it has a high diversity groundcover layer and abundant tree regeneration.

This community also occurs at higher elevations in the northern part of the site, where it occurs as remnant trees and patches rather than extensive stands. Despite this Benson *et al.* regard it as of “least concern”, presumably because large areas are reserved in Coolah Tops National Park.

Common Name: Silvertop Stringybark - Yellow Box +/- Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion

Scientific Name: *Eucalyptus laevopinea* - *Eucalyptus nortonii* - *Eucalyptus melliodora* - *Angophora floribunda* / *Cassinia quinquefaria* - *Bursaria spinosa* subsp. *spinosa* - *Hibbertia obtusifolia* - *Olearia elliptica* subsp. *elliptica* / *Echinopogon ovatus* - *Austrodanthonia racemosa* var. *racemosa* - *Acaena novae-zelandiae* - *Desmodium varians*

Veg. Comm. ID.: 488

Characteristic Trees: *Eucalyptus laevopinea*; *Eucalyptus nortonii*; *Eucalyptus melliodora*; *Angophora floribunda*.

Shrubs/Vines/Epiphytes: *Cassinia quinquefaria*; *Bursaria spinosa* subsp. *spinosa*; *Hibbertia obtusifolia*; *Pimelea curviflora* var. *curviflora*.

Groundcover: *Echinopogon ovatus*; *Austrodanthonia racemosa* var. *racemosa*; *Acaena novae-zelandiae*; *Desmodium varians*; *Glycine clandestina*; *Poa sieberiana*; *Lepidosperma laterale*; *Bothriochloa macra*; *Mentha satereioides*; *Pratia purpurascens*; *Plantago debilis*; *Geranium solanderi* var. *solanderi*; *Poa labillardierei* var. *labillardierei*; *Dichelachne micrantha*; *Elymus scaber* var. *scaber*; *Microlaena stipoides* var. *stipoides*; *Austrodanthonia laevis*; *Asperula conferta*; *Dichondra repens*; *Galium migrans*; *Senecio prenanthoides*; *Ranunculus lappaceus*; *Euchiton gymnocephalus*; *Hydrocotyle laxiflora*; *Rumex brownii*; *Wahlenbergia stricta* subsp. *stricta*; *Veronica calycina*; *Hypericum gramineum*; *Lomandra confertifolia* subsp. *pallida*; *Swainsona galegifolia*; *Asperula conferta*; *Dichondra repens*; *Lomandra filiformis* subsp. *filiformis*; *Clematis aristata*; *Viola betonicifolia*; *Brachyscome microcarpa*; *Senecio hispidulus*; *Senecio quadridentatus*; *Arthropodium* sp. B; *Carex breviculmis*.

Vegetation Description: Tall or mid-high woodland to open woodland dominated by Silvertop Stringybark (*Eucalyptus laevopinea*) often with Norton's Box (*Eucalyptus nortonii*), Yellow Box (*Eucalyptus melliodora*) or Rough-barked Apple (*Angophora floribunda*). The shrub layer is very sparse or absent and includes *Cassinia quinquefaria*, *Bursaria spinosa* subsp. *spinosa*, *Hibbertia obtusifolia* and the low shrub *Pimelea curviflora* var. *curviflora*. The ground cover is usually dense with a diversity of grasses and forbs. Grass species include *Poa sieberiana*, *Echinopogon ovatus*, *Bothriochloa macra*, *Austrodanthonia racemosa* var. *racemosa*, *Dichelachne micrantha*, *Elymus scaber* var. *scaber* and *Microlaena stipoides*. Forb species include *Acaena novae-zelandiae*, *Pratia purpurascens*, *Plantago debilis*, *Geranium solanderi* var. *solanderi*, *Asperula conferta*, *Dichondra repens*, *Galium migrans*, *Senecio prenanthoides*, *Ranunculus lappaceus* and *Euchiton gymnocephalus*. The rush *Luzula flaccida* may be present. The scramblers *Glycine clandestina* and *Desmodium varians* are

common. Occurs on black or dark brown clay loam and light clay soils derived from basalt on hillcrests and upper hillslopes in hill and mountain landform patterns on the western Liverpool Range and Warrumbungle Range. This is a grassy woodland form of a similar open forest community that occurs on the steep southern slopes of the Liverpool Range that is much more shrubby. Partly cleared but with reasonable patches remaining.

Threat Category: Vulnerable



Norton's Box or Mealy Bundy is the typical dominant of vegetation community 488 which is very abundant on the middle elevation parts of the wind farm site. It has been less cleared than the Box-Gum woodland communities (following) because it tends to occur more often on the steeper side slopes.

However, because it occurs largely on private property and is subject to grazing, Benson *et al.* regard it as a vulnerable community. It is not listed under threatened species legislation.

Common Name: Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Scientific Name: *Eucalyptus albens* <-> *moluccana intermediate* - *Eucalyptus moluccana* - *Eucalyptus albens* / *Sida trichopoda* - *Sclerolaena muricata* s.l. - *Pimelea curviflora* var. *curviflora* / *Austrostipa bigeniculata* - *Bothriochloa macra* - *Boerhavia dominii* - *Oxalis perennans*

Veg. Comm. ID.: 483

Characteristic Trees: *Eucalyptus albens* <-> *moluccana intermediate*; *Eucalyptus moluccana*; *Eucalyptus albens*; *Angophora floribunda*; *Eucalyptus melliodora*.

Shrubs/Vines/Epiphytes: *Sclerolaena muricata* s.l.; *Sida trichopoda*; *Pimelea curviflora* var. *curviflora*.

Groundcover: *Austrostipa bigeniculata*; *Bothriochloa macra*; *Boerhavia dominii*; *Oxalis perennans*; *Elymus scaber* var. *scaber*; *Cynodon dactylon*; *Chamaesyce drummondii*; *Hibiscus trionum*; *Einadia nutans* subsp. *nutans*; *Austrostipa aristiglumis*; *Aristida personata*; *Asperula conferta*; *Rumex brownii*; *Mentha diemenica*; *Cyperus gracilis*; *Panicum queenslandicum* var. *queenslandicum*; *Geranium solanderi* var. *solanderi*; *Austrostipa nodosa*; *Calotis lappulacea*; *Convolvulus graminetinus*; *Glycine latifolia*; *Chloris truncata*.

Vegetation Description: Mid-high to tall open woodland or woodland dominated by a Grey Box (*Eucalyptus moluccana*) x White Box (*Eucalyptus albens*) hybrid forming an *Eucalyptus albens* - *moluccana intermediate* taxon. The trees tend to be closer to Grey Box than White Box over most of this region. Few other tree species occur with Rough-barked Apple (*Angophora floribunda*) and Yellow Box (*Eucalyptus melliodora*) occurring on footslopes and valley flats. Shrubs are absent or very sparse and include *Sclerolaena muricata*, *Sida trichopoda* and *Pimelea curviflora* var. *curviflora*. The ground cover is dense after rain but mid-dense to sparse in dry times. Grass species include *Austrostipa bigeniculata*, *Bothriochloa macra*, *Austrostipa aristiglumis*, *Elymus scaber* var. *scaber*, *Cynodon dactylon* and *Panicum queenslandicum* var. *queenslandicum*. The sedge *Cyperus gracilis* may be present. Forb species include *Boerhavia dominii*, *Oxalis perennans*, *Chamaesyce drummondii*, *Hibiscus trionum*, *Einadia nutans* subsp. *nutans*, *Asperula conferta*, *Rumex brownii*, *Mentha diemenica*, *Geranium solanderi* var. *solanderi* and *Calotis lappulacea*. Occurs on brown to black earth, chocolate loam to clay soils derived from basalt on hillslopes, hillcrests, footslopes and valley flats on rolling hills and low hills on the Merriwa Plain and lower southern slopes of the Liverpool Range in the upper Hunter Valley in the far south-eastern corner of the Bragalow Belt South Bioregion. Mainly cleared. Listed as part of the grassy box-gum woodland EEC in both the EPBC and NSW TSC Acts. Threatened by fragmentation, weed invasion, tree dieback and intensive agricultural development of ground cover. Very poorly or not represented in protected areas as of 2009.

Threat Category: Critically Endangered.



Hybrid White Box trees are the common dominant on lower slopes. These are less grey-foliaged and have smaller buds and fruits than typical White Box which was seen on the nearby Liverpool Plains. The White Box on the site all appeared to be this hybrid form and hence all White Box-dominated vegetation has been placed into this vegetation community (483) although there are several similar White Box communities described by Benson *et al.*

This community is part of the Box-Gum Woodland EEC.

Common Name: Yellow Box grassy woodland on lower hillslopes and valley flats in the southern NSW BBS Bioregion

Scientific Name: *Eucalyptus melliodora* / *Pimelea curviflora* var. *curviflora* - *Acacia implexa* - *Acacia decora* - *Solanum cinereum* / *Bothriochloa decipiens* - *Austrostipa aristiglumis* - *Einadia trigonos* - *Oxalis perennans*

Veg. Comm. ID: 437

Characteristic Trees: *Eucalyptus melliodora*; *Angophora floribunda*; *Brachychiton populneus* subsp. *populneus*; *Casuarina cristata*; *Callitris glaucophylla*.

Shrubs/Vines/Epiphytes: *Pimelea curviflora* var. *curviflora*; *Acacia implexa*; *Acacia decora*; *Solanum cinereum*; *Acacia caesiella*; *Cassinia arcuata*; *Geijera parviflora*; *Atriplex semibaccata*.

Groundcover: *Bothriochloa decipiens*; *Austrostipa aristiglumis*; *Einadia trigonos*; *Oxalis perennans*; *Rumex brownii*; *Cymbonotus lawsonianus*; *Austrostipa verticillata*; *Aristida personata*; *Poa sieberiana*; *Panicum effusum*; *Cheilanthes sieberi* subsp. *sieberi*; *Dichelachne micrantha*; *Aristida vagans*; *Elymus scaber* var. *scaber*; *Austrostipa scabra* subsp. *scabra*; *Paspalidium gracile*; *Dichondra* sp. A; *Einadia nutans* subsp. *nutans*; *Sporobolus creber*; *Dichanthium sericeum* subsp. *sericeum*; *Cymbopogon refractus*; *Glycine tabacina*; *Desmodium brachypodium*; *Chrysocephalum apiculatum*; *Eremophila debilis*; *Lomandra filiformis* subsp. *filiformis*; *Dichondra repens*; *Bothriochloa macra*; *Hydrocotyle laxiflora*; *Calotis lappulacea*; *Sida corrugata*; *Cyperus fulvus*; *Juncus subsecundus*; *Einadia polygonoides*; *Tribulus micrococcus*; *Euchiton sphaericus*; *Vittadinia cervicus*; *Swainsona sericea*; *Chloris ventricosa*; *Goodenia pinnatifida*; *Mentha satereioides*; *Boerhavia dominii*; *Sigesbeckia orientalis* subsp. *orientalis*; *Chamaesyce drummondii*; *Tragus australianus*; *Cymbopogon refractus*; *Digitaria divaricatissima*; *Salsola tragus* subsp. *tragus*; *Glycine clandestina*; *Rhynchosia minima*; *Glycine latifolia*; *Glycine tabacina*; *Convolvulus graminetinus*.

Vegetation Description: Tall woodland dominated by Yellow Box (*Eucalyptus melliodora*) sometimes with *Angophora floribunda* or *Brachychiton populneus*. Shrubs are absent or very sparse and include *Acacia implexa*, *Pimelea curviflora*, *Solanum cinereum*, *Acacia caesiella* or *Acacia decora*. The ground cover is often dense and dominated by grasses and forbs. Grass species include *Bothriochloa decipiens*, *Aristida personata*, *Austrostipa verticillata*, *Dichelachne micrantha*, *Aristida vagans*, *Poa sieberiana*, *Elymus scaber* var. *scaber*, *Austrostipa scabra* subsp. *scabra* and *Austrostipa aristiglumis*. The sedge *Cyperus fulvus* may occur. Forb species include *Einadia trigonos*, *Rumex brownii*, *Cymbonotus lawsonianus*, *Dichondra* sp. A, *Einadia nutans* subsp. *nutans*, *Oxalis perennans*, *Hydrocotyle laxiflora*, *Tribulus micrococcus*, *Euchiton sphaericus*, *Vittadinia cervicus*, *Calotis lappulacea* and *Sida corrugata*. The sedge *Carex inversa* and the climbers *Glycine clandestina*, *Rhynchosia minima*, *Glycine latifolia*, *Glycine tabacina* and *Convolvulus graminetinus* may be present. Occurs on clay loam to light clay soils on valley flats, plains and hillslopes mainly in the southern half of the NSW Brigalow Belt South Bioregion grading into the floristically similar Blakely's Red gum - Yellow Box woodland (ID599) on the Liverpool Plains or in the upper Hunter into Grey Box - White Box grassy woodland (ID483). Exotic weed species dominates many sites and represent over 30% of the species and ground cover present. Part of the grassy box woodland EEC.

Threat Category: Endangered.



This remnant Yellow Box patch is located on a ridge crest rather than a valley flat and may therefore be part of preceding community 483 rather than 437, as White Box does occur in small numbers nearby.

Clearing history can alter the tree composition at any one area, making it difficult to assign a vegetation community to particular sample sites.

This community is part of the Box-Gum Woodland EEC.

Common Name: Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSWWS and BBS Bioregions

Scientific Name: *Angophora floribunda* - *Eucalyptus blakelyi* - *Eucalyptus melliodora* / *Acacia implexa* - *Dodonaea viscosa* subsp. *angustifolia* - *Bursaria spinosa* subsp. *spinosa* - *Hibbertia obtusifolia* / *Austrostipa verticillata* - *Aristida ramosa* -

Calotis lappulacea - *Arundinella nepalensis*

Veg. Comm. ID.: 281

Characteristic Trees: *Angophora floribunda*; *Eucalyptus blakelyi*; *Eucalyptus melliodora*; *Callitris endlicheri*; *Callitris glaucophylla*; *Eucalyptus camaldulensis*; *Casuarina cunninghamiana* subsp. *cunninghamiana*; *Eucalyptus albens*; *Brachychiton populneus* subsp. *populneus*.

Shrubs/Vines/Epiphytes: *Acacia implexa*; *Dodonaea viscosa* subsp. *angustifolia*; *Bursaria spinosa* subsp. *spinosa*; *Hibbertia obtusifolia*; *Acacia penninervis* var. *penninervis*; *Acacia gladiiformis*; *Acacia uncinata*; *Acacia leiocalyx*; *Acacia decora*; *Olearia elliptica* subsp. *elliptica*; *Brachyloma daphnoides* subsp. *daphnoides*; *Acacia sertiformis*; *Persoonia cuspidifera*; *Beyeria viscosa*; *Cassinia quinquefaria*; *Notelaea microcarpa* var. *microcarpa*; *Melichrus urceolatus*; *Pimelea curviflora* var. *curviflora*; *Phyllanthus subcrenatus*; *Acacia deanei* subsp. *deanei*; *Geijera parviflora*; *Brachyloma daphnoides* subsp. *daphnoides*; *Ozothamnus diosmifolius*; *Acacia ulicifolia*; *Acacia leiocalyx*; *Macrozamia diplomera*; *Macrozamia heteromera*; *Persoonia cuspidifera*; *Grevillea floribunda*; *Exocarpos cupressiformis*; *Cassytha pubescens*; *Indigofera linnaei*; *Cassinia quinquefaria*.

Groundcover: *Austrostipa verticillata*; *Aristida ramosa*; *Calotis lappulacea*; *Arundinella nepalensis*; *Aristida calycina* var. *praealta*; *Lomandra longifolia*; *Lomandra confertifolia*; *Swainsona galegifolia*; *Haloragis heterophylla*; *Themeda australis*; *Einadia nutans*; *Juncus continuus*; *Juncus ochrocoleus*; *Juncus usitatus*; *Eragrostis brownii*; *Dianella revoluta* var. *revoluta*; *Ranunculus sessiliflorus* var. *sessiliflorus*; *Epaltes australis*; *Dichondra repens*; *Scutellaria humilis*; *Hydrocotyle laxiflora*; *Desmodium brachypodum*; *Desmodium varians*; *Austrodanthonia racemosa* var. *obtusata*; *Poa labillardierei* var. *labillardierei*; *Bothriochloa decipiens*; *Carex appressa*; *Carex inomitata*; *Oncinocalyx betchei*; *Wahlenbergia luteola*; *Wahlenbergia stricta*; *Senecio queenslandicus*; *Microlaena stipoides* var. *stipoides*; *Dichelachne micrantha*; *Dichopogon fimbriatus*; *Daucus glochidiatus* s.l.; *Cheilanthes sieberi* subsp. *sieberi*; *Urtica incisa*; *Plantago hispida*; *Geranium solanderi* var. *solanderi*; *Podolepis neglecta*; *Rubus parvifolius*; *Glycine clandestina*; *Clematis glycinoides* var. *glycinoides*; *Commelina cyanea*; *Echinopogon intermedius*; *Echinopogon caespitosus* var. *caespitosus*; *Elymus scaber* var. *scaber*; *Echinopogon ovatus*; *Aristida vagans*; *Einadia hastata*; *Oxalis perennans*; *Cymbonotus lawsonianus*; *Cynoglossum australe*; *Lomandra bracteata*; *Sigesbeckia australiensis*; *Galium migrans*; *Vittadinia dissecta* var. *dissecta*; *Calotis cuneifolia*; *Ajuga australis*; *Galium gaudichaudii*; *Aristida jerichoensis* var. *jerichoensis*; *Wahlenbergia graniticola*; *Vittadinia cuneata* var. *hirsuta*; *Vittadinia tenuissima*.

Vegetation Description: Tall open forest or woodland with trees up to 30 m high dominated by Rough-barked Apple (*Angophora floribunda*) usually with *Eucalyptus blakelyi* or *Eucalyptus melliodora*. Other tree species may include *Callitris glaucophylla*, *Brachychiton populneus* and various red gum intergrades. River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) may be present but often forms its own riparian community in nearby river banks. The shrub layer is sparse or absent in heavily grazed locations. Shrub species may include wattles such as *Acacia implexa*, *Acacia decora*, *Acacia penninervis* var. *penninervis* and *Acacia deanei*. Other shrub species may include *Dodonaea viscosa* subsp. *angustifolia*, *Bursaria spinosa*, *Olearia elliptica* subsp. *elliptica* and *Hibbertia obtusifolia*. The ground cover is usually dense to mid-dense. It includes grass species such as *Austrostipa verticillata*, *Austrostipa scabra*, *Arundinella nepalensis*, *Digitaria breviglumis*, *Echinopogon* spp., *Dichelachne micrantha*, *Poa labillardierei* var. *labillardierei* and *Themeda australis*. The mat-rush *Lomandra longifolia* may be common. Rush (*Juncus* spp.) occur along creeks and in depressions along with sedges such as *Carex inomitata*. Forb species include *Swainsona galegifolia*, *Haloragis heterophylla*, *Dianella revoluta* var. *revoluta*, *Ranunculus sessiliflorus* var. *sessiliflorus*, *Dichondra repens*, *Epaltes australis*, *Haloragis heterophylla*, *Epaltes australis*, *Calotis cuneifolia*, *Ajuga australis*, *Dichondra repens*, *Scutellaria humilis* and *Hydrocotyle laxiflora*. Scramblers include *Desmodium brachypodum*, *Desmodium repens* and *Glycine clandestina*. A widespread community that occurs on black, brown and grey alluvial and colluvial clay loam, loam or sandy loam soils derived from a range of substrates on valley flats and footslopes in valleys in hill landform patterns mainly in the Brigalow Belt South Bioregion. Some areas also occur north of Mudgee in the Gulgong-Dunedoo area in the NSW South-western Slopes Bioregion. Most of its original extent has been cleared and weeds have invaded many remnants but some stands remain.

Threat Category: Vulnerable.



This image is of the closely related vegetation community 481, which includes the same dominant trees as community 281 but occurs on sandstone. Very little of this community fell within the development envelope on the wind farm site because it occurs mainly on valley flats.

It is part of the Box-Gum Woodland EEC.

Common Name: River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South and Nandewar Bioregions

Scientific Name: *Casuarina cunninghamiana* subsp. *cunninghamiana* - *Angophora floribunda* - *Eucalyptus blakelyi* - *Eucalyptus melliodora* / *Acacia implexa* - *Bursaria spinosa* subsp. *spinosa* - *Notelaea microcarpa* var. *microcarpa* - *Callistemon*

sieberi / *Microlaena stipoides* var. *stipoides* - *Austrostipa verticillata* - *Lomandra longifolia* - *Commelina cyanea*

Veg. Comm. ID.: 84

Characteristic Trees: *Casuarina cunninghamiana* subsp. *cunninghamiana*; *Angophora floribunda*; *Eucalyptus blakelyi*; *Eucalyptus camaldulensis* subsp. *camaldulensis*; *Eucalyptus melliodora*; *Eucalyptus albens*; *Brachychiton populneus* subsp. *populneus*; *Callistemon viminalis*; *Ficus rubiginosa*; *Melia azedarach*; *Melaleuca bracteata*; *Eucalyptus laevopinea*; *Eucalyptus bridgesiana*.

Shrubs/Vines/Epiphytes: *Acacia implexa*; *Bursaria spinosa* subsp. *spinosa*; *Notelaea microcarpa* var. *microcarpa*; *Callistemon sieberi*; *Phyllanthus subcrenatus*; *Cassinia laevis*; *Glochidion ferdinandi* var. *ferdinandi*; *Psdrax odorata*; *Acacia salicina*; *Olearia viscidula*; *Pimelea neo-anglica*; *Acacia neriifolia*; *Acacia viscidula*; *Leptospermum brachyandrum*; *Leptospermum brevipes*; *Leptospermum polygalifolium* s.l.; *Pittosporum undulatum*; *Melicytus dentatus*; *Rubus parvifolius*; *Alectryon forsythii*; *Celastrus subspicata*; *Nyssanthus diffusa*; *Stephania japonica* var. *japonica*; *Pandorea pandorana* subsp. *pandorana*; *Clematis glycinoides* var. *glycinoides*; *Eustrephus latifolius*; *Parsonsia straminea*; *Pittosporum angustifolium*.

Groundcover: *Microlaena stipoides* var. *stipoides*; *Austrostipa verticillata*; *Lomandra longifolia*; *Commelina cyanea*; *Urtica incisa*; *Cynodon dactylon*; *Chloris virgata*; *Bothriochloa macra*; *Oplismenus imbecillis*; *Cynodon dactylon*; *Lachnagrostis filiformis*; *Arundinella nepalensis*; *Elymus scaber* var. *scaber*; *Poa sieberiana*; *Paspalidium jubiflorum*; *Austrostipa aristiglumis*; *Epilobium billardierianum* subsp. *hydrophilum*; *Alternanthera denticulata*; *Persicaria maculosa*; *Ranunculus lappaceus*; *Gahnia aspera*; *Hydrocotyle laxiflora*; *Senecio quadridentatus*; *Aristida ramosa*; *Echinopogon ovatus*; *Imperata cylindrica* var. *major*; *Austrodanthonia racemosa* var. *racemosa*; *Swainsona queenslandica*; *Swainsona cadellii*; *Eleocharis acuta*; *Carex incomitata*; *Carex appressa*; *Carex breviculmis*; *Cyperus vaginatus*; *Lepidosperma laterale*; *Geranium solanderi* var. *solanderi*; *Dichondra repens*; *Viola betonicifolia*; *Glycine tabacina*; *Wahlenbergia communis*; *Scutellaria humilis*; *Rumex brownii*; *Desmodium brachypodum*; *Adiantum aethiopicum*; *Adiantum formosum*; *Pellaea nana*; *Doodia aspera*; *Cheilanthes sieberi* subsp. *sieberi*; *Aristida personata*.

Vegetation Description: Tall woodland or open forest to 30 m high dominated by River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) often with Rough-barked Apple (*Angophora floribunda*), River Red Gum (*Eucalyptus camaldulensis*), Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*Eucalyptus blakelyi*) and occasionally White Box (*Eucalyptus albens*). A sparse shrub layer may occur including Hickory Wattle (*Acacia implexa*), various tea-tree species (*Leptospermum* spp.), hopbush species (*Dodonaea* spp.), *Phyllanthus subcrenatus*, *Blackthorn* (*Bursaria spinosa*), bottlebrushes (*Callistemon* spp.), *Olearia viscidula* and the vines such as *Pandorea pandorana*, *Clematis glycinoides*, *Parsonsia straminea* and *Stephania japonica*. In some places a "dry rainforest" lower tree/high shrub layer may occur that includes Red Ash (*Alphitonia excelsa*), *Alectryon* spp., Rusty Fig (*Ficus rubiginosa*) and Mock Olive (*Notelaea microcarpa*). The ground cover can be dense or sparse and contains a rich flora of small shrubs, grasses, sedges and forbs. Grasses include *Microlaena stipoides* var. *stipoides*, *Cynodon dactylon*, *Chloris virgata*, *Oplismenus imbecillis*, *Austrostipa verticillata*, *Lachnagrostis filiformis*, *Arundinella nepalensis*, *Elymus scaber* var. *scaber* and *Poa sieberiana*. The graminoid *Lomandra longifolia* is common in some locations. Sedges include *Carex appressa*, *Carex incomitata* and *Cyperus vaginatus*. Ferns include *Cheilanthes sieberi*, *Adiantum aethiopicum*, *Doodia aspera* and *Pellaea nana*. Forbs include *Urtica incisa*, *Dichondra repens*, *Ranunculus lappaceus*, *Einadia hastata* and *Scutellaria humilis*. Weeds may be common in some places. They include Willow (*Salix babylonica*), Tree of Heaven (*Ailanthus altissima*) and forbs such as *Conyza bonariensis*, *Sonchus oleraceus*, *Bidens pilosa*, *Fumaria capreolata*, *Modiola caroliniana* and *Hypochaeris radicata*. Occurs on clay sand or sandy loam soils on riverine deposits on stream-banks and terrace flats of major rivers and creeks in low hills and hills landforms of Nandewar and Brigalow Belt South Bioregions. This community grades into ID78 River Red Gum along sections of the rivers. Varies in floristic composition with altitude and substrate with different species occurring on rocky substrates compared to deeper alluviums. The surrounding country is often cleared to the edge of streams. This community has also been substantially cleared in some regions and it is subject to weed invasion by Willow (*Salix*) and exotic forbs and grasses. While sampled in a number of reserves, overall, it requires riparian management of stock grazing and stock trampling. In some locations control of weeds is the primary requirement.

Threat Category: Near Threatened.



Very little of this community falls within the development envelope on the wind farm site because it occurs on valley flats along the larger creeks and rivers. It occasionally intercepts transmission line corridors or roads.

It tends to be highly degraded by grazing, partial clearing and weed invasion. Few large old trees were seen, suggesting that most stands in the district are regrowth.

Common Name: Derived speargrass - wallaby grass - wire grass mixed forb grassland mainly in the Coonabarabran - Pilliga - Coolah region

Scientific Name: *Acacia deanei* subsp. *deanei* - *Acacia salicina* - *Senna aciphylla* - *Dodonaea viscosa* subsp. *angustifolia* / *Austrostipa scabra* subsp. *falcata* - *Austrostipa verticillata* - *Dichanthium sericeum* subsp. *sericeum* - *Panicum queenslandicum* var. *queenslandicum* / *Calotis lappulacea* - *Sida corrugata* - *Wahlenbergia stricta* subsp. *stricta* - *Vittadinia cuneata*

Veg. Comm. ID.: 395

Characteristic Trees: Generally cleared but tree species may have included: *Callitris glaucophylla*; *Atalaya hemiglauca*; *Alstonia constricta*; *Geijera parviflora*; *Alectryon oleifolius* subsp. *canescens*; *Eucalyptus albens*; *Eucalyptus crebra*; *Eucalyptus melliodora*.

Shrubs/Vines/Epiphytes: *Acacia deanei* subsp. *deanei*; *Acacia decora*; *Senna aciphylla*; *Dodonaea viscosa* subsp. *angustifolia*; *Acacia salicina*; *Notelaea microcarpa* var. *microcarpa*.

Groundcover: *Austrostipa scabra* subsp. *falcata*; *Austrostipa verticillata*; *Dichanthium sericeum* subsp. *sericeum*; *Calotis lappulacea*; *Vittadinia dissecta*; *Austroanthonia bipartita*; *Austroanthonia caespitosa*; *Bothriochloa decipiens*; *Themeda australis*; *Enteropogon acicularis*; *Aristida vagans*; *Boerhavia dominii*; *Oxalis perennans*; *Dichondra* sp. A sensu Harden (1992); *Cyperus gracilis*; *Wahlenbergia stricta* subsp. *stricta*; *Einadia hastata*; *Xerochrysum bracteata*; *Sida corrugata*; *Cheilanthes sieberi* subsp. *sieberi*; *Rumex brownii*; *Podolepis neglecta*; *Carex inversa*; *Cymbopogon refractus*; *Panicum queenslandicum* var. *queenslandicum*; *Austroanthonia racemosa* var. *obtusata*; *Aristida caput-medusae*; *Chloris truncata*; *Sporobolus elongatus*; *Chloris ventricosa*; *Bothriochloa macra*; *Eragrostis elongata*; *Vittadinia cuneata*; *Vittadinia muelleri*; *Swainsona galegifolia*; *Cymbonotus lawsonianus*; *Solanum ferocissimum*; *Hydrocotyle laxiflora*; *Cynoglossum australe*; *Acaena novae-zelandiae*; *Geranium solanderi* var. *solanderi*; *Geranium retrorsum*.

Vegetation Description: Mid-high to tall grassland or open grassland derived from the clearing of grassy woodlands. Original tree species may have included *Callitris glaucophylla*, *Atalaya hemiglauca*, *Alstonia constricta*, *Geijera parviflora*, *Alectryon oleifolius* subsp. *canescens* or *Eucalyptus albens*. Re-generating shrub species include *Notelaea microcarpa* var. *microcarpa*, *Dodonaea viscosa* subsp. *angustifolia*, *Acacia salicina*, *Acacia deanei* subsp. *deanei*, *Acacia decora* and *Senna aciphylla*. The ground cover is dense to mid-dense or sparse in dry times. It is dominated by a range of grass and forb species including a high number of exotic species. Native grasses include *Austrostipa scabra*, *Austrostipa verticillata*, *Dichanthium sericeum* subsp. *sericeum*, *Austroanthonia racemosa*, *Austroanthonia bipartita*, *Austroanthonia caespitosa*, *Aristida caput-medusae*, *Chloris truncata*, *Sporobolus elongatus*, *Bothriochloa decipiens*, *Themeda australis*, *Enteropogon acicularis* and *Aristida vagans*. Native forb species include *Calotis lappulacea*, *Vittadinia dissecta*, *Wahlenbergia stricta* subsp. *stricta*, *Einadia hastata*, *Xerochrysum bracteata*, *Sida corrugata*, *Cheilanthes sieberi* subsp. *sieberi*, *Rumex brownii*, *Podolepis neglecta*, *Carex inversa*, *Cymbopogon refractus*, *Panicum queenslandicum* var. *queenslandicum*, *Austroanthonia racemosa* var. *obtusata*, *Vittadinia cuneata*, *Vittadinia muelleri*, *Cymbonotus lawsonianus*, *Hydrocotyle laxiflora* and *Cynoglossum australe*. Occurs on a range of soils including clay to sandy loams on a range of landscapes including hills, low hills, rises and outwash plains across a large geographical area from the Pilliga Scrub and Warrumbungle Range region in the north to Coolah in the south where woodland has been cleared for grazing. While being a derived vegetation type, this community may contain threatened species and form a native ground cover matrix between bushland areas.

Threat Category: Least Concern.



Native pasture is most common in the southern part of the windfarm site, and is often dominated by Plains Grass (*Austrostipa aristiglumis*) or by Corkscrew Grass (*Austrostipa scabra* subsp. *falcata*) in rocky or overgrazed areas with shallow soils. On ridge tops it generally has a low level of native non-grass groundcover species diversity but the lower slopes may be in better condition, as on this site near the Cassilis Road.

Benson *et al.* regard this community as being of “least concern” as it is very extensive in the region. However, if in good condition and contiguous with stands of Box-Gum Woodland EEC, it could be regarded as part of that EEC.

Common Name: Bottlebrush riparian shrubland wetland of the NSW northern NSW South-western Slopes and southern BBS Bioregions

Scientific Name: *Callistemon sieberi* / *Carex appressa* - *Microlaena stipoides* var. *stipoides* - *Cynodon dactylon* - *Dichondra repens*

Veg. Comm. ID.: 333

Characteristic Trees: *Eucalyptus blakelyi*; *Eucalyptus albens*; *Brachychiton populneus* subsp. *populneus*; *Angophora floribunda*; *Eucalyptus camaldulensis* subsp. *camaldulensis*; *Eucalyptus polyanthemos* subsp. *polyanthemos*.

Shrubs/Vines/Epiphytes: *Callistemon sieberi*; *Acacia leucoclada* subsp. *leucoclada*; *Acacia implexa*; *Leptospermum continentale*.

Groundcover: *Carex appressa*; *Microlaena stipoides* var. *stipoides*; *Cynodon dactylon*; *Dichondra repens*; *Asplenium aethiopicum*; *Cheilanthes austrotenuifolia*; *Geranium solanderi* var. *solanderi*; *Acaena ovina*; *Paspalidium distans*; *Sporobolus creber*; *Austrodanthonia racemosa* var. *racemosa*; *Daucus glochidiatus* sens lat.; *Viola hederacea*; *Scutellaria humilis*; *Alternanthera denticulata*; *Urtica incisa*; *Rumex brownii*; *Euchiton involucratus*; *Boerhavia dominii*; *Lmandra filiformis* subsp. *coriacea*; *Lomandra longifolia*; *Poa labillardierei* var. *labillardierei*; *Juncus subglaucus*; *Eleocharis sphacelata*; *Persicaria prostrata*; *Enteropogon acicularis*; *Juncus usitatus*; *Juncus homalocaulis*; *Carex incomitata*; *Chloris truncata*.

Vegetation Description: Tall shrubland or open shrubland dominated by the bottlebrush *Callistemon sieberi* that often forms dense stands along creeks sometimes with *Acacia leucoclada*, *Acacia implexa* or species of *Leptospermum*. The ground cover may be dense on creek banks but is largely composed of gravel or rock in the creek bed. Ground cover includes the sedge *Carex appressa*, and grasses such as *Microlaena stipoides* var. *stipoides*, *Poa labillardierei*, *Paspalidium distans*, *Sporobolus creber*, *Cynodon dactylon* and *Austrodanthonia racemosa* var. *racemosa*. Rush species include *Juncus usitatus* and *Juncus homalocaulis*. Forb species include *Geranium solanderi* var. *solanderi*, *Acaena ovina*, *Dichondra repens*, *Urtica incisa*, *Dichondra repens*, *Urtica incisa*, *Persicaria prostrata*, *Daucus glochidiatus* sens lat., *Viola hederacea*, *Scutellaria humilis*, *Alternanthera denticulata*, *Rumex brownii*, *Euchiton involucratus* and *Boerhavia dominii*. The graminoid *Lomandra longifolia* may be common along with rush species such as *Juncus subglaucus*. The ferns *Asplenium aethiopicum* and *Cheilanthes austrotenuifolia* may be present. Weed species dominate the ground cover of disturbed sites. Woodland trees may overlean the creeks and include tree species such as Rough-barked Apple (*Angophora floribunda*), Red Box (*Eucalyptus polyanthemos* subsp. *polyanthemos*), Blakely's Red Gum (*Eucalyptus blakelyi*), River Red Gum (*Eucalyptus camaldulensis*), White Box (*Eucalyptus albens*), Red Stringybark (*Eucalyptus macrorhyncha*), Long-leaved Box (*Eucalyptus goniocalyx*) and Kurrajong (*Brachychiton populneus* subsp. *populneus*). Weed species dominate some areas. Occurs on alluvial sands, loams, clays, gravels overlaying various rock types on creek banks and on stream bars in the riparian zone of creeks in hill landscapes in the upper slopes sub-region in the central and northern parts of the NSW South-western Slopes Bioregion, southern Brigalow Belt South bioregion and on the adjoining tablelands. This community has some similarities with the riparian tea-tree shrubland in the southern section of the NSW South-western Slopes Bioregion (ID302). As of 2008 there was limited information on this community but it appears to be threatened because it mainly occurs on private land that has been substantially cleared or is infested with weeds.

Threat Category: Vulnerable.



Bottlebrush riparian shrubland occurs in the upper parts of catchments at high altitude in the northern part of the wind farm site. It tends to be embedded within mixed native/exotic pasture consisting of large tussocks of the native *Poa labillardierei*, “improved” by over-sowing of clover and ryegrass, as seen in the image at left. The trees at this location are Brittle Gum, *E. praecox*.

Callistemon sieberi also occurs as an understorey in community 084, River Oak riparian woodland.

