RATCH-Australia Corporation

BIODIVERSITY ASSESSMENT

COLLECTOR WIND FARM

MAY 2012

nghenvironmental

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Acronyms used in this report

BA	Biodiversity Assessment Collector Wind Farm (this report)
BS	Biodiversity Study Collector Wind Farm (**ngh**environmental 2010b)
CEEC	Critically Endangered Ecological Community
DECCW	Department of Climate Change and Water (NSW)
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities (C'th)
DEWHA	Department of Environment, Water, Heritage and the Arts (C'th)
EEC	Endangered Ecological Community
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999 (C'th)
NPWS	National Parks and Wildlife Service (NSW)
OEH	Office of Environment and Heritage (NSW)
PEI	Preliminary Ecological Investigation Collector Wind Farm (**ngh**environmental 2010a)
ROTAP	Rare or Threatened Australian Plants register (CSIRO)
SCIVI	South Coast – Illawarra Vegetation Inventory
SCRA	Southern Region Comprehensive Regional Assessment (the project area is within the northern sub-region of the SCRA area), vegetation mapping
TSC Act	Threatened Species Conservation Act 1995 (NSW)

Terminology used in this report

Development envelope	The area within which infrastructure may be located. This area is defined by buffering the indicative infrastructure layout. This is the area that has been assessed. The buffer allows the proponent some flexibility in the final placement of infrastructure.
Development footprint	The actual area that would be occupied by project infrastructure (ie not buffered).
Key species or key taxa	'Key species' or 'key taxa' refers to the definition given in EPHC 2009. This includes taxa listed under any category of conservation status by relevant legislation, taxa that meeting IUCN criteria for threatened conservation status even if not yet listed under relevant legislation, taxa listed as protected under relevant legislation but are not threatened (such as migratory species) and taxa naturally occurring at low densities (such as raptors).
Proposal area / site	Defined as the amalgamated boundary of all involved properties.
Study area / local area	Proposal area and adjacent habitat areas, including Lake George.
Threatened entity	Refers to all units listed as threatened under the EPBC Act and/ or TSC Act including species, populations and ecological communities

EXECUTIVE SUMMARY

This Biodiversity Assessment has been prepared by **ngh**environmental on behalf of RATCH Australia Corporation (RAC) Limited (the Proponent) to assess the potential impacts to biodiversity associated with development of the proposed Collector Wind Farm. The proposal is to be assessed as a Part 3A Major Project under the NSW *Environmental Planning and Assessment Act 1979*. This Biodiversity Assessment will form a component of the broader Environmental Assessment which is being completed as a requirement of this Act.

This assessment:

- Describes the biodiversity values of the proposed Collector Wind Farm site.
- Identifies and assesses biodiversity impacts.
- Identifies measures to manage risks and avoid or mitigate potential impacts.

The proposal

RAC proposes to construct a wind farm approximately 33 km south-west of Goulburn NSW, west of Collector. The wind farm will be situated within an area of approximately 6,125 hectares and will comprise up to 68 turbines and associated infrastructure. The land on which the site is situated consists of 13 involved properties, currently managed for sheep grazing.

Site description

The site is located at the northern end of the Lake George Range and consists of an undulating granitic and occasionally metasedimentary undulating plain. Vegetation consists of a variety of native woodland assemblages, derived grasslands and sown exotic pastures. The most common vegetation community at the site is Box-Gum Woodland and derived grassland which is widespread onsite on granitic derived substrates. Areas of underlying metasedimentary geology often support a range of other dry grass forest types. The vegetation at the site has been extensively cleared and modified for agricultural purposes.

Vegetation of conservation significance occurs onsite (NSW and federally listed Endangered Ecological Communities: Box-Gum Woodland and NSW listed Tablelands Snow Gum Grassy Woodland). Threatened and migratory fauna species identified with the potential to be impacted by the proposed wind farm include: Little Eagle, Spotter Harrier, Square-tailed Kite, Brown Treecreeper, Diamond Firetail, Varied Sittella, White-fronted Chat, Gang-gang Cockatoo, Superb Parrot, Powerful Owl, Eastern Bentwing Bat, Yellow-bellied Sheathtail Bat, Large-footed Myotis, East Coast Freetail-bat and White-bellied Sea-eagle.

Measures undertaken during design of the proposal

During the process of biodiversity assessment, the design of the proposal has been refined taking into account biodiversity constraints. The proposal now has:

- A reduced number of turbines (initially up to 80 turbines were being considered; the final layout comprises 68 turbines).

- A reduced number of turbines in sensitive areas (four fewer turbines in forest to avoid threatened species habitat, four fewer turbines in woodland, three fewer turbines in EEC).
- No turbines proposed along Lake George escarpment, removed to avoid raptor habitat.
- Minimised the removal of hollow-bearing trees through micrositing turbines and associated layout features away from paddock trees and outside of forest as much as possible.

Impacts to biodiversity

The proposal would involve the construction, operation and decommissioning of up to 68 turbines, substation, associated electrical connections, access tracks, hard stand areas, construction compound and sediment erosion controls.

The proposal will result in direct impacts to biodiversity, predominately from:

- Loss and degradation of flora and fauna habitat during construction, such as:
    - Vegetation clearing.
    - Earth moving and landform reshaping.
    - Associated sediment, erosion, weed and pollution risks.
- Collision with infrastructure by fauna causing injury or fatality, during operation.

This biodiversity assessment identified a number of threatened entities that are at risk from these impacts. Direct impact in the form of vegetation clearing will occur to two Endangered Ecological Communities both listed under the NSW TSC Act and one also listed under the Commonwealth EPBC Act. Additionally 11 threatened fauna species were recorded at the site and are at risk of impact by the proposal.

Onsite investigations, literature review and consultation with experts were used to evaluate the risks and inform Assessments of Significance for the revised layout, pursuant to NSW and Commonwealth legislation, to characterise the significance of potential impacts. Impacts have been assessed as manageable and unlikely to generate a significant impact for any NSW or Commonwealth listed entity.

Management measures

Specific mitigation measures have been developed as part of this assessment to manage the risks identified at each stage of the development; design, construction and operation. Key measures centre on:

- Micro-siting infrastructure to avoid higher conservation value areas.
- Offsetting residual loss of native vegetation and habitat.
- Reducing the development footprint with strict controls to protect soil, water and native vegetation.
- Monitoring collision and avoidance impacts during operation.

Conclusion

Through iterative development of the final proposal, concurrent with biodiversity constraints assessment and other studies, the proposal has been refined to:

Avoid many areas of high biodiversity conservation

High (blade-strike) risk areas to birds and bats near to the escarpment south of the site layout have been excluded from the development.

Minimise impacts in these areas, where avoidance is not possible

The development envelope has been reduced and a set of management prescriptions have been designed within this assessment to ensure that significant impacts are avoided.

Offsetting has been recommended to ensure a positive net overall environmental outcome.

Areas and appropriate management measures have been outlined to demonstrate that offsetting is feasible within the proposal site boundaries.

With the effective implementation of management measures within this report, and with reference to Step 5 of the Guidelines for Threatened Species Assessment (DEC 2005), the proposal is considered to:

- Be likely to maintain or improve biodiversity values.
- Be unlikely to reduce the long-term viability of a local threatened species population or ecological community.
- Be unlikely to accelerate the extinction of a species, population or ecological community or place it at risk of extinction.
- Not adversely affect critical habitat.

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Tables

1 INTRODUCTION

1.1 THE PROPOSAL

The proposed Collector Wind Farm is discrepancy located in the Tablelands region of New South Wales, approximately 33km south-west of Goulburn and 50km north-east of Canberra (Figure 1-1). The Collector Wind Farm proposal is within the Upper Lachlan Local Government Area (LGA), and the Monaro subregion of the Murrumbidgee Catchment Management Authority (CMA) region.

The site is approximately 6,215 hectares, situated immediately west of Collector village (Figure 1-2). It is currently managed for sheep grazing and comprises pasture (exotic and native) and remnant woodlands.

The construction phase of the proposal would involve the construction of:

- Up to 68 wind turbines, 125-150m tall (80-90m to tower hub, 45-60m blade length).
- One substation and control building.
- Access tracks onsite (where existing tracks will be used, these tracks will be upgraded).
- Underground electricity cabling connecting turbines onsite (located within track areas).
- Overhead electricity cabling from the substation to the existing overhead lines to the north of the site.

Additionally, temporary construction infrastructure would include:

- Crane hard stand areas adjacent to turbine sites.
- Construction compound including site offices.
- Sediment erosion controls.

After construction, ground cover within the hard stand areas and construction compound area would be rehabilitated. It is likely that the width of some tracks could also be reduced, for operational purposes.

The operational phase of the proposal would require access by standard 4WD vehicles on a regular basis. A limited number of permanent onsite staff may be required. The operational life of the wind farm is 25-30 years, at which time the wind farm may be recommissioned (infrastructure upgraded) or decommissioned (removal of all above ground infrastructure).

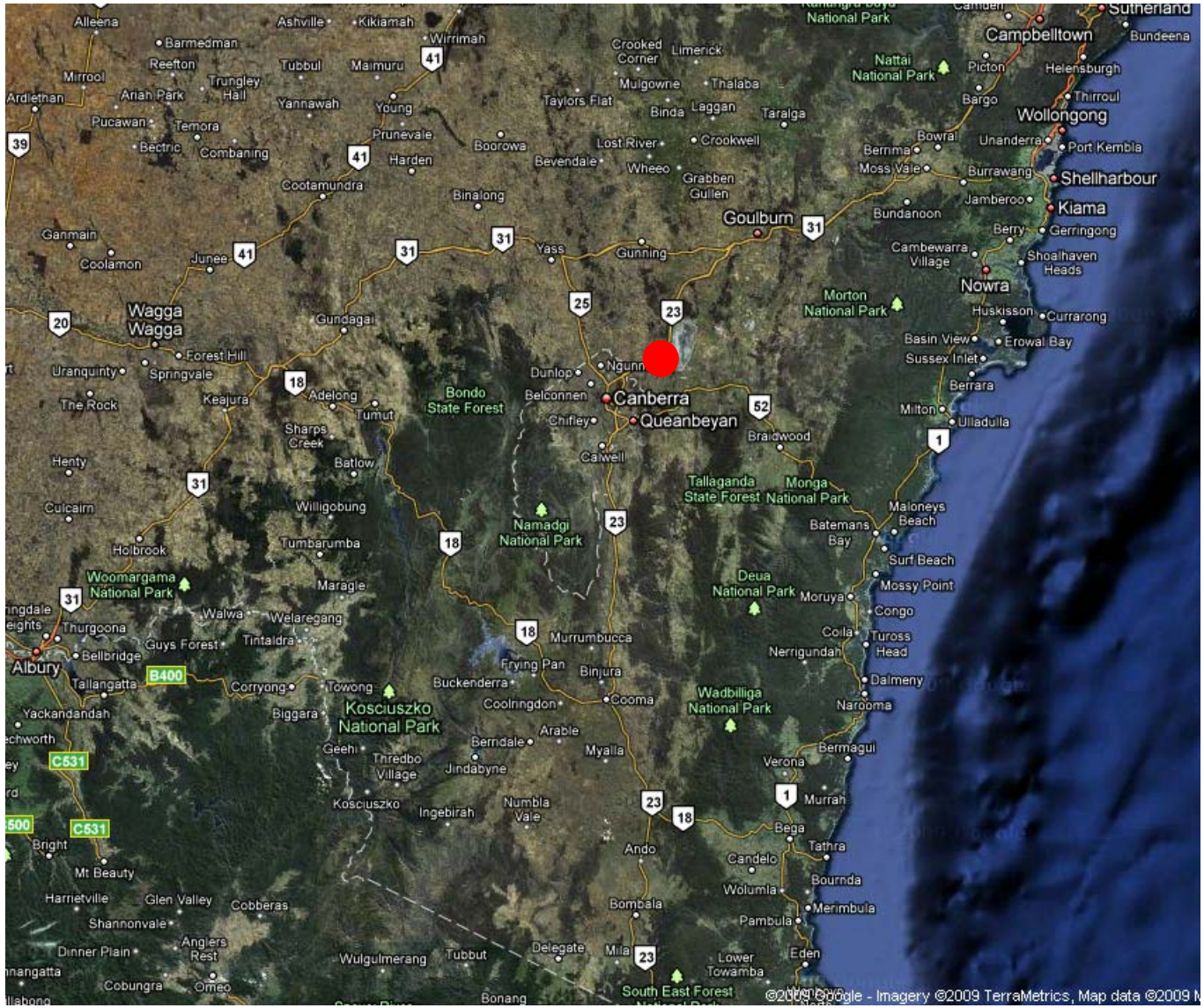


Figure 1-1 Location of Collector proposal area (red dot) in NSW (map courtesy of Google Maps)

1.2 SITE DESCRIPTION

The site is located at the northern end of the Lake George Range, a north-south oriented ridgeline on uplifted metasediments and volcanics, at 600-800 metres elevation (Figure 1-2). Topography, vegetation and land use reflects variation in underlying geology. The eastern edge of the Lake George fault features metasedimentary geology, with shallow, stony loams on steep slopes. West of the fault scarp slope is an undulating granitic plain with deeper, more fertile soils, sometimes with rounded boulders on the surface and in the soil profile (DECCW 2010). Another steep metasedimentary ridge occurs in the north-west of the site. Slopes range from 0-10% on ridge crests and undulating plains and valleys, to over 20% on range side slopes. Minor watercourses at the site drain both eastwards into the Lake George catchment and west into the Murrumbidgee system.