B.4 FAUNA

Species name	Common name	Trans Line/Offsite
Amphibians		
<i>Crinia signifera</i>	Common Eastern Froglet	x
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog	x
<i>Limnodynastes dumerillii</i>	Southern Banjo Frog	x
<i>Litoria peronii</i>	Peron's Tree Frog	x
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	x
<i>Litoria latopalmata</i>	Broad-palmed Frog	x
<i>Litoria wilcoxii</i>	Stoney Creek Frog	x
<i>Platyplectrum</i> (=Opisthodon=Limnodynastes) <i>ornatus</i>	Ornate Burrowing Frog	x
<i>Uperoleia laevigata</i>	Smooth Toadlet	x
Reptiles		
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle	x
<i>Amalosia</i> (=Oedura) <i>lesueurii</i>	Lesueur's Velvet Gecko	x
<i>Diplodactylus vittatus</i>	Wood Gecko	x
<i>Underwoodisaurus milii</i>	Barking Gecko	x
<i>Pogona barbata</i>	Bearded Dragon	x
<i>Varanus gouldii</i>	Gould's Goanna	x
<i>Varanus varius</i>	Lace Monitor	x
<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard	Offsite
<i>Morethia boulengeri</i>	South-eastern Morethia Skink	x
<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink	x
<i>Anomalopus leuckartii</i>	Two-clawed Worm-skink	x
<i>Acritoscincus platynotum</i>	Red-throated skink	x
<i>Ctenotus taeniolatus</i>	Copper-tailed Skink	x
<i>Liopholis</i> (=Egernia) <i>whitii</i>	White's Skink	x
<i>Hemiergis talbingoensis</i> (=decreasiensis)	Three-toed Earless Skink	x
<i>Lerista bougainvillii</i>	Bougainville's Skink	x
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	x
Mammals		
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	x
<i>Sminthopsis murina</i>	Common Dunnart	x
<i>Vombatus ursinus</i>	Common Wombat	x
<i>Petaurus breviceps</i>	Sugar Glider	x
<i>Petaurus norfolcensis</i>	Squirrel Glider	x
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	x
<i>Acrobates pygmaeus</i>	Feathertail Glider	x
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	x
<i>Macropus giganteus giganteus</i>	Eastern Grey Kangaroo	x
<i>Macropus robustus</i>	Common Wallaroo	x
<i>Macropus rufogriseus</i>	Red-necked Wallaby	x
<i>Wallabia bicolor</i>	Swamp Wallaby	x
* <i>Vulpes vulpes</i>	Fox	x
* <i>Canis familiaris</i>	Dog	x
* <i>Felis catus</i>	Cat	x

Species name	Common name	Trans Line/Offsite
<i>*Oryctolagus cuniculus</i>	Rabbit	x
<i>*Lepus capensis</i>	Brown Hare	x
<i>*Sus scrofa</i>	Pig	x
<i>*Bos taurus</i>	European Cattle	x
<i>*Capra hircus</i>	Goat	x
<i>*Dama dama</i>	Fallow Deer	x
<i>Rhinolophus megaphyllus</i>	Eastern horseshoe-bat	x
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	x
<i>Mormopterus</i> sp. 4	Unnamed Freetail-bat	x
<i>Mormopterus ridei</i>	Little Northern Freetail-bat	x
<i>Miniopterus schreibersii</i>	Common Bentwing-bat	x
<i>Nyctophilus corbeni</i>	Northern Long-eared Bat	x
<i>Nyctophilus</i> sp.	Unidentified long-eared bat	x
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	x
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	x
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	x
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	x
<i>Tadarida (=Nyctinomus=Auromomus) australis</i>	White-striped Freetail-bat	x
<i>Vespadelus darlingtoni</i>	Large Forest Bat	x
<i>Vespadelus regulus</i>	Southern Forest Bat	x
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	x
<i>Vespadelus vulturinus</i>	Little Forest Bat	x
Birds		
<i>Dromaius novaehollandiae</i>	Emu	x
<i>Chenonetta jubata</i>	Australian Wood Duck	x
<i>Cygnus atratus</i>	Black Swan	x
<i>Anas superciliosa</i>	Pacific Black Duck	x
<i>Aythya australis</i>	Hardhead	x
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	x
<i>Pelecanus conspicillatus</i>	Australian Pelican	Offsite*
<i>Egretta novaehollandiae</i>	White-faced Heron	x
<i>Ardea pacifica</i>	White-necked Heron	Offsite
<i>Ardea alba</i>	Great Egret	x
<i>Threskiornis spinicollis</i>	Straw-necked Ibis	x
<i>Elanus axillaris</i>	Black-shouldered Kite	x
<i>Milvus migrans</i>	Black kite	Offsite
<i>Lophoictinia isura</i>	Square-tailed Kite	x
<i>Haliastur sphenurus</i>	Whistling Kite	x
<i>Aquila audax</i>	Wedge-tailed Eagle	x
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	Offsite *
<i>Falco longipennis</i>	Australian Hobby	x
<i>Fulica atra</i>	Eurasian Coot	Offsite *
<i>Porphyrio porphyrio</i>	Purple Swamphen	Offsite *
<i>Falco cenchroides</i>	Nankeen Kestrel	x
<i>Vanellus miles</i>	Masked Lapwing	x
<i>Elsyaornis melanops</i>	Black-fronted Dotterel	Offsite *
<i>Vanellus tricolor</i>	Banded Lapwing	x

Species name	Common name	Trans Line/Offsite
<i>Columba livia</i>	Rock Dove	Offsite
<i>Phaps chalcoptera</i>	Common Bronzewing	x
<i>Geopelia placida</i>	Peaceful Dove	x
<i>Ocyphaps lophotes</i>	Crested Pigeon	x
<i>Calyptrorhynchus lathamii</i>	Glossy Black-cockatoo	x
<i>Eolophus roseicapillus</i>	Galah	x
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	x
<i>Glossopsitta concinna</i>	Musk Lorikeet	x
<i>Glossopsitta pusilla</i>	Little Lorikeet	Offsite
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	x
<i>Alisterus scapularis</i>	Australian King-Parrot	x
<i>Aprosmictus erythropterus</i>	Red-winged Parrot	x
<i>Platycercus elegans</i>	Crimson Rosella	x
<i>Platycercus eximius</i>	Eastern Rosella	x
<i>Psephotus haemattonotus</i>	Red-rumped Parrot	x
<i>Cacomantis variolosus</i>	Brush Cuckoo	x
<i>Cuculus pallidus</i>	Pallid Cuckoo	x
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	x
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo	x
<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo	x
<i>Ninox boobook</i>	Southern Boobook	x
<i>Ninox strenua</i>	Powerful Owl	x
<i>Tyto alba</i>	Barn Owl	x
<i>Podargus strigoides</i>	Tawny Frogmouth	x
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	x
<i>Eurostopodus mystacalis</i>	White-throated Nightjar	x
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	x
<i>Todiramphus sanctus</i>	Sacred Kingfisher	x
<i>Merops ornatus</i>	Rainbow Bee-eater	x
<i>Eurystomus orientalis</i>	Dollarbird	x
<i>Cormobates leucophaeus</i>	White-throated Treecreeper	x
<i>Climacteris picumnus</i>	Brown Treecreeper	x
<i>Malurus lamberti</i>	Variegated Fairy-wren	x
<i>Malurus cyaneus</i>	Superb Fairy-wren	x
<i>Pardalotus punctatus</i>	Spotted Pardalote	x
<i>Pardalotus striatus</i>	Striated Pardalote	x
<i>Origma solitaria</i>	Rockwarbler	x
<i>Sericornis frontalis</i>	White-browed Scrubwren	x
<i>Smicrornis brevirostris</i>	Weebill	x
<i>Chthonicola sagittata</i>	Speckled Warbler	x
<i>Gerygone olivacea</i>	White-throated Gerygone	x
<i>Acanthiza pusilla</i>	Brown Thornbill	x
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	x
<i>Acanthiza nana</i>	Yellow Thornbill	x
<i>Acanthiza lineata</i>	Striated Thornbill	x
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	x
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	x

Species name	Common name	Trans Line/Offsite
<i>Anthochaera carunculata</i>	Red Wattlebird	x
<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	x
<i>Philemon citreogularis</i>	Little Friarbird	x
<i>Philemon corniculatus</i>	Noisy Friarbird	x
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	x
<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	x
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	x
<i>Manorina melanocephala</i>	Noisy Miner	x
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	x
<i>Lichenostomus leucotis</i>	White-eared Honeyeater	x
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	x
Melithreptus gularis	Black-chinned Honeyeater	x
<i>Melithreptus lunatus</i>	White-naped Honeyeater	x
Grantiella picta	Painted Honeyeater	x
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	x
<i>Microeca fascians</i>	Jacky Winter	x
<i>Petroica goodenovii</i>	Red-capped Robin	x
<i>Eopsaltria australis</i>	Eastern Yellow Robin	x
Pomatostomus temporalis	Grey-crowned Babbler	x
<i>Pomatostomus superciliosus</i>	White-browed Babbler	x
<i>Cinclosoma punctatum</i>	Spotted Quail-thrush	x
Daphoenositta chrysoptera	Varied Sittella	x
<i>Pachycephala pectoralis</i>	Golden Whistler	x
<i>Pachycephala rufiventris</i>	Rufous Whistler	x
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	x
<i>Myiagra rubecula</i>	Leaden Flycatcher	x
<i>Myiagra inquieta</i>	Restless Flycatcher	x
<i>Grallina cyanoleuca</i>	Magpie-lark	x
<i>Rhipidura fuliginosa</i>	Grey Fantail	x
<i>Rhipidura leucophrys</i>	Willie Wagtail	x
<i>Lalage sueurii</i>	White-winged triller	x
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	x
<i>Coracina tenuirostris</i>	Cicadabird	x
<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike	x
<i>Oriolus sagittatus</i>	Olive-backed Oriole	x
<i>Cracticus torquatus</i>	Grey Butcherbird	x
<i>Cracticus nigrogularis</i>	Pied Butcherbird	x
<i>Gymnorhina tibicen</i>	Australian Magpie	x
<i>Strepera graculina</i>	Pied Currawong	x
<i>Artamus personatus</i>	Masked Woodswallow	x
<i>Artamus superciliosus</i>	White-browed Woodswallow	x
<i>Artamus cyanopterus</i>	Dusky Woodswallow	x
<i>Corvus coronoides</i>	Australian Raven	x
<i>Corvus mellori</i>	Little Raven	x
<i>Corcorax melanorhamphos</i>	White-winged Chough	x
Stagonopleura guttata	Diamond Firetail	x
<i>Neochmia temporalis</i>	Red-browed Finch	x

Species name	Common name	Trans Line/Offsite
<i>Taeniopygia bichenovii</i>	Double-barred Finch	x
<i>Dicaeum hirundinaceum</i>	Mistletoebird	x
<i>Hirundo neoxena</i>	Welcome Swallow	x
<i>Hirundo ariel</i>	Fairy Martin	x
<i>Hirundo nigricans</i>	Tree Martin	x
<i>Acrocephalus australis</i>	Australian Reed-Warbler	Offsite *
<i>Cincloramphus mathewsi</i>	Rufous Songlark	x
<i>Megalurus gramineus</i>	Little Grassbird	x
<i>Zosterops lateralis</i>	Silvereye	x
<i>Sturnus vulgaris</i>	Common Starling	x

B.5 SITE PHOTOS

WIND FARM (Representative habitat types)



Typical open woodland patch on ridgetop



Typical open grassland on ridgetop



Typical ridgeline proposed for location of turbines



Typical riparian habitat with fringing woodland



Typical area of fallen logs and leaf litter



Typical grassland with scattered surface rocks

B.6 FLORA PLOT AND INSPECTION POINT DATA – WINDFARM STUDY AREA

DATA			LOCATION				VEGETATION COMMUNITY & CONDITION				STATUS		
Survey	Date	Personnel/ Team	GPS location	Easting	Northing	Elevation	Flora Survey ID (plots only)	Veg community type	Condition	Benson ID	NSW EEC?	EPBC CEEC?	Threatened species
Flora plot	11/10/12	JM	AA1	780476	6484776	1002	AA1FL	Improved pasture and scattered eucs	Poor	488	No	No	
Flora plot	11/10/12	JM	AA2	780250	6484804	1004	AA2FL	Mixed native/exotic pasture & scattered trees on rocky rises, more natives in rocks etc.	Moderate	488	No	No	
Flora plot	11/10/12	JM	AA4	779262	6484260	943	AA4FL	see Benson ID	Good	488	No	No	
Flora plot	11/10/12	JM	AA5	778549	6484028	942	AA5FL	Benson laevo / angoph / nortonii are = 488	Good	488	No	No	
Flora plot	11/10/12	JM	AA6	777880	6483818	927	AA6FL	native pasture, scattered trees	Moderate	488	No	No	
Flora plot	11/10/12	JM	AA9	775759	6483123	915	AA9FL	Not BGW EEC	Poor	488	No	No	
Flora plot	11/10/12	KS	BW1	771535	6467828	702	BW1FL	Yellow box open woodland-woodland	Poor	281	Yes	No	
Flora plot	11/10/12	KS	BW2	771739	6468045	703	BW2FL	E. melliodora open woodland	Poor	281	Yes	No	
Flora plot	11/10/12	KS	BW5	775005	6468593	648	BW3FL	White box open grassy woodland	Poor	483	Yes	No	
Flora plot	11/10/12	KS	BW6	774923	6468183	667	BW4FL	Native & exotic grassland	Poor	395	Yes?	No	
Flora plot	11/10/12	KS	BW9	779422	6470394	567	BW5FL	River she-oak riparian woodland - open woodland	Poor-mod	84	No	No	
Flora plot	12/10/12	JM	AA10	781037	6488193	993	AA10FL	Riparian scrub strips within poa lab etc.	Good	446	No	No	
Flora plot	12/10/12	JM	AA11	781619	6487946	1013	AA11FL	Benson 488 / 490 intergrade	Poor	488 / 490	No	No	
Flora plot	12/10/12	JM	AA12	781585	6487406	1020	AA12FL	Improved pasture and scattered trees, derived from 488	Poor	derived from 488	No	No	
Flora plot	12/10/12	JM	AA15	775560	6483162	890	AA15FL	Presence of angophra suggests this is still type 488, despite local dominance of E. melliodora at this location	Poor (where treed); exotic (ground cover almost totally exotic on hill crest etc)	488	No	No	
Flora plot	12/10/12	KS	BW10	779361	6473655	610	BW6FL	E. blakelyi/A. floribunda/E. laevopinia woodland	Moderate	281	yes	no	
Flora plot	12/10/12	KS	BW15	779752	6467397	676	BW7FL	White box open woodland	Poor	483	yes	no	
Flora plot	12/10/12	KS	BW17	780766	6467681	748	BW8FL	Exotic/native grassland	Poor	395	yes	No	
Flora plot	13/10/12	JM	AA16	777655	6457192	594	AA16FL	BGW	Poor to moderate	483	Yes	No	
Flora plot	13/10/12	JM	AA17	777627	6457073		AA17FL	BGW	Good	483	Yes	Yes	
Flora plot	13/10/12	JM	AA18	777449	6461957	624	AA18FL	BGW EEC	Moderate	483	Yes	No	
Flora plot	13/10/12	JM	AA19	777747	6461763	645	AA19FL	BGW EEC	Poor	483	Yes	No	
Flora plot	13/10/12	JM	AA21	776877	6462207	621	AA21FL	BGW EEC	Mod-good	483	Yes	No	
Flora plot	13/10/12	JM	AA22	780188	6466902		AA22FL	BGW	Moderate	483	Yes	No	
Flora plot	13/10/12	JM	AA23	780562	6467511	750	AA23FL	Overgrazed pasture	Exotic	Exotic	No	No	
Flora plot	13/10/12	JM	AA25	782336	6459878	562	AA25FL	BGW EEC	Moderate	483	Yes	No	
Flora plot	13/10/12	JM	AA26	782282	6460156	585	AA26FL	BGW EEC	Poor	483	Yes	No	
Flora plot	15/10/12	JM	AA27	781605	6484974	1014	AA27FL	tall wet forest	moderate to Good	490	No	No	
Flora plot	15/10/12	JM	AA29	779583	6488040	1065	AA29FL	mixed pasture, scattered trees derived from bensons 490	mod	490	No	No	
Flora plot	15/10/12	JM	AA31	778980	6488460	1082	AA31FL	bensons 490	Good	490	No	No	
Flora plot	15/10/12	JM	AA32	779220	6488951	1050	AA32FL	E. praecox-laevopinea	Good	495 w 488	No	No	
Flora plot	15/10/12	JM	AA38	776681	6486896	917	AA38FL	E. nortonii - open woodland	Poor	488	No	No	
Flora plot	16/10/12	JM	AA39	777407	6485736	996	AA39FL	E nortonii	poor	488	No	No	
Flora plot	16/10/12	JM	AA43	778361	6486378	1070	AA43FL	E nortonii	Poor	488	No	No	
Flora plot	16/10/12	JM	AA46	779651	6487212	1078	AA46FL	pracox leveopinea	Poor	495	No	No	
Flora plot	16/10/12	JM	AA48	775216	6488278	870	AA48FL	E nortonii	exotic if treeless-poor where there are trees	488	no	no	
Flora plot	16/10/12	JM	AA49	775946	6488298	835	AA49FL	E nortonii	poor	488	no	no	
Flora plot	16/10/12	JM	AA51	776516	6488021	915	AA51FL	E nortonii	Moderate	488	no	no	
Flora plot	16/10/12	JM	AA54	777843	6488666	1007	AA54FL	E nortonii	Good	488	no	no	
Flora plot	16/10/12	BVTD	BW21	774659	6474155	816	BW9FL	Yellow box/White box woodland	Poor	483	Yes	No	

DATA			LOCATION				VEGETATION COMMUNITY & CONDITION				STATUS		
Survey	Date	Personnel/ Team	GPS location	Easting	Northing	Elevation	Flora Survey ID (plots only)	Veg community type	Condition	Benson ID	NSW EEC?	EPBC CEEC?	Threatened species
Flora plot	16/10/12	BVTD	BW23	774287	6473259	807	BW10FL	Yellow box/White box woodland	Moderate	483	Yes	No	
Flora plot	16/10/12	BVTD	BW25	773361	6471708	782	BW11FL	Box gum open grassy woodland	Poor	483?	Yes	No	
Flora plot	16/10/12	BVTD	BW26	772790	6470421	773	BW12FL	A. floribunda/E. melliodora open grassy woodland	Exotic-poor	281	Yes	No	
Flora plot	16/10/12	BVTD	BW28	775459	6474000	652	BW13FL	River she oak/Callistemon open forest	Poor	84	No	No	
Flora plot	16/10/12	BVTD	BW29	776065	6472768	763	BW14FL	Yellow box woodland	poor-mod	437	Yes	No	
Flora plot	16/10/12	BVTD	BW31	776167	6473560	784	BW15FL	Yellow box open woodland	Poor	437	yes	No	
Flora plot	16/10/12	BVTD	BW32	776598	6474451	822	BW16FL	Yellow box - A. floribunda woodland	Poor-mod	281	yes	No	
Flora plot	16/10/12	BVTD	CW1	782113	6478998	742	CW1FL	White box/Yellow box/E. nortonii woodland	Moderate	483	yes	No	
Flora plot	17/10/12	JM	AA55	764500	6487084	940	AA55FL	E laevopinea	poor	488	No	No	
Flora plot	17/10/12	JM	AA56	765119	6487013	930	AA56FL	E laevopinea	moderate	488	No	No	
Flora plot	17/10/12	JM	AA58	765742	6486785	909	AA58FL	mixed pasture	poor	488	no	no	
Flora plot	17/10/12	JM	AA61	766620	6487866	894	AA61FL	E nortonii w occ E. melliodora	Good	488	no	no	
Flora plot	17/10/12	JM	AA64	767655	6488777	947	AA64FL	E nortonii w occ E. melliodora	Poor-mod	488	no	no	
Flora plot	17/10/12	JM	AA67	768912	6490683	1055	AA67FL	laevo/praecox	poor	495	no	no	
Flora plot	17/10/12	BVTD	CW4	782078	6478307	880	CW4FL	Yellow box woodland	Poor	483	yes	No	
Flora plot	17/10/12	BVTD	CW7	781409	6477182	884	CW7FL	Yellow box open woodland	Poor	483	yes	No	
Flora plot	17/10/12	BVTD	CW9	780947	6476062	770	CW9FL	Yellow box woodland	Poor	483	yes	No	
Flora plot	17/10/12	BVTD	Adjacent ridge A	780000	6463500		Adjacent ridge A	White box/Yellow box open woodland	Poor	483	yes	No	
Flora plot	18/10/12	JM	AA68	767297	6472582	744	AA68FL	exotic pasture wherever treeless	exotic	Exotic	no	no	
Flora plot	18/10/12	JM	AA69	767354	6473906	778	AA69FL		poor		no		
Flora plot	18/10/12	JM	AA70	767429	6474250	794	AA70FL	BGW EEG, just around trees	poor	483	Yes	no	
Flora plot	18/10/12	JM	AA74	766450	6476482	948	AA74FL	exotic	exotic	exotic	no	no	
Flora plot	18/10/12	BVTD	BW45	771905	6476243	899	BW17FL	A. floribunda/E. nortoni open forest		488	no	no	
Flora plot	18/10/12	BVTD	BW47	771557	6475661	860	BW18FL	White box woodland	Poor	483	yes	no	
Flora plot	18/10/12	BVTD	BW50	770177	6476185	896	BW19FL	Yellow box/E. nortoni woodland	Poor	488	no	no	
Flora plot	18/10/12	BVTD	BW52	769916	6478450	901	BW20FL	E. nortoni derived grassland	Exotic-poor	395	no	no	
Flora plot	18/10/12	BVTD	Adjacent ridge B	773000	6479000		BW21FL	Yellow box open woodland/derived grassland	Poor	437	yes	No	
Flora plot	18/10/12	BVTD	BW54	772835	6480134	923	BW22FL	E. nortoni woodland	Poor	488	no	no	
Flora plot	18/10/12	BVTD	BW55	775385	6477833	813	BW23FL	E. nortoni woodland	Poor	488	no	no	
Flora plot	19/10/12	BVTD	AA81	781802	6487667	1032	BW24FL	E. laevopina/A. floribunda woodland	Moderate	488	No	No	
Flora plot	19/10/12	BVTD	AA83	782099	6488706	1061	BW25FL	see Benson ID		495	No	No	
Flora plot	19/10/12	BVTD	AA85	781330	6489600	1083	BW26FL	E. nortonii/E.praecox woodland	Poor	488	No	No	
Flora plot	19/10/12	BVTD	AA86	780643	6489448	1054	BW27FL	E. laevopinia woodland	Moderate	490	No	No	
Flora plot	19/10/12	BVTD	AA88	780743	6488857	1038	BW28FL	E. laevopinia woodland	Moderate	490	No	No	
Flora plot	5/10/13	B	50	772094	6484474	847	B19_FL	E. albens hybrid + B.populneus + A.floribunda	Poor	483	Yes	No	
Flora plot	5/10/13	B	54	773175	6486243	968	B20_FL	E.laevopinia + A.floribunda + E.melliodora	Poor-moderate	488	no	no	
Flora plot	5/10/13	B	59	773429	6488948	994	B21_FL	E.nortonii + A.floribunda	Moderate	488	No	No	
Flora plot	5/10/13	B	61	769580	6486090	692	B22_FL	E.albens hybrid + A.floribunda	Poor	483	Yes	No	
Flora plot	6/10/13	B	64	780109	6476210	653	B23_FL	E.melliodora + E. albens hybrid	Poor	483	Yes	No	
Inspection point	11/10/12	JM	AA3	779877	6484441	1013		Angophora/E. laevopinia/E. nortonii/B. populneus	Moderate	488	No	no	
Inspection point	11/10/12	JM	AA7	777428	6483350	897		E. meliodora & improved pasture, almost entirely exotic	Poor	437	Yes	no	
Inspection point	11/10/12	JM	AA8	776691	6483111	912		Ryegrass & clover pasture	Exotic	Exotic	No	No	
Inspection point	11/10/12	KS	BW3	771874	6468335	697		Native grassland with isolated White box	Poor	395	Yes	No	
Inspection point	11/10/12	KS	BW4	771889	6468409			Native grassland with isolated White box and Yellow box	Poor-mod	395	Yes	No	

DATA			LOCATION				VEGETATION COMMUNITY & CONDITION				STATUS		
Survey	Date	Personnel/ Team	GPS location	Easting	Northing	Elevation	Flora Survey ID (plots only)	Veg community type	Condition	Benson ID	NSW EEC?	EPBC CEEC?	Threatened species
Inspection point	11/10/12	KS	BW7	774383	6466914	546		East side of fence E. melliodora dom, some White box	Poor-mod	395	Yes	No	
Inspection point	12/10/12	JM	AA13	782130	6487108	1022		Poa lab improved pasture with clover, bromes between tussocks	Exotic	Exotic	No	No	
Inspection point	12/10/12	JM	AA14	782202	6486456	1028		Less poa, more exotics	Exotic	Exotic	No	No	
Inspection point	12/10/12	KS	BW11	779435	6473681	625		Exotic dom grassland with scattered Yellow Box & Angophora & White box	Poor	395	Yes	No	
Inspection point	12/10/12	KS	BW12	779301	6473623	591		Creekline of Angophora and River sheoak, Blakelys on adjacent river flat	Poor-mod	481-84	No	No	
Inspection point	12/10/12	KS	BW13	779397	6475205	616		Creekline of River sheoak and Callistemon sieberi, Phalaris sp., Silvertop stringy and occasional Blakelys on adjacent alluvial flats	Poor-mod	84	No	No	
Inspection point	12/10/12	KS	BW16	780320	6467103	751		Austrostipa grassland no canopy, WB & YB along midslope to E	Poor	395	Yes	No	
Inspection point	15/10/12	JM	AA28	775543	6483267	901		Weedy adj. to road but >80% native	Moderate	395	Yes	No	
Inspection point	15/10/12	JM	AA30	779061	6488042	1093		Mixed ryegrass/clover/bracken, scattered E. laevopinia and E. dalrymp			No	No	
Inspection point	15/10/12	JM	AA33	779669	6488780	1043		E. praecox-laevopinea	Good	495 w 488	No	No	
Inspection point	15/10/12	JM	AA34	779361	6487655	1068		Poa lab and clover pasture and scattered E. dalrymp	Moderate		No	No	
Inspection point	15/10/12	JM	AA35	778664	6487164	1015		At gate, ryegrass/clover/poa lab pasture, occasional e. dalrymp & laevo	Poor		No	No	
Inspection point	15/10/12	JM	AA36	777610	6487164	991		Totally exotic pasture, ryegrass/clover	Exotic	Exotic	No	No	
Inspection point	15/10/12	JM	AA37	777136	6487078	949		Weedy native pasture >50% ST johns Wort	Poor		No	No	
Inspection point	16/10/12	JM	AA40	777025	6485708	993		E. nortonii and exotic pasture	Poor	488	No	No	
Inspection point	16/10/12	JM	AA41	776710	6485388	953		exotic pasture	Exotic	Exotic	No	No	
Inspection point	16/10/12	JM	AA42	778040	6485921	1028		Exotic pasture, no trees	Exotic	Exotic	No	No	
Inspection point	16/10/12	JM	AA44	778549	6485932	1047		Ryegrass/clover & scattered E.nortonii/Angophora	Exotic	488	No	No	
Inspection point	16/10/12	JM	AA45	778511	6486355	1053		Ryegrass/clover & scattered E. laevopinia	Exotic	495	No	No	
Inspection point	16/10/12	JM	AA47	779352	6486741	1093		Exotic and scattered big E. laevopinia & E. praecox	Exotic	495	No	No	
Inspection point	16/10/12	JM	AA50	776593	6488252	915		Clover/ryegrass pasture & scattered Angophora	Exotic	Exotic/481	No	No	
Inspection point	16/10/12	JM	AA52	776974	6488549	983		Mostly exotic pasture under scattered young trees	Exotic	Exotic	No	No	
Inspection point	16/10/12	JM	AA53	777382	6488656	995		Poor, trees < 4%, exotic pasture under	Exotic	Exotic	No	No	
Inspection point	16/10/12	BVTD	BW22	774750	6474504	815		White Box/Yellow box woodland	Poor	483	Yes	No	
Inspection point	16/10/12	BVTD	BW24	773743	6472219	779		White Box/Yellow box woodland	Poor	483	Yes	No	
Inspection point	16/10/12	BVTD	BW26	772790	6470421	773		Yellow box/Angophora open woodland	Poor	281	Yes	No	
Inspection point	17/10/12	JM	AA57	765571	6487163	910		Esdaile W end open pasture. Angophora & improved Poa lab pasture	Poor	481	No	No	
Inspection point	17/10/12	JM	AA59	765709	6487350	940		Esdaile patchy E. meliodora over exotic pasture	Poor	473	Yes	No	
Inspection point	17/10/12	JM	AA60	766135	6487421	956		As for AA59, Hordeum and nettle	Poor	473	Yes	No	
Inspection point	17/10/12	JM	AA62	766956	6488077	890		Esdaile - knoll. E. meliodora + E. nortonii x 1. Nettle, Tagetes	Poor	488	No	No	
Inspection point	17/10/12	JM	AA63	767621	6488655	949		Dense E. meliodora multistem regen & Marrubium vulg.	Poor	473	Yes	No	
Inspection point	17/10/12	JM	AA65	767952	6489144	949		Exotic pasture, clover/ryegrass	Exotic	Exotic	No	No	
Inspection point	17/10/12	JM	AA66	768204	6490009	1000		Exotic clover/Pasture	Exotic	Exotic	No	No	

DATA			LOCATION				VEGETATION COMMUNITY & CONDITION				STATUS		
Survey	Date	Personnel/ Team	GPS location	Easting	Northing	Elevation	Flora Survey ID (plots only)	Veg community type	Condition	Benson ID	NSW EEC?	EPBC CEEC?	Threatened species
Inspection point	17/10/12	JM	AA67B	769790	6491350	1070		Poa lab/Phalaris/clover pasture	Moderate	395	No	No	
Inspection point	17/10/12	BVTD	BW42	778871	6464116	547		Open woodland/derived grassland	Mod	395	Yes	No	
Inspection point	17/10/12	BVTD	CW10	780483	6475494	751		Open woodland/grassland	Poor	395	Yes	No	
Inspection point	17/10/12	BVTD	CW12	779887	6475040	724		50/50 exotic and native groundcover	Poor-exotic	Exotic/395	No	No	
Inspection point	17/10/12	BVTD	CW5	781818	6477686	871		Yellow box woodland	Poor-mod	437	Yes	No	
Inspection point	17/10/12	BVTD	CW8	781326	6476618	804		Exotic, cleared derived grassland	Exotic	Exotic	No	No	
Inspection point	18/10/12	JM	AA71	767447	6474559	842		James Prop N end, exotic pasture & ringbarked trees	exotic	exotic	No	no	
Inspection point	18/10/12	JM	AA72	767323	6475096	853		James prop. E. albens (dieback) + exotic (Lolium) under one or two E. meliodora	exotic	483	no	no	
Inspection point	18/10/12	JM	AA73	767061	6475716	884		Sick E. meliodora, V. sparse + Hordeum	exotic	437	no	no	
Inspection point	18/10/12	JM	AA75	766689	6476996	916		James N end above yards, exotic weeds	exotic	exotic	No	no	
Inspection point	18/10/12	JM	AA76	766497	6477107	879		S side = healthy E. meliodora over exotic pasture. N = treeless overgrazed native pasture	Poor	exotic/437	Yes where treed	no	
Inspection point	18/10/12	JM	AA77	766175	6475765	932		James property, W ridge, exotic pasture/weeds.	exotic	exotic	No	no	
Inspection point	18/10/12	JM	AA78	766117	6475666	933		James property, end of road, Hordeum and nettle	exotic	exotic	No	no	
Inspection point	18/10/12	JM	AA79	765481	6484136	573		BGW poor condition	poor	483	yes	no	
Inspection point	18/10/12	JM	AA80	766562	6481325	557							
Inspection point	18/10/12	BVTD	BW46	771728	6475893	883		Mealy bundy woodland		488			
Inspection point	18/10/12	BVTD	BW48	771858	6476927	933		Yellow box open woodland-grassland	Poor	488	No	No	
Inspection point	18/10/12	BVTD	BW49	771088	6476908	911		Yellow box & Mealy bundy open woodland	Poor	488	No	No	
Inspection point	18/10/12	BVTD	BW51	771160	6477498	905		Mealy bundy open woodland with derived grassland	Poor	488	Maybe	No	
Inspection point	18/10/12	BVTD	BW53	771980	6479218	915		Yellow box open woodland with derived grassland	Poor	488	No	No	
Inspection point	18/10/12	BVTD	BW56	775456	6477836	811		Silvertop stringybark tall woodland	Poor	488	No	No	
Inspection point	18/10/12	BVTD	BW57	775852	6478443	827		Yellow box woodland	poor	488	No	No	
Inspection point	18/10/12	BVTD	BW58	776866	6478427	933		Yellow box woodland	poor	488	no	No	
Inspection point	18/10/12	BVTD	BW59	777300	6478946	912		exotic	exotic	exotic	no	no	
Inspection point	18/10/12	BVTD	BW60	777466	6480268	918		E nortonii	Poor	488	No	No	
Inspection point	18/10/12	BVTD	BW61	779412	6481906	1026		E. laevopinia, A. floribunda derived grassland	Poor-exotic	488	No	No	
Inspection point	18/10/12	BVTD	BW62	780179	6482042	1005		Mealy bundy	Poor-exotic	488	No	No	
Inspection point	18/10/12	BVTD	BW63	777773	6482548	763		Mealy bundy & Angophora forest	Poor	488	No	No	
Inspection point	19/10/12	BVTD	AA82	781654	6488307	1056		E. laevopinia derived grassland	Poor	490	No	No	
Inspection point	19/10/12	BVTD	AA84	781145	6489127	1051		E. praecox open woodland/derived grassland	poor	488	No	No	
Inspection point	5/10/13	B	49	772647	6484486	760		E.albens hybrid	Poor	483	yes	No	
Inspection point	5/10/13	B	51	772608	6485237	882		Cleared near turbine, surrounding veg E.albens hybrid	Exotic-poor	483	yes	No	
Inspection point	5/10/13	B	52	772765	6485660	930		Exotic	Exotic	Exotic	No	No	

DATA			LOCATION				VEGETATION COMMUNITY & CONDITION				STATUS		
Survey	Date	Personnel/ Team	GPS location	Easting	Northing	Elevation	Flora Survey ID (plots only)	Veg community type	Condition	Benson ID	NSW EEC?	EPBC CEEC?	Threatened species
Inspection point	5/10/13	B	56	773183	6487072	993		Exotic	Exotic	Exotic	No	No	
Inspection point	5/10/13	B	58	773492	6488938	992		E.laevopinia + A.floribunda	Mod-good	495	No	No	
Inspection point	5/10/13	B	60	774103	6489266	983		E.laevopinia + A.floribunda	Mod-good	495	No	No	
Inspection point	5/10/13	B	62	768161	6481970	573		exotic either side of rd w scattered E.melliodora	Exotic	437	No	No	
Inspection point	6/10/13	B	63	780327	6470192	604		native pasture	poor-mod	437	yes	no	
Inspection point	6/10/13	B	65	779544	6475283	632		exotic w patch of e nortonii	poor-mod	exotic/488	no	no	

B.7 FAUNA HABITAT ASSESSMENT DATA

DATA				HABITAT FEATURES												HABITAT QUALITY						
Date	Easting	Northing	Site code (FHAL)	Tree hgt (m)	Hollows	Hollow No.	Mature trees	Leaf litter	Fallen <50cm	Fallen >50cm	Mistletoe	Rock outcrop	Small rock	Large rock	Cliffs	Hollow dep.	Rock dep.	Ant tunnels	Log fauna	Small birds	Waterbirds	Glossy Black-cockatoo
11/10/12	771534.586	6467828.345	BW1FL	15-18	Common	9 of 12	scattered	scattered	scattered	scattered	Absent	Absent	Absent	Absent	Absent	Good	poor	poor	average	poor	Absent	Absent
11/10/12	771739.46	6468045.32	BW2FA	18	Common	8 of 12	Common	scattered	scattered	scattered	Absent	Absent	Absent	Absent	Absent	Good	poor	average	Good	poor	Absent	Absent
11/10/12	775005.187	6468593.375	BW3FA	14	scattered	3 of 3	scattered	scattered	scattered	scattered	Absent	Absent	Absent	Absent	Absent	average	poor	poor	poor	poor	Absent	Absent
11/10/12	774923.157	6468182.937	BW4FA	none	absent		absent	absent	absent	absent	Absent	Absent	common	scattered	Absent	absent	good	good	absent	absent	Absent	Absent
11/10/12	780476.025	6484776.042	AA1	18	abundant	4, 100%	abundant	absent	Common	absent	Absent	common	common	Absent	Absent	average	poor	Absent	poor	poor	poor	Absent
11/10/12	780250.484	6484804.372	AA2	10m tallest 15	abundant	3 of 4	abundant	absent	abundant	scattered	Absent	abundant	abundant	Absent	Absent	excellent	average	poor	average	poor	poor	Absent
11/10/12	779876.967	6484441.051	AA3	10m tallest20	abundant	95-100%	abundant	absent	abundant	scattered	scattered	abundant	abundant	scattered	Absent	Good	average	poor	average	poor	poor	Absent
11/10/12	779262.392	6484259.942	AA4	av18-25m tallest	Common	7,50%	abundant	scattered	abundant	scattered	common	abundant	abundant	scattered	Absent	average	good	average	poor	poor	Absent	Absent
11/10/12	778548.877	6484027.979	AA5	12m 18m	Common	30% 6	abundant	Common	abundant	scattered	Absent	common	abundant	scattered	Absent	average	good	average	average	poor	Absent	Absent
11/10/12	777879.628	6483818.415	AA6	14 tallest18	abundant	2 of 3, 65%	abundant	absent	Common	scattered	common	common	abundant	common	Absent	poor	average	poor	average	poor	poor	Absent
12/10/12	779421.892	6470394.146	BW5FA	22	scattered	2 of 7	Common	absent	scattered	absent	Absent	Absent	Absent	Absent	Absent	poor	average	Absent	poor	average	good	Absent
12/10/12	779360.513	6473655.305	BW6FA	20-22	scattered	4 of 8	Common	scattered	Common	Common	scattered	Absent	Absent	Absent	Absent	Good	excellent	good	Good	average	Absent	Absent
12/10/12	779435.128	6473681.466	BW7FA	16	scattered	2 of 2		scattered	scattered	scattered	scattered	Absent	common	common	Absent	average	good	good	average	poor	Absent	Absent
12/10/12	779751.737	6467396.896	BW8FA	16	scattered	2 of 2	scattered	scattered	scattered	absent	Absent	Absent	scattered	Absent	Absent	average	average	average	poor	absent	Absent	Absent
12/10/12	780765.806	6467681.487	BW9FA	N/A trees on edge to 20m	absent		absent	absent	absent	absent	Absent	Absent	abundant	scattered	Absent	poor	good		poor	absent	Absent	Absent
12/10/12	781036.992	6488193.033	AA10	8 avg+14mtall est	scattered		abundant	scattered	scattered	scattered	abundant	Absent	scattered	Absent	Absent	poor	poor	poor	average	Excellent	average	Absent
12/10/12	781618.895	6487945.765	AA11	12m 18m	abundant	8,60%	abundant	absent	Common	scattered	Absent	Absent	scattered	Absent	Absent	Good	poor	poor	poor	poor	poor	poor
12/10/12	781584.725	6487406.301	AA12	20m stag, avg 12				absent	Common	Common	Absent	Absent	common	common	Absent	Good	poor	poor	Good	absent	Absent	Absent
12/10/12	775560.007	6483161.978	AA15	avg10, tallest16	Common	4 of 8	abundant	absent	scattered	scattered	Absent	Absent		scattered	Absent	average	Absent	poor	average	absent	Absent	Absent
13/10/12	777654.691	6457192.338	AA16	8	abundant	21 of 21	abundant	scattered	Common	Common	Absent	common	common	common	Absent	excellent	good	average	Good	poor	Absent	Absent
13/10/12	777449.065	6461956.872	AA18	14m,tallest18m	Common	65%	abundant	scattered	Common	Common	Absent	Absent	Absent	Absent	Absent	Good	Absent	Absent	Good	absent	Absent	Absent

DATA				HABITAT FEATURES												HABITAT QUALITY						
Date	Easting	Northing	Site code (FHAL)	Tree hgt (m)	Hollows	Hollow No.	Mature trees	Leaf litter	Fallen <50cm	Fallen >50cm	Mistletoe	Rock outcrop	Small rock	Large rock	Cliffs	Hollow dep.	Rock dep.	Ant tunnels	Log fauna	Small birds	Waterbirds	Glossy Black-cockatoo
13/10/12	777747	6461763	AA19	10avg,16tallest	scattered	2 of 2	abundant	scattered	scattered	scattered	Absent	abundant	abundant	common	Absent	poor	good	poor	poor	poor	Absent	Absent
13/10/12	776877.039	6462207	AA21	avg10m,tallest14	abundant	3 of 3	abundant	scattered	Common	scattered	Absent	Absent	Absent	Absent	Absent	Good	Absent	poor	average	poor	Absent	Absent
13/10/12	780187.97	6466901.77	AA22	avg7, tallest16	Common	3 of 9	Common			Common	Absent	common	common	scattered	Absent	average	poor		average	poor	Absent	Absent
13/10/12	780561.712	6467510.936	AA23		absent		absent	absent	scattered	scattered	Absent	Absent	common	scattered	Absent	poor	poor	average	average	absent	Absent	Absent
13/10/12	780742.363	6467638.066	AA24	avg16,tallest20	abundant	5, 100%	abundant	absent	Common	scattered	Absent	common	abundant	common	Absent	excellent	average	average	poor	absent	Absent	Absent
13/10/12	782336.005	6459877.981	AA25	avg9,tallest11	scattered	1 of 10	abundant	scattered	Common	absent	scattered	common	common	scattered		poor	average	average	absent	absent	Absent	Absent
13/10/12	782282.357	6460155.614	AA26	8m	abundant	2 of 3, 66%	abundant	absent	scattered	absent	Absent	scattered	scattered	Absent	Absent	Good	poor	average	poor	poor	Absent	Absent
15/10/12	781605.031	6484974.012	AA27	avg20,tallest28	scattered	4, 15%	abundant	Common	Common	scattered	Absent	Absent	scattered			poor	Absent	poor	Good	good	Absent	Absent
15/10/12	779582.882	6488040.183	AA29	22	scattered	2 of 6	abundant	scattered	Common	Common	Absent	Absent	scattered	scattered	Absent	average	poor	average	average	poor	Absent	Absent
15/10/12	778980.259	6488459.583	AA31	25	scattered	5% 8	Common	Common	Common	absent	Absent	Absent	common	Absent	Absent	poor	poor	average	Good	average	Absent	Absent
15/10/12	779219.937	6488950.98	AA32	8-10m	scattered	10%	Common	Common	scattered	Common	scattered	Absent	scattered	Absent	absent	poor		poor	Good	poor	average	Absent
15/10/12	779361.063	6487654.856	AA34	30	absent		abundant	absent	scattered	absent	Absent	Absent	scattered	Absent	Absent	poor	poor	poor	poor	absent	poor	Absent
15/10/12	776680.558	6486895.922	AA38	avg10,tallest24m	Common	4 of 10 40%	abundant	scattered	Common	scattered	Absent	abundant	abundant	common	Absent	Good	average	average	Good	poor	Absent	Absent
16/10/12	774659.149	6474155.46	BW10FA	15	scattered	2 of 2	scattered	absent	scattered	absent	Absent	Absent	scattered	Absent	Absent	poor	poor	poor	poor	poor	Absent	Absent
16/10/12	774286.817	6473258.686	BW11FA	20	Common	7 of 13	Common	scattered	Common	scattered	Absent	Absent	Absent	Absent	Absent	Good	average	good	excellent	average	Absent	Absent
16/10/12	773360.881	6471708.442	BW12FA	16	scattered	3 of 4	scattered	absent	scattered	scattered	Absent	Absent	common	Absent	Absent	average	poor	poor	poor	poor	Absent	Absent
16/10/12	772790.348	6470421.482	BW13FA	7	scattered	2 of 3	absent	absent	scattered	Common	Absent	Absent	scattered	scattered	Absent	poor	poor	average	average	poor	Absent	Absent
16/10/12	775458.895	6473999.754	BW14FA	,emergent E.-22m	scattered	2 of 9	Common	scattered	scattered	scattered	Absent	Absent	common	scattered	Absent	average	average	poor	poor	good	average	Absent
16/10/12	776065.112	6472767.647	BW15FA	18	scattered	3 of 4	scattered	scattered	scattered	scattered	Absent	Absent	s	Absent	Absent	average	average	poor	average	average	Absent	Absent
16/10/12	776166.566	6473559.898	BW16FA	18	scattered	1 of 1	scattered	absent	Common	scattered	scattered	Absent	common	Absent	Absent	average	average	average	poor	poor	Absent	Absent
16/10/12	776597.564	6474450.602	BW17FA	16	Common	7 of 10	scattered	scattered	Common	Common	Absent	Absent	abundant	scattered	Absent	Good	good	poor	excellent	average	Absent	Absent
16/10/12	777407.237	6485735.836	AA39	avg24m,tallest26	scattered	2 of 20	scattered	scattered	Common	scattered	scattered	Absent	Absent	Absent	Absent	poor	Absent	poor	average	poor	Absent	Absent
16/10/12	778361.267	6486378.033	AA43	avge20,tallest	scattered	8%	scattered	scattered	Common	scattered	scattered	Absent		Absent	Absent	poor	poor	Absent	average	poor	Absent	Absent

DATA				HABITAT FEATURES												HABITAT QUALITY						
Date	Easting	Northing	Site code (FHAL)	Tree hgt (m)	Hollows	Hollow No.	Mature trees	Leaf litter	Fallen <50cm	Fallen >50cm	Mistletoe	Rock outcrop	Small rock	Large rock	Cliffs	Hollow dep.	Rock dep.	Ant tunnels	Log fauna	Small birds	Waterbirds	Glossy Black-cockatoo
				st25m																		
16/10/12	779651.062	6487212.495	AA46	avge20,talle st30	Common	3 of 6	abundant	scattered	Common	absent	Absent	common	common	common	Absent	Good	average	good	Good	poor	Absent	Absent
16/10/12	775215.999	6488277.956	AA48	18m only 2trees	scattered	2 of 2	scattered	absent	scattered	absent	Absent	Absent	Absent	Absent	Absent	poor	Absent	Absent	poor	poor	Absent	Absent
16/10/12	775946.038	6488297.975	AA49	avg20,talles t30	scattered	3 of 6	scattered	absent	scattered	absent	Absent	Absent	scattered	scattered	Absent	poor	poor	Absent	poor	poor	Absent	Absent
16/10/12	776516.329	6488021.13	AA51	avge15,talle st18	scattered	2 of 30	scattered	scattered	Common	scattered		s	common	Absent	Absent	poor	poor	Absent	poor	poor	Absent	Absent
16/10/12	777843.076	6488666.382	AA54	avg18,talles t22	scattered	2 of 10	scattered	Common	Common	scattered	scattered	abundant	common	abundant	Absent	average	good	poor	Good	poor	Absent	Absent
17/10/12	780699.752	6473235.32	BW18FA	16	scattered	3 of 11	Common	scattered	scattered	Common	scattered	Absent	abundant	abundant	Absent	average	excellent	average	excellent	good	Absent	Absent
17/10/12	780809.02	6473298.704	BW19FA	12	scattered	1 of 1	scattered	absent	absent	absent	Absent	Absent	scattered	Absent	Absent	poor	poor	Absent	absent	absent	Absent	Absent
17/10/12	781167.133	6473066.038	BW20FA	18-20	scattered	4 of 10	scattered	scattered	Common	scattered	scattered	Absent	scattered	scattered	Absent	average	poor	average	poor	poor	Absent	Absent
17/10/12	774659.149	6474155.46	BW21FA	18	scattered		scattered		scattered	scattered	probably	Absent	scattered	Absent	Absent	poor	poor	?	poor	poor	Absent	Absent
17/10/12	780362.862	6470215.75	BW22FA		scattered		scattered	scattered	absent	absent	Absent	Absent	scattered	Absent	Absent	poor	poor		poor	poor	Absent	Absent
17/10/12	779481.786	6474274.978	BW23FA	19	scattered	2 of 11	scattered	Common	scattered	scattered	scattered	Absent	common	scattered	Absent	average	average	average	poor	poor	Absent	Absent
17/10/12	779478.309	6464431.739	BW24FA	18	scattered		scattered	minor	scattered	absent	scattered	Absent	scattered	Absent	Absent	poor	poor	poor	poor	poor	Absent	Absent
17/10/12	765742.187	6486784.729	AA58	avg7,tallest 10	abundant	4 of 5	abundant	scattered	Common	scattered	Absent	Absent	Absent	Absent	Absent	Good	Absent	poor	Good	absent	Absent	Absent
17/10/12	766620.291	6487866.242	AA61	an7- 10,tallest10	scattered	2 of 20	abundant	Common	Common	scattered	Absent	scattered	scattered	Absent	Absent	average	average	average	Good	poor	Absent	Absent
17/10/12	767654.955	6488776.957	AA64	av10,tallest 12	scattered	1 of 5	abundant	Common	abundant	scattered	Absent	Absent	Absent	Absent	Absent	poor	poor	poor	excellent	poor	Absent	Absent
17/10/12	768911.641	6490682.788	AA67	av20,tallest 35	abundant	6 of 8	abundant	scattered	scattered	absent	Absent	Absent	Absent	Absent	Absent	Good	Absent	Absent	average	absent	Absent	Absent
17/10/12	782113	6478998	CW1FA	av 12m, 18 tallest	scattered	3 of 12	scattered	Common	scattered	scattered	Absent	Absent	scattered	scattered	Absent	poor	Absent	average	poor	average	Absent	Absent
17/10/12	782078	6478307	CW4FA	av 8m, tallest 12m	absent		Common	scattered	scattered	absent	Absent	Absent	scattered	Absent	Absent	Absent	Absent	Absent	average	average	Absent	Absent
17/10/12	781408	6477182	CW7FA	av15 tallest 23	absent		scattered	Absent	Absent	Absent	Absent	Absent	scattered	Absent	Absent	Absent	Absent	poor	Absent	Absent	Absent	Absent
17/10/12	780947	6476062	CW9FA	12 av, 15 tallest	absent		Common	scattered	scattered	scattered	scattered	Absent	scattered	scattered	Absent	absent	average	average	poor	average	Absent	Absent

DATA				HABITAT FEATURES												HABITAT QUALITY						
Date	Easting	Northing	Site code (FHAL)	Tree hgt (m)	Hollows	Hollow No.	Mature trees	Leaf litter	Fallen <50cm	Fallen >50cm	Mistletoe	Rock outcrop	Small rock	Large rock	Cliffs	Hollow dep.	Rock dep.	Ant tunnels	Log fauna	Small birds	Waterbirds	Glossy Black-cockatoo
18/10/12	771905.114	6476242.566	BW25FA	12	Common	6 of 8	Common	Common	Common	abundant	Absent	Absent	common	Absent	Absent	Good	average	average	excellent	average	Absent	Absent
18/10/12	771556.67	6475661.37	BW26FA	16	scattered	2 of 2	scattered	scattered	Common	Common	Absent	Absent	scattered	Absent	Absent	average	poor	poor	Good	average	Absent	Absent
18/10/12	770176.576	6476184.715	BW27FA	16	scattered	2 of 12	scattered	scattered	scattered	scattered	Absent	Absent	scattered	Absent	Absent	average	poor	poor	poor	average	Absent	Absent
18/10/12	769916.323	6478450.267	BW28FA	12	absent		scattered	absent	absent	absent	Absent	Absent	scattered	Absent	Absent	poor	poor	poor	absent	poor	Absent	Absent
18/10/12	773000	6479000	BW29FA	16	scattered		absent	absent	scattered	scattered	scattered	Absent	scattered	Absent	Absent	poor	poor		poor	absent	Absent	Absent
18/10/12	772835.128	6480134.399	BW30FL	14	scattered	2 of 7	Common	scattered	Common	abundant	Absent	Absent	common	common	Absent	average	good		excellent	good	Absent	Absent
18/10/12	775385.35	6477832.632	BW31FL	18	scattered	2 of 7	Common	scattered	scattered	Common	Absent	Absent	common	common	Absent	average	good		excellent	average	Absent	Absent
18/10/12	767297.022	6472581.964	AA68	15				absent	absent	absent	Absent	scattered	scattered	Absent	Absent	absent	Absent	poor	absent	absent	Absent	Absent
18/10/12	767429.028	6474250.033	AA70	av15,tallest 18	scattered	1 of 5	scattered		scattered	absent	scattered	Absent	scattered	scattered	Absent	poor	poor	poor	poor	poor	Absent	Absent
18/10/12	766449.991	6476481.969	AA74		absent		absent	absent	absent	absent	Absent	common	scattered	common	scattered	absent	average	poor	absent	absent	Absent	Absent
18/10/12	766688.85	6476996.02	AA75		absent		absent	absent	absent	absent	Absent	scattered	scattered	scattered	Absent	absent	average	poor	absent	absent	Absent	Absent
18/10/12	766496.988	6477106.975	AA76	18	scattered	2 of 10	scattered	scattered	Common	scattered	scattered	Absent	scattered	Absent	Absent	poor	poor	poor	poor	poor	Absent	Absent
18/10/12	766117.013	6475665.952	AA78		absent		absent	absent	absent	absent	Absent	common	common	common	Absent	absent	average	poor	poor	poor	Absent	Absent
18/10/12	765480.964	6484136.029	AA79+AA 80	18	scattered		scattered		scattered	scattered	scattered	Absent	scattered	scattered	Absent	poor	poor	poor	poor	poor	Absent	Absent
19/10/12	781802	6487667	AA81	av10,tallest 10	abundant	13/18	abundant	Common	Common	absent	Absent	common	common	scattered		Good	average	poor	average	absent	Absent	Absent
19/10/12	782098.61	6488706.138	AA83	avg8,tallest 18	abundant	60%	abundant	scattered	Common	scattered	Absent	common	abundant	Absent	Absent	Good	good	average	Good	Excellent	Absent	Absent
19/10/12	781329.99	6489600.02	AA85	16m av. 7m	Common	9 of 25	abundant	scattered	absent	Common	Absent	Absent	scattered	scattered	Absent	average	poor		average	average	Absent	Absent
19/10/12	780642.998	6489448.015	AA86	24m av.16	Common	6 of 41	abundant	scattered	Common	absent	Absent	scattered	common	scattered	Absent	Good	average	good	Good	average	Absent	Absent
19/10/12	780742.697	6488856.969	AA88	25av,12m	Common	5 of 20	abundant	scattered	Common	scattered	Absent	scattered	common	common	Absent	Good	average	poor	average	average	Absent	Absent
5/10/13	772094.475	6484474.278	B18_FA			2 of 2	scattered	absent	scattered	absent	absent	scattered	abundant	absent	absent	average	good	absent	poor	poor	absent	absent
5/10/13	773175.345	6486242.882	B19_FA			2 of 2	scattered	scattered	scattered	scattered	absent	absent	scattered	absent	absent	average	poor	average	poor	poor	absent	absent
5/10/13	773429.03	6488947.813	B20_FA			4 of 7	common	scattered	common	common	absent	scattered	scattered	common	absent	Good	average	good	average	good	absent	absent
5/10/13	769580.225	6486090.325	B21_FA			0 of 5	scattered	scattered	scattered	common	absent	common	scattered	abundant	absent	absent	good	poor	good	average	poor	absent
6/10/13	780108.837	6476210.397	B22_FA			1 of 8	scattered	scattered	scattered	absent	absent	absent	absent	absent	absent	poor	Absent	poor	poor	poor	poor	absent

B.8 THREATENED SPECIES RECORDS IDENTIFIED DURING FIELD WORK (WIND FARM STUDY AREA OCT 2012/2013)

Name	Scientific name	Description	Map Reference	Zone	x_proj	y_proj	Altitude	Surveyors
Scarlet Robin	<i>Petroica multicolor</i>	19 Oct 2012	WF3_H6	55J	782099	6488706	1061 m	BVT/RG
Squirrel Glider	<i>Petaurus norfolcensis</i>	16 Oct 2012, 9.30pm	WF6_B16	55J	779291	6473699	599 m	MF
Varied Sittella	<i>Daphoenositta chrysoptera</i>	18 Oct 2012	WF6_G9	55H	769929	6441880	457 m	BVT/FB
Varied Sittella	<i>Daphoenositta chrysoptera</i>	17 Oct 2012		55J	781572	6477356	880 m	GF
Common Bentwing-bat	<i>Miniopterus schreibersii</i>	VARIOUS RECORDS	Anabat locations – see survey effort maps (Appendix E.2)					Anabat
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	VARIOUS RECORDS	Anabat locations – see survey effort maps (Appendix E.2)					Anabat
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	VARIOUS RECORDS	Anabat locations – see survey effort maps (Appendix E.2)					Anabat
Eastern Cave Bat	<i>Vespadelus troughtoni</i>	VARIOUS RECORDS	Anabat locations – see survey effort maps (Appendix E.2)					Anabat

APPENDIX C THREATENED SPECIES EVALUATIONS

The tables in this appendix present the habitat evaluation for threatened species, ecological communities and endangered populations returned from NSW threatened species database searches inclusive of the wind farm and the transmission line for the following catchment areas:

- Wind farm - Hunter/Central Rivers CMA (Liverpool Range and Pillaga subregions), Central West CMA (Liverpool Range and Pillaga subregions) and Namoi CMA (Liverpool Range subregion)
- Power line – Hunter/Central Rivers (Kerrabee and Pillaga subregions) and Central West CMA (Pillaga subregion)

Where “N/A” is indicated in the table the threatened species search did not return records for that individual species from that aspect of the development. Hence, the species may be known for the wind farm site, but no records are known for the transmission line site or vice versa.

The *Environment Protection and Biodiversity Conservation Act* Protected Matters search tool was also used to search listed threatened species within a 10 km buffer around the boundary of the project area.

The likelihood of occurrence is based on presence of habitat, proximity of nearest records and mobility of the species (where relevant). The assessment of potential impact is based on the nature of the proposal, the ecology of the species and its likelihood of occurrence. The following classifications are used:

Presence of habitat

Present: Potential or known habitat is present within the Project Area.

Marginal: Habitat present is not typical but may be suitable, or habitat is typical but condition is poor or microhabitat requirements are not present.

Absent: No potential or known habitat is present within the Project Area.

Likelihood of occurrence¹

None: Species known or predicted to occur within the locality but no suitable habitat present within the Project Area.

Unlikely: Species known or predicted within the locality. Suitable habitat may be present in the Project Area but the proximity of nearest records suggests it is unlikely to occur.

Possible: Suitable habitat present and the species could occur in the Project Area based on the proximity of nearest records.

Present: Species was recorded during the field investigations.

Potential for impact

No: The proposal would not result in an impact to this species.

Low: The proposal is unlikely to result in an impact to this species. No Assessment of Significance (AoS) is considered necessary for this species.

¹ In the study area for highly mobile fauna, i.e. birds and bats; likelihood of occurrence in the development envelope for ground- or tree-dwelling fauna and flora (i.e. reptiles, marsupials, amphibians, plants).

Moderate: The proposal could impact this species or its habitats but risks are considered highly manageable. An Assessment of Significance (AoS) has been completed for this species. Management measures have been developed to address the risks.

High: The proposal is likely to impact this species or its habitats. An AOS has been applied to these entities to properly characterise the impact and provide information then used to either develop management measures to protect the entity or justify avoidance of the entity.

Information on habitat is sourced from species profiles on the NSW OEH threatened species database or the Australian Government's Species Profiles and Threats database (SPRAT) unless otherwise stated.

C.1 FLORA

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
<i>Acacia dangarensis</i> E TSC	Small tree to 10m, with bipinnate foliage similar to <i>Acacia decurrens</i> . Flowers Aug-Sep. In pure stands or in sclerophyll woodland on basalt, Mt Dangar, Goulburn River NP.	Recorded in the Goulburn River NP.	Absent	Unlikely	No	
Flockton Wattle <i>Acacia flocktoniae</i> V TSC V EPBC	Shrub 2-3m in height, with angled glabrous branchlets, phyllodes straight, linear. Fl June-Aug. On sandstone, Blue Mountains and south.	Known from the Goulburn River NP.	N/A	N/A	N/A	
Weeping Myall <i>Acacia pendula</i> <i>Acacia pendula</i> population in the Hunter catchment E TSC	Major inland floodplains on heavy soils W from upper Hunter region, sometimes dominant. Tree 5-13m, weeping branches, grey foliated.	OEH Atlas – one record (dated 1932) located SE of Cassilis. Observed 4km N of wind farm site on Liverpool Plains.	Absent	Unlikely	No	
Granite Boronia <i>Boronia granitica</i> V TSC E EPBC	Granite Boronia is a medium-sized shrub 0.6 - 2 m tall. It occurs in scattered localities on the New England Tablelands and North West Slopes north from the Armidale area to the Stanthorpe district in southern Queensland. It can be locally common in appropriate habitat.		N/A	N/A	N/A	
<i>Commersonia rosea</i> E TSC E EPBC	Prostrate shrub with trailing branches to 60cm. Known from 4 localities within 8km radius of Sandy Hollow, upper Hunter Valley. Post-fire coloniser. Grows in skeletal sandy soils in scrub or heath with occas emergent <i>E. caleyi</i> , <i>E. crebra</i> , <i>Callitris endlicheri</i> .	Known to occur in Goulburn River NP.	N/A	N/A	N/A	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
<i>Cymbidium canaliculatum</i> population in the Hunter Catchment <i>Cymbidium canaliculatum</i> End Pop TSC	An epiphytic orchid which grows in the hollows and forks of eucalypts and wattles, with a scattered distribution across northern and eastern Australia, extending from Hunter River in NSW to Cape York and across northern NT and Queensland to the Kimberley region in WA. Not listed as a species, but only as an Endangered Population, so occurrences outside the Hunter catchment are not relevant. Only part of the site is within the Hunter catchment.	Known to occur in Goulburn River NP. Observed just off-site to the north of Pandora Pass.	Present	Unlikely (not seen)	Low	
White-flowered Wax Plant <i>Cynanchum elegans</i> E TSC E EPBC	A climber growing in rainforest gullies and on scree slopes, NC, CC, CWS, and west as far as Merriwa in the upper Hunter Valley. Habitat includes dry and littoral rainforest, red gum woodland, spotted gum open forest. Majority of known populations are <30 plants.	Records known from Goulburn River NP, Wollemi NP.	N/A	N/A	N/A	
Bluegrass <i>Dichanthium setosum</i> V TSC V EPBC	Grows in woodland and grassland, NT, NWS, CWS, NWP, Q, WA. Associated with heavy basalt soils, often in moderately disturbed areas such as cleared woodland or roadsides. Either tolerates or is advantaged by disturbance. Can be locally common or scattered plants. Associated species include <i>E. albens</i> , <i>E. melliodora</i> , <i>E. viminalis</i> , <i>Aristida ramosa</i> , <i>Themeda australis</i> , <i>Bothriochloa macra</i> , <i>Poa sieberiana</i> .	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	Present	Possible at S end where less pasture improvement and on side slopes	Mod	Assessment of significance undertaken.
Lobed Blue-grass <i>Bothriochloa biloba</i> V EPBC	<i>Bothriochloa biloba</i> is an erect or decumbent perennial grass to 1 metre high. In NSW the species is widespread along the New England Tablelands and North West Slopes and Plains, including Warialda, Bingara, Merriwa, Hunter Valley and Dubbo areas. It also occurs in Southern Queensland. Prefers (but not limited to) heavy textured soils, such as brown or black clay soils. Flowers from November to June.	OEH Atlas – 2 records located north of Turill SCA and several records located along Warrumbungles Way towards Coolah.	Marginal	Possible at S end where less pasture improvement and on side slopes	Mod	Assessment of Significance under the EPBC Act undertaken
Finger Panic Grass <i>Digitaria porrecta</i> E TSC E EBC	In grassland, woodland or open forest on better soils, NWS, Q. From near Moree south to Tambar Springs and from Tamworth to Coonabarabran, mostly on private property, roadsides or TSRs. Flowers mid-Jan to late Feb. Frequent associates include <i>E. albens</i> , <i>Acacia pendula</i> , <i>Austrostipa aristiglumis</i> , <i>Enteropogon acicularis</i> , <i>Hibiscus trionum</i> .	OEH Atlas – 3 records (dated 2004) located approx. 5km NW of the proposed wind farm site.	Present	Possible at S end where less pasture improvement and on side slopes	Mod	Assessment of significance undertaken.

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
<i>Euphrasia arguta</i> CE EPBC	An erect, semi-parasitic annual herb known from Nundle State Forest and adjacent private land where it was rediscovered in 2008 (NSW DPI 2008). These populations occur at the border between the New England Tableland and the North Coast Bioregions (NSW DECCW 2010). Prior to this, the species had not been sighted since 1904 and was previously known from Sydney to Bathurst and north to Walcha, NSW. Collections had also been made from Nundle on the New England Tableland; the Paterson and William Rivers in the Hunter Valley; Mudgee; and the plains near Bathurst (Bentham 1869 cited in Leigh <i>et al.</i> 1984). Habitat is said to be grassy area near rivers, presumably in good condition.	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	Absent	None	No	
<i>Diuris pedunculata</i> Small Snake Orchid E TSC E EPBC	Moist grassy areas in sclerophyll forest, Sydney to Tenterfield. Flowers Aug-Sept (Flora of NSW) or Oct (DECCW). Distribution is “mainly NE Tableland, grassland, in stony soils on low ridges or moist flats.” (Bishop, 2005).		Marginal	Unlikely	Low	
Pine Donkey Orchid <i>Diuris tricolor</i> V TSC	Fl. Sep-Nov (flowers lightly scented). Sclerophyll forest among grass, often with <i>Callitris</i> , NT, CT, NWS, CWS, Q (Flora of NSW). Jones: “Widespread and locally common in <i>Callitris</i> woodland in well-drained sandy soils or on low forested ridges in laterite, plains and slopes. Known localities include Muswellbrook, Condobolin-Nymagee Road. Associated species include <i>Callitris glaucophylla</i> , <i>E. populnea</i> , <i>E. intertexta</i> , ironbarks, wattle scrub. Often with a grassy understorey including plants such as <i>Bulbine</i> sp.	Predicted to occur in Coolah Tops NP and Goulburn River NP.	N/A	N/A	N/A	
<i>Eucalyptus camaldulensis</i> population in the Hunter catchment End. Pop. EPBC	Widely distributed on alluvial soils near permanent water west from Singleton (from Bylong south of Merriwa east to Hinton in Port Stephens LGA, on the Hunter River, mostly on private property (only coastal occurrence in NSW).	OEH Atlas – one record (dated 1970) located approx. 16km SE of Ulan.	N/A	N/A	N/A	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Capertree Stringybark <i>Eucalyptus cannonii</i> V TSC V EPBC	Similar to the widespread <i>E. macrorhyncha</i> , with more angular buds and larger fruit with a medial rim. May co-occur and hybridise. Restricted to 100 x 60km area of CT with eastern edge on a line between Lithgow and Bylong (67 locations recorded, 460-1040m elevation, most situations except valley floors). Found with numerous other eucalypts including <i>E. rossii</i> , <i>dives</i> , <i>goniocalyx</i> , <i>melliodora</i> , <i>blakelyi</i> , <i>viminalis</i> , <i>dalrympleana</i> , <i>oblonga</i> , <i>sparsifolia</i> .	OEH Atlas – three records (dated 2004-2006) located south of the Ulan Colliery. Known to occur in Goulburn River NP.	N/A	N/A	N/A	
Pokolbin Mallee <i>Eucalyptus pumila</i> V TSC V EPBC	A mallee-form eucalypt to 6 m high. Known from one small area on skeletal soil on a west-facing sandstone ridge in Pokolbin Flora Reserve and an adjacent private property (& old records from Sandy Hollow and Wyong). Grows in woodland with <i>E. fibrosa</i> , <i>C. maculata</i> , <i>Callitris endlicheri</i> . An additional two populations of about 150 plants have been found 4km NW of the type locality, occupying flat benches on a steep-sided N-facing spur, separated by a valley.		N/A	N/A	N/A	
Homoranthus darwinoides V TSC V EPBC	Shrub 1-1.5m in height Grows in dry sclerophyll forest or woodland, usually on sandstone outcrops or ridges from Dubbo to Merriwa, chiefly Goonoo Forest and Lees Pinch.	OEH Atlas – 22 records (dated 1951-2000) located mostly in the eastern part of the Goulburn River NP.	N/A	N/A	N/A	
Granite Homoranthus <i>Homoranthus prolixus</i> V TSC V EPBC	Grows in heath in skeletal soil among crevices in granite outcrops near Inverell and Bendemeer (NT and NWS botanical regions) (Flora of NSW)	Not recorded on the NSW OEH Database or EPBC database.	N/A	N/A	N/A	
Leafless Indigo <i>Indigofera efoliata</i> E TSC E EPBC	Only known from a few old collections in the Dubbo area (Harden, 2002). Grows in stony ground. Perennial herb or sub-shrub to 40cm with leaves absent or to 3.5cm long with 5-9 tiny obcordate leaflets, only present at base of annual growth. Flowers pink.	Not recorded on the NSW OEH Database or EPBC database.	N/A	N/A	N/A	
Kennedia retrorsa V TSC V EPBC	Climber. Flowers in spring. Mt Dangar, Goulburn River valley to near Putty in dry sclerophyll forest and woodland.	Recorded in the Goulburn River NP.	N/A	N/A	N/A	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
<i>Lasiopetalum longistamineum</i> V TSC V EPBC	Shrub. Grows in rich alluvial deposits in Gungal-Mt Dangar area.	Recorded in Goulburn River NP.	N/A	N/A	N/A	
Hoary Sunray <i>Leucochrysum albicans</i> <i>var. tricolor</i> E EPBC	An annual or biennial forb which occurs from Queensland to Victoria and in Tasmania, west from the tablelands. Records from Queensland are historic, and the species most current northern occurrence is Goulburn, NSW (OEH). The species could easily be confused with the unlisted <i>L. molle</i> (distribution NWS, CWS, plains and far inland).	OEH Atlas – 2 records (dated 2005-2008) located within semi-vegetated areas S and SW of Ulan Colliery.	Present in parts	Unlikely	Low	
Spiny Peppergrass <i>Lepidium aschersonii</i> V TSC V EPBC	Erect perennial herb to 30 cm high. Not widespread, occurring in the marginal central-western slopes and north-western plains regions of NSW (and potentially the south western plains).		Present	Unlikely	Low	
<i>Ozothamnus tessellatus</i> V TSC V EPBC	Dense shrub to 1m high. Grows in eucalypt woodland north of Rylstone.	Recorded in the Goulburn River NP.	N/A	N/A	N/A	
Omeo Stork's-bill <i>Pelargonium sp. striatellum</i> MS E EPBC	<i>Pelargonium sp. striatellum</i> (G.W.Carr 10345) is known to occur in NSW and Victoria (NSW SC, 2010) on 5 widely separated tableland lakes between Lake Omeo and Lake Bathurst. It grows just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds.	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	N/A	N/A	N/A	
Clandulla Geebung <i>Persoonia marginata</i> V TSC V EPBC	Low spreading shrub. Grows in dry sclerophyll forest on sandstone, restricted to area between Kandos and Portland.	Known to occur in Goulburn River NP.	N/A	N/A	N/A	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
<i>Philotheca ericifolia</i> V EPBC	Shrub growing to 2 m high .This species inhabits the north-western slopes and central western slopes of NSW, from the upper Hunter Valley, to Pilliga and to the Peak Hill district (Harden 1991). The species is found at Goonoo Forest near Mogriguy, Pilliga Forest, Harvey Ranges and Peak Hill (Ayres <i>et al.</i> 1996). Grows from damp sandy flats to rocky ridges and clifftops (but possibly in seepage areas in this situation as it is said to be water-loving). Found after fire or other disturbance.	Known to occur in Goulburn River NP.	N/A	N/A	N/A	
Leek-orchid <i>Prasophyllum</i> sp. Wybong CE EPBC	<i>Prasophyllum</i> sp. Wybong is a terrestrial orchid known from nine populations between Muswellbrook and the Pilliga area, of which the Wybong population is the largest. Habitat is open eucalypt woodland and grassland, presumably principally or entirely on sedimentary substrates such as sandstone.		Absent	None	No	
Scant Pomaderris <i>Pomaderris queenslandica</i> E TSC	A 2-3m shrub growing in open forest, chiefly on Slopes, north from Peak Hill district, also in Gloucester district, NC, NWS, CWS, Q. DECC: widely scattered, a few locations on New England Tbl and NWS including Torrington and Coolatai, and on NC, in moist eucalypt forest or sheltered woodlands with a shrubby understorey, occasionally along creeks. Bell (2001) collected recently in upper Hunter – 2 sites near Denman (single plant each) & several plants on creek on Diamond Ridge Trail in Manobalai NR N of Denman, and in new additions to Towarri NP near Scone.		N/A	N/A	N/A	
Denman Pomaderris <i>Pomaderris reperta</i> CE TSC CE EPBC	In dry sclerophyll woodland, along a single ridgeline over 1ha in the Denman area (Muswellbrook LGA). Growing with <i>E. crebra</i> , <i>E. blakelyi</i> , <i>Allocasuarina littoralis</i> , <i>Notelaea microcarpa</i> . Bell (2001): recently located at Myambat Logistics Company site W of Denman along the same sandstone ridgeline (20-40 plants). Not found in surveys of Goulburn River or Wollemi NP or Manobalai NR.		N/A	N/A	N/A	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Silky Pomaderris <i>Pomaderris sericea</i> E TSC V EPBC	Previously only an old record from Berrima area (CT) and Vic. Found in Benjang Gap area of NW Wollemi NP (Bell, 2001).	Not recorded on the NSW OEH Database or EPBC database.	N/A	N/A	N/A	
Singleton Mint Bush <i>Prostanthera cineolifera</i> V TSC V EPBC	Strongly aromatic shrub. Apparently grows in sclerophyll forest, distribution unclear, NC? CC? DECC: restricted to a few localities near Walcha, Scone and St Albans in open woodland on exposed sandstone ridges. Presumed to be short-lived (10-20 years).		N/A	N/A	N/A	
Wollemi Mint-bush <i>Prostanthera cryptandroides</i> subsp. <i>cryptandroides</i> V TSC V EPBC	Strongly aromatic shrub. Grows in dry sclerophyll forest, heath or rock scrub, often in rocky sites, chiefly Lithgow to Sandy Hollow area. Also north from Sandy Hollow into Border Rivers/Gwydir catchment and Qld. In open forest. Flowers Sept-May.	In Wollemi NP and probably in Goulburn River NP.	N/A	N/A	N/A	
<i>Prostanthera discolor</i> V TSC V EPBC	Narrow-leaved, strongly aromatic shrub. Flowers Sept-Oct. In dry sclerophyll forest in rocky gullies in Sandy Hollow-Merriwa area.	Known to occur in Goulburn River NP.	N/A	N/A	N/A	
Mount Vincent Mint-bush <i>Prostanthera stricta</i> V TSC V EPBC	Shrub to 2 x 3m, aromatic. Flowers winter-spring. Grows in sclerophyll forest, in sandy alluvium near streams, Widdin Valley area, CWS.	Known to occur in Goulburn River NP.	N/A	N/A	N/A	
<i>Pultenaea</i> sp. <i>olinda</i> E TSC	An erect to procumbent shrub with spreading hairy stems. Known only from a small area at Currant Mountain Gap east of Rylstone within the Rylstone Local Government Area. The majority of known individuals occur within Wollemi National Park.		N/A	N/A	N/A	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Inland Rustyhood <i>Pterostylis cobarensis</i> V EPBC	Terrestrial orchid, flowering Sept-Oct, growing on “sparsely treed rocky hills, stony slopes and in mallee communities, sometimes on isolated rocky outcrops” (Jones, 2006). The known distribution of this species is Broken Hill-Nyngan area to Young (Jones, 2006). Terrestrial orchids seldom persist in heavily grazed areas and the likelihood of this species occurring in farming areas is very low.	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	N/A	N/A	N/A	
<i>Rulingia procumbens</i> V TSC V EPBC	Prostrate shrub, stems to 30cm long. In sandy sites (often roadsides), mainly in Dubbo-Mendooran-Gilgandra area, also Pilliga and Nymagee areas, CWS, NWP, SWP. Also recent collections from upper Hunter (W-facing spur and a nearby ridge near Sandy Hollow on crown reserve between Goulburn River NP and Manobalai NR– Bell, 2001) and 4 populations in Goonoo SF. Associated spp = <i>E. dealbata</i> , <i>sideroxylon</i> , <i>fibrosa</i> , <i>albans</i> , <i>melliodora</i> , <i>Callitris glaucophylla</i> , <i>Acacia triptera</i> , <i>Philotheca salsolifolia</i> , <i>Calytrix tetragona</i> . Also found on slopes of Mt Dangar in Goulburn River NP, in a burnt area – may be a fire ephemeral.	Known to occur in Goulburn River NP.	N/A	N/A	N/A	
<i>Senecio linearifolius</i> var. <i>dangarensis</i> E TSC	Weakly shrubby perennial forb to 2 metres high. <i>Senecio linearifolius</i> var. <i>dangarensis</i> is restricted to a single known population in the Goulburn River National Park where it has been recorded growing on an open scree slope and in woodland and rainforest communities on basalt. The population is estimated to contain 500 - 1000 individuals over an area of 20 hectares.	Recorded in the Goulburn River NP.	Absent	None	No	
<i>Stemmacantha australis</i> Extinct TSC	Erect, thistle-like forb to 60cm. Early records from the Jenolan Caves area and “Namoi River”, where it is thought to have grown on heavy soils. Possibly extinct in NSW.	Species considered extinct	Present	Unlikely	Low	
Slender Darling Pea <i>Swainsona murrayana</i> V TSC V EPBC	Prostrate to erect forb to 25cm high. “Often grows with <i>Maireana</i> species on heavy soils, especially in depressions, west from Warialda district, NWS, CWS, SWS, NWP, SWP, Q, Vic, Tas” (Harden 2002). Mostly W slopes and plains, with records from between Dubbo and Moree. In saltbush, black box and grassland communities on plains, floodplains and depressions, occasionally on intermittently cultivated or grazed sites.		Marginal	Unlikely	Low	

Species	Ecology and distribution	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Silky Swainson-pea <i>Swainsona sericea</i> V TSC	Prostrate to erect forb to 10cm high, stems silvery hairy. Grows in grassland or grassy eucalypt woodland, sometimes with <i>Callitris</i> , widespread, tablelands, slopes, plains, Vic, SA.	Found at one location on transmission line site.	Present	Possible	Mod	Assessment of significance undertaken
Austral Toadflax <i>Thesium australe</i> V TSC V EPBC	In <i>Themeda</i> grassland, coastal headlands and inland grassland or grassy woodland, NC, CC, SC, NT, ST, NWS, CWS, Q, Vic, Tas, E Asia. A partial root parasite on Kangaroo Grass (<i>Themeda australis</i>). Unlikely to persist in heavily grazed sites, or to occur where Kangaroo Grass is not at least moderately common.	OEH Atlas – one record (dated 1959) located in Cassilis.	Present in the NE corner of the study area.	Possible	Low	Areas dominated by Kangaroo grass in the NE part of the site have been avoided as part of the revised design.
<i>Tylophora linearis</i> V TSC E EPBC	A small vine which grows in dry scrub and open forest in the Barraba, Mendooran, Temora and West Wyalong districts, NWS, CWS, Q. Common associated species are <i>E fibrosa</i> , <i>sideroxylon</i> , <i>albens</i> , <i>Callitris</i> spp, <i>Allocasuarina leuhmanii</i> , <i>Acacia hakeoides</i> , <i>A. lineata</i> .	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	N/A	N/A	N/A	
<i>Wollemi nobilis</i> Wollemi Pine E TSC E EPBC	Restricted to remote canyons in the Wollemi National Park, north-west of Sydney. Occurs in warm temperate rainforest and rain forest margins in remote sandstone canyons.	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	N/A	N/A	N/A	
Keith's Zieria <i>Zieria ingramii</i> E TSC E EPBC	Slender, spindly shrub to 0.6 m high, known only from Goonoo SF near Dubbo (Harden 2002), growing in dry sclerophyll forest on light sandy soils.	Not recorded on the NSW OEH Database or EPBC database.	N/A	N/A	N/A	

KEY:

V TSC	Listed as Vulnerable on the <i>NSW Threatened Species Conservation Act, 1995</i>
E TSC	Listed as Endangered on the <i>NSW Threatened Species Conservation Act, 1995</i>
V EPBC	Listed as Vulnerable on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
E EPBC	Listed as Endangered on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
CE EPBC	Listed as Critically Endangered on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
M EPBC	Listed as Migratory on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>

N/A indicates that the threatened species search did not return the species from the wind farm development area searches, and is only therefore applicable to the transmission line.