The site consists of 13 involved properties, totalling 6,215 ha. Land use is predominantly sheep grazing, with some areas sown to exotic pasture for feed. Within the site boundary, the development envelope was defined as the area within which wind farm infrastructure would be located. It was defined (as shown in Figure 1-3) by applying a buffer zone to an indicative infrastructure layout (200m buffer applied to turbine locations, 25m buffer applied to access tracks. Underground cabling will be installed within the areas disturbed for access tracks.

The site consists of an undulating granitic and occasionally metasedimentary plain, that typically carries woodland assemblages dominated by Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*E. blakelyi*), Apple Box (*E. bridgesiana*) and occasionally Broad-leaved Peppermint (*E. dives*), often with Red Stringybark (*E. macrorhyncha*). Higher more fertile granitic soils occur south of the site and carry a Ribbon Gum (*E. viminalis*) – Snow Gum (*E. pauciflora*) association. Metasedimentary ridges carry dry forest types dominated by Brittle Gum (*E. mannifera*), White or Scribbly Gum (*E. rossii*) or Broad-leaved Peppermint. The site's woodlands have been extensively cleared and modified for sheep and cattle grazing.

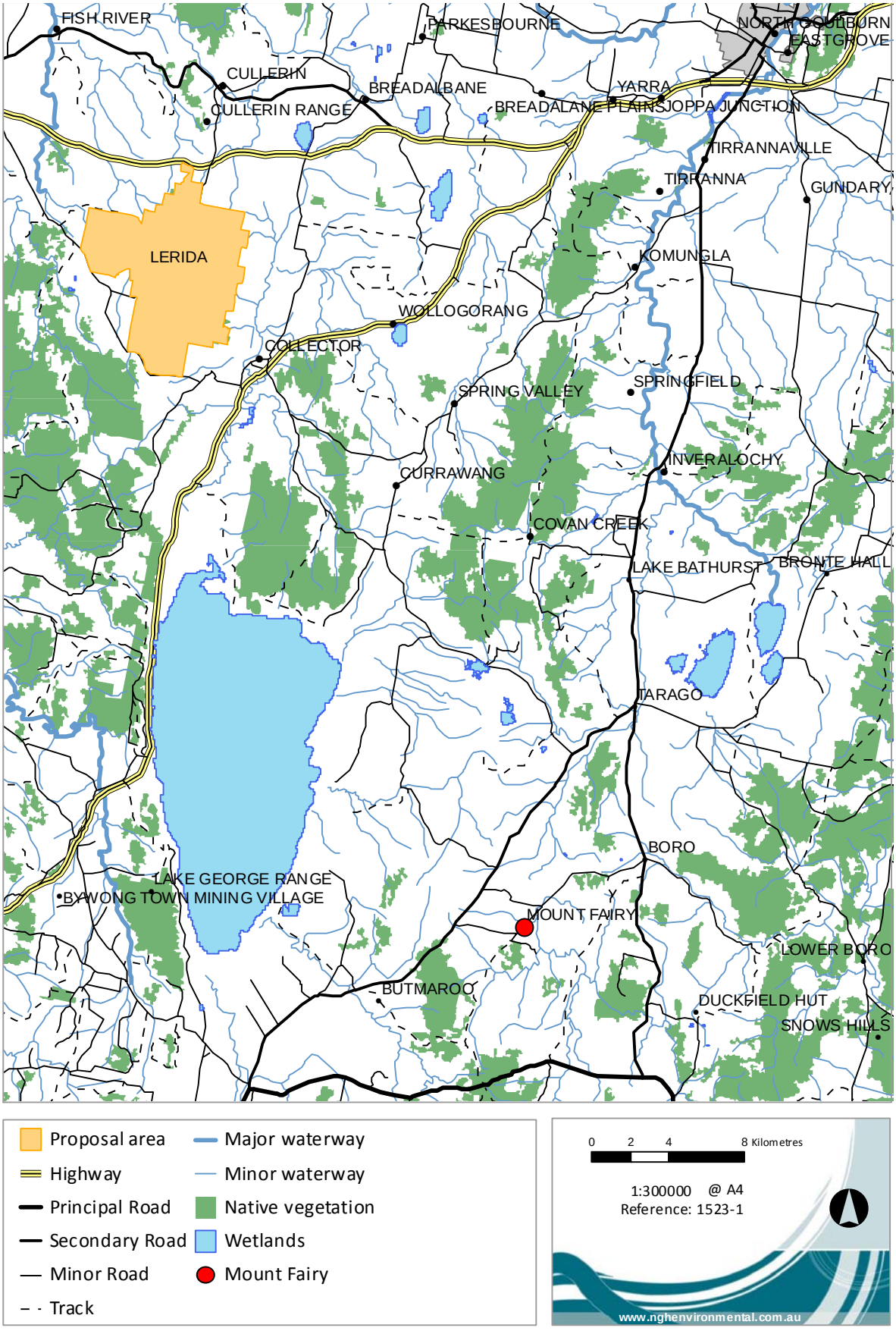
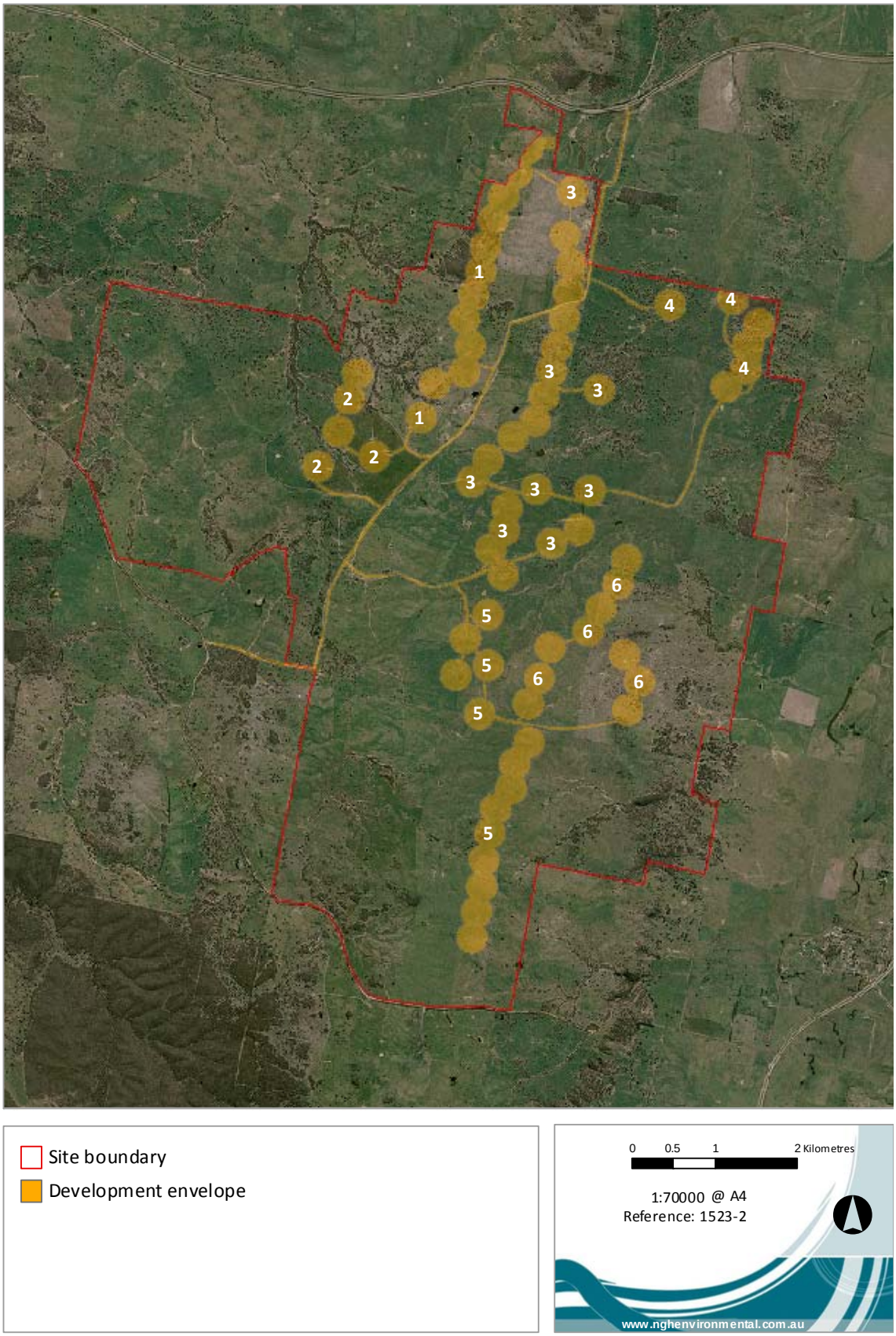


Figure 1-2 Regional location of proposal area



Site boundary
Development envelope

0 0.5 1 2 Kilometres

1:70000 @ A4
Reference: 1523-2

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Figure 1-3 Development envelope in relation to the proposal site boundary.

Note: the development envelope has been refined during the course of site investigations to minimise biodiversity impacts. Numbers identify 'turbine clusters' referred to in this report

1.3 OBJECTIVE OF THIS ASSESSMENT

This report documents the findings of onsite and regional biodiversity investigations undertaken to assess the impact of the proposal on biodiversity values.

Two investigations were undertaken, prior to this report. These included:

1. Preliminary Ecological Investigation of the proposed Collector Wind Farm (PEI), February 2010

Report prepared by **ngh**environmental to identify potentially significant ecological issues on site and assess the level of risk to flora and fauna posed by the development and operation of a wind farm. This report assisted in developing a responsive project design and developing a targeted program for further ecological investigations.

2. Biodiversity Study Collector Wind Farm, July 2010

Report prepared by **ngh**environmental to address the issues identified in the PEI. The report included a targeted flora and fauna survey program.

This report constitutes the third study:

3. Biodiversity Assessment Collector Wind Farm, Version 5.3 March2012

The aim of this report is to draw on the existing information above as well as provide additional survey effort sufficient to assess the impact of the final proposal on biodiversity values. This report is intended as a stand-alone report summarising all previous information and providing a comprehensive impact assessment, pursuant to NSW and Commonwealth guidelines where required, for threatened entities. Further, it recommends a series of mitigation measures considered to be required to avoid the risk of significant impact for threatened entities.

There have been several versions of this assessment reflective of iterative layout changes in response to constraints and recommendations, as well as liaison with agencies such as the NSW Office of Environment & Heritage (OEH).

Specific to the site and the potential impacts, this report focuses on:

- Endangered Ecological Communities.
- Threatened flora and fauna species with potential to occur and be impacted by the proposal.
- Bird and bat collision and avoidance behaviour risks.
- Key biodiversity features (wetlands and bird movement corridors).