C.2 ENDANGERED ECOLOGICAL COMMUNITIES

EEC name & Status*	Description	Wind Farm		Notes
		Presence on site	Potential to be impacted	
Brigalow within Brigalow Belt South (BBS), Nandewar & Darling River Plains (DRP) bioregions (<i>Acacia harpophylla</i>)	Dense scrubs or clumps in open box and myall communities on clay loam soils north from Roto. Dominated by <i>Acacia harpophylla</i> , with pockets of <i>Casuarina cristata</i> and <i>Eucalyptus populnea</i> subsp. <i>bimil</i> . The canopy tends to be quite dense and the understorey and ground cover are only sparse.	Absent	No	
<i>Cadellia pentastylis</i> (ooline) community in the Nandewar and BBS bioregions	In thickets, W from Tenterfield and N from Maules Ck (49km SE of Narrabri). A distinctive community with the canopy dominated by <i>Cadellia pentastylis</i> , sometimes with emergent eucalypts. Now known from seven main locations on the NW Slopes between Narrabri and the Qld border, and in Qld. Usually on undulating terrain on a variety of soil types, 300-450m altitude.	Absent	No	
Carbeen (<i>Corymbia tessellaris</i>) open forest community in DRP and BBS bioregions	Woodland on flat, deep soils of med-high fertility, N from Woodenbong, N and NW from Narrabri	Absent	No	
Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC TSC	Occurs in the Central Hunter Valley between about Singleton and Muswellbrook, in areas of relatively low rainfall and high temperatures. It is associated mostly with Permian lithology, and is situated on gently undulating hills, slopes and valleys, or occasionally on rocky knolls. Typically forms a woodland dominated by <i>Eucalyptus crebra</i> , <i>Brachychiton populneus</i> and <i>E. moluccana</i> . Other tree species such as <i>Angophora floribunda</i> and <i>Callitris endlicheri</i> may be present and occasionally dominate or co-dominate. Common shrub species include <i>Notelaea microcarpa</i> , <i>Breynia oblongifolia</i> , <i>Bursaria spinosa</i> , <i>Cassinia quinquefaria</i> and <i>Dodonaea viscosa</i> . Subshrubs may also be common and include <i>Solanum cinereum</i> , <i>Phyllanthus virgatus</i> and <i>Maireana microphylla</i> . Ground cover can be moderately dense to dense, and consist of numerous forbs and grass species as well as a small number of ferns, sedges and twiners.	N/A as this part of the site is not within NSW North Coast or Sydney Basin bioregions.	No	
Coolibah-Black Box woodland of the northern riverine plains in the DRP and BBS bioregions (<i>E. coolabah</i>, <i>E. largiflorens</i>) EEC EPBC	Grassy woodland on heavy black clay soils in seasonally flooded areas.	Absent	No	

EEC name & Status*	Description	Wind Farm		Notes
		Presence on site	Potential to be impacted	
Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains & Brigalow Belt South bioregions (<i>Eucalyptus conica</i>) EEC TSC	Grassy or shrubby woodland on light loamy soils of med fertility N from Wagga. A woodland or open forest usually dominated by <i>Eucalyptus conica</i> , which often grows with <i>E. microcarpa</i> , <i>E. melliodora</i> or <i>Brachychiton populneus</i> (or less often <i>E. blakelyi</i> , <i>E. intertexta</i> or <i>E. populnea</i>). <i>Allocasuarina luehmannii</i> is common in places. It occurs on loam or clay alluvial or colluvial soils on prior streams & abandoned channels or slight depressions on the undulating plains or flats of the western slopes of the Great Dividing Range, often upslope from River Red Gum communities, just above frequently inundated areas on the floodplain. It also occurs on colluvial soils on lower slopes and on valley flats.	Absent	No	
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia EEC EPBC	A grassy woodland found on relatively fertile soils of the western slopes and plains of NSW, Victoria and Qld in which <i>Eucalyptus microcarpa</i> (Inland Grey Box) is the most characteristic species. Prober and Thiele (2004) identified a correlation between <i>Eucalyptus microcarpa</i> communities and soils of Tertiary and Quaternary alluvial origin. This ecological attribute helps distinguish between Inland Grey Box Woodlands and the White Box Yellow Box Blakely's Red Gum Woodland. The latter community generally occurs further east and typically occupies a wide variety of alluvial and non-alluvial soils. Grey Box woodland also more often contains chenopod shrubs in the understorey.	Absent	No	
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions EEC TSC	See above. This is the same as the EPBC-listed community.	Absent	No	
Hunter Valley Weeping Myall Woodland in the Sydney Basin bioregion (<i>Acacia pendula</i>)	<i>Acacia pendula</i> , which may occur with <i>E. crebra</i> , <i>A. salicina</i> (Cooba) and/or trees within the <i>A. homalophylla</i> <i>A. melvillei</i> complex. Understorey shrubs may be absent or include <i>Canthium buxifolium</i> , <i>Dodonaea viscosa</i> , <i>Geijera parviflora</i> , <i>Notelaea microphylla</i> var. <i>microphylla</i> and <i>Senna zygophylla</i> . Groundcover varies from dense to sparse, and includes a range of grasses and forbs. Grows on alluvial flats.	N/A as this part of the site is not within Sydney Basin bioregion.	No	
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC TSC	Generally occurs on floodplains and associated floodplain rises along the Hunter River and tributaries and typically forms a tall woodland. All sites are within the NSW North Coast and Sydney Basin Bioregions. Typical eucalypts are <i>Angophora floribunda</i> , <i>E. camaldulensis</i> , <i>E. melliodora</i> , <i>E. tereticornis</i> sometimes with <i>Casuarina cunninghamii</i> and <i>C. glauca</i> .	N/A as this part of the site is not within NSW North Coast or Sydney Basin bioregions.	No	

EEC name & Status*	Description	Wind Farm		Notes
		Presence on site	Potential to be impacted	
Hunter Valley Foothills Slaty Gum Woodland in the Sydney Basin Bioregion EEC TSC	Generally occurs at the interface of Narrabeen Sandstone and Permian sediments in the Hunter Valley and typically forms a low to mid-high woodland. All sites are within the Sydney Basin Bioregion. Typical eucalypts are <i>E. dawsonii</i> , <i>crebra</i> , <i>moluccana</i> and <i>punctata</i> , with small trees <i>Brachychiton populneus</i> , <i>Callitris endlicheri</i> , <i>Allocasuarina leuhmanii</i> , <i>Geijera salicifolia</i> , shrubs <i>Myoporum montanum</i> , <i>Notelaea microcarpa</i> , <i>Olearia elliptica</i> .	N/A as this part of the site is not within Sydney Basin bioregion.	No	
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions EEC TSC		N/A as this part of the site is not within NSW North Coast or Sydney Basin bioregions.	No	
Myall Woodland in the DRP, BBS, Cobar Peneplain bioregions (<i>Acacia pendula</i>)	Typically occurs on red-brown earths and heavy textured alluvial soils within a climatic belt receiving between 375 and 500 mm rainfall. Structure varies from low woodland to low sparse woodland or open shrubland, depending on site quality and disturbance history. The tree layer grows up to a height of about 10 metres and invariably includes <i>Acacia pendula</i> as one of the dominant species or the only tree species present. The understorey includes an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of grasses and herbs.	Absent	No	
Native vegetation on cracking clay soils of the Liverpool Plains EEC TSC	Mainly a native grassland community which includes a range of small forb and herb species. The main grass species include <i>Austrostipa aristiglumis</i> , <i>Dichanthium sericeum</i> and <i>Panicum queenslandicum</i> . May contain scattered shrubs and trees, including <i>Acacia pendula</i> , <i>Angophora floribunda</i> , <i>Eucalyptus conica</i> , <i>E. populnea</i> and <i>E. melliodora</i> . In wetter locations rushes and sedges are common. It occurs on the highly fertile cracking clay soils of the Liverpool Plains. Located around Coonabarabran, Gunnedah, Murrumbidgee, Narrabri, Tamworth and Quirindi, on the NWS & NWP.	N/A as site is not on the Liverpool Plains.	No	
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland CEECP EPBC	Essentially the same community as the preceding one, but with the Commonwealth listing covering a wider geographical area.	Absent, grasslands are all derived from clearing of woodland.	No	

EEC name & Status*	Description	Wind Farm		Notes
		Presence on site	Potential to be impacted	
Semi-evergreen Vine Thicket in the BBS & Nandewar bioregions	A low, dense dry rainforest <10 m high, made up of vines and rainforest trees & shrubs. Includes <i>Cassine australis</i> var. <i>angustifolia</i> , <i>Geijera parvifolia</i> , <i>Notelaea microcarpa</i> var. <i>microcarpa</i> , <i>Ehretia membranifolia</i> , with taller eucalypts and cypress pines from surrounding woodland vegetation emerging above the main canopy. Currant Bush (<i>Carissa ovata</i>) is often present and typical vines include <i>Parsonsia eucalytophylla</i> and <i>Pandorea pandorana</i> . Often occurs on rocky hills, in high nutrient soils derived from basalt or other volcanic rocks, in areas which are sheltered from frequent fire. A scattered distribution near Gunnedah, Barraba, Bingara and Warialda on the NWS & NWP & Qld.	Absent	No	
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion EEC EPBC		N/A as this part of the site is not within Sydney Basin bioregion.	No	
White Box-Yellow Box-Blakely's Red Gum Woodland EEC TSC CEEC EPBC	Grassy woodland widespread on the NSW tablelands and slopes, growing on flats, slopes or ridges on higher fertility soils, restricted to drainage lines on poorer soils. Characteristic trees are Yellow Box (<i>E. melliodora</i>), White Box (<i>E. albens</i>) and Blakely's Red Gum (<i>E. blakelyi</i>).	Present	Yes	Assessment of Significance under TSC Act and EPBC Act undertaken.

KEY:

EEC TSC	Listed as an Endangered Ecological Community on the <i>NSW Threatened Species Conservation Act, 1995</i>
CEEC TSC	Listed as a Critically Endangered Ecological Community on the <i>NSW Threatened Species Conservation Act, 1995</i>
EEC EPBC	Listed as an Endangered Ecological Community on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
CEEC EPBC	Listed as a Critically Endangered Ecological Community on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>

N/A Species was not recorded or predicted to occur within the Wind Farm Study Area. These species were recorded or predicted to occur within the Transmission Line Study Area.

C.3 FAUNA

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Amphibians						
Sloane's Froglet <i>Crinia sloanei</i> VTSC	Sloane's Froglet has been recorded from widely scattered sites in the floodplains of the Murray-Darling Basin, with the majority of records in the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions in New South Wales. It has not been recorded recently in the northern part of its range and has only been recorded infrequently in the southern part of its range in NSW. It is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats (DECCW 2009).	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Unlikely	No	
Giant Burrowing Frog <i>Heleioporus australiacus</i> V TSC V EPBC	The species is predicted to be associated with dry forest environments (elevation 150-900m) with high habitat complexity (Penman <i>et al.</i> 2007). It will travel several hundred metres to creeks to breed. It has also been recorded in roadside drains and near slow-flowing creek pools with fringing fern and sedge vegetation. Breeds summer and autumn, apparently in burrows in creek banks, favouring deep loam soils. Coastal lowlands are generally considered unsuitable habitat and the species is rarely associated with permanent ponds or streams (DEWHA 2009; Penman <i>et al.</i> 2007). However, records around Vincentia and Ulladulla suggest this species may in fact be found on coastal lowlands (<100mASL).	Known to occur in Goulburn River NP.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Giant Barred Frog <i>Mixophyes iteratus</i> E TSC E EPBC	Giant Barred Frogs are large frogs, up to 115 mm in length. They are olive to dark brown above with paler or darker blotches, and cream to pale yellow below. The skin is finely granular. The pupil of the eye is vertical and the iris is pale golden in the upper half and brown in the lower half. Coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. North-eastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold. Considered to have disappeared south of the Hawkesbury and there are no recent records from the Blue Mountains.	Goulburn River NP – 2 records (dates 2001-2002) SE of Ulan.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Red-crowned Toadlet <i>Pseudophryne australis</i> V TSC	The Red-crowned Toadlet is an unmistakable small frog, usually measuring less than 30 mm long. It is dark brown to black, with distinctive reddish-orange patches, one between the eyes and one along the rump. It also has a white patch at the base of each arm. The belly is marbled black and white. The tadpoles are black and reach about 25 mm. The short, grating and "squelchy" call can be heard all year round. The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains.	Predicted to occur in Coolah Tops NP and Goulburn River NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are no records of this species.
Bush Stone-curlew <i>Burhinus grallarius</i> E TSC	Has a broad distribution although has suffered severe declines throughout its range, particularly in disturbed and fragmented areas and where foxes are common (DEC 2006a). In NSW, it is not found on the escarpments but on lower elevation grassy woodlands of the coast or west of the divide. The area bounded roughly by Albury, Wagga Wagga, Hay and Wentworth is regarded as the stronghold for the species in NSW (DEC 2006a). This species inhabits open forests and grassy woodlands where it builds nests directly on the ground (DECCW). It requires logs, fallen trees and branches, coarse litter and some shrubs for shelter. Foraging may occur over a wide area within woodlands, paddocks, grasslands, residential gardens and saltmarsh (DEC 2006a). Breeding pairs are generally sedentary within home ranges estimated to be 250-600ha for foraging year round, with a core of 10-25ha during breeding. It is very vulnerable to predation by exotic predators, the clearing of native woodlands, habitat degradation and even trampling by stock.	OEH Atlas – One record (dated 2005) located approx 8km W of Ulan near Cope SF. Predicted to occur in Coolah Tops NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are no records of this species.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Speckled Warbler <i>Chthonicola sagittata</i> V TSC	This species occurs in a wide range of eucalypt woodland communities in the hills and tablelands of the Great Dividing range. Habitats typically are structurally diverse with a grassy understorey, a sparse shrub layer and an open canopy (DECCW 2010; Watson <i>et al.</i> , 2001). Declines have been linked to habitat fragmentation as the species appears to be locally extinct in districts where no habitat fragments larger than 100ha remain (Watson <i>et al.</i> , 2001). Further, larger remnants (about 300ha) may be required for populations to be viable (Gardner, 2002). The species is sedentary and nests and forages on the ground. Nests are built directly on the ground amongst leaf litter and understorey vegetation and are vulnerable to predation by large birds such as Currawongs (Gardner, 2002).	OEH Atlas – 75 records (dated 1963-2010) scattered records concentrated around vegetated areas within Durrigere SF, Goulburn River NP, Coolah Tops NP and vegetated areas north of Ulan Colliery.	Marginal	Unlikely	Moderate minor habitat loss	Assessment of Significance undertaken
Brown Treecreeper (eastern subspecies) <i>Climacteris picumnus victoricae</i> V TSC	Occurs in eucalypt woodlands, mallee and drier open forest of eastern Australia, preferring woodlands lacking dense understorey (Schodde and Tidemann 2007). Feeds on insects in the leaf litter and trunks of trees. Nests in tree hollows, stumps or rotted fence posts. Requires relatively intact woodland areas, nesting in a tree hollow.	OEH Atlas – 81 records (dated 1963-2009) scattered through study area but with most records vegetated areas north of Ulan Colliery and within Goulburn River NP. Also several records within Coolah Tops NP.	Present	Possible	Moderate	Assessment of Significance undertaken

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Varied Sittella <i>Daphoenositta chrysoptera</i> V TSC	The Varied Sittella is a small (10 cm) songbird with a sharp, slightly upturned bill, short tail, barred undertail, and yellow eyes and feet. In flight the orange wing-bar and white rump are prominent. In NSW most individuals have a grey head and are streaked with dark brown, but in the extreme north-east they have a white head, and in the extreme south-west a black cap. Varied Sittellas are more active and acrobatic among branches than the larger treecreepers. They fly into the heads of trees, typically working their way down branches and trunk with constant motion. The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west.	OEH Atlas – 18 records (dated 1976-2010) scattered throughout vegetated areas along the proposed powerline routes and one record within W part of Coolah Tops NP.	Present	Present	Moderate minor habitat loss	Assessment of Significance undertaken
White-fronted Chat <i>Epthianura albifrons</i> V TSC	The White-fronted Chat is found across the southern half of Australia, from southernmost Queensland to southern Tasmania, and across to Western Australia as far north as Carnarvon. Found mostly in temperate to arid climates and very rarely sub-tropical areas, it occupies foothills and lowlands up to 1000 m above sea level. In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the western part of the state. The species is gregarious, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground.	Predicted to occur in Coolah Tops NP.	Marginal	Possible	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are no records of this species.
Regent Honeyeater <i>Anthochaera phrygia</i> E TSC E EPBC M EPBC	There are now only a small number of known breeding sites in NSW, the most important of which are: Warrumbungles NP, Pilliga NR, Barraba district, central coast around Gosford, Hunter Valley, and Capertee Valley (DECCW 2010). Most records are from box-ironbark eucalypt associations and it appears to prefer wetter fertile sites within these associations (Menkhorst <i>et al.</i> , 1999). It is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Yellow Gum, Blakely's Red Gum and White Box (Menkhorst <i>et al.</i> , 1999). It also occurs in riparian forests of River She-oak and wet lowland coastal forests dominated by Swamp Mahogany and Spotted Gum and (DECCW 2010). The species can undertake large-scale nomadic movements in the order of hundreds of kilometres.	OEH Atlas – 11 records (dated 1985-2000) mostly from eastern Goulburn River NP and SW of Ulan.	Present	Possible	Low minor habitat loss	Habitat for this species within the Wind Farm Study Area is marginal and there are no recent records of this species.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Painted Honeyeater <i>Grantiella picta</i> V TSC	This species primarily occurs on the inland slopes of the Great Dividing Range, although is nomadic and may occur in low densities in other parts of NSW in suitable habitat. It inhabits dry open forests and woodland including Boree, Brigalow and Box Gum Woodlands and Box-Ironbark open forests, also paperbark and casuarinas (DECCW 2010; Pizzey <i>et al.</i> , 2003). It is a specialist feeder on mistletoe, particularly of genus <i>Amyema</i> , and generally requires 5 or more mistletoes per hectare (DECCW 2010). Seasonal migrant, movements are linked to the fruiting of mistletoe.	OEH Atlas – 3 records (dated 2005) located within semi-cleared areas west of Curryall SF and near Goulburn River Stone Cottages.	Present	Possible	Low some habitat loss	Assessment of Significance undertaken
Pied Honeyeater <i>Certhionyx variegatus</i> V TSC	Inhabits wattle shrub (primarily Mulga, <i>Acacia aneura</i>), mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (<i>Eremophila</i> spp.); also from mistletoes and various other shrubs (e.g. <i>Brachysema</i> spp. and <i>Grevillea</i> spp.); also eats saltbush fruit, berries, seed, flowers and insects.	N/A	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Black-chinned Honeyeater (eastern subspecies) <i>Melithreptus gularis gularis</i> V TSC	This species is widespread west of the Great Dividing Range, although has declined throughout its range due to removal and fragmentation of habitat. It inhabits the upper levels of drier open forests or woodlands most often dominated by box and ironbark eucalypts, particularly Mugga Ironbark, White Box, Grey Box, Yellow Box and Forest Red Gum. A gregarious species usually seen in pairs and small groups of up to 12 birds and occupies large home ranges of at least 5 hectares. Local populations appear not to persist in remnants less than 200 ha in area (NSW Scientific Committee, 2001).	OEH Atlas – 9 records (dated 1998-2006) concentrated around vegetated areas of Goulburn River NP, NW section of Coolah Tops NP and north of Ulan Colliery.	Present	Possible	Low	Assessment of Significance undertaken

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Gilbert's Whistler <i>Pachycephala inornata</i> V TSC	<p>This species is sparsely distributed over much of the arid and semi-arid zone of inland southern Australia, west of the western slopes of NSW (DECCW 2010). There are only three separate populations left in NSW. Most of the eastern population occurs in an area enclosed by a line joining Gilgandra to Cobar, then south to Narrandera, east to Wagga Wagga, north to Wellington and back to Gilgandra.</p> <p>In NSW the species occurs mostly in mallee shrubland in association with Spinifex and low shrubs. It also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. In woodland habitats, the species requires a dense shrubby understorey (DECCW 2010).</p>	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Unlikely	Low	Database searches did not show any records of this species within the Wind Farm Study Area.
Hooded Robin (south-eastern form) <i>Melanodryas cucullata cucullata</i> V TSC	<p>This species is sparsely distributed throughout much of NSW, and is rarely found on the coast. It is sedentary and occurs in open eucalypt woodland and scrub, often in or near cleared areas (DECCW 2010). The species generally occurs in woodland remnants with high habitat complexity (Watson <i>et al.</i>, 2001) and uses stumps, posts or fallen timber for nesting and locating prey on the ground. Territories range from 10 to 30ha (DECCW 2010).</p>	<p>OEH Atlas – 18 records (dated 63-2009) from vegetated areas along Ulan Rd, Goulburn River NP, north of Ulan Colliery and two records from NW part of Coolah Tops NP.</p>	Marginal	Possible	Low	Habitat for this species within the Wind Farm Study Area is marginal and it was not recorded during the survey.
Scarlet Robin <i>Petroica boodang</i> V TSC	<p>The Scarlet Robin is found in south-eastern Australia and south-west Western Australia. In NSW it occupies open forests and woodlands from the coast to the inland slopes. Scarlet robins breed in dry eucalypt forests and temperate woodland. Fallen timber is an important habitat feature for this species.</p>	<p>OEH Atlas -15 records dated (1975-2009) with majority of records from NW section of Coolah Tops NP and come scattered records around Ulan Colliery.</p>	Present	Present	Moderate habitat loss	Assessment of Significance undertaken

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Flame Robin <i>Petroica phoenicea</i> V TSC	Flame Robins are found throughout south-eastern Australia, associated with areas of native vegetation with an open understory. It breeds in upland forests and woodlands and migrates to more open lowland habitats in winter. The South Western Slopes bioregion is considered the core wintering region for this species (DECCW 2010).	OEH Atlas – 4 records (dated 1975-2005) with majority of records from NW section of Coolah Tops NP.	Marginal	Possible	Low	Habitat for this species within the Wind Farm Study Area is marginal and it was not recorded during the survey.
Pink Robin <i>Petroica rodinogaster</i> V TSC	The male Pink Robin has a sooty black throat and upperparts. The wings have faint, tan-buff wing-bars. The breast and belly are deep lilac-pink, and there is a small white patch on the forehead. The Pink Robin is found in Tasmania and the uplands of eastern Victoria and far south-eastern NSW, almost as far north as Bombala. On the mainland, the species disperses north and west and into more open habitats in winter, regularly as far north as the ACT area, and sometimes being found as far north as the central coast of NSW.	Not recorded on the NSW OEH Database or EPBC database.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Grey-crowned Babbler (eastern subspecies) <i>Pomatostomus temporalis temporalis</i> V TSC	In NSW this species occurs west of the Great Dividing Range and on the coast near the Hunter Valley and several locations on the north coast of NSW. It prefers Box Gum Woodlands although also inhabits open forests, scrub lands, even farmlands and suburbs (DECCW 2010; Pizzey <i>et al.</i> , 2003). The species is gregarious and forage on the ground on invertebrates on tree trunks and branches and by foraging amongst litter and tussocks. Territories of family groups range from one to fifty hectares (DECCW 2010).	OEH Atlas – 35 records (dated 1975-2010) concentrated around Ulan Colliery and to the north. One record from Coolah Tops NP.	Present	Present	Moderate minor habitat loss	Assessment of Significance undertaken
Rufous Fantail <i>Rhipidura rufifrons</i> M EPBC	This species is found in a variety of habitats including eucalypt woodlands and watercourses where it nests in a horizontal fork of a tree up to 12m from the ground. Breeds in southern Australia, but is known to migrate to inland Australia, PNG, Solomon Islands, New Caledonia and Indonesia.	Predicted to occur from the EPBC Database.	Marginal	Possible	Low	

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Diamond Firetail <i>Stagonopleura guttata</i> V TSC	Occurs predominantly west of the Great Dividing Range (Blakers <i>et al.</i> 1984) although local populations are known. Feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde and Tidemann 2007), nesting in pairs or communally in shrubs and small trees. Restricted largely to ungrazed or lightly grazed woodland remnants of grassy eucalypt woodlands, including Box-Gum and Snow Gum Woodlands, and grassland and riparian areas, and sometimes lightly wooded farmland. May form large flocks during winter and autumn.	OEH Atlas – 24 records (dated 1963-2010) with majority of records concentrated within vegetated areas E and W of the proposed transmission line routes.	Marginal	Unlikely	Moderate	
Little Lorikeet <i>Glossopsitta pusilla</i> V TSC	Forages primarily in the canopy of open <i>Eucalyptus</i> forest and woodland, yet also finds food in <i>Angophoras</i> , <i>Melaleucas</i> and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.	OEH Atlas – 12 records (dated 1963-2008) scattered throughout study area near Ulan, Goulburn River NP and Coolah Tops NP.	Present	Recorded to the north of the Study area during the survey period	High habitat loss; potential blade-strike	Assessment of Significance undertaken
Gang-gang Cockatoo <i>Callocephalon fimbriatum</i> V TSC	In NSW, this species is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the ACT. It feeds in pairs or small flocks on seeds of eucalypts and wattles, and occurs primarily in heavily timbered and mature wet forest, but occasionally in towns, farming areas (DECCW 2010). It is often a seasonal altitudinal migrant, moving to lower altitudes and more open forests and woodlands (particularly Box-Ironbark assemblages for winter). This species requires large hollows in which to breed (Gibbons and Lindenmayer, 2000)	OEH Atlas – Four records (dated 2000-2006) located in vegetated areas near Curryall SF, within Goulburn River NP and 3km north of Ulan Colliery. Closest record 2.2km from powerline.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and it was not recorded during the survey.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Glossy Black-Cockatoo <i>Calyptrorhynchus lathamii</i> V TSC	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species, particularly Black She-oak (<i>Allocasuarina littoralis</i>), Forest She-oak (<i>A. torulosa</i>) or Drooping She-oak (<i>A. verticillata</i>) occur. Feeds almost exclusively on the seeds of several species of she-oak (<i>Casuarina</i> and <i>Allocasuarina</i> species), shredding the cones with the massive bill.	<p>OEH Atlas – 260 records (dated 1975-2010) scattered throughout study area, several records located on proposed powerline routes.</p> <p>Moolarben Coal Project (2006) – 39 records mainly from veg assoc. with Black Cypress Pine near Ulan Rd and adjacent ridges.</p>	Marginal	Possible	Moderate habitat loss; potential blade-strike	Assessment of Significance undertaken
Swift Parrot <i>Lathamus discolor</i> E TSC E EPBC	This species breeds in Tasmania, migrating to south and eastern NSW in autumn/winter where it inhabits eucalypt forests and woodlands, particularly Box-Ironbark Forests of central Victoria and southern NSW (DECCW 2010; Smales, 2005). Mostly occurs on the south-west slopes. It feeds on nectar flowers of eucalypts and lerp-insects, also soft fruits and berries sometimes foraging in grass (Pizzey and Knight 2003). Favoured feed trees include winter flowering species such as Swamp Mahogany, Spotted Gum, Red Bloodwood, Mugga Ironbark, and White Box (DECCW 2010).	<p>OEH Atlas – 2 records (dated 2005) located approx. 4km W of Curryall SF in a cleared area.</p> <p>Predicted to occur in Coolah Tops NP.</p>	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.
Major Mitchell's Cockatoo <i>Lophochroa leadbeateri</i> V TSC	Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. In NSW it is found regularly as far east as about Bourke and Griffith, and sporadically further east than that. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines.	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Unlikely	Low	Database searches did not show any records of this species within the Wind Farm Study Area.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Turquoise Parrot <i>Neophema pulchella</i> V TSC	In NSW, this species is typically recorded west of the escarpment in the tablelands and on the western slopes, extending to the coastal districts through the Hunter Valley (DECCW 2010). It occurs in grassy woodland and open forest carrying a mixed assemblage of White Box, Yellow Box, Blakely's Red Gum, Red Box and Red Stringybark (NPWS, 1999f). The species will also utilise the edges of woodland, timbered ridges and creeks in farmland and nests in tree hollows, logs or posts (DECCW 2010). The species lives in pairs or small groups and forages on the ground.	OEH Atlas – 14 records (dated 1975-2008) located mostly within Goulburn River NP and one record from Coolah Tops NP.	Marginal	Possible	Moderate habitat loss; potential blade-strike	Assessment of Significance undertaken
Superb Parrot <i>Polytelis swainsonii</i> V TSC V EPBC	This species is found throughout eastern inland NSW. On the South-western slopes the core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west (DECCW 2010). It inhabits Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. The species nests in the hollows of large trees (dead or alive) in open Box Gum Woodland or isolated paddock trees. Species known to be used for nesting are Blakely's Red Gum, Yellow Box, Apple Box and Red Box (DECCW 2010). It forages on the ground in grassy woodland, also on fruit, seeds and blossoms of acacias, eucalypts and mistletoes (Pizzey and Knight, 2003).	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Possible	Low	Database searches did not show any records of this species within the Wind Farm Study Area.
Square-tailed Kite <i>Lophoictinia isura</i> V TSC	This species has a large and sparsely populated range throughout mainland Australia (Griffioen and Clarke, 2002) and is a breeding migrant to the south east from July to December. It occurs primarily in coastal and sub-coastal open forest, woodlands and mallee. It has been recorded inland along timbered watercourses and adjacent areas. The species hunts small passerines, especially honeyeaters in the tree canopy. Resident pairs have large hunting ranges of greater than 100 km ² (DECCW 2010). Nests are a platform of sticks up to 90cm in diameter in a fork of a tall tree in forest or woodland (DEC NSW, 2004).	OEH Atlas – Four records (dated 2000-2002) located in open and vegetated areas approx. 13km east of Ulan, within the Goulburn River NP and adjacent farming areas.	Marginal	Possible	Moderate potential blade-strike	Assessment of Significance undertaken

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Red Goshawk <i>Erythrorhynchus radiatus</i> CE TSC V EPBC	<p>This raptor is distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. The species is very rare in NSW, extending south to about 30°S, with most records north of this, in the Clarence River Catchment, and a few around the lower Richmond and Tweed Rivers. Formerly, it was at least occasionally reported as far south as Port Stephens. Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, <i>Melaleuca</i> swamp forest and riparian <i>Eucalyptus</i> forest of coastal rivers.</p>	<p>Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.</p>	Marginal	Unlikely	Low	<p>Database searches did not show any records of this species within the Wind Farm Study Area.</p>
Little Eagle <i>Hieraetus morphnoides</i> V TSC	<p>Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.</p>	<p>OEH Atlas – Eleven records (dated 1975-2004). Several located around the Ulan colliery and within Durridgere SF as well as near Coolah and Coolah Tops NP approx. 2.5km from the proposed Wind Farm.</p>	Marginal	Possible	High potential blade strike	
Black-breasted Buzzard <i>Hamirostra melanosternon</i> V TSC	<p>Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion. Also specialises in feeding on large eggs, including those of emus, which it cracks on a rock. Breeds from August to October near water in a tall tree. The stick nest is large and flat and lined with green leaves. Normally two eggs are laid.</p>	<p>OEH Atlas – One record (dated 2005) recorded approx. 10km SW of Turill, located on the edge of grassland/woodland vegetation.</p>	Marginal	Unlikely	Low	<p>Habitat for this species within the Wind Farm Study Area is marginal and there are few local records. It was not recorded during the fauna survey.</p>

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Grey Falcon <i>Falco hypoleucos</i> E TSC	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey. Utilises old nests of other birds of prey and ravens, usually high in a living eucalypt near water or a watercourse	Known from Coolah Tops NP.	Marginal	Unlikely	Low potential blade strike	No records in vicinity of either Study Area, and any sightings in the region will only be vagrant records.
Spotted Harrier <i>Circus assimilis</i> V TSC	The Spotted Harrier occurs in a variety of habitats including grassy open woodland and riparian woodland. They generally do not occur in densely forested or wooded habitats of the coast, escarpment and ranges. It is commonly associated with native grasslands.	OEH Atlas – Three records (dated 1997-2008) located at Ulan Colliery, near Uarbry and 10km SW of Turill. Records located in open semi-cleared areas. Known from Coolah Tops NP.	Marginal	Possible	Low potential blade strike	
Malleefowl <i>Leipoa ocellata</i> E TSC V EPBC	The Malleefowl is a large (60 centimetres long, 43 centimetres high and weighing between 1.5 and 2.5 kilograms), distinctive, ground-dwelling bird. It possesses robust, powerful legs, a short bill and a flattish head while the wings are short, broad and rounded at the tip. The head and neck is greyish above, topped with black, the chin is chestnut and the throat and chest are white with a central black stripe. The stronghold for this species in NSW is the mallee in the south west centred on Mallee Cliffs NP and extending east to near Balranald and scattered records as far north as Mungo NP. West of the Darling River a population also occurs in the Scotia mallee including Tarawi NR and Scotia Sanctuary, and is part of a larger population north of the Murray River in South Australia.	Goulburn River NP – one record (dated 1989) near Mogo.	Absent	Unlikely	No	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Plains Wanderer <i>Pedionomus torquatus</i> E TSC	The vast majority (>99%) of records of Plains-wanderers in NSW over the past 30 years come from an area of the western Riverina bounded by Hay and Narrandera on the Murrumbidgee River in the north, the Cobb Highway in the west, the Billabong Creek in the south, and Urana in the east. Even within its western Riverina stronghold, the Plains-wanderer has a very patchy distribution. They occur in semi-arid, lowland native grasslands that typically occur on hard red-brown soils. These grasslands support a high diversity of plant species, including a number of state and nationally threatened species. Grassland habitat structure is more important than species composition. Preferred habitat typically has 50% bare ground, 10% fallen litter, and the remaining 40% comprised of herbs, forbs and grasses.	OEH Atlas – One record (dated 1984) from near Uarabry approx. 8.5km west of the powerline.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Australian Bustard <i>Ardeotis australis</i> E TSC	Mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams. Breeds on bare ground on low sandy ridges or stony rises in ecotones between grassland and protective shrubland cover; roosts on ground among shrubs and long grasses or under trees. Forages on insects, young birds, lizards, mice, leaves, seeds and fruit. Dispersive, with irregular widespread movements over long distances; movements are thought to be in response to habitat and climatic conditions; known to converge on areas with high mice numbers and in recently burnt areas.	Not recorded on the NSW OEHS Database or EPBC database.	Marginal	Unlikely	Low	Database searches did not show any records of this species within the Wind Farm Study Area.
Black-tailed Godwit <i>Limosa limosa</i> V TSC	Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps	Not recorded on the NSW OEHS Database or EPBC database.	Absent	Unlikely	No	Database searches did not show any records of this species within the Wind Farm Study Area and suitable habitat does not occur.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Australian Painted Snipe or Painted Snipe <i>Rostratula benghalis</i> E TSC V EPBC M EPBC	<p>In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. It is most common in the Murray-Darling Basin (DECCW 2010). It inhabits inland and coastal ephemeral and permanent freshwater wetlands, especially where there is a cover of vegetation. It has been recorded on the margins of wetlands, dams and even sewage ponds, also found in wet pastures, marshy areas, irrigation systems, tea tree scrub and adjacent open woodlands (Pizzey and Knight 2003). The species is likely to be nomadic in response to suitable conditions, such as floods (DECCW 2010).</p>	<p>Predicted to occur in Coolah Tops NP.</p>	Marginal	Unlikely	Low	<p>Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.</p>
Black-necked Stork <i>Ephippiorhynchus asiaticus</i> E TSC	<p>It occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast. In NSW, the species becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of Sydney.</p>	<p>Not recorded on the NSW OEH Database or EPBC database.</p>	Absent	None	No	<p>Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.</p>
Australasian Bittern <i>Botaurus poiciloptilus</i> E TSC E EPBC	<p>Little is known of the behaviour of this cryptic waterbird. May be nomadic as it has been observed occupying ephemeral wetlands. Seeds and invertebrates are foraged for on the water's edge.</p>	<p>Predicted to occur in Coolah Tops NP.</p>	Marginal	Unlikely	Low	<p>Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.</p>
Black Bittern <i>Ixobrychus flavicollis</i> V TSC	<p>The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.</p>		Absent	Unlikely	No	<p>Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.</p>

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Brolga <i>Grus rubicunda</i> E TSC	This species was formally found across Australia, except for the south-east corner. It inhabits large open wetlands, grassy plains, coastal mudflats and irrigated croplands. Breeding and foraging habitat includes shallow (< 50 cm) wetlands, mudflats and margins of deeper water bodies with emergent vegetation (e.g. canegrass, lignum or sedges) (DECCW 2009).	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Unlikely	Low	Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.
Magpie Goose <i>Anseranas semipalmata</i> V TSC	The Magpie Goose is a large, distinctive black and white water-bird (from 70 - 90 cm long) with a prominent knob on the head, and orange legs. It is black at each 'end' - head, neck and upper chest, plus rump and tail - with white body and wings in between. Immature birds have no head-knob and their white parts are mottled grey or brown. It is not a duck or goose, but is regarded as a primitive relative of them. The Magpie Goose is still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Vagrants can follow food sources to south-eastern NSW.	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Unlikely	Low	Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.
Freckled Duck <i>Stictonetta naevosa</i> V TSC	This species occurs on wetlands of inland NSW. Large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina are a breeding stronghold (DECCW 2010). The species is partially migratory and may move to coastal habitats during severe inland drought. The species inhabits a variety of plankton-rich wetland types, including swamps, lakes, farm dams, sewerage ponds and floodwaters that are heavily vegetated with Cumbungi, Lignum, Canegrass or Tea-tree (DECCW 2010).	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Unlikely	Low	Database searches did not show any records of this species within the Wind Farm Study Area and any areas of suitable habitat occur outside of the development footprint.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Barking Owl <i>Ninox connivens</i> V TSC	<p>This species is found throughout Australia except for the central arid regions and Tasmania. It has declined across much of its range across NSW and is most frequently recorded on the western slopes and plain. It occurs in dry box-dominated forest and woodlands and roosts in dense foliage of <i>Acacia</i>, <i>Casuarina</i> or <i>Eucalyptus</i> species. It nests in large hollows (20-46 cm diameter) of large, old eucalypts including River Red Gum, White Box, Red Box and Blakely's Red Gum (NPWS 2003a). Nest and roost sites are usually near watercourses or wetlands (NPWS, 2003a). The species have also been recorded in remnants of forest and woodland and in clumps of trees at farms, towns and golf courses (NPWS, 2003a). Have large territories of 30 to more than 200 hectares (NPWS, 2003a).</p>	<p>OEH Atlas – 11 records (dated 1976-2006) scattered throughout study area, mostly around Coolah and Goulburn River NP. One record from Durrigere SF approx. 1.4km from the proposed powerline route and one record approx. 2km from turbine envelope. Most records located in vegetated areas or on edges.</p>	Marginal	Possible	Moderate habitat loss; potential blade-strike	Assessment of Significance undertaken
Powerful Owl <i>Ninox strenua</i> V TSC	<p>This species occurs primarily in tall, moist productive eucalypt forests of the eastern tableland edge and the mosaic of wet and dry sclerophyll forests occurring on undulating, gentle terrain nearer the coast (DEC NSW, 2006b). Only scattered, mainly historical records are from the western slopes and plains (DECCW 2010). The species requires old hollow eucalypts in unlogged, unburnt forests for nesting, and roosts in dense mid-canopy trees or tall shrubs (She-oaks, wattles or rainforest species). Nesting and roosting habitat occurs in sheltered gullies, or within 100m of streams, creekflats or minor drainage lines (DEC NSW, 2006b). Hollows greater than 45 cm diameter and greater than 100 cm deep are required. Breeding pairs of this species defend large (300-1500 hectare), permanent territories. Optimal habitat includes a tall shrub layer with abundant hollows and supporting high densities of arboreal marsupials (DEC NSW, 2006b).</p>	<p>OEH Atlas – 24 records dated (1985-2012) scattered throughout Study area, mostly from vegetated areas within Goulburn River NP and Coolah Tops NP. Some records located along powerline route.</p>	Marginal	Possible	Moderate minor habitat loss; potential blade-strike	Assessment of Significance undertaken

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Masked Owl <i>Tyto novaehollandiae</i> V TSC	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. Pairs have a large home-range of 500 to 1000 hectares.	OEH Atlas – five records (dated 1993-2005) from within densely vegetated areas of Goulburn River NP, Coolah Tops NP and near Uarbry.	Marginal	Possible	Moderate minor habitat loss; potential blade-strike	Assessment of Significance undertaken
White-throated Needletail <i>Hirundapus caudacutus</i> M EPBC	Noted as one of the world's fastest birds, this species has been recorded in the airspace above woodlands, forests and farmlands. Often seen 'patrolling' favoured feeding grounds above ridges and hilltops. This species migrates to Australia from mid-October and is a regular summer migrant until April when it returns to breed.	Predicted to occur from the EPBC Database.	Moderate	Possible	Moderate potential blade-strike	Will possibly occur infrequently in the study area during migration to southern hemisphere during our spring and summer months. Predominantly coastal.
Rainbow Bee-eater <i>Merops ornatus</i> M EPBC	This species inhabits open woodlands with sandy, loamy soil. It builds a burrow in sandy ground or bank cuttings such as roads or creeks. The species is a summer breeding migrant (Sept-Apr) to south-eastern Australia, but winters in northern Australia, Solomon Islands, PNG and Indonesia.	Predicted to occur from the EPBC Database.	Marginal	Possible	Low	
Satin Flycatcher <i>Myiagra cyanoleuca</i> M EPBC	This species is found in heavily vegetated gullies in forests, usually above a shrub layer. During migration it is often found in coastal forests. It breeds mostly in south-east Australia, and usually departs in March to winter in northern QLD, PNG and the Torres Strait Islands. Occasional vagrant to New Zealand.	Predicted to occur from the EPBC Database.	Marginal	Possible	Low	
Fork-tailed Swift <i>Apus pacificus</i> M EPBC	This species breeds from central Siberia eastwards through Asia and winters south to Australia. Uncommon in eastern Australia. It spends most of its time in the air feeding on insects, occasionally roosting on cliffs or in large trees (Pizzey <i>et al.</i> , 2006). It occurs throughout mainland Australia, mostly west of the divide.	Predicted to occur from the EPBC Database.	Marginal	Possible	Low	

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Great Egret <i>Ardea alba</i> M EPBC	The Great Egret has been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). These include swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs. The Great Egret can retreat to permanent wetlands or coastal areas when other wetlands are dry (for example, during drought). This may occur annually in some regions with regular wet and dry seasons or erratically where the availability of wetland habitat is also erratic.	Predicted to occur from the EPBC Database.	Marginal	Possible	Low	
Cattle Egret <i>Ardea ibis</i> M EPBC	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. The Cattle Egret is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation (Marchant & Higgins 1990; Morton <i>et al.</i> 1989).	Predicted to occur from the EPBC Database.	Marginal	Possible	Low	
Latham's Snipe, Japanese Snipe <i>Gallinago hardwickii</i> M EPBC	Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. They usually occur in open, freshwater wetlands that have some form of shelter (usually low and dense vegetation) nearby.	Predicted to occur from the EPBC Database.	Marginal	Unlikely	Low	

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
White-bellied sea eagle <i>Haliaeetus leucogaster</i> M EPBC	This species occurs around coastal areas, islands and estuaries, but is also found in inland areas around large rivers, wetlands and reservoirs. This species shows a high fidelity to nest sites, where it constructs conspicuous stick nests in the forks of tall trees and stags.	Predicted to occur from the EPBC Database.	Marginal	Possible	Moderate potential blade-strike	
Australian Painted Snipe or Painted Snipe <i>Rostratula benghalis</i> E TSC V EPBC M EPBC	See Diurnal Birds Above	See Diurnal Birds Above				
Regent Honeyeater <i>Anthochaera phrygia</i> E TSC E EPBC M EPBC	See Diurnal Birds Above	See Diurnal Birds Above				
Large-eared Pied Bat <i>Chalinolobus dwyeri</i> V TSC	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. It roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Hirundo ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. Found in well-timbered areas containing gullies.	OEH Atlas – 7 records (dated 2000) with all records located within vegetated areas of Goulburn River NP. Also recorded from Coolah Tops NP.	Marginal	Present (Anabat record)	Moderate found in timbered Gullies and this habitat won't be affected.	Assessment of Significance undertaken
Little Pied Bat <i>Chalinolobus picatus</i> V TSC	This species occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, bimbil box (DECCW 2010). It roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. It often forages along watercourses (Menkhorst and Knight 2003) where it feeds on moths and possibly other flying invertebrates.	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Possible	Low forages beneath canopy	

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Little Bentwing-bat <i>Miniopterus australis</i> V TSC	East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, <i>Melaleuca</i> swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.		N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Eastern Bentwing-bat <i>Miniopterus schreibersii oceanensis</i> V TSC	This species is a common although a vulnerable species that is likely to be widely distributed throughout the region. It roosts and raises its young in caves and mine tunnels (Strahan 1995). The species appears to forage above the forest canopy in a diverse range of forest types (Strahan 1995). The species forms discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	OEH Atlas – 2 records (dated 1997-2000) located within Goulburn River NP. Also recorded in Coolah Tops NP.	Marginal	Present (Anabat record)	High blade-strike	Assessment of Significance undertaken
Eastern Freetail-bat <i>Mormopterus norfolkensis</i> V TSC	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. The species occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. It roosts mainly in tree hollows but will also roost under bark or in man-made structures.	N/A	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Corben's Long-eared Bat <i>Nyctophilus corbeni</i> V TSC V EPBC	<p>The south eastern form of the Greater Long-eared Bat is also known as Eastern Long-eared Bat and has recently been described as new species Corben's Long-eared Bat (<i>N. corbeni</i>). Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation types, including mallee, bullock <i>Allocasuarina leuhmanni</i> and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. It roosts in tree hollows, crevices, and under loose bark. The species is a slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground.</p>	<p>OEH Atlas – 6 records (dated 2000-2002) with the majority of records from vegetated valleys within Goulburn NP and one record near Turill SF. Also known from Coolah Tops NP.</p>	Marginal	Present (Anabat record)	Moderate forages beneath canopy	Assessment of Significance undertaken
Yellow-bellied Sheathtail-bat <i>Saccolaimus flaviventris</i> V TSC	<p>This species is a wide-ranging species across northern and eastern Australia. It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (DECCW 2010). When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Seasonal movements are unknown, however the species may migrate to southern Australia in late summer and autumn.</p>	<p>Known to occur in Coolah Tops NP.</p>	Marginal	Present? (possible Anabat record)	High potential blade-strike	Assessment of Significance undertaken
Eastern Cave Bat <i>Vespadelus troughtoni</i> V TSC	<p>The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. It is a cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.</p>	<p>Predicted to occur in Coolah Tops NP.</p>	Marginal	Present (Anabat record)	High potential blade-strike	Assessment of Significance undertaken

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Eastern False Pipistrelle <i>Falsistrellus tasmaniensis</i> V TSC	It is widely distributed in eastern NSW from the Dividing Ranges through to the coast (Van Dyck & Strahan 2008). It is found in wet sclerophyll forest and coastal mallee. It appears to prefer wet sclerophyll forest although also utilises open forest at lower altitudes (Churchill 2008; Hall and Richards 1979). Absent from small patches of remnant forest, preferring continuous forest, although have been recorded foraging or moving through open/cleared landscapes (Churchill 2008). The Eastern False Pipistrelle prefers moist habitats, with trees taller than 20 m. It generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy.	OEH Atlas – 2 records (dated 1993-2000) located in Goulburn River NP and Coolah Tops NP within close proximity to the proposed wind farm.	Marginal	Possible	Low forages within or beneath canopy	
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i> V TSC	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.	Known from Coolah Tops NP.	Marginal	Possible	Low forages beneath canopy	
Greater Long-eared bat (south-eastern form)/ Eastern Long-eared Bat <i>Nyctophilus timoriensis</i> V TSC V EPBC	The species prefers more arid regions, the distribution of the south eastern form approximately coincides with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. This species inhabits a variety of vegetation types, including mallee, bullock but more commonly box/ironbark/cypress-pine communities that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (DECCW). It is a slow flying agile species and forages in the lower parts of the canopy, even amongst the shrub layers and on the ground (Menkhorst and Knight 2001) and often over water bodies. The species roosts in tree hollows, and under loose bark.	Not recorded on the NSW OEH Database or EPBC database.	Marginal	Possible	Low forages beneath canopy	

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Grey-headed Flying-fox <i>Pteropus poliocephalus</i> V TSC V EPBC	This species roosts in large camps, generally in wetter vegetation such as riparian areas, rainforest or swamp forest. Groups fly out at night to feed on fruit, nectar and blossom, particularly of <i>Eucalyptus</i> , <i>Melaleuca</i> and <i>Banksia</i> . This species shows fidelity to roosting areas but may feed in orchards. It appears to be showing increasing tolerance to human disturbance.	Predicted to occur in Coolah Tops NP.	Marginal	Possible	Low	
Spotted-tailed Quoll <i>Dasyurus maculatus</i> V TSC E EPBC	This species is found in a variety of forest types such as rainforest, wet and dry sclerophyll forest, woodland, coastal heath and scrub, sometimes Red Gum forest along inland waterways (Menkhorst and Knight, 2004). It utilises hollow-bearing trees, fallen logs, rock caves and crevices as denning and breeding sites (DECCW 2010). Mostly nocturnal it hunts mammals, birds and large arthropods. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creeklines.	OEH Atlas – 2 records (dated 1980-2008) located along roadsides NW of Coolah and along the Golden Hwy SE of Cassilis. Known to occur in Coolah Tops NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.
Bilby <i>Macrotis lagotis</i> Extinct TSC V EPBC	Extinct.		N/A	N/A	N/A	
Yellow-bellied Glider <i>Petaurus australis</i> V TSC	They feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. They den, often in family groups, in hollows of large trees. The species is very mobile and occupies large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south.	Predicted to occur in Coolah Tops NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Squirrel Glider <i>Petaurus norfolcensis</i> V TSC	This species inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas (DECCW 2010). It prefers mixed species stands with a shrub or Acacia understorey although will occur in areas where no understorey if there is more than one species of Eucalypt. Feeds on insects, nectar and exudates from leaves and trees (<i>Eucalyptus</i> and <i>Acacia</i>) and requires abundant tree hollows greater than 5cm diameter (DECCW 2010). It can use patches less than 1 ha & isolated trees if within 75 m of other patches (DECCW 2010). Has a mean home range of 1.4–9 ha (Ahern & van der Ree 2003; Quin, 1995; Ree and Bennett, 2003).	OEH Atlas – 16 records (dated 2000-2009) with most records from surveys done north of the Ulan Colliery within vegetated areas.	Moderate	Present	Moderate minor habitat loss	Assessment of Significance undertaken
Brush-tailed Rock-wallaby <i>Petrogale penicillata</i> V TSC V EPBC	Isolated populations along the Great Dividing Range. This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks. In many parts of their range, rock-wallabies are closely associated with dense arboreal cover, especially fig trees (NSW NPWS 2003a). The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation (Wong 1993; 1997). A range of vegetation types are associated with Brush-tailed Rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (Murray <i>et al.</i> 2008).	OEH Atlas – 3 records (dated 1999-2009) located north of the Ulan Colliery and within the E part of Goulburn River NP. Known to occur in Coolah Tops NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.
Brush-tailed Phascogale <i>Phascogale tapoatafa</i> V TSC	Found in a variety of forest types although prefers dry sclerophyll forest with a sparse groundcover (DECCW). It generally occurs in areas where the annual rainfall exceeds 500mm. Have large overlapping territories between 20 – 100 hectares. It requires tree hollows with openings 25-40mm wide for nesting and utilises multiple trees throughout its lifetime. Prefer large trees and are most abundant where there are more than 2 trees per ha greater than 60cm DBH. It requires remnants greater than 25ha in dry forests and ridges.	Predicted to occur in Coolah Tops NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Koala <i>Phascolarctos cinereus</i> V TSC V EPBC	<p>This species was historically abundant in the south of NSW, although now occurs in sparse and possibly disjunct populations. It occurs in woodland communities, coastal forests, woodlands of the tablelands and western slopes and the riparian communities of the western plains (NPWS, 2003b). May also utilise isolated paddock trees (NPWS, 2003b). Primary feed tree species listed for the central and southern tablelands are Ribbon Gum and River Red Gum, secondary species include Candle Bark, Blakely's Red Gum, White Box, Yellow Box and Brittle Gum (NPWS, 2003b).</p>	<p>OEH Atlas – 7 records (dated 1957-2002) with four of this located in close vicinity to the proposed wind farm site.</p>	Marginal	Possible	Moderate potential habitat loss	<p>Habitat for this species within the Wind Farm Study Area is marginal and there are few local records. It was not recorded during the fauna survey.</p>
Common Planigale <i>Planigale maculata</i> V TSC	<p>Common Planigales are tiny marsupials with a body length of about 8 cm and a tail as long again. They differ from the common house mouse in having a long, pointed snout and large rounded ears. The head has a flattened appearance. Their fur is grey-brown above, sometimes with tiny white spots, and paler below. Coastal north-eastern NSW, coastal east Queensland and Arnhem Land. The species reaches its confirmed southern distribution limit on the NSW lower north coast however there are reports of its occurrence as far south as the central NSW coast west of Sydney.</p>	<p>Known to occur in Coolah Tops NP.</p>	Absent	None	Low	<p>Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.</p>
Pilliga Mouse <i>Pseudomys pilligaensis</i> V TSC V EPBC	<p>The Pilliga Mouse is very sparsely distributed and appears to prefer areas with a sparse ground cover. Some evidence exists of marked population fluctuations by this species. The Pilliga Mouse is restricted to an isolated area of low-nutrient deep sand which has long been recognised as supporting a distinctive vegetation type (Pilliga Scrub). Recent studies indicate that the Pilliga Mouse were found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of kurricabah (<i>Acacia burrowii</i>) with a bloodwood (<i>Corymbia trachyphloia</i>) overstorey. Consistent features of the latter two habitats were: a relatively high plant species richness; a moderate to high low shrub cover; and a moist groundcover of plants, litter and fungi. The gully where high rates of capture were encountered had an extensive cover by low grasses and sedges, with little shrub cover and large areas of ash-covered ground. It is nocturnal and appears to live in burrows.</p>	<p>Not recorded on the NSW OEH Database or EPBC database.</p>	Absent	None	Low	<p>Database searches did not show any records of this species within the Wind Farm Study Area.</p>

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
New Holland Mouse <i>Pseudomys novaehollandiae</i> V EPBC	The New Holland Mouse has been found from coastal areas and up to 100 km inland on sandstone country. The species has been recorded from sea level up to around 900 m above sea level. Due to the largely granivorous diet of the species, sites where the New Holland Mouse is found are often high in floristic diversity, especially leguminous perennials.	Recorded in Goulburn River NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.
Stripe-faced Dunnart <i>Sminthopsis macroura</i> V TSC	A mouse-sized marsupial which is pale grey-brown above, with white underparts and feet. It has a slender pointed muzzle and a distinct black stripe that extends from between the eyes to between the ears. They often have a fattened carrot-shaped tail. Throughout much of inland central and northern Australia, extending into central and northern NSW, western Queensland, Northern Territory, South Australia and Western Australia. They are rare on the NSW Central West Slopes and North West Slopes with the most easterly records of recent times located around Dubbo, Coonabarabran, Wyallda and Ashford.	Not recorded on the NSW OEH Database or EPBC database.	Absent	None	Low	Database searches did not show any records of this species within the Wind Farm Study Area.
Eastern Pygmy-possum <i>Cercartetus nanus</i> V TSC	The Eastern Pygmy-possum is found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. It feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes, and also feeds on insects throughout the year. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (<i>Pseudocheirus peregrinus</i>) dreys or thickets of vegetation, (eg. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	Predicted to occur in Coolah Tops NP.	Marginal	Unlikely	Low	Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.
Reptiles						

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Pink-tailed Legless Lizard <i>Aprasia parapulchella</i> V TSC V EPBC	<p>This species is only known from the Central and Southern Tablelands, and the South Western Slopes (Osborne and Jones, 1995). It inhabits sloping, open woodland areas with predominantly native grass groundlayers, particularly those dominated by Kangaroo Grass (<i>Themeda australis</i>). Typically these areas are well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks in burrows below these rocks; the burrows usually have been constructed by and are often still inhabited by small black ants and termites (Osborne and Jones, 1995). This species feeds on the larvae and eggs of these ants (DECCW 2010).</p>	<p>Goulburn River NP – One record (dated 2000) near Mogo.</p>	Marginal	Possible	Low	<p>Habitat for this species within the Wind Farm Study Area is marginal and there are few local records. It was not recorded during the fauna survey despite an extensive search effort.</p>
Pale-headed Snake <i>Hoplocephalus bitorquatus</i> V TSC	<p>The Pale-Headed Snake is a medium-sized largely tree-dwelling snake to 90 cm long. It is a uniform light brown or grey above with a white or cream band on the nape, bordered by a narrow blackish bar which may be solid, or broken in the middle. The top of the head is grey, and may have a series of black spots, which are most prominent along the edge of the white nape. The lips may have black vertical bars. The belly is creamy grey sometimes with darker flecks. A patchy distribution from north-east Queensland to north-east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as Tuggerah.</p>	<p>Known to occur in Coolah Tops NP.</p>	Marginal	Unlikely	Low	<p>Habitat for this species within the Wind Farm Study Area is marginal and there are few local records.</p>
Broad-headed Snake <i>Hoplocephalus bungaroides</i> E TSC V EPBC	<p>The Broad-headed Snake is generally black above with yellow spots forming narrow, irregular cross-bands. Other yellow scales may link these cross-bands laterally to form a straight or zigzagged stripe along the body. These cross-bands help distinguish it from the similar-looking but harmless juvenile Diamond Python. Its head is flattened on top and distinct from the body. The belly is grey or greyish-black. The average length is about 60 cm, with a maximum of around 150 cm. The Broad-headed Snake is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast and ranges in an area within approximately 250 km of Sydney.</p>	<p>Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.</p>	N/A	N/A	N/A	<p>Database searches did not show any records of this species within the Wind Farm Study Area.</p>

Species	Form and Habitat	Records	Wind Farm			Notes
			Presence of Habitat	Likelihood of Occurrence	Potential for Impact	
Stephens' Banded Snake <i>Hoplocephalus stephensii</i> V TSC	Stephens' Banded Snake is a medium-sized partly tree-dwelling snake up to one metre long. It is brown or yellow-brown above, with a series of irregular, broad, dark crossbands. The head is black with a brown crown and a brown or cream patch on either side of the nape and the lips are barred with black and cream. Coast and ranges from Southern Queensland to Gosford in NSW.	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Rosenberg's Goanna <i>Varanus rosenbergi</i> V TSC	This species occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. It is found in heath, open forest and woodland. It is known to nest in termite mounds and feeds on carrion, birds, eggs, reptiles and small mammals. Individuals require large areas of habitat.	Not recorded on the NSW OEH Database. Predicted to occur from the EPBC Database.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.
Invertebrates						
Giant Dragonfly <i>Petalura gigantean</i> E TSC	The Giant Dragonfly is the third largest dragonfly in Australia and one of the largest dragonflies in the world. The Giant Dragonfly is found along the east coast of NSW from the Victorian border to northern NSW. It is not found west of the Great Dividing Range. There are known occurrences in the Blue Mountains and Southern Highlands, in the Clarence River catchment, and on a few coastal swamps from north of Coffs Harbour to Nadgee in the south.	Predicted to occur in the Goulburn River NP.	N/A	N/A	N/A	Database searches did not show any records of this species within the Wind Farm Study Area.

KEY:

V TSC	Listed as Vulnerable on the <i>NSW Threatened Species Conservation Act, 1995</i>
E TSC	Listed as Endangered on the <i>NSW Threatened Species Conservation Act, 1995</i>
V EPBC	Listed as Vulnerable on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
E EPBC	Listed as Endangered on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
CE EPBC	Listed as Critically Endangered on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>
M EPBC	Listed as Migratory on the <i>Environmental Protection Biodiversity Conservation Act, 1999</i>

N/A indicates that the threatened species search did not return the species from the Wind Farm Study Area.

APPENDIX D ASSESSMENT OF SIGNIFICANCE

D.1 NEW SOUTH WALES

Assessments of significance pursuant to EP&A Act and the TSC Act have been undertaken for the following species, following *Threatened Species Assessment Guidelines* (DECC 2007).

Flora

- *Dichanthium setosum*
- *Digitaria porrecta*
- *Swainsona sericea*
- *Acacia ausfeldii*
- *Thesium australe*

Woodland Birds

- Speckled Warbler
- Brown Treecreeper
- Diamond Firetail
- Varied Sittella
- Painted Honeyeater
- Black-chinned Honeyeater
- Grey-crowned Babbler
- Scarlet Robin
- Turquoise Parrot
- Little Lorikeet
- Glossy Black-cockatoo

Raptors

- Little Eagle
- Square-tailed Kite

Nocturnal Birds

- Powerful Owl
- Masked Owl
- Barking Owl

Mammals (excluding bats)

- Squirrel Glider

Bats

- Eastern Bentwing-bat
- Yellow-bellied Sheath-tail-bat
- Eastern Cave Bat
- Corben's Long-eared Bat
- Large-eared Pied Bat

Endangered Ecological Communities

- White Box Yellow Box Blakely's Red Gum Woodland

Flora

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Swainsona sericea

Swainsona sericea is a prostrate or low growing perennial shrub to about 10cm high. It grows in grassland and eucalypt woodland, sometimes with *Callitris* species (OEH 2011).

The OEH database search did not return any records of this species in the Wind Farm or Transmission Line search area. The online Bionet database (accessed 1/11/2013) shows one record of this species between Ulan and Gulgong, south-west of the Transmission Line Study Area.

A single individual of this species was recorded in the northern part of the Transmission Line Study Area in the 2012 survey approximately 2.5 km south-east of the junction of Ulan Road and the Golden Highway. The plant was recorded in low grazed grassland on a south facing hillside on a sheep-grazing property. This site was revisited in the 2013 survey and three individual plants were recorded. This location is about 100m to the east of the preferred transmission line route.

A thorough walkover of the surrounding area recorded no additional individuals. This population may however be more widely distributed in this part of the site. These individuals will not be directly affected by clearing for the easement or construction of the transmission line in this area. Management measures will be put in place to ensure that this area is protected from accidental damage during construction and is not used for access, parking of machinery etc.

This species has not been recorded in the Wind Farm Study Area. Habitats are considered to be marginal at best and subject to generally high levels of disturbance from grazing, feral goats and other land use pressures. It may occur however in circumstances similar to where it was recorded in the Transmission Line Study Area. The majority of proposed turbine locations were surveyed and this species was not recorded. The majority of groundcover vegetation within the nominated survey envelope will not be impacted by the development of the wind farm. It is unlikely that the Proposed development would result in a significant impact on this species should it occur in the Wind Farm Study Area.

Dichanthium setosum

Dichanthium setosum, also known as Bluegrass, is an upright perennial grass less than 1 m tall. The species can form pure swards or occur as scattered clumps. *Dichanthium setosum* occurs chiefly on the northern tablelands in the Saumarez area, west of Armidale, and 18-30 km east of Guyra. It is more rarely found on the north-western slopes, central western slopes and north-western plains of NSW, extending west to Narrabri. *Dichanthium setosum* is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown (Commonwealth Department of the Environment 2008b).

This species was not recorded in the search area in the OEH database search. It was not recorded during surveys in the Wind Farm Study Area or the Transmission Line Study Area. If it occurs in the project area it is likely to be confined to basalt derived soils in the Wind Farm Study Area. The majority of groundcover vegetation within the nominated survey envelope will not be impacted by the development of the wind farm. It is unlikely that the Proposed development would result in a significant impact on this species should it occur in the Wind Farm Study Area.

Digitaria porrecta

Digitaria porrecta, also known as Finger Panic Grass, is a loosely tufted perennial growing to 60 cm tall. It seeds from March to April but also reproduces vegetatively by dying back to the tussock base, from which it resprouts in summer. In NSW, it occurs from near Inverell south to the Liverpool Plains near Coonabarabran and Werris Creek (33 sites). Its population is estimated to be 200 000 individuals with

75% occurring near Premer (approximately 41 500 individuals) and Tambar Springs (114 000 individuals) in NSW. Finger Panic Grass usually occurs in grasslands on extensive basaltic plains, and in undulating woodlands and open forests with an underlying basaltic geology. It usually occurs on dark and fine textured soils with some degree of seasonal cracking. It also persists in disturbed habitats, such as fallow paddocks, but its capability to maintain a viable population is unknown (Commonwealth Department of the Environment 2008c).

The OEH database search for the project area returned 3 records of this species from one location in farmland (elevation 635m) 15km north of Coolah. This area is outside the Wind Farm Study Area. This species was not recorded during surveys in the Wind Farm Study Area or the Transmission Line Study Area, however this species may not have been detectable due to the timing of the surveys (October). If it occurs in the project area it is likely to be confined to basalt derived soils in the Wind Farm Study Area. The majority of groundcover vegetation within the nominated survey envelope will not be impacted by the development of the wind farm and will continue to provide potential marginal habitat for this grass. It is unlikely that the Proposed development would result in a significant impact on this species should it occur in the Wind Farm Study Area.

Acacia ausfeldii

Acacia ausfeldii is an erect or spreading shrub 2 - 4 m high. Found to the east of Dubbo in the Mudgee-Ulan-Gulgong area of the NSW South Western Slopes bioregion, with some records in the adjoining Brigalow Belt South, South Eastern Highlands and the Sydney Basin bioregions. Associated species include *Eucalyptus albens*, *E. blakelyi* and *Callitris* spp., with an understorey dominated by *Cassinia* spp. and grasses (OEH 2011). The OEH database search returned 14 records of this species from south of the Ulan mine site and from Goulburn River NP.

This species was recorded in three locations during the current survey. Two plants were recorded growing on basalt (but close to an old sandstone quarry) in the south-western corner of Turill SCA north of the Golden Highway and a second occurrence of a single plant was recorded north of the Turill Bus Route Road, on sandstone, near the alternative route. A wider search of an area of 300 x 50 metres in the vicinity of the single plant failed to locate any other plants.

Clearing for the easement for any of the proposed routes will not result in the direct removal of any of these recorded plants but will result in the temporary loss of potential habitat for this species. Following construction the easement will generally provide suitable habitat for *Acacia ausfeldii* to recolonise. The Proposed development is unlikely to result in a significant impact on the local population of this species.

Thesium australe

Austral Toadflax is a small, straggling herb to 40 cm tall. This species is often hidden amongst grasses and herbs. Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands, where it occurs in grassland or grassy woodland. A root parasite that takes water and some nutrient from other plants, it is often found in damp sites in association with Kangaroo Grass (*Themeda australis*). The OEH database search returned one record of this species from north of the village of Cassillis.

This species was not recorded during the current survey. Its potential occurrence is considered in the context of the distribution of Kangaroo grass. Kangaroo grass is uncommon in the Transmission Line Study Area and only recorded as small patches in a few locations, primarily within Box Gum woodland in the northern section of the Transmission Line Study Area. The majority of areas are in poor to moderate condition, subject to grazing pressure and provide only poor to moderate quality habitat for this species.

Clearing for the easement will result in the temporary loss of potential habitat for this species. Following construction the easement will generally provide suitable habitat for Kangaroo grass to recolonise. These areas will continue to be subject to disturbances that may threaten the local population, including from grazing, vehicles and other land use practices. The Proposed development is unlikely to result in a significant impact on the local population of this species.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable

d) In relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Swainsona sericea

- i. Suitable habitat is widespread throughout the region for this species, however previous clearing and disturbances have reduced population sizes and extents to small areas. Due to this, no particularly suitable habitat for the species is expected to be permanently removed, although some may be temporarily disturbed. Three individuals of this species were observed during the surveys, at one location in the Transmission Line Study Area, but are unlikely to be impacted by the works, particularly as there will be protections put in place prior to the commencement of works to ensure they are not impacted for access tracks, storage of materials or other indirect impacts. Clearing for the easement will result in the temporary loss of potential future habitat for the expansion of the local population of *Swainsona sericea*. Following construction the easement will provide suitable habitat. Grazed grassland and patchy woodland habitat, similar to that where this species was recorded, is widespread in the vicinity and wider locality. These areas will continue to be subject to disturbances that may threaten the local population, including from grazing, vehicles and other land use practices. Protecting the remaining individuals of the population within the study area may help the population to expand into surrounding habitat.
- ii. No area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.
- iii. The habitat to be removed or modified is not considered important to the long-term survival of the species in the locality, due to the limited occurrence of the population, and the widespread availability of similar habitat.

Dichanthium setosum

- i. Suitable habitat is widespread throughout the region for this species, however there are no records in the study area and no individuals were observed during the surveys. Due to this, no particularly suitable habitat for the species is expected to be permanently removed.
- ii. No area of habitat is likely to become fragmented or isolated from other areas of habitat as a

result of the proposed action.

- iii. The habitat to be removed or modified is not considered important to the long-term survival of the species in the locality, due to the absence of any known populations in the area.

Digitaria porrecta

- i. Suitable habitat is widespread throughout the region for this species, however there are no records in the study area and no individuals were observed during the surveys. Due to this, no particularly suitable habitat for the species is expected to be permanently removed.
- ii. No area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.
- iii. The habitat to be removed or modified is not considered important to the long-term survival of the species in the locality, due to the absence of any known populations in the area.

Acacia ausfeldii

- i. If the preferred transmission line route is developed, there is unlikely to be much, if any, potential habitat removed or modified. Two individuals were observed at one location on the second alternative route, and clearing for this route could directly or indirectly impact upon these individuals due to the removal of approximately 5 ha of good-quality Box Gum Woodland, in which the plants were found. If the alternative route is developed, there is potential to impact upon at least one other individual, which was found in a different section of Turill State Conservation Area.
- ii. No area of habitat for this species is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.
- iii. The habitat to be removed or modified varies in importance to the species in the locality, depending on the route selected. If the preferred route, which likely has fewer biodiversity constraints in general, is selected, the habitat to be removed or modified is unlikely to be important to the long-term survival of the species in the locality. However, if either of the alternative routes are selected, there is a risk that the local population(s) may be impacted, particularly as only a small number of individuals were observed despite targeted searches in surrounding areas.