2 APPROACH AND METHODS

2.1 GUIDELINES

The proposal would be assessed as a Part 3A Major Development, pursuant to the *Environmental Planning and Assessment Act 1979* and the *Major Development State Environmental Planning Policy*. Director-General's Requirements have been issued to guide the assessment of the proposal (provided as Appendix A). These incorporate the comments of relevant agencies including:

- NSW Department of Environment, Climate Change and Water.
- NSW Murrumbidgee Catchment Management Authority.
- NSW Industry and Investment.

Specifically, this report includes consideration of:

- Impacts to native vegetation.
- Impacts of blade strike on birds and bats.
- Cumulative impacts associated with nearby Capital and Cullerin Wind Farms (both farms were operational during this assessment).
- Management of identified impacts (including details of adaptive management protocols and ability to obtain achievable offsets).
- Measures to avoid, mitigate or offset impacts, consistent with 'improve or maintain' principles.

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).
- *Australian Wind Energy Association Best Practice Guidelines* (AusWind 2006).

2.1.1 OEH review

This document has been updated following the OEH adequacy review dated 5 August 2011. Specific issues raised in the adequacy review are addressed in this updated report.

2.2 DESKTOP ASSESSMENT

Database searches of threatened and migratory species were updated for the Murrumbateman, Monaro and Crookwell sub-catchments[1] (TSC Act – searches undertaken 23 November 2010) and in

[1] The study area sits near the boundary of all three CMA sub-catchments

a 25km radius from the centre of the project area (EPBC Act – search undertaken 23 November 2010).

Topographic maps, air photographs, previous surveys and records contained in national and state databases were consulted to identify known and potential values. Predictive vegetation mapping (Fallding 2002, Thomas *et al.* 2000) was used to assess the potential for the occurrence of threatened flora species and communities at the site. The Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands (Fallding 2002) was also consulted for threatened flora species and community records in the study area and analogous habitats within the region. Key web-based databases including the OEH Wildlife Atlas and DSEWPC Species Profile and Threats (SPRAT) were consulted in the preparation of this report.

2.3 CONSTRAINTS ANALYSIS

A risk assessment framework was utilised in the PEI and BS (**ngh**environmental 2010a and 2010b) to assist in the refinement of the proposal and the focus of the field survey program. Constraints related to threatened species habitat, type and condition of vegetation communities and fauna movement corridors. The proposal was revised to:

a) Avoid high constraint areas.
b) Minimise impacts in high constraint areas, where avoidance is not possible.

2.4 FIELD WORK

Four survey sessions have been conducted for this assessment (Table 2-1).

Table 2-1 Survey sessions

Date	Survey type	Reported in
8 - 11 December 2009	Flora: vegetation type (6 person days). Fauna: habitat assessment, bird (10.2 hours) and bat surveys (57 hours) (6 person days).	Preliminary Ecological Investigation (**ngh**environmental 2010a) and summarised in this Biodiversity Assessment.
22 - 26 March 2010	Flora: vegetation condition, targeted threatened species surveys (6 person days). Fauna: targeted threatened species surveys (6 person days) including bird (2 hours), bat (48 hours), frog (0.75 hours) and reptile surveys (11 hours), hollow-bearing tree quadrats, nocturnal surveys (21.5 hours – call playback, stagwatch, spotlight) and habitat assessment.	Biodiversity Study (**ngh**environmental 2010b) and summarised in this Biodiversity Assessment.
8 – 12 November 2010	Flora: vegetation condition, targeted threatened species surveys (6 person days). Fauna: targeted threatened species surveys (6 person days) including bird (1.3 hours), bat (20.25 hours), reptile (6 hours) and habitat assessment.	This Biodiversity Assessment.

28 September 2011 – 21 November 2011	Fauna: targeted presence-absence surveys for Striped Legless Lizard and Pink-tailed Worm-lizard.	This Biodiversity Assessment.

The survey plan allowed surveys to target threatened species with potential for impact in their most suitable survey period. It addressed seasonal variations (particularly relevant to vegetation condition). It also guided the development of the proposal, to avoid areas of highest risk or highest conservation significance as much as possible.

Conditions

A summary of weather conditions for the four survey periods is provided in Table 2-2.

Weather conditions for December 2009 surveys varied from mild and overcast to hot and windy. Maximum daytime temperatures ranged from 22.1^{0}C – 34.7^{0}C with the lowest overnight temperature of 9.1^{0}C. Winds were predominately west northwest. Reaching speeds of 41 kilometres an hour.

Weather conditions for the March survey session were predominately fine and clear. Maximum daytime temperatures ranged from 24.2^{o}C – 28.4^{o}C with a lowest overnight minimum of 5.5^{o}C. Winds were light to moderate averaging approximately 12 kilometres an hour and mostly northerly in the morning tending westerly in the afternoons. Recent rain in the weeks preceding the survey had stimulated vegetation growth with many species flowering in response.

Weather conditions for the November 2010 survey period were variable with a mixture of cloudy and clear skies and showers. Maximum daytime temperatures ranged from 22.9^{o}C – 29.5^{o}C with a lowest overnight minimum of 8.2^{o}C. Winds were light to moderate averaging approximately 17 kilometres an hour and mostly northerly/north-westerly in the morning tending westerly in the afternoons.

Weather conditions were variable across the three-month 2011 survey period, ranging from mild and rainy in September (maximum of 14^{o}C) to warm and dry in October and November (maximum temperatures 24.7^{o}C and 22.8^{o}C, respectively). Winds were generally light during all three surveys.

Table 2-2 Conditions during survey week, including weather, sun rise and set and moon phase (source: BOM 2010, 2011 for Goulburn Airport weather station)

Date	Temp (°C)		Rain (mm)	3pm wind (direction and km/hr)	Sunrise[2]	Sunset	Moon phase
	Min	Max			(values current for each week)		
8/12/2009	14.8	34.7	0	WNW 41	0512	1937	0048 rise
9/12/2009	11.7	25.8	3.6	WNW 20			Last Quarter
10/12/2009	9.1	29.7	0	NW 37			

[2] Australian Eastern Summer Time unless otherwise indicated

Date	Temp (°C)		Rain (mm)	3pm wind (direction and km/hr)	Sunrise[2]	Sunset	Moon phase
	Min	Max			(values current for each week)		
11/12/2009	10.0	22.1	0.2	W 31			
22/03/2010	10.1	24.3	0	NW 9	0707	1912	1547 rise
23/03/2010	5.5	26.5	0	WSW 11			First quarter
24/03/2010	5.6	24.2	0	E 9			
25/03/2010	8.0	27.1	0	WNW 24			
26/03/2010	8.2	29.3	0	W 26			
9/11/2010	8.2	22.9	0.8	WNW 13	0552	1940	0757 rise
10/11/2010	10.9	25.5	0.4	W 24			New moon
11/11/2010	11.5	26.8	3.0	W 22			
12/11/2010	9.5	29.5	0	WNW 7			
28/09/2011	3.2	15.9	16	N 16	0554[3]	1802	New moon
19/10/2011	1.4	24.5	0	SE 13	0615	1919	Last quarter
21/11/2011	4.0	23.5	1.6	W 20	0545	1950	Last quarter

2.4.2 Flora survey

The flora surveys were conducted by Paul McPherson (Lead Botanist) and Dave Maynard (Assistant Botanist) and were targeted within the DE. A three-tiered approach incorporating plot-based, traverse and general inspection methods was used to ensure that vegetation could be characterised in detail, while providing the areal coverage required for a project of this scale. Points at the centre of the survey sites relevant to the final proposed layout are shown in Figure 2-1. Flora survey locations and vegetation types from all surveys can be found in Appendix F. Approximately 120 person hours was spent in total over the three flora survey sessions.

[3] Australian Eastern Standard Time

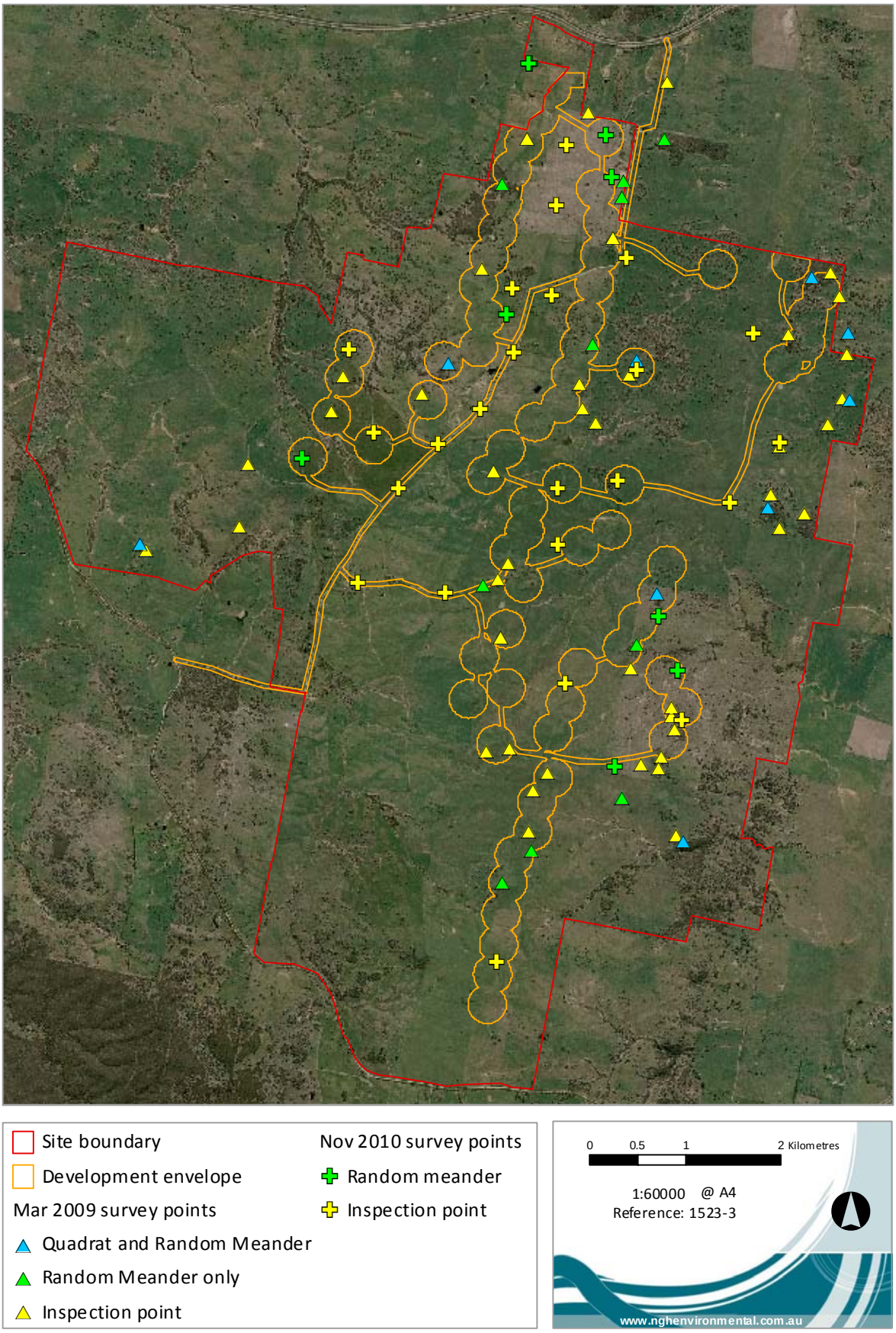

Figure 2-1 Flora survey points within the final site boundary for March and November 2010 surveys

Quadrats

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

Random meanders

Formal random meanders (after Cropper 1993) within relatively homogeneous vegetation of up to 30 minutes duration and covering up to 1 hectare were undertaken at a number of sites in each vegetation type, recording floristics, with structural and physical data. This method complements the quadrat data by improving comprehensiveness in terms of species and variation within types, and improves opportunities for detecting significant or sparsely distributed plant species. Where Quadrat data was not available for a particular vegetation type and condition class Random meander data has been included in Appendix D.

Inspections and targeted searches

In addition to the traverse and plot-based survey sites, the majority of the subject site was inspected on foot or by vehicle during the December 2009, March 2010 and November 2010 surveys to confirm vegetation types, map the distribution of Endangered Ecological Communities (EECs) and search for threatened species. EECs and areas of natural vegetation in better condition were given particular attention. Dedicated searches in specific habitat areas were undertaken for threatened species which were assessed as having at least a moderate potential to be present at the site (refer Appendix B).

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

Understorey condition assessment

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

Exotic	Groundlayer dominated by exotics, no native overstorey present.
Poor	Groundlayer dominated by one or two native grass species, <5 native non-grass species **OR** native overstorey present and Groundlayer dominated by exotics
Moderate	Groundlayer dominated by native grasses, 5-11 native non-grass species present
Good	Groundlayer dominated by native grasses with a diversity of native non grass (at least 12 native non-grass species).

These classes are most relevant for vegetation types with a grassy groundcover, such as Box-Gum Woodland.

All of the above classes 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 percent foliage cover greater than 25% of the lower value of the over-storey percent foliage cover benchmark of that vegetation type. The exotic class would equate to 'low' condition vegetation.

It should be noted that condition assessment was only carried out for areas within the DE. Vegetation mapped outside of the DE has not been given a condition class as these areas have not been surveyed and as such the assignment of a condition class is not possible.

Threatened species and communities

Threatened species and communities declared under the *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were specifically targeted in the assessment. Threatened species or communities recorded in the study area, or with potential to occur there, were identified using previous survey records and a DECC Wildlife Atlas search based on the Murrumbateman and Monaro sub-regions of the Murrumbidgee Catchment Management Area (CMA) and the Murrumbateman and Crookwell sub-regions of the Lachlan CMA. The Commonwealth online Protected Matters search tool was used to identify flora and other values in the study area listed under the EPBC Act. The likelihood of identified threatened species to occur within the study area and their potential to be impacted by the proposal was assessed by habitat evaluation (Appendix B).

The identification of the White Box, Yellow Box, Blakely's Red Gum Woodland Endangered Ecological Community (EEC) ('Box-Gum Woodland') and the Tableland Basalt Forest EEC draws on the definition provided in the Final Determination and the OEH identification guidelines for these EECs (DECCW, 2010).

Survey timing

The combined timing of the three surveys (December, March and November) was considered adequate for the identification of all species. Targeted surveys for the threatened species *Rutidosis leptorrhynchoides* were undertaken in areas of suitable habitat during the March survey as survey timing was suitable for detecting this species. Target surveys for spring flowering threatened species were undertaken in areas of suitable habitat during the November survey as survey timing was suitable for detecting these species.

2.4.3 Fauna survey

The fauna surveys were conducted by:

- Andrew Morrison (lead ecologist, survey periods 1-3).
- Bianca Heinze (ecologist, survey period 1, 2 and 4).
- Kate Carroll (ecologist, survey period 3).
- Jane McIntosh (technical officer, survey period 4).

Generally, fauna surveys were undertaken pursuant to the habitat types and quality of habitat found in the study area during the preliminary investigation (PEI).

Figure 2-2 shows an overview of fauna survey locations across the final proposal area. Survey effort by habitat type is shown in Appendix F. Surveys were designed around fauna considered likely to occur, based on the threatened species evaluation tables undertaken as part of the PEI. The targeted reptile survey (survey period 4 2011) was undertaken at the request of OEH. The following surveys were undertaken:

- Detailed habitat evaluation to assess the extent and condition of habitat for threatened species onsite, including searches for species signs (scats, runways, feeding signs etc) and key feed species.
- Hollow-bearing tree survey, including details of number and size of hollows and density of hollow-bearing trees in forested areas.
- Diurnal bird censuses: bird surveys targeting to threatened woodland and migratory birds. Opportunistic sightings of threatened species would also be recorded while travelling across the study area.
- Reptile hand searches targeting threatened reptile species.
- Microbat census using 'Anabat' ultrasonic call detection recording equipment.
- Nocturnal surveys including call playback and spotlighting focussing on threatened owls in suitable habitat.
- Bird utilisation surveys.
- Artificial shelter surveys targeting Striped Legless Lizard and Pink-tailed Worm-lizard.

Arboreal mammals were not specifically targeted as habitat evaluations and spotlighting undertaken during PEI and BS stages did not reveal suitable habitat for trapping surveys.

Survey types

Diurnal surveys

Diurnal surveys were undertaken in a 0.5 to 2 hectare search area (depending on habitat extent and quality) throughout the study area. Details of survey effort are given in Table 2-3. Each diurnal survey involved:

1. *Habitat description*

This included recording information about the vegetation structure and habitat components such as leaf litter, fallen timber, hollow-bearing trees, rock features, presence of water and canopy connectivity.

2. *Habitat search*

Scat, sign and track searches were undertaken to detect animal scats, footprints and other signs such as tree scratches. Scats and other signs were identified in the field using Triggs (1996) *Scats, Tracks and other traces.*

3. *Hollow-bearing tree survey*

Two methods were used to survey for hollow-bearing trees:

- Trees were surveyed in quadrats either 50x50m or 100x100m, depending on the tree density (e.g. smaller quadrats in dense regrowth forest). The total number of hollow-bearing and non-hollow-bearing trees within the quadrat were recorded to give a ratio.
- Trees in forest were surveyed in nested quadrats, with a 25x25m quadrat for total number of all trees within a 50x50m quadrat for hollow-bearing trees only. A ratio was also obtained using this method, by extrapolating the results within the nested quadrat.

Both methods were designed to enable identification of areas with the high densities of hollow-bearing trees.

To obtain a more accurate count of trees to be removed by the development, an alternative methodology was also employed in which all mature trees likely to be impacted by the proposal were counted using a high resolution aerial and GIS software showing the final infrastructure layout. A 50m radius buffer was drawn around turbine locations to allow for any orientation of the crane operation area and the maximum number of trees likely to be impacted by any particular orientation counted. Trees where tracks crossed wooded areas were also counted however, it was assumed that where trees are scattered that tracks would be able to be microsited to avoid impacts. A conservative approach was adopted to ensure that the number of trees identified was an upper limit value.

4. *Bird census*
   - The area search method was used for bird surveys, with searches generally between 20-30 minutes duration, although this was flexible depending on habitat quality (a species-time curve approach was used in 'good quality' habitat).
   - 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. The number of individuals was recorded for threatened species and raptors.
   - Bird census were undertaken as part of the 'diurnal surveys' as well as a stand alone survey: 11 'diurnal' surveys and three 'stand alone' surveys.

5. *Reptile search*
   - Three main species were targeted: Pink-tailed Worm-lizard *(Aprasia parapulchella)*, Little Whip Snake (*Suta flagellum*) and Striped Legless Lizard *(Delma impar)*, using different techniques.

- Active searching was undertaking in suitable habitat including rolling rocks, logs, and other debris. Rocks and logs were scanned for basking individuals prior to active searching. Although timing was not ideal for Pink-tailed Worm-lizard, the species was targeted in rocky outcrops particularly those on slopes within grassland and woodland. Striped Legless Lizard was targeted by rolling debris (rocks, logs, bark, etc.) in areas of native grassland, particularly where Kangaroo Grass *(Themeda australis)* was dominant.
- Depending on habitat extent and quality, searches varied between 15 and 45 minutes.

Habitat assessments

Further habitat assessments were undertaken at some sites where detailed bird surveys/hollow-bearing tree surveys etc. were not deemed necessary. Habitat assessments included recording information about the vegetation structure and habitat components such as leaf litter, fallen timber, hollow-bearing trees, rock features, presence of water and canopy connectivity.

Nocturnal surveys

Nocturnal surveys were undertaken using a variety of techniques and search areas. Details of survey effort are given in Table 2-3. Each nocturnal survey involved:

- *Stagwatch*

Trees bearing potential roost hollows were watched for 30 minutes before and after sunset to detect any species using the hollow.

- *Call playback*

Call playback was undertaken in each night following the methods of NPWS (2004), targeting Powerful Owl, Barking Owl and Masked Owl. Most surveys were in the early evening. This included an initial listening period of 10 minutes, then playing calls for 5 minutes, followed by an equal listening period.

- *Spotlight*

Spotlighting was undertaken using an area search method both by foot and slow-moving vehicle for between 15 and 60 minutes, depending on habitat quality and patch size. Spotlighting techniques included methods to detect owls, arboreal mammals and reptiles, such as nocturnal snakes (e.g. Little Whip Snake).

- *Anabat*

Microbats were surveyed for using an Anabat detector (passive survey). The detector was left in place overnight in locations chosen to maximise the potential for picking up multiple species of bats, such as near likely flyways through vegetation or along creeks. Recording was typically from approximately 30 minutes before sunset to daybreak the following morning.

Bird utilisation surveys

Bird utilisation surveys were undertaken in December 2009, using the following methodology:

- Point count surveys were undertaken in suitable habitat.
- Bird utilisation surveys followed Auswind (2006) at eight paired sites across the proposal area. Thirty-four surveys of 20 minutes duration were undertaken across eight paired sites (16 locations), totalling 12 hours of bird utilisation surveys. For each of the eight paired sites, simultaneous surveys were undertaken in two different habitat types (locations). For example, at the control site, surveys were undertaken in woodland and pasture with trees.
- As well as species observed, the following variables were recorded: distance from observer; flight height; bird behaviour and whether any juveniles were present. Flight height was broken into low (from ground level to canopy), medium (high in canopy to just above) and high (well above canopy height).
- A total of 34 bird utilisation surveys were undertaken (these are in addition to the bird census surveys).

In each habitat type, observers aimed to record only species using that habitat type, rather than those adjacent. For example, in pasture adjacent to woodland, birds heard calling from the woodland were not recorded.

Artificial shelter surveys

An artificial shelter survey was established to allow a presence-absence survey to be undertaken for the Striped Legless Lizard and the Pink-tailed Worm-lizard. While previous habitat evaluations did not identify the site to contain habitat suitable for both of these species, the surveys were undertaken at the request of the OEH.

The survey followed a methodology developed in consultation with the OEH. It involved the installation of ten arrays across the Collector Wind Farm site. Each array contained five roofing tiles that were placed at five metre intervals. The arrays were located in the highest quality potential Striped Legless Lizard /Pink-tailed Worm-lizard habitat (as determined during previous biodiversity assessments), while also ensuring good site coverage. Figure 2-3 shows the location of each of these arrays.

The tiles were placed across the site on the 10 – 11 August 2011 for survey in Spring 2011. Early placement of the tiles enables the development of suitable micro site conditions under the tiles and reduces any neophobic effects (aversion by fauna to new or foreign things) prior to surveying in Spring. The arrays were checked on the 26 August 2011 to ensure the tiles had not been broken by the stock (cattle and sheep) grazing in the paddocks. The tiles were then monitored once a month from September to November (3 surveys). This schedule was recommended by the OEH.

The tile checking surveys were undertaken on the following dates:

- 28 September 2011.
- 19 October 2011.
- 21 November 2011.

During the surveys, a wooden frame (open at the top and bottom, with a foam strip around the base to allow the box to sit flush on uneven ground), was placed over each tile prior to lifting to attempt to trap any reptiles present under the tile.

Survey effort

Across the 813 ha development envelope, surveys were stratified according to the following habitat stratification units:

- Pasture with scattered trees (341 ha).
- Woodland (58ha).
- Forest (37 ha).

For reptiles, the following microhabitat stratification units were also used:

- Rocky outcrops (area not calculated).
- Native grassland (389 ha)[4].

A description of each of these habitat units is given in the results section (Section 4.2). Survey effort summary is given in Table 2-3 and raw survey data are given in Appendix E.

[4] The remaining 149 ha in the development envelope is exotic pasture, which was not considered a suitable habitat stratification unit for threatened species

Table 2-3 Summary of fauna survey effort. Full details of survey effort is given in Appendix E and F.