Thesium australe

- i. Suitable habitat is widespread throughout the region for this species, particularly in the Wind Farm Study Area, due to the abundance of Kangaroo Grass. However, there are no records in the study area and no individuals were observed during the surveys. Due to this, no utilised habitat for the species is expected to be permanently removed. Potential habitat is likely to remain stable over the long-term, because, despite some vegetation removal, clearing activities may actually benefit Kangaroo Grass in the region.
- ii. No area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, as construction footprints are relatively minor.
- iii. The habitat to be removed or modified is not considered important to the long-term survival of the species in the locality, due to the absence of any known populations in the project area.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Swainsona sericea

Of the identified priority actions for this species, the recommendation to *Document known sites on*

database is relevant to this proposal. This study has identified additional records of this species and locations have been made available to OEH.

Dichanthium setosum

Of the identified priority actions for this species, the recommendation to *Control goats and pigs in the species range* is relevant to this proposal. This Biodiversity assessment discusses opportunities for feral goat control as part of the proposal.

Digitaria porrecta

Of the identified priority actions for this species, the recommendation to *Conduct weed control, especially of invasive exotic grasses* is relevant to this proposal. This Biodiversity assessment discusses the need for adequate weed management, including exotic invasive grasses (e.g. Coolatai Grass and African Lovegrass), as part of the proposal.

Acacia ausfeldii

There are no recovery plans, threat abatement plans, or relevant identified priority actions available for this species.

Thesium australe

Of the identified priority actions for this species, the recommendation to *Control weeds in known habitat for this species* and *Control feral animals in key habitat* is relevant to this proposal. This Biodiversity assessment discusses the need for pest and weed management as part of the proposal.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that ‘clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity’. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this is in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities.

- The invasion of native vegetation by exotic perennial grasses

A number of exotic perennial grasses, including Coolatai Grass and African Lovegrass, were observed within the project area. The proposed development may contribute to the spread of these species within or between sites, although weed management recommendations and other mitigations have been suggested to prevent this from occurring. Recommendations have been given to reduce spread of invasive weeds into good quality woodland vegetation, including a vehicle hygiene protocol for cleaning of vehicles. The proposal is not expected to significantly increase the impact of this Key Threatening Process in the Project Area.

- Loss of hollow-bearing trees

Hollow-bearing trees will be removed during the vegetation clearing required for the proposed development. The majority of these will likely be in the less-disturbed patches of vegetation that

the transmission line may pass through, such as parts of Durridgere State Conservation Area and the southern end of Ulan Road. Hollows vary considerably in density and size throughout the Transmission Line Study Area, as well as by vegetation type. Recommendations have been made to perform hollow-bearing tree targeted surveys prior to clearing to determine micrositeing of infrastructure and minimise losses. It is deemed unlikely that any threatened species will be significantly affected by the vegetation clearance associated with the proposed development. Recommendations regarding the installation of nest boxes have been made to prevent a reduction in the number of available hollows in the landscape.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that any threatened reptiles species will be utilising dead wood within the study area, although dead standing trees may provide shelter for threatened bird and bat species, and to a lesser degree, Squirrel Gliders in certain locations. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region. Recommendations are given for fallen timber greater than 50 cm to be left in place or moved to a nearby area to retain fauna habitat, where possible.

- Predation by the European Red Fox (*Vulpes vulpes*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that foxes are already present throughout most, if not all, of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for foxes.

- Predation by the Feral Cat (*Felis catus*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that feral cats are already present throughout all of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for cats.

Raptors

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Little Eagle

Little Eagles were not recorded during surveys but are known to occur in the locality. Should a Little Eagle forage or nest in the Project Area, the proposal has potential to affect the species during the operational phase; the turbine rotors present a collision risk to the species. As no Little Eagle nests were found within 100 metres of surveyed proposed turbine locations, the risk to fledging Little Eagles is considered low to moderate. Adult birds, including raptors, have generally shown an ability to habituate to the turbines by taking avoidance action around rotors or by modifying their behaviour (such as approach a root at the head of a gully from below rather than above – EBS Ecology 2012). Further, the carcass monitoring results reviewed (refer Table 10-1) suggest more common species are most at risk of colliding with turbines. Thus on the basis of probability it appears unlikely that a viable local population of Little Eagle within the Project Area would be placed at risk of extinction from the wind farm proposal. However, this species should be a focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

Square-tailed Kite

The Square-tailed Kite was not recorded in the Wind Farm Study Area but was recorded nesting near the Ulan Mine site toward the southern end of the Transmission Line Study Area in the 2013 survey. As no Square-tailed Kite nests were found within 100 metres of surveyed proposed turbine locations the risk to nesting or fledgling Square-tailed Kites is considered low to moderate. The NSW Scientific Committee (2009) considers that “windfarms may cause occasional collision mortalities of Square-tailed Kites, although this species is a very manoeuvrable, slow flyer and is probably capable of generally avoiding collisions with turbine blades”. Thus on the basis of probability it appears unlikely that a viable local population of Square-tailed Kites would be placed at risk of extinction from the wind farm proposal. However, this species should be considered as part of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

The proposed alignment has been modified to prevent interfering with an active nest. The new alignment is proposed to cross the Goulburn River approximately 250 m to the west of the former alignment, which provides an acceptable buffer zone between any clearing and construction works and the nest.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
- ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

- i) the extent to which habitat is likely to be removed or modified as a result of the action proposed,

and

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

i) Section 10 of the Wind Farm report and Section 8 of the Transmission Line report discuss the extent of native vegetation types to be removed or modified as a result of the proposal. In general, relatively small areas of good quality forest or woodland habitat would be removed or modified within the Wind Farm Study Area, with most of the proposal affecting exotic pasture or cleared scattered trees over pasture. Larger areas of better quality vegetation may be cleared within the Transmission Line Study Area for the 60 m easement which has the potential to include loss of hollow bearing trees and threatened species habitat. Recommendations have been provided to microsite infrastructure to avoid hollows in the first instance and then survey to accurately quantify hollows to be removed in order to offset or replace all hollows that are cleared during construction.

ii) In the Wind Farm Study Area, turbines are located on ridges, often adjacent ridges, with a spacing of approximately 2 to 5 km between them. Spacing between turbines in the current layout is generally around 300-600 m. The distance between turbine clusters and also the distance between individual turbines is expected to allow for safe passage between turbines for birds and bats, without creating a barrier effect. There may be some alteration to movement patterns for some species, but areas of habitat are unlikely to become isolated from each other.

iii) Areas of habitat to be removed for turbines, access tracks, power infrastructure, and transmission line associated with the proposal are well represented in the overall Project Area and surrounding locality, including within large areas of conservation reserves and state forests such as Coolah Tops NP, Goulburn River and Munghorn Gap NP, Durrigere SCA and Curryall, Turill and Munmurra State Forests. The majority of the habitat to be removed in the Wind Farm Study Area is degraded and has been subject to ongoing disturbance from agricultural land use. As a result, the majority of potential habitat within the Project Area is considered unlikely to support the fauna species assessed, considering land use history, condition assessments and the results of the field surveys.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

OEH have not identified any relevant priority actions to help recover these species (OEH 2012).

In general, design measures to avoid and mitigate impacts have included avoiding areas of high conservation value fauna habitat and this is consistent with the actions and objectives of recovery plans and priority actions developed for species considered in this assessment.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'.

Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this is in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities.

Clearing activities have been shifted to prevent any disturbance to the active Square-tailed Kite nest, which is considered to mitigate any impact on the population or species.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region.

- Predation by the European Red Fox (*Vulpes vulpes*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that foxes are already present throughout most, if not all, of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for foxes.

- Predation by the Feral Cat (*Felis catus*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that feral cats are already present throughout all of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for cats.

Woodland Birds

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Speckled Warbler

The Speckled Warbler occurs in a wide range of Eucalypt Woodland communities in the hills and tablelands of the Great Dividing range. Habitats typically are structurally diverse with a grassy understorey, a sparse shrub layer and an open canopy (Watson *et al.* 2001). Declines have been linked to habitat fragmentation as the species appears to be locally extinct in districts where no habitat fragments larger than 100 ha remain (Watson *et al.* 2001). Further, larger remnants (about 300 ha) may be required for populations to be viable (Gardner 2002a).

The Speckled Warbler was recorded on two occasions during the 2012 survey, in Sandstone Forest habitats along the proposed transmission line route. The 2013 survey recorded this species more widely in the Transmission Line Study Area. The OEH Atlas contained 75 records (dated 1963-2010), generally concentrated around vegetated areas within Durridgere SCA, Goulburn River NP, Coolah Tops NP and vegetated areas north of Ulan Colliery.

This species is unlikely to occur in the majority of the Wind Farm Study Area due to the existing high level of fragmentation of habitats in this area. It may occur in more intact patches of forest in the gullies and on the lower slopes and in areas closer to Coolah Tops. It is highly unlikely to be susceptible to blade strike from the operation of wind turbines given it will generally forage at low height, within the shrub or canopy layer.

Brown Treecreeper

The Brown Treecreeper occurs in Eucalypt Woodlands, Mallee and drier open forest on inland slopes and plains of the Great Dividing Range. Populations have declined over much of their range, particularly in fragments smaller than 300 ha that have been isolated or fragmented for more than 50 years (Barrett *et al.* 1994). Declines in NSW have been attributed primarily to habitat fragmentation which limits dispersal and recruitment (Cooper and Walters, 2002; Walters *et al.* 1999).

The Brown Treecreeper was recorded on one occasion during the 2012 survey, in Sandstone Forest habitat west of Turill State Forest. The 2013 survey recorded this species in the same location as well as several locations throughout the Transmission Line Study Area. The OEH Atlas contained 81 records (dated 1963-2009) with most records from vegetated areas north of Ulan Colliery and Goulburn River NP as well as within Coolah Tops NP.

This species is likely to be restricted to more intact patches of woodland and forest along the Transmission Line Study Area, although it may extend into larger patches of woodland within the Wind Farm Study Area. Clearing of woodland and forest vegetation for the transmission line will result in the loss of habitat for this species. The most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. The surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested areas of the transmission line easement have been recommended for other species which also includes

habitat for this species.

Grey-crowned Babbler

The Grey-crowned Babbler was recorded on six occasions during the 2012 survey, in Sandstone Forest habitats within the Transmission Line Study Area. The six records are from within, or in the vicinity of, Durridgere SCA. The 2013 survey identified additional locations for this species, including south of Durridgere SCA and on the edge of Turill SCA in the northern part of the Transmission Line Study Area. The OEH Atlas contained 35 records (dated 1975-2010) concentrated around Ulan Colliery and lands to the north. There is one record from Coolah Tops NP.

The Grey-crowned Babbler prefers Box Gum Woodlands although also inhabits open forests, scrub lands and even farmlands and suburbs (Pizzey *et al.* 2006). The proposal will largely affect heavily degraded woodland or exotic vegetation that does not support an understorey shrub layer. As a result the diversity of bird species recorded within the Wind Farm Study Area was extremely low for woodland birds and revealed high numbers of aggressive species (i.e. Noisy miner, Noisy Friarbird, and Rosellas). This species is unlikely to occur in the majority of the Wind Farm Study Area due to the existing high level of degradation as well as fragmentation of habitats in this area. It may occur in more intact patches of forest in the gullies and on the lower slopes and in areas closer to Coolah Tops.

This species is likely to inhabit more intact patches of woodland and forest along the Transmission Line Study Area. Clearing of woodland and forest vegetation for the transmission line will result in the loss of habitat for this species. The surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested areas of the transmission line easement have been recommended for other species which also includes habitat for this species.

Painted Honeyeater

This honeyeater primarily occurs on the inland slopes of the Great Dividing Range, although is nomadic and may occur in low densities in other parts of NSW in suitable habitat. It inhabits dry open forests and woodland including Boree, Brigalow and Box Gum Woodlands and Box-Ironbark open forests, also paperbark and casuarinas. It is a specialist feeder on mistletoe, particularly of genus *Amyema*, and generally requires five or more mistletoes per hectare (NSW Scientific Committee 2011). Extent of available vegetation is considered to be important for this species and it is considered less likely to be found in strips or fragmented patches of vegetation than it is in wider blocks (Robinson 1994). The known location of records in vegetated areas and the record of this species this survey in good quality Sandstone Forest, as well as its absence from most of the Project Area (i.e. degraded areas) suggests a reliance on good quality vegetation. It is therefore considered this species would not occupy the Wind Farm Study Area; however habitat may be present within the Transmission Line Study Area.

The OEH Atlas contained 18 records (dated 1976-2010) scattered throughout vegetated areas along the proposed transmission line route and one record within the western part of Coolah Tops NP. The Painted Honeyeater was recorded on one occasion during the 2012 survey, foraging in mistletoe in Sandstone Forest habitat south-west of Durridgere SCA. The 2013 survey recorded this species in similar habitat along Ulan Road in the southern part of the Transmission Line Study Area.

As mentioned for other woodland birds, the most important areas to be affected are likely to be in the Transmission Line Study Area within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line

could result in the loss of habitat for this species. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested or woodland areas of the transmission line easement have been recommended for other species which also include habitat for this species.

Black-chinned Honeyeater

The Black-chinned Honeyeater was recorded on one occasion during the 2012 survey, in scattered open woodland on native pasture in the northern part of the Transmission Line Study Area. The OEH Atlas contained 9 records (dated 1998-2006) concentrated around vegetated areas of Goulburn River NP, the north-western section of Coolah Tops NP and north of Ulan Colliery.

This honeyeater inhabits the upper levels of drier open forests or woodlands most often dominated by box and ironbark eucalypts, particularly Mugga Ironbark, White Box, Grey Box, Yellow Box and Forest Red Gum (NSW Scientific Committee 2001). Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds are locally nomadic and forage over large home ranges of at least 5 ha. The species feeds mostly on nectar and insects in the shrub or canopy layers and a diversity of species is considered to be required. The known location of records in vegetated areas and the record of this species this survey in Sandstone Forest over native grasses, as well as its absence from most of the Project Area (i.e. degraded areas) suggests a reliance on moderate-good quality vegetation. It is therefore considered this species would not be reliant on the majority of habitat within the Wind Farm Study Area given its degraded state; however habitat may be present within the Transmission Line Study Area.

As mentioned for other woodland birds, the most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line could result in the loss of habitat for this species. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested or woodland areas of the transmission line easement have been recommended for other species which also include habitat for this species.

Varied Sittella

This species inhabits Eucalypt Forests and Woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia Woodland. Survival and population viability are sensitive to habitat isolation, reduced patch size and habitat simplification, including reductions in tree species diversity, tree canopy cover, shrub cover, ground cover, logs, fallen branches and litter. The Varied Sittella is also adversely affected by the dominance of Noisy Miners in woodland patches (NSW Scientific Committee 2011). The OEH Atlas contained 18 records (dated 1976-2010) scattered throughout vegetated areas along the proposed transmission line routes and one record within the western part of Coolah Tops NP.

The Varied Sittella was recorded on two occasions during the 2012 survey, in Sandstone Forest habitat near the north-eastern corner of Durridgere SCA and in ridgetop Box Gum Woodland in the eastern part of the Wind Farm Study Area. The 2013 survey recorded this species in Turill SCA.

During the survey, this species was detected within Box Gum Woodland that supported a higher diversity of shrubs in the understorey and was not observed in other areas of the Wind Farm Study Area. It is expected this species would not occur within degraded areas (exotic pasture or scattered trees over exotic pasture) of the Wind Farm Study Area, which are the areas the majority of the proposal will affect. Additionally, the entire Project Area supports a high density of aggressive bird species, including the Noisy miner which displaces this species, as detailed above.

As the proposal will largely affect heavily degraded woodland or exotic vegetation that does not support an understorey shrub layer within the Wind Farm Study Area, the proposal is not considered to have an adverse effect on the life cycle of this species such that it would be placed at risk of extinction.

As mentioned for other woodland birds, the most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line could result in the loss of habitat for this species. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested or woodland areas of the transmission line easement have been recommended for other species which also include habitat for this species.

Diamond Firetail

The Diamond Firetail occupies eucalypt woodlands, forests and mallee where there is a grassy understorey. Firetails build bottle-shaped nests in trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects. The Diamond Firetail is threatened by clearance and fragmentation of habitat. Isolation and reductions in remnant area inhibit dispersal and increase their vulnerability to local extinction via stochastic events. Small, isolated populations also lose their long term genetic viability. Further, Diamond Firetail populations appear unable to persist in areas which lack remnants of native vegetation larger than 200ha (NSW Scientific Committee 2011). The OEH Atlas contained 24 records (dated 1963-2010) widely scattered throughout vegetated areas in the vicinity of the proposed transmission line route, including within Durridgere and Turill SCAs. There are also two records from the north-eastern slopes of Coolah Tops NP.

The 2013 survey recorded this species in four locations in or adjacent to larger tracts of sandstone forest in the Transmission Line Study Area, including within Durridgere and Turill SCAs. It is expected this species would not occur within degraded and fragmented areas (exotic pasture or scattered trees over exotic pasture) of the Wind Farm Study Area, which are the areas the majority of the proposal will affect.

As the proposal will largely affect heavily degraded woodland or exotic vegetation within the Wind Farm Study Area, the proposal is not considered to have an adverse effect on the life cycle of this species such that it would be placed at risk of extinction. This finch is highly unlikely to be affected by physical interaction with wind turbines.

As mentioned for other woodland birds, the most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line could result in the loss of habitat for this species. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey

work in forested or woodland areas of the transmission line easement have been recommended for other species which also include habitat for this species.

Scarlet Robin

The Scarlet Robin breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees (NSW Scientific Committee 2011). The OEH Atlas database search returned 15 records (dated 1975-2009) with the majority of records from the north-west section of Coolah Tops NP as well as some scattered records from around Ulan Colliery.

The Scarlet Robin was recorded on one occasion during the 2012 survey, in Brittle Gum/Silver-top Stringybark Woodland in the north-eastern corner of the Wind Farm Study Area. The habitat in the areas where this species has previously been recorded (north-east section of the Wind Farm Study Area) supports substantially superior quality habitat than most of the Wind Farm Study Area; the proposal will largely affect exotic vegetation and very open woodland habitat. The area where this species was recorded in 2012 is now no longer proposed for locating of wind turbines. This species is not expected to occur in the more open and exposed ridgetop habitats where the majority of turbines will be located and the proposal is therefore not expected to have an adverse effect on the lifecycle of this species.

As mentioned above for other woodland birds, the most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine Clearing of woodland and forest vegetation for the transmission line could result in the loss of habitat for this species also. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested or woodland areas of the transmission line easement have been recommended for other species which also include habitat for this species.

Parrots

Little Lorikeet

Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. The OEH Atlas database search returned 12 records (dated 1963-2008) scattered throughout the study area near Ulan, Goulburn River NP and Coolah Tops NP.

The Little Lorikeet was not recorded in either the Transmission line or the Wind Farm Study Area during the current survey, but was recorded about 15 kms to the north of the Wind Farm Study Area during the 2012 survey period. This species has the potential to occur at times throughout the majority of the Wind Farm and Transmission Line Study Areas where there is open forest, woodland or patches of eucalypts. It may roost within tree hollows in living or recently dead trees. It is highly unlikely to be susceptible to blade strike from the operation of wind turbines given that the species is a nomadic species and primarily feeds on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts. Hence it does not traverse large distances and will forage below the rotor swept area (OEH 2012).

The proposal will largely affect heavily degraded woodland or exotic vegetation that does not support an

understorey shrub layer. The diversity of bird species recorded within the Wind Farm Study Area was extremely low for woodland birds and revealed high numbers of aggressive species (i.e. Noisy miner, Noisy Friarbird, and Rosellas). These species are expected to occupy many of the remaining hollows that occur within the woodland patches and therefore prevent the more cryptic or threatened species from breeding in these areas. Given the high abundance of aggressive common birds and the heavily degraded nature of the site of the Wind Farm Study Area the proposal is not expected to have an adverse effect on the life cycle of the Little Lorikeet.

However, provisions for pre-clearance hollow-bearing tree surveys and micro-siting of infrastructure to avoid hollows, where possible, form mitigation measures to prevent adverse impacts to hollow-dependent species.

As mentioned above for other woodland birds, the most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line could result in the loss of habitat for this species also. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction however, mitigation strategies related to further survey work in forested areas of the transmission line easement have been recommended for other species which also include habitat for this species.

Turquoise parrot

The Turquoise Parrot inhabits eucalypt and cypress-pine open forests and woodlands (commonly box or box-ironbark) with native grasses, sometimes with a low shrubby understorey, often in undulating or rugged country, or on footslopes. It also lives in open woodland or riparian gum woodland, and often near ecotones between woodland and grassland, or coastal forest and heath. The richer habitat types on creek or river flats and foothills are preferred, but have been targeted for agricultural clearing, and habitat remnants are degraded by logging (for firewood and fenceposts), grazing, dominance by Noisy Miners, and decline in tree health (rural eucalypt dieback). The Turquoise Parrot requires live or dead trees, stumps and logs for nesting, trees and shrubs for shelter, and seeding grasses and forbs (often beneath trees) for food (NSW Scientific Committee, 2009). The OEH Atlas database search returned 14 records (dated 1975-2008) of this parrot, the majority of which are in Goulburn River NP with one record in Coolah Tops NP.

The Turquoise Parrot was not recorded in either the Transmission line or the Wind Farm Study Area during the current survey. This species has the potential to occur at times throughout areas of the Wind Farm and Transmission Line Study Areas where there is open forest, woodland or patches of eucalypts and available grassland foraging habitat. It may roost within tree hollows in living or recently dead trees. It is highly unlikely to be susceptible to blade strike from the operation of wind turbines given that it prefers to feed within 100m of the nest and is resident and locally dispersive, with most movements of less than 10km often along treed corridors (NSW Scientific Committee, 2009). Hence it does not traverse large distances and will forage below the rotor sweep area.

The proposal will largely affect heavily degraded woodland or exotic vegetation that does not support an understorey shrub layer. The diversity of bird species recorded within the Wind Farm Study Area was extremely low for woodland birds and revealed high numbers of aggressive species (i.e. Noisy miner, Noisy Friarbird, and Rosellas). These species are expected to occupy many of the remaining hollows that occur within the woodland patches and therefore prevent the more cryptic or threatened species from

breeding in these areas. Given the high abundance of aggressive common birds and the heavily degraded nature of the site of the Wind Farm Study Area the proposal is not expected to have an adverse effect on the life cycle of the Turquoise Parrot.

However, provisions for pre-clearance hollow-bearing tree surveys and micro-siting of infrastructure to avoid hollows, where possible, form mitigation measures to prevent adverse impacts to hollow-dependent species.

As mentioned above for other woodland birds, the most important areas to be affected are likely to be within private land west of, or within Durridgere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line could result in the loss of habitat for this species also. However, the surrounding locality around the Transmission Line Study Area also supports extensive areas of forest and woodland which will not be affected by the proposal (i.e. Goulburn River NP and most areas of Durridgere SCA) and it is therefore considered unlikely that a viable local population of this species would be placed at risk of extinction.

Glossy Black-cockatoo

The OEH Atlas search returned 260 records (dated 1975-2010) scattered throughout the study area, including within Coolah Tops NP, Durridgere SCA and Ulan Colliery lands. Moolarben Coal Project (2006) discusses 39 records of this species, mainly from vegetation associations with Black Cypress Pine near Ulan Road and adjacent ridges. Evidence of the Glossy Black-cockatoo (a single tail-feather) was recorded in the 2012 survey in a larger tract of Sandstone Forest in the western central part of the Transmission Line Study Area. This species was recorded in several locations (frequently where poor sandstone-derived soils have high densities of *Allocasuarina* spp. growing) within the Transmission Line Study Area during the 2013 survey and evidence of foraging was relatively widespread.

Of the *Casuarina* and *Allocasuarina* species recorded during the present study, two species - *Allocasuarina diminuta* and *A. gymnanthera* – are known to be preferred feed trees for the Glossy Black-Cockatoo. Both these species are present throughout areas of sandstone forest in the Transmission Line Study Area, with *A. gymnanthera* the more common. These species are not common in the Wind Farm Study Area. Searches for chewed seed cones were completed in fauna plots containing *Allocasuarina diminuta* and *A. gymnanthera* but no additional evidence of foraging by Glossy Black-Cockatoos was recorded in the Wind Farm Study Area.

Clearing for the transmission line easement will result in the loss of some areas of vegetation containing *Allocasuarina diminuta* and *A. gymnanthera* as well as the loss of some hollow-bearing trees and stags and mature trees that represent a future source of hollows. These habitat resources are relatively widely available within areas of the transmission line route to be retained and within the surrounding area.

The Wind Farm Study Area does not generally provide areas of suitable foraging habitat for the Glossy Black-cockatoo, although it does contain hollow-bearing trees and larger stags that may provide suitable roost sites for this species. However, given the degraded nature of the Wind Farm Study Area in general and its lack of foraging resources, it is unlikely the Glossy Black-cockatoo would be reliant on this area for breeding. The Transmission Line Study Area provides areas of suitable foraging habitat for the Glossy Black-cockatoo, and supports hollow-bearing trees and larger stags that may provide suitable roost sites for this species within the southern section of the easement (i.e. near Durridgere SCA and Ulan Road).

Provisions for pre-clearance hollow-bearing tree surveys and micro-siting of infrastructure to avoid hollows, where possible, form mitigation measures to prevent adverse impacts to hollow-dependent species such as this.

It therefore appears unlikely that a viable local population at the Liverpool Range study area would be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

i) Section 10 of the Wind Farm report and Section 8 of the Transmission Line report discuss the extent of native vegetation types to be removed or modified as a result of the proposal. In general, relatively small areas of good quality forest or woodland habitat would be removed or modified within the Wind Farm Study Area, with most of the proposal affecting exotic pasture or cleared scattered trees over pasture. However, recommendations have been given in areas of good quality habitat for follow up survey work to determine its value as threatened species habitat before clearing proceeds. Recommendations have also been provided to protect and microsite infrastructure to avoid hollows in the first instance and then survey to accurately quantify hollows to be removed in order to offset or replace all hollows that are cleared during construction.

ii) In the Wind Farm Study Area, turbines are located on ridges, often adjacent ridges, with a spacing of approximately 2 to 5 km between them. Spacing between turbines in the current layout is generally around 300-600m. The distance between turbine clusters and also the distance between individual turbines is expected to allow for safe passage between turbines for birds and bats, without creating a barrier effect. There may be some alteration to movement patterns for some species, but areas of habitat are unlikely to become isolated from each other.

The clearing of the transmission line easement is unlikely to create an impediment to movement for the woodland birds and parrots considered in this assessment.

However given the already degraded and modified state of the vegetation in the vicinity of the wind

farm, and the expansive areas of vegetation conserved in national parks and state conservation reserves in the region, the importance of any habitat loss through clearing for the wind farm should be considered relatively low. Loss of habitat through avoidance of an area (indirect habitat loss) has not been shown for any Australian wind farm. The question of indirect habitat loss through avoidance of an area under operational wind farm can be monitored through comparison of data from pre-construction baseline surveys with operational survey data. Monitoring of bird utilisation and avoidance behaviour, for woodland birds and raptors would be part of a Bird and Bat adaptive Management Plan for the project.

iii) Types of habitat to be removed for turbines, access tracks, power infrastructure, and transmission lines associated with the proposal are well represented in the overall Project Area and surrounding locality, including within conservation reserves and state forests such as Coolah Tops NP, Goulburn River NP, Durrigere SCA and Curryall, Turill and Munmurra State Forests. The majority of the habitat to be removed in the Wind Farm Study Area is degraded and has been subject to ongoing disturbance from agricultural land use. As a result, the majority of potential habitat within the Project Area is considered unlikely to support the fauna species assessed, considering land use history, condition assessments and the results of the field surveys

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

OEH have not identified any relevant priority actions to help recover *Speckled Warbler*, *Glossy Black-Cockatoo*, *Brown Treecreeper*, *Diamond firetail*, *Black-chinned Honeyeater*, *Scarlet Robin*, *Grey-crowned babbler*, *Little Lorikeet* or *Varied Sittella*

Painted Honeyeater

Of the identified priority actions for this species, the recommendation to *Encourage retention of natural densities of mistletoes, particularly Amyema sp.* is relevant to this proposal. Extent of available vegetation is considered to be important for this species and it is considered less likely to be found in strips or fragmented patches of vegetation than it is in wider blocks. Given that the proposal largely affects disturbed areas where this species is unlikely to occur, the removal of mistletoe in these parts is not expected to be significant.

Turquoise parrot

Of the identified priority actions for this species, the recommendation to *Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools* is relevant to this proposal. This assessment has identified mitigation measures to minimise the loss of hollow bearing trees and dead trees and offset hollow bearing trees that would be removed.

In general, design measures to avoid and mitigate impacts have included avoiding areas of high conservation value fauna habitat and this is consistent with the actions and objectives of recovery plans and priority actions developed for species considered in this assessment.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result

in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that ‘clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity’. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this is in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities.

- Loss of hollow-bearing trees

Hollow-bearing trees will be removed during the vegetation clearing required for the proposed development. The majority of these will likely be in the less-disturbed patches of vegetation that the transmission line may pass through, such as parts of Durridgere State Conservation Area and the southern end of Ulan Road. Hollows vary considerably in density and size throughout the Transmission Line Study Area, as well as by vegetation type. However, recommendations have been given to minimise the impact of the proposal to an acceptable level specifically in relation to hollow bearing trees. Where hollow bearing trees are to be cleared and cannot be avoided an offset ratio is to be applied at 1:1 and is supplementary to other areas offset.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that any threatened reptiles species will be utilising dead wood within the study area, although dead standing trees may provide shelter for threatened bird and bat species, and to a lesser degree, Squirrel Gliders in certain locations. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region. Recommendations are given for fallen timber greater than 50 cm to be left in place or moved to a nearby area to retain fauna habitat, where possible.

- Predation by the European Red Fox (*Vulpes vulpes*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that foxes are already present throughout most, if not all, of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for foxes.

- Predation by the Feral Cat (*Felis catus*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that feral cats are already present throughout all of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for cats.

Mammals (excluding bats)

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Squirrel Glider

Squirrel Gliders show a preference for lower altitude habitats and Rowston *et al* report that throughout their range they have not been reported above 300 m (Rowston *et al* 2002). Squirrel Gliders are unlikely to occur on higher elevation ridges to be affected by any tree removal for turbine location or ridgetop tracks.

The OEH Atlas database search returned 16 records of Squirrel Glider (dated 2000-2009) with most records from previous surveys north of the Ulan Colliery (within the Transmission Line Study Area). These records are from near Ulan and located around 420 m altitude. Clearance of habitat within the Transmission Line Study Area has the potential to affect this species.

A single Squirrel Glider was recorded during the 2012 survey program, in open woodland vegetation along a valley floor within the Wind Farm Study Area. While the Squirrel Glider was found within a valley floor of the Wind Farm Study Area, it is not considered at risk within this study area given the location of development largely on ridgetops where habitat does not occur for this species. A single individual was also recorded in riparian vegetation north-east of the Ulan Mine site in the 2013 survey.

Proposed routes for the transmission line are largely located within cleared areas that do not represent suitable habitat for the Squirrel Glider, however suitable habitat does occur within areas of more intact native forest and woodland and in areas with patchy tree distribution within the southern section of the easement nearby Durridgere SCA. As vegetation clearing for the transmission line will result in the loss of woodland and forest vegetation, it is expected that some areas of suitable habitat and some loss of tree hollows suitable for denning could be affected as part of the proposal.

Regarding potential to affect movement, the distance that Squirrel Gliders can travel in a single glide is a function of the height of the tree from which they take off. Goldingay and Taylor (2009) concluded that to travel a distance of 43 m, Squirrel Gliders would require trees at least 25m tall from which to take off. Tree heights in the Transmission Line Study Area were generally 25 m or less, indicating that a clearing of 60 m for the transmission line easement may impact on movement opportunities for the Squirrel Glider across the cleared easement, particularly as foxes pose a threat to any arboreal mammals that are on the ground for any period of time.

In practice, the total clearance of vegetation for this species is overestimated as these areas will continue to have some habitat value for this species during the operational phase of transmission line where the existing vegetation cover can be micrositied or understorey regrowth promoted after construction. However, the proposal has the potential to remove hollow-bearing trees and affect movement patterns in forested areas of good condition (i.e. nearby Durridgere SCA).

It appears unlikely that a viable local population within the Project Area would be placed at risk of extinction however further investigation of suitable denning sites (i.e. hollow-bearing trees) is required within the southern section of the transmission line easement to confirm this. Mitigation strategies related to further survey work, removal of hollow-bearing trees (i.e. potential breeding sites) and facilitation of crossing easements within suitable habitat for this species now form part of the proposal.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse

effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

i) Section 10 of the Wind Farm report and Section 8 of the Transmission Line report discuss the extent of native vegetation types to be removed or modified as a result of the proposal. In general, relatively small areas of good quality forest or woodland habitat would be removed or modified within the Wind Farm Study Area, with most of the proposal affecting exotic pasture or cleared scattered trees over pasture. Larger areas of better quality vegetation may be cleared within the Transmission Line Study Area for the 60 m easement which has the potential to include loss of hollow bearing trees and threatened species habitat. However, recommendations have been given in areas of good quality habitat for follow up survey work to determine its value as threatened species habitat before clearing proceeds. Recommendations have also been provided to protect and microsite infrastructure to avoid hollows in the first instance and then survey to accurately quantify hollows to be removed in order to offset or replace all hollows that are cleared during construction.

ii) In the Wind Farm Study Area, turbines are located on ridges, often adjacent ridges, with a spacing of approximately 2 to 5 km between them. Spacing between turbines in the current layout is generally around 300-600 m. The distance between turbine clusters and also the distance between individual turbines is expected to allow for safe passage between turbines for birds and bats, without creating a barrier effect. There may be some alteration to movement patterns for some species, but areas of habitat are unlikely to become isolated from each other.

For Squirrel Gliders, the distance that they can travel in a single glide is a function of the height of the tree from which they take off. Goldingay and Taylor (2009) concluded that to travel a distance of 43 m, Squirrel Gliders would require trees at least 25 m tall from which to take off. Tree heights in the Transmission Line Study Area were generally 25 m or less, indicating that a clearing of 60 m for the transmission line easement may impact on movement opportunities for the Squirrel Glider across the cleared easement, particularly as foxes pose a threat to any arboreal mammals that are on the ground for

any period of time. Mitigation methods including installing glider poles, and minimisation of clearance in known habitat for the Squirrel Glider are incorporated into the recommendations.

iii) Areas of habitat to be removed for turbines, access tracks, power infrastructure, and transmission line associated with the proposal are well represented in the overall Project Area and surrounding locality, including within conservation reserves and state forests such as Coolah Tops NP, Goulburn River NP, Durridgere SCA and Curryall, Turill and Munmurra State Forests. The majority of the habitat to be removed in the Wind Farm Study Area is degraded and has been subject to ongoing disturbance from agricultural land use. As a result, the majority of potential habitat within the Project Area is considered unlikely to support the fauna species assessed, considering land use history, condition assessments and the results of the field surveys.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

OEH have not identified any relevant priority actions to help recover the Squirrel Glider.

A Threat Abatement Plan (TAP) has been prepared for the threatening process *Predation by the Red Fox*. The proposal is not located near to any priority sites discussed under the TAP and is consistent with the objectives and actions of the TAP.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that ‘clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity’. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this is in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities.

- Loss of hollow-bearing trees

Hollow-bearing trees will be removed during the vegetation clearing required for the proposed development. The majority of these will likely be in the less-disturbed patches of vegetation that the transmission line may pass through, such as parts of Durridgere State Conservation Area and the southern end of Ulan Road. Hollows vary considerably in density and size throughout the Transmission Line Study Area, as well as by vegetation type. Recommendations have been made to perform hollow-bearing tree targeted surveys prior to clearing to determine micro-siting of

infrastructure and minimise losses. It is deemed unlikely that any threatened species will be significantly affected by the vegetation clearance associated with the proposed development. Recommendations regarding the installation of nest boxes have been made to prevent a reduction in the number of available hollows in the landscape.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that any threatened reptiles species will be utilising dead wood within the study area, although dead standing trees may provide shelter for threatened bird and bat species, and to a lesser degree, Squirrel Gliders in certain locations. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region. Recommendations are given for fallen timber greater than 50 cm to be left in place or moved to a nearby area to retain fauna habitat, where possible.

- Predation by the European Red Fox (*Vulpes vulpes*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that foxes are already present throughout most, if not all, of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for foxes.

- Predation by the Feral Cat (*Felis catus*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that feral cats are already present throughout all of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for cats.

Nocturnal Birds

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Powerful Owl

Powerful Owls require large territories that include woodlands. Breeding pairs are known to defend up to 1000 ha areas of permanent territories (Blakers *et al.* 1984; Soderquist and Gibbons 2007), although more recent research has shown home ranges may be up to 3000 ha (Hollands 2008). Numerous studies have found that territories usually centre around gullies (Dept. of Environment and Conservation 2006). Moist forest in unlogged corridors in gully systems is used for nesting and roosting, and also preferentially for foraging, although much foraging is also conducted in dry and regrowth forest (Kavanagh 1997). The OEH Atlas contained 24 records (dated 1985-2012) scattered nearby the Project Area, mostly from vegetated areas within Goulburn River NP and Coolah Tops NP, with some records located along the transmission line route.