Survey type	Target species	Total survey effort	Timing	Survey effort by stratification unit
Habitat assessment only	All threatened	29 Habitat Assessments	December 2009 March 2010 November 2010	Pasture with trees Woodland Forest Native pasture
Hollow-bearing tree quadrats	All hollow-dependent fauna	25 Hollow-bearing tree quadrats	March 2010	Pasture with trees = 12, most 100x100m Woodland = 9 surveys, most 20x20m, and 3 transects Forest[5] = 4 surveys, between 20x20 and 50x50m
Bird census	Threatened birds, especially woodland birds	14 surveys of between 15 and 60 minutes duration 13.5 person-hours total	March 2010 November 2010	Pasture with trees Woodland Forest
Bird utilisation	All birds	34 surveys of 20 minutes duration	December 2009	Pasture with trees Woodland Forest
Reptile search	Pink-tailed Worm-lizard Striped Legless Lizard Little Whip Snake	34 surveys of minimum 0.5 person hours 17 person-hours total	March 2010 November 2010	Pasture with trees Native pasture
Nocturnal survey summary	Details below	5 search areas (size ranging from 10-30 ha) Total area covered = 80 ha		Pasture with trees Woodland Forest

[5] High density of trees in regrowth forests made it necessary to make quadrats much smaller than in open stratification units, such as pasture with trees.

Survey type	Target species	Total survey effort	Timing	Survey effort by stratification unit
Stagwatch	Powerful Owl Masked Owl Microbats	8 surveys each by 1 person, from 45 to 60 minutes 7.5 person-hours	March 2010	Woodland Forest
Call playback	Powerful Owl Barking Owl	5 surveys of 30 minutes duration 2.5 person-hours	March 2010	Woodland Forest
Spotlighting	Powerful Owl Masked Owl Yellow-bellied Sheath-tail Bat Little Whip Snake Arboreal mammals	4 surveys vehicle-based (5.5 person-hours) 5 surveys foot-based (6 person-hours)	March 2010	Pasture with trees Woodland Forest
Anabat	All microbats	15 overnight surveys	December 2009 March 2010 November 2010	Pasture with trees = 1 overnight Woodland = 1 overnight Pasture with trees / Forest ecotone = 1 overnight Ecotone of all units = 1 overnight
Frog call survey (listen for calls)	All frogs	3 surveys of 15 minutes duration 0.75 person-hours	March 2010	Dams
Artificial shelter surveys	Pink-tailed Worm-lizard Striped Legless Lizard	1 survey of three months duration	September – November 2011	Native pasture Pasture with trees

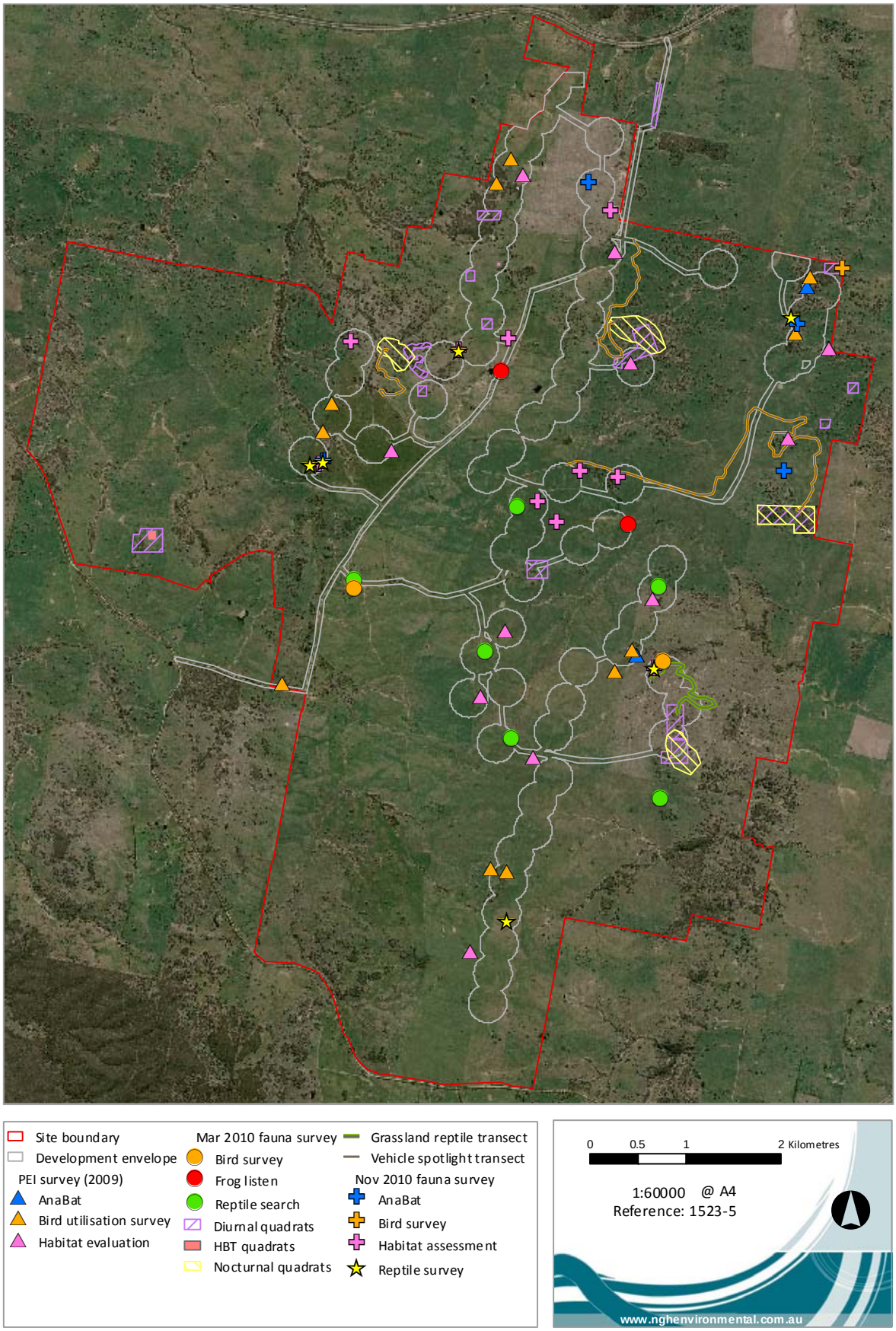

Figure 2-2 Fauna survey effort over the final proposal area, including PEI survey points (November 2009) and recent surveys (March and November 2010).

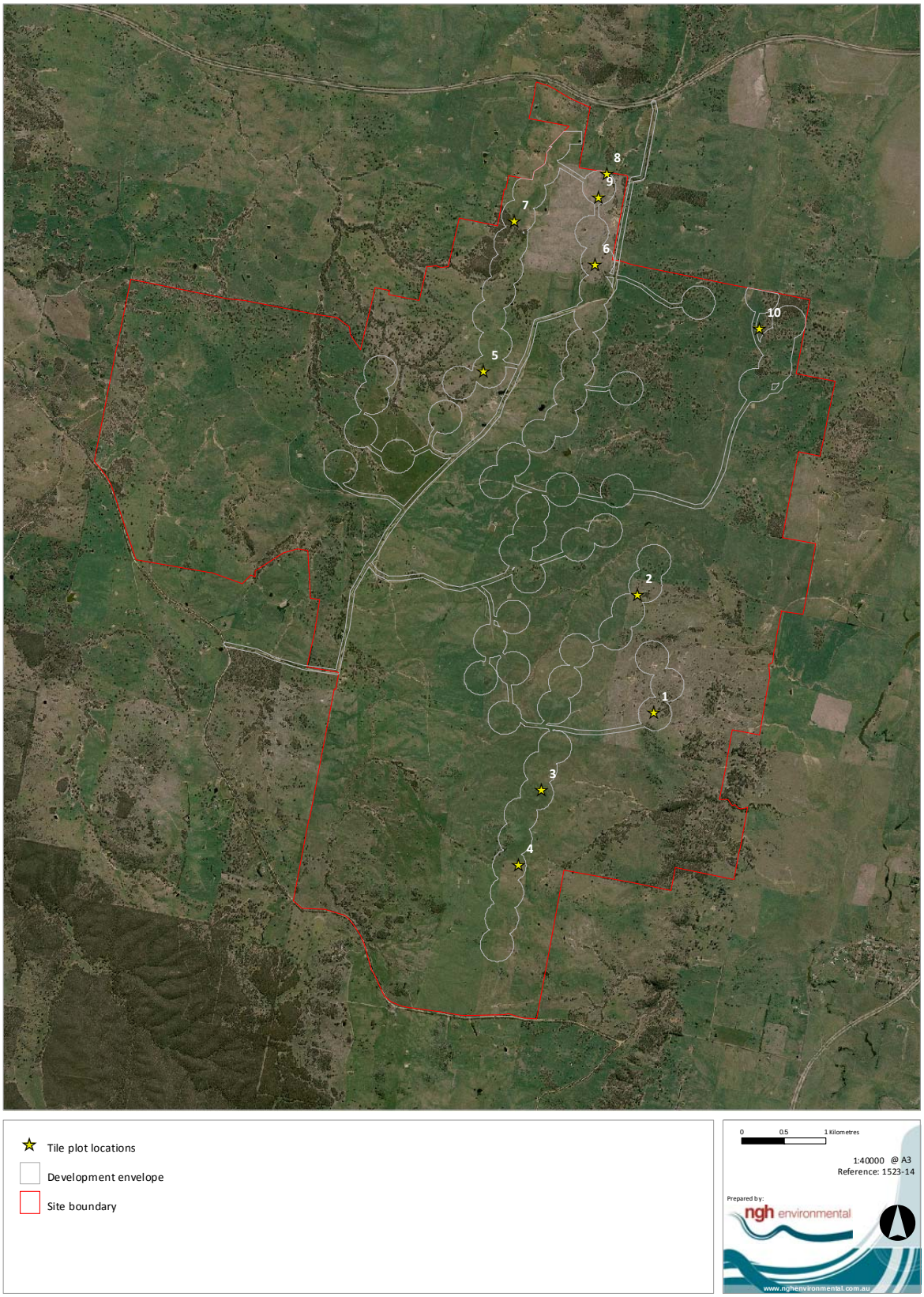

Figure 2-3 Ten tile array locations at the Collector site, surveyed September - November 2011

2.4.4 Survey limitations

The limitations to flora and fauna surveys have been identified here, as required by the OEH Guidelines (DEC 2004).

General

- Given the limited survey period and large size of the development envelope (approximately 813 hectares) it was not possible to survey the entire area in detail.
- In general, surveys were biased towards areas of better quality areas, as these were previously identified as posing the highest level of constraint to the proposal.

Flora

- Vegetation type and condition were noted in areas that were traversed while travelling between Clusters. Any areas identified as being of potential conservation significance were investigated in more detail on foot.
- Agricultural management practices appeared to be consistent within existing paddock boundaries and for mapping purposes, vegetation characteristics noted within these boundaries have been extrapolated across the broader paddock areas. This is particularly relevant to areas identified as having potential for offsetting as it was not possible to investigate these large areas in detail.
- Due to the high levels of clearing and disturbance and the resulting modification of floristics, it was difficult to accurately determine the boundaries of particular vegetation communities within the proposal area. Mapping has been primarily based upon indicative overstorey species and observed patterns of vegetation distribution in the field. A conservative approach has been taken where communities of conservation significance occurred.
- Spring flowering annual exotic grasses were prolific in many areas of the site during the November survey. Dense cover of these species obscures other ground cover vegetation making detection difficult. It is possible that some native species may have been overlooked in these areas however, due to their degraded nature it is not considered likely that any species of conservation significance would occur in these areas and as such it is unlikely any would have been overlooked.

Fauna

- Some surveys were not undertaken at ideal times during the day, i.e. bird surveys were undertaken throughout the day. To obtain best results, surveys would be limited to early morning and late afternoon as these are periods when birds are most active. A reduction in the number of species detected during mid-day surveys is observable. However, this is considered unlikely to have affected the results to the point where any important species were missed, as surveys were spread over a broad area and time frame.
- Issues with the use of Anabat to detect microbats. The identification of bats by echolocation calls involves considerable subjectivity, due to call variation in regions, different habitats and depending on the quality of the call. Some species are easily identifiable, while others can be difficult to distinguish. Furthermore, some species are less likely to be detected by the Anabat due to quiet, low frequency or infrequent echolocation calls (e.g. Golden-tipped Bat and White-striped Mastiff-bat).

- Moon phases, for call playback and spotlighting surveys, was not considered a limitation to the study. Moon phase may affect the response of owls and detection of other nocturnal species, although the actual influence of this appears to vary widely (Kavanagh and Peake 1993 v. Olsen et al. 2002).

In order to address any deficiencies, the precautionary principle has been adopted by assuming that a species may be present if suitable habitat occurs on site.

2.5 ADDITIONAL INVESTIGATIONS

Additional research and investigation was undertaken, based on the recommendations of previous assessments (**ngh**environmental 2010a and 2010b) into:

- Proximity to Lake George (Birds and bats).
- Bat risks.

These are reported in Section 5 of this report.

2.6 GIS MAPPING

Figures have been produced by **ngh**environmental using ArcView 10. Georeferenced aerial imagery and proposed infrastructure location layers were provided by RAC. The development envelope (DE) has been based on the infrastructure layers provided and buffered with estimated infrastructure footprints. Vegetation and habitat mapping within the DE have been hand-digitised by **ngh**environmental based on aerial imagery and field records. Broad-scale vegetation mapping outside the DE was hand-digitised by **ngh**environmental based on aerial imagery, field observations, existing vegetation mapping (Southern Region Comprehensive Regional Assessment; provided by OEH November 2011) and extrapolation from known vegetation types within the DE. Other polygon source data includes:

- GIS topography dataset (250K scale) from Geoscience Australia.

Point data includes the following:

- Features marked by handheld GPS in the field by **ngh**environmental.

2.6.1 Vegetation mapping

The vegetation of the proposal area has been classified using the system developed for the SCRA (Thomas et al. 2000), revised by Gellie (2005). The recent SCIVI classification supersedes the SCRA work for the coast and eastern tablelands, but does not extend westward to include the study area. The SCRA classification provides better context for each vegetation type, particularly in terms of areal estimates of remaining extent and reservation, which are critical for assessments of conservation status and impact significance. The Comprehensive Regional Assessment work developed an ecosystem classification using computer (PATN) analysis of full floristic plot data and modelling of the distribution of each ecosystem within three sub-regions.

2.6.2 Limitations of mapping

Source data at a large scale (e.g. 1:250,000) is very coarse. Contours and road locations, for example, could differ from actual ground position by up to a kilometre. Where this discrepancy could be important, the location of features such as roads and contours were cross checked using aerial imagery and finer scale topographical maps (e.g. 1:25,000).

The broad-scale vegetation mapping outside of the DE was completed using techniques including extrapolation from known vegetation types and coarse existing vegetation mapping. This mapping has not been ground truthed and is provided as an indication only of what vegetation communities may be present and their extent.

2.7 REPORTING

This document reports the methods and findings from all previous site survey and investigation and is intended as a stand-alone biodiversity assessment of the final proposal on the biodiversity values of the site and, where relevant, its surrounds.

3 RESULTS: FLORA

3.1 DISTURBANCE AND WEEDS

The majority of the proposal area has been cleared and grazed by sheep and cattle over a long period. A large proportion of the pasture has been cultivated and sown to exotic pasture species such as Bromes, Ryegrass, Fescues and Cocksfoot. Stock camp areas under trees and on ridge crests are degraded by an excess of nutrients and high grazing pressure and support few native groundcover species.

Dry forest remnants within the proposal area are generally comprised of mature regrowth with a few old growth trees. Some older trees are present in paddocks and in woodland remnants. The shrub layer has been almost completely removed in both forest and woodland areas by clearing and grazing.

Minor pasture weed species were common across the majority of the study area, with higher concentrations in stock camp areas. Noxious weeds declared for the Upper Lachlan Shire Council Area observed at or adjacent to the study area include Blackberry (Class 4), Gorse (Class 3), Scotch Thistle (Class 4), St John's Wort (Class 4), Sweet Briar (Class 4) and Serrated Tussock (Class 4). Serrated Tussock was widespread across the development envelope and recorded at a number of survey locations.

3.2 VEGETATION COMMUNITIES

The conservation status of each of the vegetation types present within the DE[6] is identified in Table 3-1. The distribution of the vegetation communities within the proposal area and condition was a focus of the surveys and is mapped in Figure 3-1. Detailed species lists and representative data from quadrats and Random Meanders in each vegetation type and class can be found in Appendix D.

Brittle Gum – Broad-leaved Peppermint Dry Forest

This community occurs primarily on metasedimentary ridges along the fault scarp in the east of the proposal area with isolated occurrences within the central and northern areas, often adjoining areas of Box-Gum Woodland. It is characterised within the proposal area by an overstorey of Brittle Gum (*Eucalyptus mannifera*) and/or Broad-leaved Peppermint (*E. dives*), occasionally with Apple Box (*E. bridgesiana*) Long-leaved Box (*E. goniocalyx*) and Red Stringybark (*E. macrorhyncha*), a very sparse shrub layer including *Hibbertia obtusifolia* and *Melichrus urceolatus* and variable grazed groundcover with *Poa sieberiana*, *Gonocarpus tetragynus* and *Lomandra filiformis* ssp. *coriacea*. This community corresponds to Group 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest.

[6] A number of areas within the original proposal area (assessed during the surveys) are no longer encompassed by final Development Envelope (DE). These are however included in this results section as they inform the context of the proposal. All area estimations are based on the final DE.

White Gum Dry Forest

This community occurs in three areas; in the north-east and the far north of the site with an isolated patch on a ridge crest to the south west of Cluster 2 which is no longer within the DE. In the northern occurrences it comprises a nearly monospecific overstorey of regrowth White Gum (*E. rossii*). Broad-leaved Peppermint, Brittle Gum and Red Stringybark have localised occurrences in this community within the proposal area. Sparse small trees and shrubs within the northern occurrences include *Acacia dealbata, Hibbertia obtusifolia, Lissanthe strigosa, Indigofera australis* and *Cassinia arcuata* and the open groundcover is dominated by *Poa sieberiana* with *Gonocarpus tetragynus, Goodenia hederacea, Stellaria pungens, Poranthera microphylla, Hydrocotyle laxiflora* and *Helichrysum scorpioides* and *Bossiaea prostrata*. The small occurrence to the south west of Cluster 2 is dominated by White Gum with a predominately exotic understorey.

The understorey in all occurrences has been simplified by past clearing and grazing and a definitive attribution to a SCRA vegetation type is difficult. The community has some affinity to Vegetation Group 115 South East Tablelands Dry Shrub/Tussock Grass Forest, or may represent a variant of Group 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest.

Ribbon Gum – Snow Gum Forest

Remnants of this taller forest type occur to the south of Gunning Road on fertile granitic soils. This area was previously within the DE however, the revised layout now excludes it. The community features a tree layer dominated by Ribbon Gum (*Eucalyptus viminalis*) with Snow Gum (*E. pauciflora*) as a sub-dominant. Broad-leaved Peppermint may also be locally dominant. The relatively moist grassy understorey has a small tree layer of *Acacia dealbata, Acacia deanei* ssp *paucijuga* and *Exocarpus cupressiformis*.

The groundcover has the grasses *Microlaena stipoides, Elymus scaber* and *Poa sieberiana*, the shrubs *Daviesia latifolia, Hovea heterophylla* and *Rubus parvifolius*, a diverse range of forbs including *Acaena novae-zelandiae, Asperula conferta, Plantago varia, Chaerophyllum eriopodum, Stellaria pungens, Viola betonicifolia, Einadia nutans, Scleranthus fasciculatus* and *Dichondra repens*, and patches of Bracken Fern (*Pteridium esculentum*). This community does not fit neatly into the SCRA system, but bears closest similarity to Group 73 Eastern Tableland Dry Shrub/Grass Forest (although it occurs on granitic rather than sedimentary substrates), and has some affinity to Group 111 Central Northern Tablelands Dry Shrub/Grass Forest (with *E. dalrympleana* replaced by *E. viminalis*).

Snow Gum Grassy Woodland

A small (15m diameter) and discrete patch of Snow Gum trees over a native grassy groundlayer at the edge of what may be a cold air drainage basin was recorded in the north-east of the proposal area within Cluster 6 (at MGA 719261 6137467). More extensive patches occur in the north of Cluster 3 and the south of Cluster 5. The community within the proposal area carries an overstorey of predominately regrowth Snow Gums (*E. pauciflora*) over a groundlayer disturbed by grazing stock. Overstorey is sparse in the south of Cluster 5 and Ribbon Gum (*E. viminalis*) occurs in the community in the north of Cluster 3. Areas within and adjacent to this community have a relatively high diversity groundcover with Kangaroo Grass and a range of woodland forb species. Surrounding grasslands may be derived from this community, particularly if cold air ponding occurs in winter however, due to the high levels of clearing it is difficult to accurately determine the boundaries of this community within the proposal area. This community may represent a woodland form of Vegetation Group 73

Eastern Tableland Dry Shrub/Grass Forest or the related Group 74 South Eastern Tablelands Dry Shrub/Grass/Herb Forest.

Box-Gum Woodland and Secondary Grassland

Box-Gum Woodland is the original vegetation over the majority of the site, particularly the rolling hills and plains used most intensively for agriculture. In most places within the proposal area the understorey has been highly modified by grazing, even replaced by exotic pasture species in many paddocks. Most native pastures are derived from this community and have lost much of their original structure and diversity. Relatively hardy native grasses such as Wallaby Grasses (*Austrodanthonia* spp.) and Spear Grasses (*Austrostipa scabra* ssp *falcata* and *A. bigeniculata*) dominate native pastures, and have recolonised in patches in improved pastures. Weeping Grass (*Microlaena stipoides*) is dominant in some moister grazed areas, and Kangaroo Grass (*Themeda australis*) remains dominant in areas with a lighter grazing history. Several pasture areas particularly towards the centre and north of the proposal area exhibited a high diversity (>12) of woodland forb species.

Tree cover is variable, ranging from zero to forest-density regrowth. Dominant tree species within the proposal area are Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Apple Box (*E. bridgesiana*). Broad-leaved Peppermint, Long-leaved Box and Red Stringybark also occur in Box-Gum Woodland vegetation within the proposal area. This vegetation belongs to one or more of the several Southern CRA tableland woodland vegetation types. Because of the level of disturbance to the natural understorey, it is difficult to attribute the vegetation to a particular CRA type/s. Based on the native understorey species remaining, and type distribution patterns, the closest and most likely match is with 160 Western Slopes Dry Grass Woodland and 161 Tablelands and Slopes Dry Herb/Grass Woodland. These types are closely related and have similar composition, conservation status and protection requirements.