The Powerful Owl was recorded during the 2013 survey on two occasions within the southern part of the Transmission Line Study Area, although it is likely to have been the same individual. The Project Area contains several gully systems containing mature trees or patches of mature forest within the north-eastern section of the Wind Farm Study Area. As most of the Wind Farm Study Area has been cleared in the past due to agricultural practices, most of the remnant mature vegetation is also concentrated in gullies. This area of the Wind Farm Study Area provides a habitat corridor to Coolah Tops NP in which most known records of the Powerful Owl are located. Common Brushtail Possums and Greater Gliders were observed during the survey in very high abundance in the north-eastern section of the Wind Farm Study Area and are known prey species for the Powerful Owl.

The ability of Powerful Owls to avoid wind turbines is not well understood. Generally, raptors have been found to be at greatest risk when swooping on prey, a risk not present for the Powerful Owl which hunts within forest. Powerful Owls have great manoeuvrability and it is expected that their ability to avoid turbines while dispersing would be high. However ecological characteristics such as low density and low reproduction rates increase the consequence of collisions to the local population's viability.

The habitat clearance associated with the Wind farm and transmission line easement is not expected to be large enough to have an adverse effect on the Powerful Owl given the transmission line generally traverses degraded habitat, except for the southern section of the alignment. The most important areas to be affected are likely to be within private land west of, or within Durrigere SCA and west of Ulan Road just above the Ulan Coal Mine. Clearing of woodland and forest vegetation for the transmission line is unlikely to result in an adverse impact for this species, given the large home ranges it occupies and available habitat in the wider region which also connects to this area. The most likely affect would be the clearance of hollow-bearing trees; however provisions for pre-clearance hollow-bearing tree surveys and micro-siting of infrastructure to avoid hollows, where possible, form mitigation measures to prevent adverse impacts to hollow-dependent species.

Given the large home ranges of the Powerful Owl, the presence of forested gullies, and a high abundance of known prey species in the location of turbines within the north eastern section of the Wind Farm Study Area, the proposal has the potential to reduce foraging habitat or result in blade strike for this species within this area. Proposed turbine locations in the very north-eastern section of the Wind Farm Study Area have been removed from the proposal due to these ecological considerations.

The Powerful Owl should be a focal species of the adaptive Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

Masked Owl

This species forages in a range of forest and woodland types but roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. It requires forested areas adjacent to areas of dense and sparse ground cover within close proximity for foraging. Suitable large tree hollows for breeding are generally rare within the Wind Farm Study Area. The OEH Atlas contained five records (dated 1993-2005) from within densely vegetated areas within Goulburn River NP and Coolah Tops NP and near Uarbry. Kavanagh (1995) discusses a relatively high number of recordings of the Masked Owl within Coolah Tops NP.

The Masked Owl was not recorded during the current survey. Masked Owls are more likely to roost and nest within moister, denser forest types in Coolah Tops and Goulburn River NPs and other more vegetated areas outside of the Project Area. They may occur where these moister forest types occur in denser gullies in the north eastern corner of the Wind Farm Study Area.

Masked Owls prey on small terrestrial and scansorial mammals (and to a lesser extent, on birds) and may forage throughout the study areas, including in more open habitats and pasture where rats, rabbits and other small terrestrial mammals occur. Loss of habitat affecting the prey base for this species (primarily terrestrial mammals) is likely to be less of a factor than for the Powerful Owl.

Whilst clearing for small (< 200 ha) forest fragments that are more than 1 km from large areas of forest are not used by Powerful Owls, they may provide marginal habitat for non-breeding Masked Owls. Due to the patchy nature of most of the vegetation that occurs in the study area, the impact of the proposal on this species is considered less than for the Powerful Owl, and unlikely to affect the lifecycle of this species such that it is placed at risk of extinction. Proposed turbine locations in the very north-eastern section of the Wind Farm Study Area have been removed from the proposal partly due to the potential for owls to be utilising the high-quality habitat of that area.

The Masked Owl should be a species considered within the adaptive Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

Barking Owl

The Barking Owl was not recorded during the current survey. The OEH Atlas contained 11 records (dated 1976-2006) scattered throughout the Project Area, mostly around Coolah Tops and Goulburn River NP. There is one record from Durrigere SCA approximately 1.4 km from the proposed transmission line alignment. Most records are located in vegetated areas or on the edge of these areas.

This species occurs in dry box-dominated forest and woodlands and roosts in dense foliage of *Acacia*, *Casuarina* or *Eucalyptus* species. It nests in large hollows (20-46 cm diameter) of large, old eucalypts including River Red Gum, White Box, Red Box and Blakely's Red Gum. Although the Barking Owl is known from Coolah Tops NP, it is considered likely to depend on lower slopes outside the park for foraging (NPWS 2002).

Roost sites are typically in, or under dense foliage in large trees of streamside gallery forests (NPWS 2003). Such habitats are rare in the Transmission Line and Wind Farm Study Areas, where watercourses are generally small and surrounded by degraded areas and also feature sparse vegetation. Loss of habitat affecting the prey base for this species (including arboreal mammals, birds and terrestrial mammals including rabbits) is likely to be less of a factor than for the Powerful Owl.

Similarly to the Masked Owl, the impact of the proposal on this species is considered less than for the Powerful Owl, and unlikely to affect the lifecycle of this species such that it is placed at risk of extinction. Proposed turbine locations in the very north-eastern section of the Wind Farm Study Area have been removed from the proposal partly due to the potential for owls to be utilising the high-quality habitat of that area.

The Barking Owl should be a species considered within the adaptive Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse

effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

i) Section 10 of the Wind Farm report and Section 8 of the Transmission Line report discuss the extent of native vegetation types to be removed or modified as a result of the proposal. In general, relatively small areas of good quality forest or woodland habitat would be removed or modified within the Wind Farm Study Area, with most of the proposal affecting exotic pasture or cleared scattered trees over pasture. Larger areas of better quality vegetation may be cleared within the Transmission Line Study Area for the 60 m easement which has the potential to include loss of hollow bearing trees and threatened species habitat. However, recommendations have been given in areas of good quality habitat for follow up survey work to determine its value as threatened species habitat before clearing proceeds. Recommendations have also been provided to protect and microsite infrastructure to avoid hollows in the first instance and then survey to accurately quantify hollows to be removed in order to offset or replace all hollows that are cleared during construction.

ii) In the Wind Farm Study Area, turbines are located on ridges, often adjacent ridges, with a spacing of approximately 2 to 5 km between them. Spacing between turbines in the current layout is generally around 300-600m. The distance between turbine clusters and also the distance between individual turbines is expected to allow for safe passage between turbines for birds and bats, without creating a barrier effect. There may be some alteration to movement patterns for some species, but areas of habitat are unlikely to become isolated from each other.

iii) Areas of habitat to be removed for turbines, access tracks, power infrastructure, and transmission line associated with the proposal are well represented in the overall Project Area and surrounding locality, including within conservation reserves and state forests such as Coolah Tops NP, Goulburn River NP, Durridgere SCA and Curryall, Turill and Munmurra State Forests. The majority of the habitat to be removed in the Wind Farm Study Area is degraded and has been subject to ongoing disturbance from agricultural land use. As a result, the majority of potential habitat within the Project Area is considered

unlikely to support the fauna species assessed, considering land use history, condition assessments and the results of the field surveys. However, the importance of habitat in the southern section of the Transmission Line Study Area and the north-eastern section of the Wind Farm Study Area are not known and precautionary measures, primarily focusing on more survey work, have been implemented to ensure that significant impacts to the species considered in this assessment are avoided.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Owls

The recovery plan for the Large Forest Owls, including Powerful Owl and Masked Owl, identifies the actions that need to be undertaken to ensure their long-term conservation. The action proposed is generally consistent with the objectives of the recovery plan for large forest owls, however the vegetation clearing required for the proposal is likely to remove foraging and potentially breeding habitat. Despite this, vegetation clearing is not expected to increase the barriers to gene flow between populations.

Relevant non-specific actions and plans

In general, design measures to avoid and mitigate impacts have included avoiding areas of high conservation value fauna habitat and this is consistent with the actions and objectives of recovery plans and priority actions developed for species considered in this assessment.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this is in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities.

- Loss of hollow-bearing trees

Hollow-bearing trees will be removed during the vegetation clearing required for the proposed development. The majority of these will likely be in the less-disturbed patches of vegetation that the transmission line may pass through, such as parts of Durridgere State Conservation Area and the southern end of Ulan Road. Hollows vary considerably in density and size throughout the

Transmission Line Study Area, as well as by vegetation type. Recommendations have been made to perform hollow-bearing tree targeted surveys prior to clearing to determine micro-siting of infrastructure and minimise losses. It is deemed unlikely that any threatened species will be significantly affected by the vegetation clearance associated with the proposed development. Recommendations regarding the installation of nest boxes have been made to prevent a reduction in the number of available hollows in the landscape.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that any threatened reptiles species will be utilising dead wood within the study area, although dead standing trees may provide shelter for threatened bird and bat species, and to a lesser degree, Squirrel Gliders in certain locations. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region. Recommendations are given for fallen timber greater than 50 cm to be left in place or moved to a nearby area to retain fauna habitat, where possible.

- Predation by the European Red Fox (*Vulpes vulpes*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that foxes are already present throughout most, if not all, of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for foxes.

- Predation by the Feral Cat (*Felis catus*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that feral cats are already present throughout all of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for cats.

Bats

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Microbats

Eastern Bentwing Bat

This species was observed to utilise all habitats in the Wind Farm Study Area except pasture with scattered trees and exposed ridgetops with sparse trees. The Atlas database search showed two records of this species, from within Coolah Tops NP and Goulburn River NP. The proposal has the potential to affect the species during the operational phase as a result of collisions with infrastructure. Based on carcass search results reviewed for other projects, the risk to Eastern Bentwing Bat within general habitat appears low; however in overseas studies, migratory bats are considered at higher risk. The Eastern Bentwing Bat is known as a sub- and over-canopy feeder, so the majority of foraging is expected to be below the rotor-swept area.

There are no known maternity caves in close proximity to the Project Area or within the region. The known nearest maternity cave is within Willi Willi (near Kempsey), approximately 500 km east (OEH 2012). These caves are used by a large proportion of the female and juvenile population. Given the apparent distribution of the species across the Project Area over summer it appears possible that the local population of Eastern Bentwing Bats may spike slightly during migration periods (November and February-March).

Given the long distance of the Project Area from known maternity caves the proposal is unlikely to have an adverse impact on the lifecycle of this species so that it would be placed at risk of extinction. Additionally, on the basis of carcass search monitoring elsewhere it appears unlikely that the local population would be placed at risk of extinction from the wind farm proposal; however given that the bat was recorded from six locations across the wind farm, there is potential for this species to be impacted as a result of collision with turbine blades during the operation life of the wind farm. This species should be a focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

Eastern Cave Bat

The proposal has the potential to affect this species during the operational phase (blade-strike risk and barotrauma). The Eastern Cave Bat is a cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs. It has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. Churchill (2008) suggests that forests without natural roosting sites (caves or large rock overhangs) do not provide habitat for this species. Maternity caves have generally been found in shallow sandstone caves (Churchill 2008). While the Eastern Cave Bat is considered to be a sub- and over-canopy feeder, little is known about the ecology of this species. It is considered the species forages over a small area and will forage close to the ground, but has been observed flying up to 500 m over cleared paddocks. Given the available information on this species it is expected it would forage well below the rotor-swept area on most occasions, primarily with a preference for creeklines.

Given that this species is more likely to forage in gullies or creeklines, rather than on ridgetops and the

carcass searching monitoring does not indicate high fatality rates for this species, it appears unlikely that the local population would be placed at risk of extinction. However, given that sandstone rocky outcrops are present within the Transmission Line Study Area this species should be a focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

Corben's long-eared Bat

The proposal has the potential to affect this species during the operational phase (blade-strike risk and barotrauma) as well as a result of habitat loss. Corben's long-eared bat inhabits a variety of vegetation types, including mallee, bullocke (*Allocasuarina leuhmannii*) and box eucalypt-dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.

The bat data from the 2012 survey indicated that *N. corbeni* showed a distinct preference for *Casuarina* along creeklines, open forest without understorey and dense woodland, supporting the concept that all long-eared bats prefer cluttered habitats (Greg Richards & Associates 2012). This species roosts in tree hollows, crevices and under bark.

This species is a slow flying agile bat and utilises the understorey to hunt non-flying prey - especially caterpillars and beetles - even hunting on the ground (OEH 2012). It is considered unlikely to encounter turbines and be susceptible to blade-strike and/or barotrauma impacts.

Given that this species is likely to forage in the understorey and that sandstone forest types to be cleared for the transmission line are widespread in the surrounding area, it appears unlikely that the local population would be placed at risk of extinction. However, this species should be a focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

Yellow-bellied Sheath-tail Bat

The 2012 Anabat survey completed as part of this assessment returned one possible record of this species, from along the north-eastern edge of Durrigere SCA in the Transmission Line Study Area. This species was not recorded at sites in the Wind Farm Study Area. This species is known to roost in large hollow-bearing trees in a variety of habitats. They migrate into Southern Australia during the summer months (Jan – Apr). This species forages at canopy level, but lower over open spaces at forest edges. In pursuit of prey, this species is capable of tight lateral turns (Chruchill 2008).

The data suggests this species is not common in the area as only one 'possible' call of this species was recorded and only in the Transmission Line Study Area. Given that the species is more likely to forage near the forest edge beneath the rotor-swept area in open habitat it is not expected the proposal will have an adverse effect on this species such that it would be placed at risk of extinction from blade-strike. In practice, the Wind Farm Study Area will also continue to have foraging habitat value for this species during the operational phase of the development, where the existing vegetation cover will largely be retained within turbine envelopes. However, some habitat removal is expected within the Transmission Line Study Area and there may be some loss of hollow-bearing trees (roost sites) for this species, primarily within the southern section of the easement (near Durrigere SCA).

On the basis of the results of the site survey (low call recordings), it appears unlikely that the local

population would be placed at risk of extinction. However, this species should be a focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty. Mitigation strategies related to further survey work and removal of hollows (i.e. potential breeding sites) in the southern section of the Transmission Line Study Area have been recommended to ensure impact to this species is not significant.

Large-eared Pied Bat

The Large-eared pied bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. It roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Hirundo ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. It is found in well-timbered areas containing gullies.

The OEH database search returned 7 records of this species, all from within Goulburn River NP. The 2013 survey recorded this bat in 2 locations in the Wind Farm Study Area and 4 in the Transmission Line Study Area. The 2013 survey recorded this species in an additional 2 locations in the Transmission Line Study Area.

This bat roosts in caves and will not be affected by the loss of tree hollows. Based on their wing aspect ratio (an indicator of foraging style) the Large-eared pied bat is likely to be a sub- and over-canopy feeder and the majority of foraging in the Wind farm would be below the rotor-swept area (Richards 2012). The primary impact on this species associated with the Proposed development would result from clearance of forest and woodland areas along the transmission line within the Transmission Line Study Area. The transmission line easement would result in the loss of between 126ha and 162.2ha (depending on the final route option selected) of forest and woodland habitat types.

Given that sandstone forest types to be cleared for the transmission line are widespread in the surrounding area, it appears unlikely that the local population would be placed at risk of extinction. However, this species should be a focal species of an operational Bird and Bat Management Plan to confirm the assumptions of this assessment, addressing inherent uncertainty.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

- i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

- ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

Bats

i) Section 10 of the Wind Farm report and Section 8 of the Transmission Line report discuss the extent of native vegetation types to be removed or modified as a result of the proposal. In general, relatively small areas of good quality forest or woodland habitat would be removed or modified within the Wind Farm Study Area, with most of the proposal affecting exotic pasture or cleared scattered trees over pasture. However, recommendations have been given in areas of good quality habitat for follow up survey work to determine its value as threatened species habitat before clearing proceeds. Recommendations have also been provided to protect and microsite infrastructure to avoid hollows in the first instance and then survey to accurately quantify hollows to be removed in order to offset or replace all hollows that are cleared during construction.

ii) In the Wind Farm Study Area, turbines are located on ridges, often adjacent ridges, with a spacing of approximately 2 to 5 km between them. Spacing between turbines in the current layout is generally around 300-600m. The distance between turbine clusters and also the distance between individual turbines is expected to allow for safe passage between turbines for birds and bats, without creating a barrier effect. There may be some alteration to movement patterns for some species, but areas of habitat are unlikely to become isolated from each other. Vegetation in the landscape is already very fragmented, and bats persist in that environment because of their mobility. The small amount of clearing for each turbine location is unlikely to increase fragmentation at a landscape level, particularly for mobile bat species.

The clearing of the transmission line easement is unlikely to create an impediment to movement for the microchiropteran bat species considered in this assessment.

iii) Types of habitat to be removed for turbines, access tracks, power infrastructure, and transmission line associated with the proposal are well represented in the overall Project Area and surrounding locality, including within conservation reserves and state forests such as Coolah Tops NP, Goulburn River NP, Durridgere SCA and Curryall, Turill and Munmurra State Forests. The majority of the habitat to be removed in the Wind Farm Study Area is degraded and has been subject to ongoing disturbance from agricultural land use.

The presence of the wind farm has the potential to represent indirect habitat loss if bats avoid the entire area of the wind farm. However, research to date (summarised in the main report) suggests that bats readily fly among turbines with only a small percentage suffering mortality from collision with turbines. There is no evidence available to suggest that bat utilisation of remnant vegetation within the turbine envelope, decreases following wind farm construction. Regardless, microchiropteran bats (species diversity and activity levels) would be a focus of the Bird and Bat Adaptive Management Plan for the project.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Eastern Cave Bat

Of the identified priority actions for this species, the recommendation to *Identify and protect natural roost habitat such as caves and overhangs* is relevant to this proposal. No roost sites were identified that were considered appropriate for this species during the field survey.

Corben's long-eared Bat

Of the identified priority actions for this species, the recommendation to *Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools* is relevant to this proposal. This assessment has identified mitigation measures to minimise the loss of hollow bearing trees and dead trees and offset hollow bearing trees that would be removed.

Yellow-bellied Sheath-tail Bat

Of the identified priority actions for this species, the recommendation to *Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools* is relevant to this proposal. This assessment has identified mitigation measures to minimise the loss of hollow bearing trees and dead trees and offset hollow bearing trees that would be removed.

Eastern Bentwing Bat

OEH have identified priority actions which relate to protection of roost sites; none are relevant to the proposal.

Large-eared Pied Bat

Of the identified priority actions for this species, the recommendation to *Ensure protection of caves and overhangs in area of suitable geology when undertaking PVP assessments (offsets should include nearby remnants in high productivity) or other land assessment tools* is relevant to this proposal. No roost sites were identified that were considered appropriate for this species during the field survey.

Relevant non-specific actions and plans

In general, design measures to avoid and mitigate impacts have included avoiding areas of high conservation value fauna habitat and this is consistent with the actions and objectives of recovery plans and priority actions developed for species considered in this assessment.

A Threat Abatement Plan (TAP) has been prepared for the threatening process *Predation by the Red Fox*. The proposal is not located near to any priority sites discussed under the TAP and is consistent with the objectives and actions of the TAP.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that ‘clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity’. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this is in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities.

- Loss of hollow-bearing trees

Hollow-bearing trees will be removed during the vegetation clearing required for the proposed development. The majority of these will likely be in the less-disturbed patches of vegetation that the transmission line may pass through, such as parts of Durridgere State Conservation Area and the southern end of Ulan Road. Hollows vary considerably in density and size throughout the Transmission Line Study Area, as well as by vegetation type. Recommendations have been made to perform hollow-bearing tree targeted surveys prior to clearing to determine micro-siting of infrastructure and minimise losses. It is deemed unlikely that any threatened species will be significantly affected by the vegetation clearance associated with the proposed development. Recommendations regarding the installation of nest boxes have been made to prevent a reduction in the number of available hollows in the landscape.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that any threatened reptiles species will be utilising dead wood within the study area, although dead standing trees may provide shelter for threatened bird and bat species, and to a lesser degree, Squirrel Gliders in certain locations. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region. Recommendations are given for fallen timber greater than 50 cm to be left in place or moved to a nearby area to retain fauna habitat, where possible.

- Predation by the European Red Fox (*Vulpes vulpes*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that foxes are already present throughout most, if not all, of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for foxes.

- Predation by the Feral Cat (*Felis catus*)

There is potential for the proposed works to increase the suitability of certain areas of the project area for use by foxes. It is likely that feral cats are already present throughout all of the study area, although tree-clearing within large intact vegetation patches may result in more easily-traversed terrain and provide movement corridors for cats

Endangered Ecological Communities

White Box Yellow Box Blakely's Red Gum Woodland

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

i) *White Box Yellow Box Blakely's Red Gum Woodland* is the predominant woodland vegetation type present within the Wind Farm Study Area, with the exception of the northern ridge tops above roughly 950 m. The community occurs on lower slopes in the northern part of the site and on the lower elevation ridge tops and adjacent slopes in the southern part of the site. Areas of Yellow Box occurring on valley floor flats are also included in this community (although these areas are located outside the turbine envelope, but may be subject to impacts associated with access routes and/or powerline construction).

The EEC is less common in the Transmission Line Study Area where sandstone forest vegetation types are dominant.

Under the TSC Act, areas of degraded native pasture that once comprised Box Gum Woodland canopy species may still be considered part of the EEC. The EEC over the vast majority of the entire Project Area is characterised by low diversity native pasture in poor or poor-moderate condition.

In terms of EECs, calculations are expressed for the entire project area (approximately 7920 ha) including the Wind Farm Study Area and the Transmission Line Study Area in order to assess a cumulative impact to this EEC. Calculations are provided for the three alternative infrastructure layouts so comparisons can be made (see Tables 7-1 to 7-3 in the main report). Total clearing of the EEC is lowest under the preferred infrastructure layout (441.7 ha), slightly more under the alternative layout (445.7 ha), and greatest under the second alternative layout (462.8 ha). These values represent approximately 0.16% of the cumulative Box Gum Woodland remaining in the South-western Slopes and the Brigalow Belt South Bioregions, a total of approximately 270800 ha. Due to the overlap between the three CMAs and three Bioregions that occur in the region, it is difficult to determine the extent of the community at a more localised scale. However, as there is a general trend for Box Gum Woodland to be present in the Coolah region below altitudes of 800-900 m (pers. obs.), it is expected that the local extent of the EEC is also far greater than the maximum extent of proposed clearing. This assumption is strengthened by the fact that

the condition of the EEC on the side slopes of hills (which is to be retained) is better than the condition of the EEC on hilltops (where most clearing will occur), due to the greater impact that livestock and management practices have on the flat ridge tops.

When considering clearing of EEC in Moderate-good and Good condition, the least clearing would again occur under the preferred infrastructure layout (3.9 ha), more than three times as much under the 2nd alternative (14.0 ha), and the most (23.0 ha) under the alternative route.

It should be noted that the amount of clearing on the wind farm varies little with each infrastructure layout as the alternatives relate primarily to the transmission line route to the south of the wind farm. As there is far more Box Gum Woodland present in the Wind Farm Study Area than the Transmission Line Study Area, the overall extents of clearing for the three alternatives are similar.

ii) The majority of impacts associated with the wind farm construction will occur along the ridge tops. These areas are generally in poorer condition than the adjacent slopes due to more grazing pressure. These areas are typically defined by a more open canopy layer with little to no native understorey compared to adjacent slopes. Therefore construction of turbines along the ridge tops would most likely only result in the clearing of scattered trees within the turbine footprints.

Within the Wind Farm Study Area, and areas of Transmission Line Study Area EEC with little or no tree component, EEC values will still be retained to a large extent despite the location of powerpoles, turbines and other infrastructure and shorter term disturbance from construction impacts.

Areas of better quality EEC with a greater understorey diversity and structural integrity are typically concentrated along adjacent slopes. These areas are located outside the turbine envelopes and would remain mostly undisturbed except where they intersect with transmission line easements and access roads; existing tracks are to be utilised where possible. These impact areas are considered minor in terms of the extent of the community available in the locality

Predominately, the areas to be impacted contain a moderate to low tree density with an understorey of exotic and/or native grass dominated pasture with a relatively low native forb and shrub diversity (0 – 11 non-grass species in poor and moderate condition). This structural and understorey configuration is common and widespread within the locality and there are large expanses of this vegetation type with or without tree cover. Based on field observations and known extents of Box Gum Woodland within the Wind Farm Project Area and surrounding region, the loss of this vegetation is not considered likely to substantially affect the extent or modify the community such that it would be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

i) The proposal will impact upon habitat for Box Gum Woodland in the form of direct clearing of this community and the extent of this impact is discussed in Section c) above. Up to 462 ha of Box Gum Woodland EEC may be cleared as a result of the proposal, although the actual clearing is expected to be far less.

ii) The areas of habitat within the site are already largely fragmented due to previous clearing, grazing

pressure, the planting of exotic pastures, the ingress of weeds and the occurrence of other vegetation communities in habitats not suitable for Box Gum Woodland. The proposal would not further fragment or isolate habitat for this community.

iii) The majority of suitable habitat likely to be removed by the proposal is in poor condition. Generally a canopy layer is present (sometimes very sparse), but much of the understorey is cleared and altered to such a state that it is highly unlikely to regenerate without costly and intensive long-term assistance. The extent of clearing is not anticipated to impact the long-term survival of this ecological community in the locality, due to (1) the total extent of the community present in the region, (2) the small footprint of the proposed infrastructure, (3) the poor quality of most of the EEC proposed for clearing, and (4) the retention of understorey species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There are no areas of declared critical habitat within the Project Area or greater locality.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A draft national recovery plan for this community has been prepared and is currently available for public comment. The proposal is inconsistent with the objective of the draft recovery plan that aims to '*achieve no net loss in extent and condition of the ecological community throughout its geographic distribution*'. Of the 7171.7 ha assessed, Box Gum Woodland covers up to 462.8 ha of which approximately 61.4% is in poor or poor-moderate condition. However, as discussed above, given the majority to be cleared is in poor condition, there is a large extent of the community remaining within the Project Area and the locality, and the potential to improve outcomes for this community through off setting, the clearing is not considered to be significant.

With the correct implementation and management of an offset plan the proposal has the potential to contribute to the following Recovery Plan Objectives;

- Increasing landscape functionality of the ecological community through management and restoration of degraded sites;
- Increasing transitional areas around remnants and linkages between remnants; and
- Bringing about enduring changes in participating land manager attitudes and behaviours towards environmental protection and sustainable land management practices to increase extent, integrity and function of Box Gum Woodland.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposal may increase the impact of the following key threatening processes relevant to the species assessed herein:

- Clearing of native vegetation.

In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer, increased habitat for invasive species and off-site impacts such as

downstream sedimentation.

While the proposal contributes to clearing of native vegetation, including the potential removal of over 400 ha of threatened Box Gum Woodland (although approximately half of this is derived grassland and actual clearing extents will be much less), the majority of this will occur in historically cleared and fragmented areas that have been highly degraded through long-term grazing practices. Clearing of better quality vegetation is generally restricted to proposed access tracks and powerline easements where these intersect with more closed woodland or sandstone forest communities. As most of the overstorey and shrub clearing is expected to occur in common and well-conserved sandstone forest communities, and relatively little clearing in the historically cleared Box Gum Woodland environments, the proposal is expected to contribute minimally to this key threatening process with respect to EECs.

- The invasion of native vegetation by exotic perennial grasses

A number of exotic perennial grasses, including Coolatai Grass and African Lovegrass, were observed within the project area. The proposed development may contribute to the spread of these species within or between sites, although weed management recommendations and other mitigations have been suggested to prevent this from occurring. Recommendations have been given to reduce spread of invasive weeds into good quality woodland vegetation, including a vehicle hygiene protocol for cleaning of vehicles. The proposal is not expected to significantly increase the impact of this Key Threatening Process in the Project Area.

- Loss of hollow-bearing trees

Hollow-bearing trees will be removed during the vegetation clearing required for the proposed development. The majority of these will likely be in the less-disturbed patches of vegetation that the transmission line may pass through, such as parts of Durridgere State Conservation Area and the southern end of Ulan Road. Hollows vary considerably in density and size throughout the Transmission Line Study Area, as well as by vegetation type. Recommendations have been made to perform hollow-bearing tree targeted surveys prior to clearing to determine micro-siting of infrastructure and minimise losses. It is deemed unlikely that any threatened species will be significantly affected by the vegetation clearance associated with the proposed development. Recommendations regarding the installation of nest boxes have been made to prevent a reduction in the number of available hollows in the landscape.

- Removal of dead wood and dead trees

The removal of dead wood and dead trees from the landscape may occur as a result of the proposed development. It is unlikely that any threatened reptiles species will be utilising dead wood within the study area, although dead standing trees may provide shelter for threatened bird and bat species, and to a lesser degree, Squirrel Gliders in certain locations. It is unlikely that the removal of dead wood and trees will result in a significant impact to any threatened species in the region. Recommendations are given for fallen timber greater than 50 cm to be left in place or moved to a nearby area to retain fauna habitat, where possible.

D.2 COMMONWEALTH

The following species listed under the EPBC Act are assessed in accordance with *EPBC Policy Statement 1.1, Significant Impact Guidelines*:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- *Digitaria porrecta*
- *Bothriochloa biloba*
- *Dichanthium setosum*
- Large-eared Pied Bat

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

a) Will the action reduce the extent of a community?

The proposal would result in the clearing of a small area of Box Gum woodland within the Wind Farm Study Area which forms part of the CEEC. No areas of CEEC were located within the Transmission Line Study Area.

Areas of moderate-good and good condition EEC are likely to meet the condition thresholds of the CEEC. The proposal has the potential to result in the removal of up to 3.9 ha (preferred), 23 ha (alternative) or 14 ha (2nd alternative) of the Box Gum Woodland CEEC causing a localised reduction in the occurrence of this community. This assessment has considered that the worst case scenario would be the total loss of CEEC within the TL easement (up to 60 m); however in reality the vegetation is open woodland meaning that only scattered trees would need to be cleared. The understorey would also be mostly retained excluding small areas required for footings and a maintenance track. It is considered likely that the community would maintain its existing functionality following construction. Large extents of moderate-good condition Box Gum Woodland occur within the Project Area which will not be affected as a result of the proposed works.

b) Will the action fragment or increase fragmentation of the community, for example by clearing vegetation for roads or transmission lines?

The Box Gum Woodland CEEC community within the proposal site boundary has already been highly fragmented due to past clearing and agricultural practices. Permanent clearing will be limited to the removal of scattered trees and high diversity ground cover for the purposes of constructing access roads and the transmission line easement. The preferred route would only require the removal of a small amount (3.9 ha) of Box Gum Woodland CEEC. This includes two small areas of CEEC which are located adjacent to existing roads and thus would not fragment any larger areas of CEEC. The first and second alternative routes would result in a higher amount of fragmentation as they pass directly through larger areas of CEEC.

c) Will the action adversely affect habitat critical to the survival of an ecological community which consists of, or includes, fauna species?

The proposal will permanently remove less than 4 ha (preferred route) of habitat for the CEEC. The proposed works would not impact habitat critical to the survival of the CEEC, which is abundant across the northern part of the Transmission Line study area and the majority of the Wind Farm study area. Given the relatively small amount to be removed is not considered critical to the survival of the CEEC.

d) Will the action modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns?

Localised disturbance to hydrological patterns that support the CEEC may result from the proposal but are unlikely to be substantial. The risks associated with the ingress of invasive species and disease and potential impacts from chemicals and fertilizers are considered to be acceptable if the recommendations included within Section 12 of this report are adhered to.

Soils and nutrient balance in parts of the Project Area are already highly disturbed due to grazing and clearing impacts which have been widespread and long-term in nature. The proposal would have a short term gross impact upon soils and possibly surface water flow, within discreet areas. These impacts are manageable with the implementation of erosion and sediment controls and would be unlikely to further degrade the Project Area above levels already occurring from present landuses.

The construction of roads may cause minor alterations to drainage patterns due to localised reduction in infiltration and runoff. However, the actions associated with the proposal are not considered likely to substantially alter hydrological patterns necessary for the community's survival.

e) Will the action cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?

The development is unlikely to cause a substantial change in species composition in areas of CEEC, including through clearing, harvesting, disease infection, weed invasion or alteration to grazing, burning or flooding regimes. Management associated with offsetting has the potential to increase the diversity of functionally important species within more extensive areas of the CEEC within the proposal site.

Large potential offset areas exist within the site boundary that if properly managed can assist with the recovery of this community, arresting existing threats and managing the land for biodiversity outcomes in perpetuity. Offsetting is recommended by this report to maintain or improve the biodiversity values associated with the proposal in the longer term. The offset plan for the proposal would include provisions for offsetting Commonwealth listed EEC to demonstrate compliance with the Commonwealth Offset Policy.

f) Will the action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - assisting invasive species, that are harmful to the listed ecological community, to become established; and - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community?

The construction phase of the proposal has the potential to introduce or assist the spread of invasive weed species. The invasion of native vegetation by exotic perennial grasses is a particular risk for the CEEC. These risks could be reduced to acceptable levels through weed hygiene protocols, pre- and post-works weed control, soil erosion and sedimentation control, effective and timely site rehabilitation and the avoidance of fertiliser use in areas within and adjacent to the CEEC.

Protocols for pollution prevention and site management are given in Section 12. With controls in place, the works are not expected to result in significant impacts from weeds or pollutants.

g) Will the action interfere with the recovery of an ecological community?

The proposal is unlikely to interfere with the recovery of the CEEC and with the implementation of a suitable offset plan is likely to assist with the recovery of the broader extent of the community within the proposal site.

Conclusion

With the implementation of the controls and recommendations of this report the proposal is considered unlikely to have a significant impact on the Box Gum Woodland CEEC and, through long-term

management and improvement, would result in a net gain. Referral to the Commonwealth government under the EPBC Act is also recommended however, to confirm that the action would not be deemed a Controlled Action on the basis of impacts to the Commonwealth listed EEC.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

- **reduce the area of occupancy of an important population**
- **fragment an existing important population into two or more populations**
- **adversely affect habitat critical to the survival of a species**
- **disrupt the breeding cycle of an important population**
- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**
- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**
- **introduce disease that may cause the species to decline, or**
- **interfere substantially with the recovery of the species.**

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- **key source populations either for breeding or dispersal**
- **populations that are necessary for maintaining genetic diversity, and/or**
- **populations that are near the limit of the species range.**

Large-eared Pied Bat

The Large-eared Pied Bat is listed as Vulnerable under the EPBC Act 1999.

The OEH database search returned 7 records of this species, all from within Goulburn River NP. The 2013 survey recorded this bat in 2 locations in the Wind Farm Study Area and 4 in the Transmission Line Study Area. The 2013 survey recorded this species in an additional 2 locations in the Transmission Line Study Area.

This bat roosts in caves and will not be affected by the loss of tree hollows. Based on their wing aspect ratio (an indicator of foraging style) the Large-eared Pied Bat is likely to be a sub- and over-canopy feeder and the majority of foraging in the Wind farm would be below the rotor-swept area (Richards 2012). The primary impact on this species associated with the Proposed development would result from clearance of forest and woodland areas along the transmission line within the Transmission Line Study Area.

Given that sandstone forest types to be cleared for the transmission line are widespread in the surrounding area, it is considered that the Proposed development (including wind farm and

transmission line components) is unlikely to reduce the area of occupancy of the local population of Large-eared Pied Bats, fragment this population, adversely affect critical habitat, disrupt the breeding cycle or modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Dichanthium setosum* and *Bothriochloa biloba

Neither *Dichanthium setosum* nor *Bothriochloa biloba* were recorded within the Wind Farm or Transmission Line Study Area. Both are considered possible occurrences in the Wind Farm Study Area. *Dichanthium setosum* was not recorded in the OEH database search. If this species occurs in the project area it is likely to be confined to basalt derived soils in the Wind Farm Study Area.

Lobed blue-grass (*Bothriochloa biloba*) is an erect or decumbent grass to 1m high. This species grows in cleared eucalypt forests and relict grassland, preferring heavier-textured soils such as brown or black clay soils (Commonwealth Department of the Environment 2008a). The OEH database search returned 27 records of this species, indicating that the local population is quite widespread. The majority of these records are from west of the Wind Farm and Transmission Line Study Areas, however some records are from within the Study Areas.

The majority of groundcover vegetation within the Wind Farm survey envelope will not be impacted by the development of the wind farm and will continue to provide potential marginal habitat for these grasses. Within the Transmission line easement, grass species will not be cleared except to create some new access tracks, widen existing ones and install power poles (with associated ground disturbance in the vicinity of this infrastructure). It is unlikely that the Proposed development would result in a significant impact on these grass species should they occur in the Project Area.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- **lead to a long-term decrease in the size of a population;**
- **reduce the area of occupancy of the species;**
- **fragment an existing population into two or more populations;**
- **adversely affect habitat critical to the survival of a species;**
- **disrupt the breeding cycle of a population;**
- **modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;**
- **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;**
- **introduce disease that may cause the species to decline; or**
- **interfere with the recovery of the species.**

Digitaria porrecta

Digitaria porrecta was not recorded within the Wind Farm or Transmission Line Study Area. This species may not have been detectable in site surveys due to the timing of the surveys (October). The OEH database search for the project area returned 3 records of *Digitaria porrecta* in one location in farmland (elevation 635m) 15km north of Coolah. This area is outside the Wind Farm Study Area. If this species occurs in the project area it is likely to be confined to basalt derived soils in the Wind Farm Study Area.

The population of this species is estimated to be 200 000 individuals with 75% occurring near Premer (approximately 41 500 individuals) and Tambar Springs (114 000 individuals) in NSW (Commonwealth

Department of the Environment 2008c).

The majority of groundcover vegetation within the nominated survey envelope will not be impacted by the development of the wind farm and will continue to provide potential marginal habitat for this grass. It is unlikely that the Proposed development would result in a significant impact on this species should it occur in the Wind Farm Study Area.