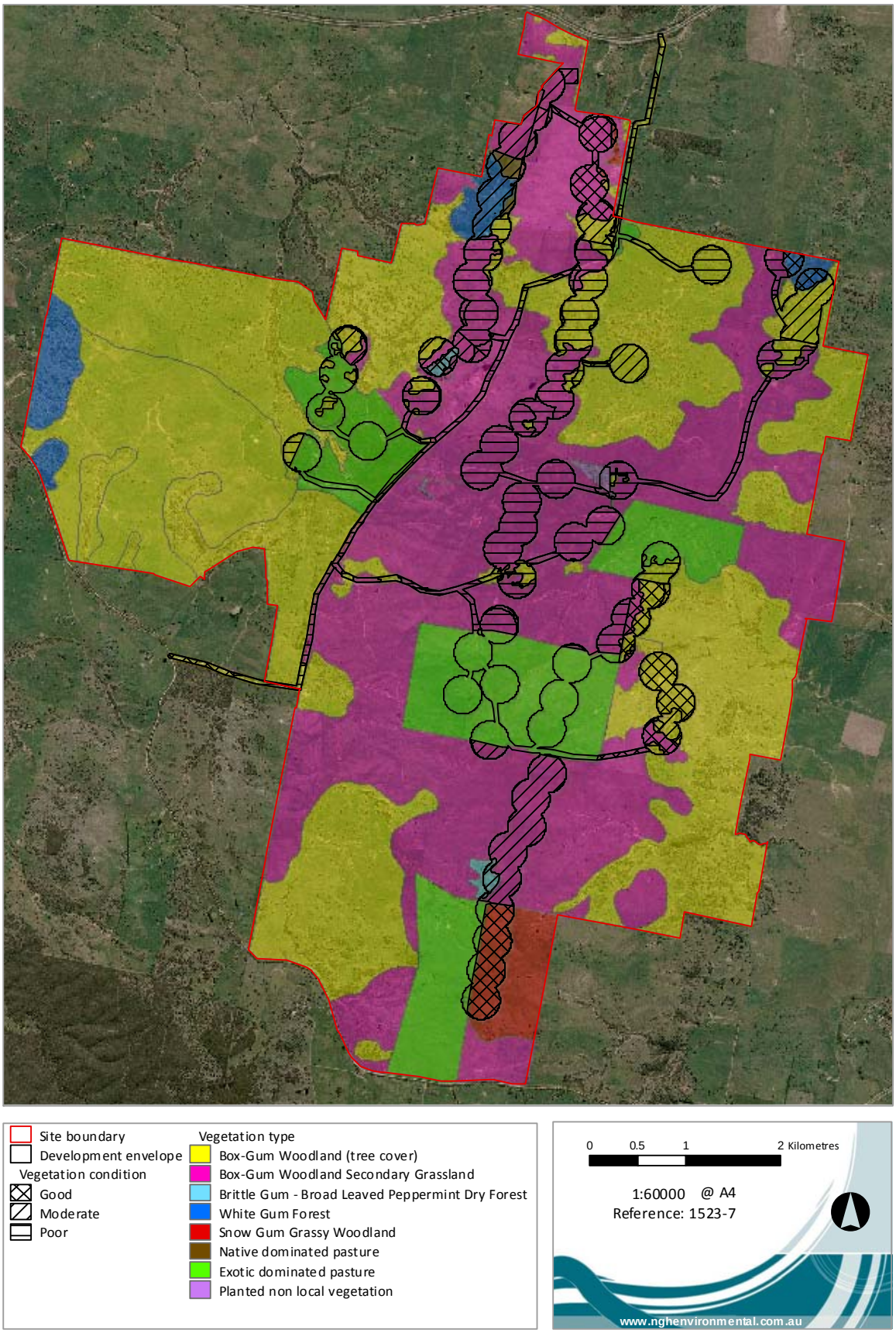

Figure 3-1 Vegetation community type and condition within the DE (detailed) and site boundary (broad scale)

3.3 CONSERVATION STATUS OF VEGETATION TYPES

Table 3-1 shows the high level of depletion and poor conservation status of the woodland vegetation types in the Southern CRA region which would have originally occupied the majority of the study area. Since Box-Gum Woodland habitat coincides with prime farmland, this community has been heavily impacted by clearing, grazing, cultivation and the introduction of weed and pasture species. The impact of this depletion is compounded by the severe fragmentation and continuing degradation of remaining stands.

Applying the general JANIS reservation target of 15% of the original extent for each forest type (JANIS 1997), all of the vegetation types within the proposal area are under-represented in the conservation reserve system (refer Table 3-1). Under JANIS criteria, 60% of the remaining stands of vulnerable types and 100% of endangered types should be reserved or otherwise protected.

Table 3-1 Conservation status of vegetation types at the proposal area

Vegetation type	Pre-1750 extent in CRA region (ha)	Extant area in CRA region (ha)	Reserved in CRA region (ha)
Brittle Gum - Broad-leaved Peppermint dry forest			
Vegetation Group 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest	158,000	70,600 (45% of 1750 extent)	16,200 (10% of 1750 extent)
White Gum dry forest			
Vegetation Group 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest	158,000	70,600 (45% of 1750 extent)	16,200 (10% of 1750 extent)
Vegetation Group 115 South East Tablelands Dry Shrub/Tussock Grass Forest	74,200	59,800 (80.6% of 1750 extent)	5,200 (7% of 1750 extent)
Ribbon Gum – Snow Gum forest			
Vegetation Group 73 Eastern Tableland Dry Shrub/Grass Forest (PART)	276,200	63,900 (23.1% of 1750 extent)	5,500 (2% of 1750 extent)
Vegetation Group 111 Central Northern Tablelands Dry Shrub/Grass Forest	54,700	6,000 (11% of 1750 extent)	nil
Snow Gum woodland			
Vegetation Group 73 Eastern Tableland Dry Shrub/Grass Forest (PART)	276,200	63,900 (23.1% of 1750 extent)	5,500 (2% of 1750 extent)
Vegetation Group 74 South Eastern Tablelands Dry Shrub/Grass/Herb Forest	144,500	60,800 (42.1% of 1750 extent)	9,800 (7% of 1750 extent)
Box-Gum Woodland			

Vegetation type	Pre-1750 extent in CRA region (ha)	Extant area in CRA region (ha)	Reserved in CRA region (ha)
Vegetation Group 90 Northern Tablelands Acacia Herb/Grass Dry Forest	77,800	28,400 (36.5% of 1750 extent)	3,300 (4.2% of 1750 extent)
Vegetation Group 92 Tablelands Acacia/Grass/Herb Dry Forest	4,200	1,300 (30.9% of 1750 extent)	90 (2% of 1750 extent)
Vegetation Group 159: Northern Slopes Dry Grass Woodland	17,700	1,900 (10.7% of 1750 extent)	nil
Vegetation Group 160 Western Slopes Dry Grass Woodland	247,500	7,000 (3% of 1750 extent)	695 (0.2% of 1750 extent)
Vegetation Group 161 Tablelands and Slopes Dry Herb/Grass Woodland	87,100	3,800 (4% of 1750 extent)	nil
Vegetation Group 163 Central North Slopes Dry Grass Woodland	7,400	260 (22% of 1750 extent)	nil

3.4 ENDANGERED ECOLOGICAL COMMUNITIES

The Commonwealth and State online database searches indicated the recorded or potential presence of six threatened communities in the wider study area (including nominated communities). The threatened species evaluation in Appendix B identified habitat for three threatened communities:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland; EPBC and TSC).
- Tablelands Basalt Forest (TSC).
- Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands (Tablelands Snow Gum Grassy Woodland; TSC).

The potential for the Natural Temperate Grasslands EEC to occur at the site was also considered however, it was not detected during the surveys. Vegetation belonging to Box-Gum Woodland EEC and Tablelands Basalt Forest EEC was recorded at the proposal area during the PEI and March field survey. The Tablelands Basalt Forest EEC is outside of the final proposed DE. Three areas of Tablelands Snow Gum Grassy Woodland EEC were identified within the proposal area during the November 2010 survey. An indicative distribution of the EEC areas within the final DE is presented in Figure 3-2.

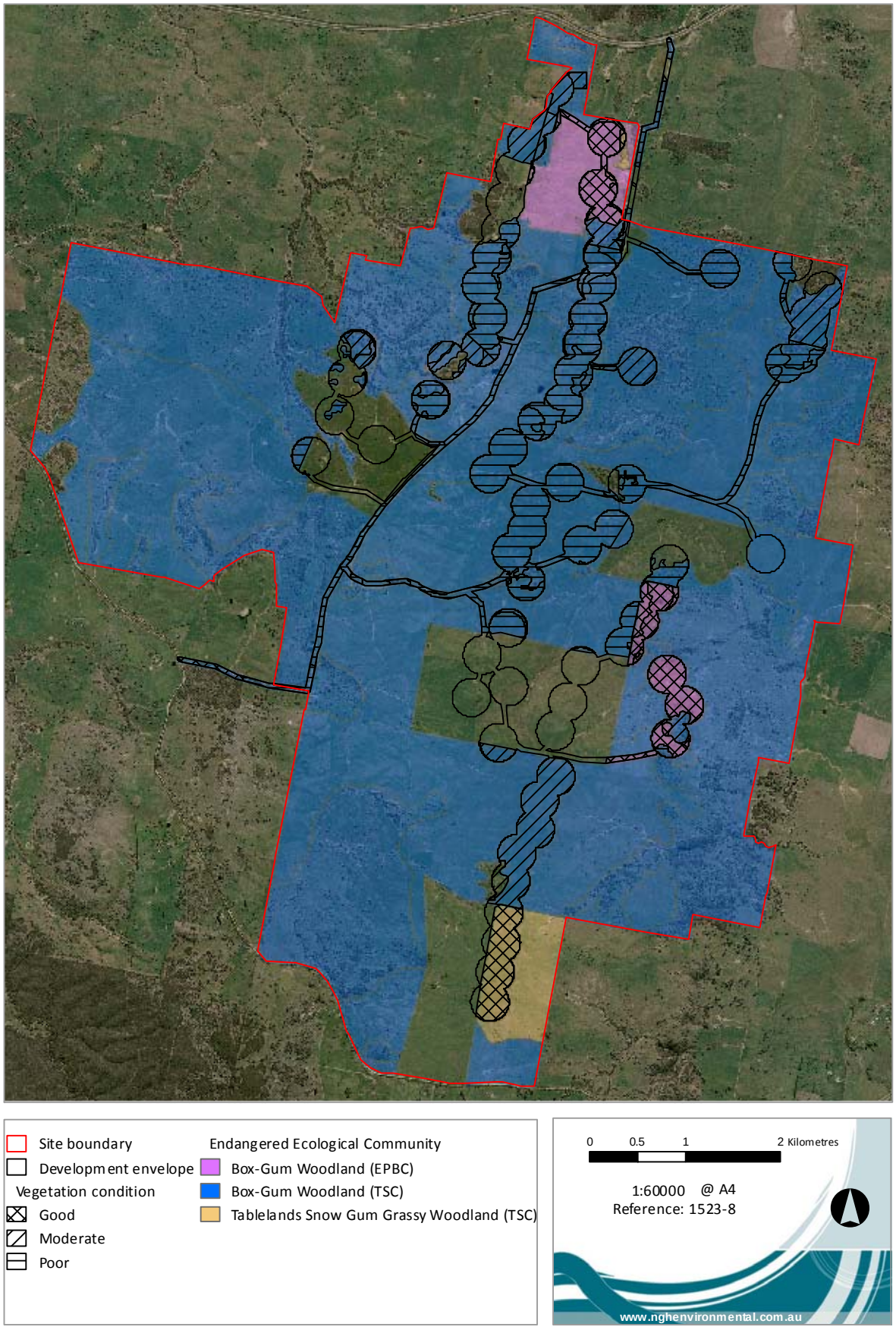

Figure 3-2 Endangered Ecological Communities, and condition classes (within the DE), within the site boundary

3.4.1 Box-Gum Woodland

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 which include Yellow Box or Blakely's Red Gum (with or without native understorey); and
- Grasslands and pastures dominated by native grasses that are derived from this community.

Stands dominated by Long-leaved Box, Apple Box or Broad-leaved Peppermint may be regarded as part of the EEC if Yellow Box and/or Blakely's Red Gum are present as minority components or are located close by in the same landscape element. Pastures with at least 50% native grass cover are widespread within the proposal area, usually dominated by Wallaby Grasses and Spear Grasses. Stands of Kangaroo Grass (*Themeda australis*) remain in some areas, particularly in the central and north-east of the proposal area, indicating a less intensive grazing history.

Most examples within the proposal area are generally in poor condition in terms of flora values, with extensive loss of diversity from the understorey. Relatively intact understorey is present in areas at the central and northern sections of the proposal area usually dominated by several grasses and a varying diversity of forbs. Understorey diversity had appeared to have increased in the period between the PEI survey and the March 2010 survey, resulting in better condition levels particularly in the north eastern section of the proposal area. This may be due to favourable conditions in the weeks preceding the survey or alterations to land management practices. Condition levels during the November 2010 survey appeared to be lower due to the dominance of exotic annual grasses in a number of locations which hampered species detection. Conversely, diversity in particular areas which were in good condition during previous surveys had increased with a number of spring flowering forbs being recorded that were previously undetectable.

Larger areas of structural woodland may have high conservation value for threatened woodland fauna, particularly birds and microbats.

Commonwealth Critically Endangered Ecological Community (CEEC)

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (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.

This includes the denser Yellow Box and Blakely's Red Gum woodland patches in the very north (and just outside) of the proposal area (based on the structural criteria) and native pastures and woodlands with relatively high groundcover diversity (>12 non grass species) in the northern and central portion of the proposal area. CEEC areas represent relatively high conservation value examples of Box-Gum Woodland. Clearing in these areas may require Commonwealth approval.

Further survey work during the November 2010 survey was undertaken to confirm the condition assessment and qualification of CEEC areas identified during previous surveys, as well as to better identify the extent of these areas. This has resulted in more accurate mapping and in some cases the determination that areas previously extrapolated based on paddock boundaries do not necessarily meet the requirements of the CEEC.