Conclusion

The proposal has the potential to result in the removal of up to 0.8 ha of the Box Gum Woodland CEEC causing a localised reduction in the occurrence of this community. This assessment has considered that the worst case scenario would be the total loss of this vegetation type however, in reality, the actual impact is likely to be considerably less as vegetation within this area is open woodland and groundcover vegetation would only be affected where footings and a maintenance track is required. The proposal will not impact on the broader extent of the CEEC within the Project Area. Localised disturbance to hydrological patterns that support the CEEC may result from the proposal but are unlikely to be substantial. The risks associated with the ingress of invasive species and disease and potential impacts from chemicals and fertilizers are considered to be acceptable if the recommendations included within Section 12 of this report are adhered to.

Offsetting is recommended by this report to maintain and improve the biodiversity values associated with the CEEC within the Project Area. Additionally, provisions are given within the offset strategy to comply with the Commonwealth offset policy for this community. Large areas potentially exist within the Project Area that if properly managed can assist with the recovery of this community, arresting existing threats and managing the land for biodiversity outcomes.

With the implementation of the controls and recommendations of this report the proposal is considered unlikely to have a significant impact on the EPBC-listed Box Gum Woodland CEEC.

For the Large-eared Pied Bat, the Proposed development (including wind farm and transmission line components) is unlikely to reduce the area of occupancy of the local population, fragment this population, adversely affect critical habitat, disrupt the breeding cycle or modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

APPENDIX E MAPS

E.1 LOCATION OF PROJECT AREA & PROJECT DESIGN

E.2 SURVEY EFFORT

E.3 SURVEY RESULTS

E.4 EEC & CEEC AREAS

E.5 CONSTRAINT MAPS

APPENDIX F OFFSET STRATEGY

F.1 INTRODUCTION

The objective of offsetting is to ensure that an overall ‘maintain or improve’ outcome is met for the project; where impacts cannot be avoided, or sufficiently minimised, the residual impact will be offset in perpetuity.

The biodiversity offset principles developed by the former DECCW (now DOE) would guide the selection and management of the offset site, namely:

- Impacts must be avoided first by using prevention and mitigation measures.
- All regulatory requirements must be met.
- Offsets must never reward ongoing poor performance.
- Offsets will complement other government programs.
- Offsets must be underpinned by sound ecological principles.
- Offsets should aim to result in a net improvement in biodiversity over time.
- Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.
- Offsets should be agreed prior to the impact occurring.
- Offsets must be quantifiable - the impacts and benefits must be reliably estimated.
- Offsets must be targeted.
- Offsets must be located appropriately.
- Offsets must be supplementary.
- Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

The proponent commits to the preparation of an Offset Strategy, developed with input from OEH and the CMA and finalised prior to any construction impacts.

Further, the proponent commits to the preparation of an Offset Plan, developed with input from OEH and the CMA prior to operation, demonstrating the suitability of the final offset site and providing detailed management actions specific to the site.

An Offset Strategy outline is provided below, to provide certainty around:

1. How offsets will be identified
2. How offsets will be managed
3. How offsets will be secured

These issues are outlined below.

F.1.1 Background

The DGRs for this proposal require that an Offset Package be developed where the proposal cannot adequately avoid or mitigate impacts on biodiversity. While measures have been taken to minimise impacts (refer to mitigation strategies set out in Section 11 of the main report), residual impacts remain and therefore an Offset Package is considered to be required.

The following commitments are made by the proponent to address this requirement:

1. The proponent commits to the preparation of an **Offset Strategy**, developed with input from OEH and the CMA and finalised prior to any construction impacts.
2. Further, the proponent commits to the preparation of an **Offset Plan**, developed with input from OEH and the CMA prior to operation, demonstrating the suitability of the final offset site and providing detailed management actions specific to the site.

The wording of the above commitments ensures that prior to any impact, the offset site, the offset ratios, the management measures in place and the means to secure the site have been developed with input from OEH and the CMA.

In order to better understand their requirements regarding offsets for this project consultation was undertaken with OEH on 12 March 2013, following submission of the draft BA for validation and prior to public exhibition. The following discussion provides additional information specifically addressing the issues raised by OEH in this meeting and their detailed comments provided as part of BA validation.

The strategy proposed in this document is based on similar strategies undertaken in consultation with OEH for renewable energy projects in NSW.

F.1.2 Scope and aim of this Draft Offset Strategy

The key aim of the provision of this information is to demonstrate, prior to project approval that the offsets required can be achieved and will be acceptable to the impact proposed. Furthermore, it sets out a clear pathway to implementation of the offsets, to provide certainty regarding the outcomes for all parties involved.

Because of the different nature of the impacts of wind farms versus transmission lines and the scale of the project, two separate biodiversity assessments have been prepared for the Liverpool Range Wind Farm project. However, it is proposed that one Offset Package be produced to offset the residual biodiversity impacts. Hence, this appendix is duplicated in each Biodiversity Assessment.

Specific to issues raised by OEH, offsets for the Liverpool Wind Farm Project would:

- | | |
|--|--|
| • Be supported by a suitable metric. | <i>Standardised survey techniques used.</i> |
| • Addresses the Department's 'Principles for Biodiversity Offsets in NSW'. | <i>These are addressed below.</i> |
| • Ensure that offset sites are located remote from the influence of wind turbines (and any habitat modification that could be expected in nearby habitat). | <i>Location criteria are included in the offset guidelines.</i> |
| • Be governed by conservation mechanisms to ensure long-term protection and management of the site, including funding arrangements. | <i>One Conservation Property Vegetation Plan (CPVP) proposed for each private property offset site.</i> |
| • Include a management plan to ensure management measures are appropriate. | <i>Guidance on development of appropriate management measures is provided below.</i> |
| • Be able to be demonstrated prior to the impact occurring (including precise quantification of impact vs offset lands and their locations). | <i>Commitment to upfront ratios put a limit on clearing allowed. Commitment to validate actual clearing and ensure this is offset is provided.</i> |
| • Be able to ensure a maintain or improve outcome. | <i>Ratios proposed are in line with guidance documents and consultants experience, as set out below.</i> |

Specific to key components of this outline, it is noted that:

In advance of project approval, allowances have to be made for changes in the infrastructure layout. The movement of infrastructure within the development envelope is termed ‘micro-siting’. Limits are placed on micro-siting by the draft standard conditions for wind farms developed by the NSW Department of Planning and Infrastructure (a location allowance of 100 metres radius for development components as long as impacts remain consistent with that assessed - <http://www.planning.nsw.gov.au/standard-and-model-conditions>). These changes may also affect the landowners involved in the project and therefore the ability to use suitable areas of their property in the Offset Package. In response to this issue, a ‘criteria approach’ has been adopted in the development of this offset outline. The criteria and methods set out below are intended to guide the finalisation of the Offset Package whilst allowing the project the flexibility it requires to be developed.

While a Biobanking offset methodology is not proposed, the *Part 3A Transitional Project Biobanking Guidance for Offset Ratios* has been referenced where relevant below.

F.2 IMPLEMENTATION OVERVIEW

The following stages of implementing the Offset Package are proposed:

Stage	Timing
1. Offset Strategy	Draft Strategy pre project approval (this document). Final Strategy endorsed by agencies, prior to any impact.
a. Estimation of loss of habitat required for the project.	
b. Calculation of the required offsets, using predetermined offset ratios.	
c. Consultation and endorsement of CMA and OEI to finalise the Offset Strategy.	
2. Offset Plan	Prior to any impact.
a. Selection of offset sites	
b. For each offset site:	
o Establishment of baseline data.	
o Documentation of key biodiversity risks, opportunities and relevant local initiatives.	
o Refinement of management actions specific to the site (with input from the landowner), including monitoring regime and reporting requirements.	
o Consultation and endorsement of CMA and OEI to finalise the Offset Plan (could be documented separately for each site or in one combined document).	
3. Verification of the actual area of native vegetation clearing of the constructed wind farm and transmission line.	After construction.
4. Formalisation of the offset on the title of each involved property by way of a CPVP, including the inclusion of the management plan and its required management actions and land use restrictions.	Prior to operation.

These stages are detailed further in the sections below.

F.3 OFFSET STRATEGY

F.3.1 *Estimation of loss of habitat*

The Biodiversity Assessment estimates the impact area for the proposal through calculation of habitat loss on a worst case scenario. This information is contained in Section 9 of the main report and provides an upper limit on the clearing proposed for the project and therefore required to be offset. Vegetation and habitat loss is currently grossly overestimated by the inclusion of large buffers around infrastructure and tracks (e.g. 20m buffer allowed for underground powerlines and tracks). In reality clearing for tracks will be much less and some tracks are already cleared. Similarly, where infrastructure is being placed in areas of degraded grassland/pasture these areas will not require clearing.

F.3.2 *Calculation of required offsets*

The proponent commits to determining an offset ratio with reference to:

- The conservation status of the vegetation (EECs would be offset at a higher ratio than common vegetation types)
- The condition of the vegetation (a standard metric has been used to collect condition data and would be used to ensure vegetation in better condition is offset at a higher ratio than degraded vegetation²)
- Habitat values (important habitat elements or verified threatened species habitat would be offset at a higher ratio)

The offset ratios are proposed to be via negotiated agreement with OEH, rather than using the Biometric Assessment Methodology. A large amount of biodiversity survey work has been undertaken onsite. The intention is to supplement rather than redo this survey work in the calculation of offset areas. Using the Biometric Assessment Methodology at this time would duplicate survey effort.

The proposed ratios below have been developed based on **ngh**environmental's experience with the Biobanking calculator in similar vegetation types as well as in negotiations with OEH for similar renewable energy projects. They are proposed as a starting point for a negotiated agreement. They have the benefit of being transparent to the proponent and the consent authority, facilitating an upfront understanding of the offset requirements for the project in advance of impacts occurring. Where multiple factors apply and their ratios are contradictory (i.e. threatened species habitat and low condition vegetation) it is proposed that the highest offset ratio would apply. Hollow-bearing tree requirements (HBT) are supplementary to area offsets. While the Biometric Assessment Methodology has the advantage of being more clear cut, we propose a negotiated agreement that is flexible to achieving an overall beneficial outcome and is better suited to the many individual sites that are likely to be included in the final offset plan.

Proposed offset ratios

² This is a five class condition categorisation, documented within the BA and able to be easily related to the Biometric two-class condition categories.

Condition class	Biometric condition ³	Vegetation <u>NOT</u> <u>OF</u> conservation significance	Vegetation <u>OF</u> conservation significance	Threatened species habitat	HBT removed: nest box
Poor	Low	1 : 1	1 : 2	1 : 2	1 : 1
Poor-moderate	Moderate- Good	1 : 1	1 : 2	1 : 2	1 : 1
Moderate	Moderate- Good	1 : 1	1 : 5	1 : 5	1 : 1
Moderate-good	Moderate- Good	1 : 1	1 : 10	1 : 10	1 : 1
Good	Moderate- Good	1 : 1	1 : 20	1 : 20	1 : 1

Justification of these ratios is based on the following:

- In a recent project with Dubbo OEH office, a 1:5 ratio was endorsed by OEH for all native vegetation to be impacted; that being the ratio for the Grey –Crowned Babbler, considered to be the key significant species to be impacted. The ratios above are lower than this for degraded vegetation and higher than this for vegetation in moderate to good quality, achieving a comparative offset.
- In a recent project with Queanbeyan OEH office, a 1:10 ratio was suggested by OEH for Box Gum Woodland EEC with tree cover and 1: 5 ratio for EEC derived pasture. The ratios above are lower than this for degraded vegetation and higher than this for vegetation in good quality, achieving a comparative offset.
- In a recent project with South West OEH office, a 1:1 ratio was endorsed by OEH for a common vegetation type. The offset site included better habitat values than the development site. The ratios above include 1:1 for common vegetation types and higher ratios for threatened species habitat values, achieving a comparative offset.
- In several Biobanking Assessments undertaken using the BioBanking calculator, EECs in moderate to good biometric condition have returned ratios averaging 1:6. This can be verified as required.
- The Part 3A Transitional Project Biobanking Guidance for Offset Ratios allow a Tier 2 ‘no net loss’ option rather than an ‘maintain or improve’ option, whereby lesser ratios are accepted if ‘maintain or improve’ cannot be achieved. This pathway must consider whether feasible alternatives to the clearing exist and the value of the resource (in this case wind energy). It is considered that the location of turbines and associated infrastructure is necessarily restricted to sites with suitable wind speed and that a lesser goal of ‘no net loss’ may be applicable to this project.

F.4 SELECTION OF OFFSET SITES

The proponent would establish offsets within the private land holdings of the project site.

Epuron have lease agreements with all involved landholders (where infrastructure is proposed to be located). These contracts stipulate that the land may be considered for biodiversity offsets. The intention is to select offset lands impacted from within the project boundary in areas that will not be. Broad scale mapping for the site identifies that the vegetation is representative of that that would be cleared and therefore allows a like for like offset criteria to be targeted. Additional criteria that would be used to select offset sites that will together make up the Offset Package include:

- Of sufficient combined size to achieve the set ratios above (or as negotiated with OEH)

- Complying with *Principles for the use of biodiversity offsets in NSW* guidance document (refer below for explicit reference to these principles)
- Will include provisions for offsetting Commonwealth listed EEC to demonstrate compliance with the Commonwealth offset policy.
- Selected to minimize:
 - Edge area
 - Number of land holdings
- Selected to maximize:
 - Landscape connectivity
 - Preservation of declining habitat types and resources
- Located no closer than 500 m from a wind turbine (to minimise any indirect impacts of the wind farm)

Any areas of ambiguity will be clearly stated so that a decision can be made about the overall suitability of the site. For example, it may be that exact ratios and types are not achieved but the overall package is still considered to achieve an overall neutral or beneficial outcome. If so, this will be identified and justified.

While specific sites have yet to be identified, there are large amounts of land of suitable type and condition within the project boundaries to demonstrate that offsets are achievable. In principle, agreements with landholders are in place.

F.5 FOR EACH OFFSET SITE:

F.5.1 Establishment of baseline data

The following baseline data would be collected for all sites within the Offset Package:

Desktop assessment

Evaluation of potential for threatened species to occur onsite, with reference to prior field work and database searches, below:

- The OEH threatened species database to identify species listed as threatened under the NSW *Threatened Species Conservation Act 1995* (TSC Act).
- The DSEWPC protected matters search tool to identify species listed as threatened or migratory under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act).

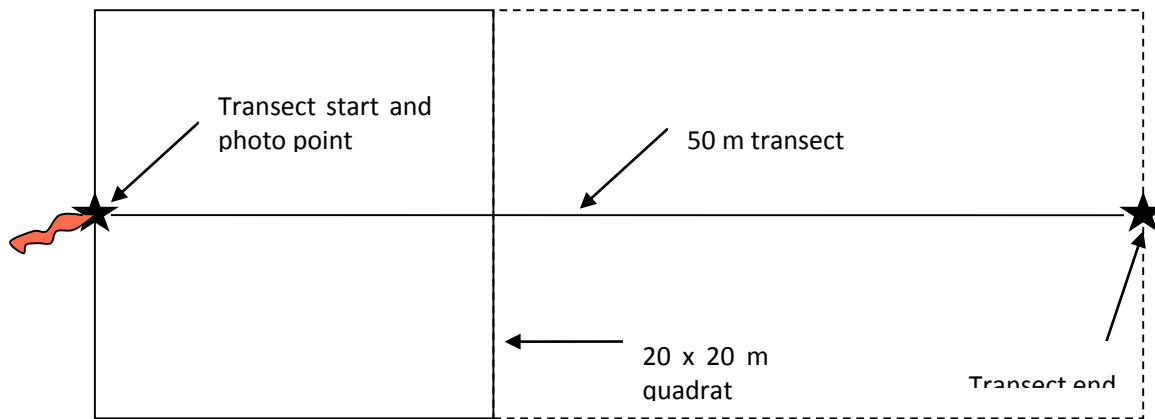
Field survey

A field survey would be undertaken by an ecologist. This would include:

- Mapping of vegetation types and condition
- Establishment of monitoring plots
- Ongoing validation / assessment of habitats for threatened species with the potential to occur at the site

BioBanking plots would be established in accordance with the BioBanking Assessment Methodology (BBAM, DECC 2009) to collect baseline data on vegetation structure and quality. The location of the plots would be marked using 1650 mm star pickets to facilitate the replication of the plots. The ends of the star pickets would be painted white to enable easy identification in the field. Star pickets would be placed at

the start and end of the 50 metre transect required by the BBAM and their co-ordinates recorded. To delineate the start point of transects, orange flagging tape would be tied to the top of the appropriate picket. The 20 x 20 metre quadrat required by the BBAM would be conducted within an area bounded by the first 20 metres of the transect and extending 10 metres either side as shown below. Photo points would be established at each of the start points of the transects, with views along the length of the transect.



Monitoring plot layout

Data evaluation

Data recorded from the BioBanking monitoring plots would be compared with the benchmark data for the vegetation type as provided in the BioBanking vegetation types benchmark database (DECC 2008). Monitoring plot data would also be entered into the BioBanking Credit Calculator (BBCC) version 2 to obtain a baseline site value score for dominant vegetation formations at each site.

F.5.2 Key biodiversity risks, opportunities and relevant local initiatives

As a background to the development of appropriate management actions for the site, key biodiversity risks, opportunities and relevant local initiatives for each site would be documented.

F.5.3 Site specific management actions

Offset site management measures are required to be specific to each area in question. These measures aim to result in an improvement in the biodiversity values of the site and are designed to be adaptive (informed by a monitoring regime). These management measures would be incorporated into a detailed management plan for each offset site (one plan per landowner).

Management measures would be developed with reference to the Biobanking Management Plan template and with input from the CMA. Examples of likely measures are included below.

Example offset site management measures

Management measure	Objective	Justification	Action	Timing
Exclusion of stock	To prevent overgrazing and encourage regeneration of native vegetation. Any exclusion fencing must take into account access to macropods to enable natural levels of grazing to continue, requirements of threatened flora species and fire regimes.	Grazing would be likely to degrade habitat.	<ul style="list-style-type: none"> Install stock proof fencing around the perimeter of the Offset Site (consider access for Macropods). 	<ul style="list-style-type: none"> At establishment of the Offset Site. Ongoing repairs as required.
Weed control	To minimise the occurrence of weeds within the Offset Site particularly Weeds of National Significance (WoNS) and listed noxious weeds.	Weeds compete with native species and degrade habitats.	<ul style="list-style-type: none"> Survey to identify target locations for weed control. Weed control using appropriate methodologies considering target species and landscape context. 	<ul style="list-style-type: none"> At establishment of the Offset Site. Ongoing as required.
Exclusion of feral pigs	To exclude feral pigs.	Feral species can degrade habitat, compete for resources with native fauna and introduce disease.	<ul style="list-style-type: none"> Install and maintain preventative fencing suitable for the target species. Remove pigs (by trapping or other means) if detected within the Offset Site. 	<ul style="list-style-type: none"> At establishment of the Offset Site. Ongoing as required.
Rabbit control	To minimise the risk of the Offset Site becoming a refuge for rabbits.	<p>Increased rabbit numbers can reduce native regeneration and support higher numbers of pest animals such as cats and foxes.</p> <p>Competition and grazing by the feral European rabbit is listed as a key threatening process (KTP) under the TSC Act and EPBC Act.</p>	<ul style="list-style-type: none"> Monitor for presence of rabbits. Conduct baiting or controlled grazing to reduce the ability of the site to act as a refuge to rabbits. Where possible, coordinate baiting with adjacent landowners to maximise effects 	<ul style="list-style-type: none"> Consideration given to action on the basis of monitoring results.

Management measure	Objective	Justification	Action	Timing
Fox control	To minimize the impacts of foxes on native fauna	Numerous native species are potentially at risk of becoming threatened as a result of fox predation. Predation by the European Red Fox is listed as a KTP under the TSC Act and EPBC Act.	<ul style="list-style-type: none"> Conduct fox baiting in coordination and with the assistance of LHPA and/or CMA 	<ul style="list-style-type: none"> March and April are considered the most effective months in which to carry out control programs when foxes are dispersing and finding new territory (LHPA) Ongoing as required
Goat control/exclusion	To exclude goats and/or control numbers	Feral species can degrade habitat, compete for resources with native fauna and introduce disease. Competition and habitat degradation by feral goats is listed as a KTP under the TSC Act and EPBC Act.	<ul style="list-style-type: none"> Install and maintain preventative fencing suitable for the target species. Control goat numbers in coordination and with the assistance of LHPA and/or CMA 	<ul style="list-style-type: none">
Monitoring	To determine the effectiveness of management measure	Monitoring is required to determine whether current management is effective and to inform ongoing management.	<ul style="list-style-type: none"> Conduct monitoring as detailed for this site. Adapt management measures where required 	<ul style="list-style-type: none"> Every two years

F.5.4 Requirement to monitor the offset site

In order to ensure that biodiversity improvement is occurring within the offset sites (and therefore that a 'maintain or improve outcome' can be met over time), monitoring is required.

Monitoring is recommended to be repeated initially, every two years. As a part of monitoring surveys, a report would be prepared to document the success or otherwise of management and adaptations required to obtain better results.

Reporting is proposed every two years to the Department of Planning and Infrastructure, until such time as this is deemed acceptable to cease. The reports would also be submitted to OEH for comment.

A decision to reduce or continue reporting every two years may also be made by DPI or OEH following submission of each report. A final report should be prepared prior to decommissioning of the project, to verify that a 'maintain or improve' outcome is being met and that residual management actions can largely coincide with routine agricultural land management.

F.6 VERIFICATION OF THE ACTUAL AREA OF NATIVE VEGETATION CLEARING

Verification of the actual area of impact of the constructed wind farm and transmission line is required to be verified, prior to finalising the CPVPs. This provides an incentive throughout construction to minimise impacts and thereby reduce the offset requirement for the project. It also verifies that the actual amount and type of clearing undertaken is offset, as required.

It is expected that a detailed Flora and Fauna Management Plan would be prepared to guide construction. This would contain updated vegetation mapping specific to the final infrastructure layout (refer to note on micro-siting above). Verification of the actual area of native vegetation clearing can be undertaken as an audit after construction. (Incentives to minimize clearing would be an appropriate stipulation in EPC contracts).

F.7 FORMALISATION OF INDIVIDUAL CPVPS AND FUNDING ARRANGEMENTS

Offsets would be governed by conservation mechanisms to ensure long-term protection and management of the site, including funding arrangements.

A Conservation Property Vegetation Plan (CPVP) would be implemented on each involved private land holding. The process would be driven by Epuron, with input from each landholder. The CPVP would include management actions associated with the offset area that would apply in perpetuity.

To ensure that the CPVP is binding on successors in title, an abstract of the CPVP would be registered with the Land and Property Management Authority under the *Real Property Act 1900*. The CPVP would be a legally binding agreement under both the *Native Vegetation Act 2003* and the *Threatened Species Conservation Act 1995*. The terms of the CPVP would not be affected by any changes to local or state planning rules or new listings of threatened species. A CPVP can be varied at the landholder's request, provided the variation would still improve or maintain environmental outcomes.

As the CPVP is attached to the land title, the landowner is ultimately responsible for funding the management actions required at the Offset Site and monitoring the effectiveness of their

implementation. However the Proponent would take responsibility for management and would ensure the landowner has sufficient resources and information to implement the management actions for the operational life of the project, as management of offsets would form a condition of the project's consent.

Even though a CPVP is binding in perpetuity, it is acknowledged that there is less incentive to manage the offset site after the decommissioning of the wind farm. Therefore, it is proposed that the bulk of the management actions be focused in the early years of the project. Monitoring and reporting, as outlined above, would demonstrate whether this is being satisfactorily achieved and allow a point for the consent authority to intervene.

F.8 MAINTAIN OR IMPROVE

With the effective implementation of the stages outlined above, a 'maintain or improve' outcome would be achieved for the project. By the coordinated selection of offset sites over such a large area, and their management for biodiversity improvement, a regional scale beneficial biodiversity impact is anticipated. Benefits are expected to include:

- Incentive to minimize clearing during the detailed design and construction phases of the wind farm project
- Targeted and coordinated weed and feral animal management, informed by ecologists working with landowners
- Retention of declining habitat resources including hollows, fallen timber and logs, riparian habitats
- Protection of specific habitat linkages and wildlife corridors
- Improved infrastructure to assist management including fencing and access

F.9 'PRINCIPLES FOR BIODIVERSITY OFFSETS IN NSW'.

The biodiversity offset principles developed by the former DECCW (now OEH) would guide the selection and management of the offset site, namely:

Impacts must be avoided first by using prevention and mitigation measures.	<i>The BA sets out mitigation measures to minimise impacts. The aim of the offset package is to ensure that where impacts cannot be avoided, or sufficiently minimised, the residual impact would be offset in perpetuity.</i>
All regulatory requirements must be met.	<i>Offset land is required as part of the approval conditions for the project. The proposed offsets would not be used to satisfy approvals or assessments under other legislation.</i>
Offsets must never reward ongoing poor performance.	<i>Monitoring would be required as part of the implementation of management actions for the offset site.</i>
Offsets will complement other government programs.	<i>The Offset Package would be finalised in consultation with OEH and the CMA, allowing any local programs or initiatives to be considered and included.</i>
Offsets must be underpinned by sound	<i>Selection criteria have been developed to ensure the</i>

ecological principles.	<i>location of offset sites is appropriate. Management measures have been outlined by an ecologist. Specific management plans would accompany each CPVP, developed in consultation with the CMA and the proponent.</i>
Offsets should aim to result in a net improvement in biodiversity over time.	<i>Management actions would be developed specific to each offset site (one per private property).</i>
Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.	<i>Native vegetation clearing impacts are deemed permanent and therefore the offset sites would be preserved and managed in perpetuity.</i>
Offsets should be agreed prior to the impact occurring.	<i>The offset criteria set out in this document form part of the proposal. If approved, the commitment is carried over as a condition of consent. The commitment includes consultation with OEH and the CMA to ensure the final offset package is acceptable, prior to construction impacts.</i>
Offsets must be quantifiable - the impacts and benefits must be reliably estimated.	<i>An estimation of impact has been provided based on GIS mapping. Criteria have been proposed that provide clear quantification of offsets, based on the actual area cleared.</i>
Offsets must be targeted.	<i>Refer to selection criteria.</i>
Offsets must be located appropriately.	<i>Refer to selection criteria.</i>
Offsets must be supplementary.	<i>Offsets would be comprised of private land not currently under any form of biodiversity conservation protection. In this way the land would be additional to government reserves and programs. Refer to selection criteria.</i>
Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	<i>A CPVP would be attached to the title of the offset land (one per landowner). To ensure that the CPVP is binding on successors in title, an abstract of the CPVP would be registered with the Land and Property Management Authority under the Real Property Act 1900. The CPVP would be a legally binding agreement under both the Native Vegetation Act 2003 and the Threatened Species Conservation Act 1995. The terms of the CPVP would not be affected by any changes to local or state planning rules or new listings of threatened species. A CPVP can be varied at the landholder's request, provided the variation would still improve or maintain environmental outcomes.</i>

APPENDIX G TEAM QUALIFICATIONS AND EXPERIENCE

Role, staff member	Pencil portrait
Authors	
Manager Biodiversity Principal Ecologist Dr Jacqueline Coughlan	Jacqui's practical ecological skills in terrestrial and freshwater ecology have been developed over 20 years in several states. She has conducted and managed numerous fauna and flora surveys in New South Wales, ACT, Queensland and Western Australia and has a thorough working knowledge of State and Commonwealth legislation related to flora and fauna. She has a broad knowledge base of ecological issues and is able to provide clients with sound and practical advice regarding environmental legislation and assessment protocols. Jacqui provides both project management and mentoring advice for the biodiversity team as well as personally contributing vital technical expertise to environment projects. Jacqui joined ngh environmental in 2008 after five years as Principal Ecologist at ERM. She has a PhD in Bird Ecology, a Graduate Diploma in Environmental Law and is an accredited Biobanking Assessor.
Senior ecologist (fauna) Deb Frazer	Deb holds a bachelor degree in Applied Science (Biodiversity Management) and an honours degree. Deb has over 8 years experience as an Ecologist and within biodiversity assessment, including several wind farm assessment. Deb's positions have included management and senior roles, as well as educational and research assistant positions. Deb has experience in impact assessment and fauna survey projects throughout southern NSW and South Australia. Deb has broad knowledge and demonstrated skills in environmental management; coordinating and delivering environmental programs / plans; assessment of development proposals; preparation of biodiversity and management plans and monitoring programs. In particular Deb is skilled in interpretation and application of legislation and statutory controls; stakeholder, contractor, and client consultation; design and execution of field work; data collection and analysis; and reporting (verbal and written).
Principal ecologist (fauna) Mark Free	<p>Mark holds a bachelor degree in Applied Science (Coastal Management) and an honours degree in Geography and has over 15 years experience as an Ecologist. Formerly with the Commonwealth Government's Australian Nature Conservation Agency, Mark has for the last 12 years worked as a flora and fauna consultant based on the NSW Far North Coast. Since 2003 Mark has been the Manager and Principal consultant of Blackwood Ecological Services Pty Ltd.</p> <p>Mark has extensive experience in impact assessment and fauna survey projects throughout northern NSW, southern Queensland and further afield. He has provided professional services to all levels of government, natural resource managers, industry, private landowners and community organisations, working on projects for a broad range of clients including the NSW National Parks and Wildlife Service, NSW Department of Public Works, NSW Department of Education, Qld Murray Darling Committee, NSW Roads and Traffic Authority, Consolidated Rutile Limited, Conics, Broken Head Quarry and Birds Australia.</p> <p>Mark has undertaken fauna surveys and completed Ecological assessment reports for linear infrastructure projects including the Pacific Highway Upgrade (Woodburn to Ballina section), PNG to Queensland Gas Pipeline, Lismore Southern Trunk Water Main and Lennox Head to Ballina Coastal walk and Shared path.</p>

Role, staff member	Pencil portrait
<p>Bat Specialist Dr. Greg Richards</p>	<p>Greg holds a PhD that focused on forest bat ecology. Greg has been an ecological consultant specialising in bat fauna for 16 years. Prior to this Greg spent 27 years with CSIRO in the Wildlife and Ecology Division. Greg has experience in Australia, Papua New Guinea and Pacific, and Southeast Asia.</p> <p>Greg's specialty is in bat fauna assessments, development and execution of bat monitoring programs, and experience in legal reviews and challenges. He is also author of several major bat books and scientific papers.</p> <p>As an ecological consultant, Greg provides specialist bat fauna advice to industry and Government, contributing to EIA and SIS, particularly for wind farm assessments.</p>
<p>Co-author Ecologist (Flora) Kelly Simpson</p>	<p>Kelly is a senior botanist at Blackwood Ecological Services and has managed a number of botanical projects and undertaken numerous field surveys across NSW. Kelly holds a Bachelor of Science and a Graduate Certificate in Natural Resources.</p> <p>Kelly's field survey experience includes a variety of large scale infrastructure projects and the surveying of vegetation communities over a broad area particularly for linear projects such as powerlines, pipelines and roads. She worked on the Queensland to Hunter Gas Pipeline including the co-ordination of the botanical teams and the surveying of vegetation communities along the proposed 630km pipeline. Following the surveys Kelly assisted with the preparation of the report with regards to key flora constraints and vegetation mapping. She also had a key role in the Silverton Wind Farm and proposed powerline to Red Cliffs, Victoria. Kelly was involved with the management of the botanical component of this project which included detailed background research, vegetation mapping, survey design, vegetation surveys and targeted surveys for threatened species, constraints mapping and reporting.</p> <p>Recently Kelly has undertaken botanical surveys and impact assessment for the proposed Coastal recreational path from Lennox Head to Ballina. These projects included identification and mapping of significant species and Endangered Ecological Communities and identification of mitigation measures to manage potential impacts on vegetation within the study areas.</p>
<p>Co-author Ecologist (Flora) Jackie Miles</p>	<p>Jackie holds bachelor degree in Zoology and has since gone on to specialise in botany. Jackie has worked on a number of large scale assessments involving botanical surveys for vegetation mapping and targeted species searches. Past projects include Comprehensive Region Assessment (CRA) full floristics surveys, field validation for NPWS Vegetation Map for South East Forests, vegetation mapping for all NSW ski resort areas and surveys of significant remnant grassy vegetation in the Bega Valley.</p> <p>Jackie has co-authored a number of papers and factsheets on threatened species and ecological communities, regularly contributes information to the NSW Scientific Committee and has provided training for Council planning and works staff on conservation significant remnant vegetation. Jackie also has extensive experience in fauna surveys, including fauna surveys across the alpine region for the CRA. Jackie's expertise extends throughout south-eastern NSW.</p>

Role, staff member	Pencil portrait
Co-author Ecologist (Flora & Fauna) Brenton von Takach Dukai	<p>Brenton is a botanist and ecologist with nghenvironmental's biodiversity team, and performs flora and fauna assessments for a wide variety of projects. Brenton has been involved with developments ranging from large-scale wind farms and dam upgrades to minor road upgrades. He is familiar with a broad array of monitoring and survey techniques for both flora and fauna, and has conducted surveys in a number of biogeographic regions of NSW. As a result, he is familiar with many of the vegetation types and communities found throughout the state.</p> <p>Brenton's work requires knowledge of and experience in the management of threatened species and communities as well as a solid understanding of legislative requirements at both State and Commonwealth levels. Prior to joining nghenvironmental he worked for the <i>Australian Wetlands and Rivers Centre</i> at the University of NSW, conducting survey trips across Australia to undertake vegetation assessments and fauna trapping programs. He has been involved in fauna monitoring programs with OEH and radio tracking fauna for the Australian Wildlife Conservancy. Brenton is a very capable field ecologist with excellent reporting skills.</p>
Field Team	
Ecologist (Fauna) Freya Gordon	<p>Freya Gordon is a senior ecologist with extensive field experience. She holds a Bachelor of Science with Honours from Monash University, Melbourne. Projects she has managed and implemented include a microbat monitoring program for the Holbrook Bypass (RMS); a Squirrel Glider monitoring program for the Albury Bypass (Conneq); and multiple ecological assessments and constraints analyses for Stockland, RMS, Lake Coal, Epuron, and local councils. Freya has completed an Environmental Assessment for a Solar Farm in western NSW including a detailed investigation of the status of the Grey-crowned Babbler on the site and surrounding study area. Her work requires experience in Commonwealth and State environmental legislation, policies and standards. Prior to joining nghenvironmental she worked for the Institute of Wildlife Research, The University of Sydney, designing, managing and implementing survey programs for a range of species. She has managed large scale field programs in the Simpson Desert for the University of Sydney Desert Ecology Research Group.</p>
Ecologist (Fauna) George Madani	<p>George Madani is a freelance wildlife ecologist and has an extensive background in wildlife ecology with ten years of field survey skills and practical research and applied management experience. He has conducted fauna surveys and field studies across various regions and habitats in Australia. His work has taken him into remote areas as the Kimberley, Cape York, Simpson and Strzelecki Deserts as well across a range of temperate sclerophyll woodlands and rainforests along the East Coast and inland into the WA Goldfields, Victorian Mallee Country and rangelands of Western NSW. He has comprehensive knowledge of and experience with the identification, distribution, habitat and ecology of terrestrial vertebrate fauna, especially reptiles, amphibians and avifauna. George has a Masters in Wildlife Health and Population Management from the University of Sydney. He has worked with various State and Federal Government departments, universities, environmental consultancies and NGO's on projects ranging from wildlife monitoring, baseline inventory surveys to impact based assessments.</p>

Role, staff member	Pencil portrait
Ecologist Rena Gaborov	Rena holds a Bachelor of Arts (Geography) and a Master of Natural Resources. Rena has been working as a field ecologist with Wildlife Unlimited since 2008 while she concurrently completed a Master in Natural Resources. She has been involved with a number of management and conservation projects as part of her work with Wildlife Unlimited as well as with government, university and community groups. She has also led a number of projects. Her masters research involved a mark recapture population study on the threatened long-nosed potoroo and its reactions to fragmentation. Rena also coordinated a baseline vertebrate fauna survey of Palm Island, Northeast Queensland in 2009.
Ecologist Frank Bird	Frank completed a Diploma, Conservation and Land Management in 2006 and a Certificate III and IV Conservation and Land Management in 2005. He has been working with Wildlife Unlimited Pty Ltd on several field based projects including setting up monitoring plots for introduced deer species, feral cat trapping at Mt Buller, threatened orchid surveys and biodiversity assessments of northern savannah woodlands (Kimberley WA). In 2009 Frank was part of a team that undertook terrestrial vertebrate surveys on Palm Island, North Queensland. Mammal, bird, reptile and amphibians were all surveyed across the island. Survey methods included funnel and pitfall trapping, active searching, Elliot trapping, Harp trapping, remote infrared cameras, hair tubing and diurnal bird. Frank has volunteered for numerous conservation expeditions and projects across Australia, in arid and temperate regions, to gain invaluable field experience.
Ecologist Paul Shipway	Paul has an Associate Degree in Applied Science (Environmental Resource Management) from Southern Cross University. Paul has undertaken several field surveys with Blackwood Ecological Services, including Land for Wildlife fauna surveys in Stanthorpe, a Squirrel glider radio-tracking program at Forster and the Lismore Southern Trunk Main project for Lismore City Council. Paul worked for several years on rainforest restoration projects with Rous Water and currently works as a freelance ecologist and bush regenerator.
Senior review	
Senior review Brooke Marshall (CEnvP)	Brooke has an honours degree in Natural Resources from the University of New England (UNE) where she specialised in wildlife management and ecosystem rehabilitation. Since joining nghenvironmental, Brooke has undertaken environmental impact assessment, biodiversity survey and assessment, environmental management documentation and community consultation. Brooke has worked on large scale infrastructure projects and project managed the input of specialists, as required. She is a specialist in wind farm assessment. Brooke is an accredited Biobanking Assessor and Certified Environmental Practitioner.