3.4.2 Tableland Basalt Forest

NSW Endangered Ecological Community (EEC)

The taller Ribbon Gum – Snow Gum forest that occurs south of Gunning Road on fertile granitic soils belong to the Tableland Basalt Forest EEC, based on observed structure and floristics. Consistent with the EEC Determination, the community has an open canopy of Ribbon Gum, with Snow Gum as a subdominant; a small tree layer including Silver Wattle and a diverse grassy groundlayer including the grasses *Poa sieberiana, Austrodanthonia* sp. and *Microlaena stipoides*, the scrambler Native Raspberry, and the forbs *Acaena novae-zelandiae, Asperula conferta, Plantago varia, Chaerophyllum eriopodum* (syn. *Oreomyrrhis eriopoda*), *Stellaria pungens, Hydrocotyle laxiflora, Viola betonicifolia, Einadia nutans* and *Dichondra repens*, and Bracken Fern (*Pteridium esculentum*).

While the EEC typically occurs on basalt, it may also occur on relatively fertile granitic soils. Native pastures adjacent to these stands that are derived from the community may also form part of the EEC if they contain characteristic non-woody species listed in the Determination.

This community was identified as occurring within a previous definition of the proposal area. It does not occur in the current proposal area and will not be impacted by the proposal.

3.4.3 Tablelands Snow Gum Grassy Woodland

NSW Endangered Ecological Community (EEC)

Three areas of Snow Gum trees over a native grassy groundlayer within or at the edge of what may be cold air drainage basins in the north, east and south of the proposal area belong to the Tablelands Snow Gum Grassy Woodland EEC. Consistent with the determination this community forms an open grassy woodland community that is dominated by Snow Gum (*Eucalyptus pauciflora*), in some cases with Ribbon Gum (*E. viminalis*), and is occurring on valley floors, frost hollows, footslopes and undulating terrain. A shrub layer may or may not be present in this community but commonly contains species such as Urn-heath (*Melichrus urceolatus*) which was sparsely distributed.

Characteristic forb species present include *Hypericum gramineum, Chrysocephalum apiculatum, Leptorhynchos squamatus, Asperula conferta, Convolvulus angustissimus, Hydrocotyle laxiflora, Gonocarpus tetragynus, Haloragis heterophylla* and *Acaena echinata.* Characteristic grasses and sedges include *Austrodanthonia pilosa* and *Carex inversa.*

This community is known to occur on a variety of substrates including granite, basalt, metasediments and Quaternary alluvium. Examples within the proposal area were observed to be occurring in areas with a more granitic substrate.

3.5 BIOMETRIC STATUS

Under the OEH Biometric guidelines (DECC 2008a), 'red flag' areas are important for biodiversity conservation and cannot easily be replaced. They include:

- Over-cleared vegetation (>70%) in moderate to good condition.
- EEC in moderate to good condition.
- Threatened species records (where species cannot withstand further loss in the CMA).

Approval to impact red flag areas may be granted provided:

- All reasonable measures have been considered – to avoid adverse impacts on the red flag area or to retain the viability of the red flag area.
- The contribution that the development site's impacted biodiversity values make to regional biodiversity values is low.
- The development site's biodiversity values are low, or not viable.
- If the development impacts on a vegetation type that has 10% or less remaining in the catchment management area, the area of land containing this highly cleared vegetation type is less than four ha in size (DECC 2008a).

According to the BioMetric 2.0 Operations Manual (DECCW 2008b) definitions for native vegetation in low condition are:

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, treeless native pasture derived from an EEC and dominated by native grasses, and trees in woodland formation satisfying the over storey per cent foliage cover over exotic pasture, are considered 'moderate to good' Biometric condition and are red flag areas. However, it should be noted that:

> *Only patches of vegetation >0.25ha are assessed separately (as distinct zones) from surrounding vegetation (e.g. a patch of vegetation with benchmark overstorey cover that is <0.25ha is not assessed separately from surrounding vegetation with sparser overstorey cover)* (DECCW 2008b).

As such small isolated patches of Box-Gum trees (>25% minimum per cent foliage cover) occurring in exotic pasture or crop land that don't meet the minimum patch size would be assessed as per the surrounding vegetation type. In the case of large areas of exotic pasture or crop, these small patches would be considered low condition and not a red flag area.

3.6 THREATENED FLORA

The Commonwealth and State online database searches and NSW Wildlife Atlas threatened species records indicated the recorded or potential presence of 32 threatened species in the wider study area (including nominated species). The threatened species evaluation in Appendix B concluded that the following seven threatened species have at least moderate potential to be present at the proposal area, based on site quality, disturbance history, known distribution ranges and the results of the field survey.

Yass Daisy	*Ammobium craspedioides*	TSC, EPBC
Mauve Burr-daisy	*Calotis glandulosa*	TSC, EPBC
Buttercup Doubletails	*Diuris aequalis*	TSC, EPBC
Hoary Sunray	*Leucochrysum albicans var tricolor*	EPBC
Button Wrinklewort	*Rutidosis leptorrhynchoides*	TSC, EPBC
Small Purple-pea	*Swainsona recta*	TSC, EPBC
Austral Toadflax	*Thesium australe*	TSC, EPBC

Targeted searches for the Button Wrinklewort were conducted during the March 2010 survey (which is considered suitable timing for detecting this species) and failed to locate any individuals. Targeted searches for the remaining species above were conducted in all areas of suitable habitat during the November 2010 survey. An early November survey was required for *Diuris aequalis* and *Swainsona recta*. This timing was also considered suitable for the perennials *Ammobium craspedioides, Calotis glandulosa, Leucochrysum albicans* and *Thesium australe.* These targeted surveys would have also been suitable for detecting the other subject species defined within the DGRs, *Lepidium hyssopifolium.* No threatened species were detected within the development envelope. A population of Hoary Sunray was detected on the verges of Lerida Road in the south-west of the proposal area (Figure 3-3) and extended into the adjacent travelling stock reserve to the south.

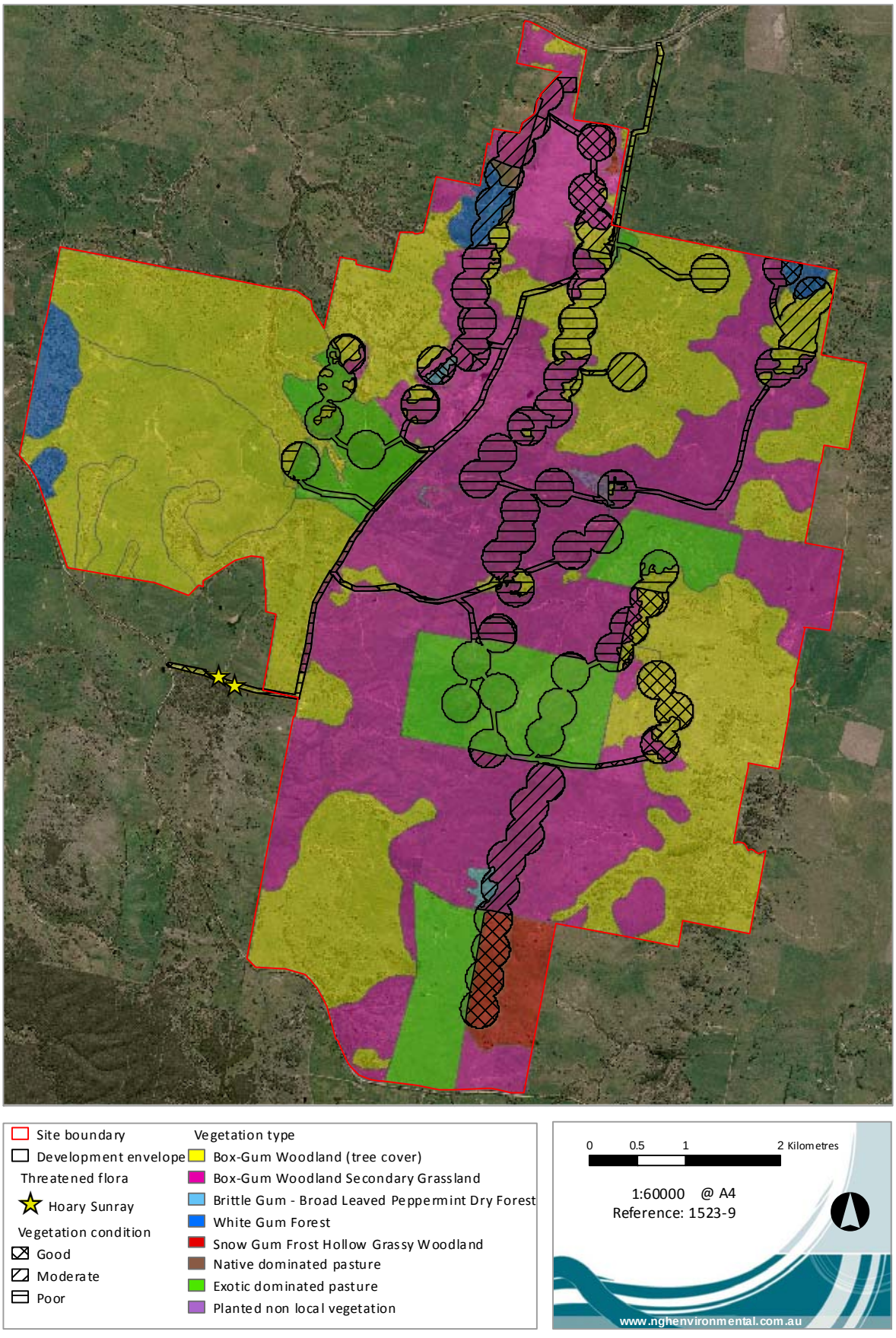

Figure 3-3 Location of Hoary Sunray population in the south-west of the proposal site

3.7 REGIONALLY AND LOCALLY SIGNIFICANT SPECIES

None of the nationally significant (ROTAP - Rare or Threatened Australian Plants) species listed by Briggs and Leigh (1995) or regionally significant species listed for the wider Goulburn region (RACAC 1999) were recorded during the PEI survey. Several species characteristic of grassy woodlands are now rare or declining because of the general depletion of these communities in the region. Wild Sorghum (*Sorghum leiocladum*) is considered to be of regional significance (ACT Government 2004) and was recorded in pasture derived from Box-Gum Woodland in the north-east of the proposal area, outside the turbine Cluster impact area during the PEI survey. This species was not recorded during the March or November surveys.

Other grassy woodland species present within the proposal area which are likely to have local conservation significance include Blue Devil (*Eryngium ovinum*), New Holland Daisy (*Vittadinia muelleri*), Scaly Buttons (*Leptorhynchos squamatus*), Yellow Buttons (*Chrysocephalum apiculatum*), Tick Trefoil (*Desmodium varians*), Australian Bindweed (*Convolvulus angustissimus*), Creeping Bossiaea (*Bossiaea prostrata*) Curved Rice Flower (*Pimelea curviflora*) and Yellow Centaury (*Sebaea ovata*) (Figure 3-4 & Figure 3-5). Most of these species are listed as 'important' species belonging to the Box-Gum Woodland community by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPC).

Figure 3-4 Blue Devil in woodland understorey in the north east

Figure 3-5 Yellow Buttons in Box-Gum Woodland derived grassland in the Central section of the site.

4 RESULTS: FAUNA

4.1 DATABASE SEARCHES

Searches of the OEH Wildlife Atlas data found six amphibians, 34 birds, 13 mammals (five marsupials, eight bats), five reptiles and one insect listed as threatened under the TSC Act. A search of the EPBC Act listings found 16 threatened species, 12 migratory species and 10 marine listed species.

4.2 HABITAT AND SPECIES EVALUATION

Information about the habitat in the study area was gathered during field surveys. Information was collected from detailed habitat assessments and additional general habitat information was obtained from bird, frog and reptile survey sites. Habitat descriptions for each of these sites are given in Appendix E.

4.2.1 Habitat types

As noted in Section 2.4.3, habitat in the project area can be broken into four main stratification units. Exotic pasture, whilst presenting little value as fauna habitat, was also recorded and mapped. The four habitat types are:

- Pasture with scattered trees.
- Woodland.
- Forest.
- Native pasture.

The distribution of these habitat types is shown on Figure 4-1.

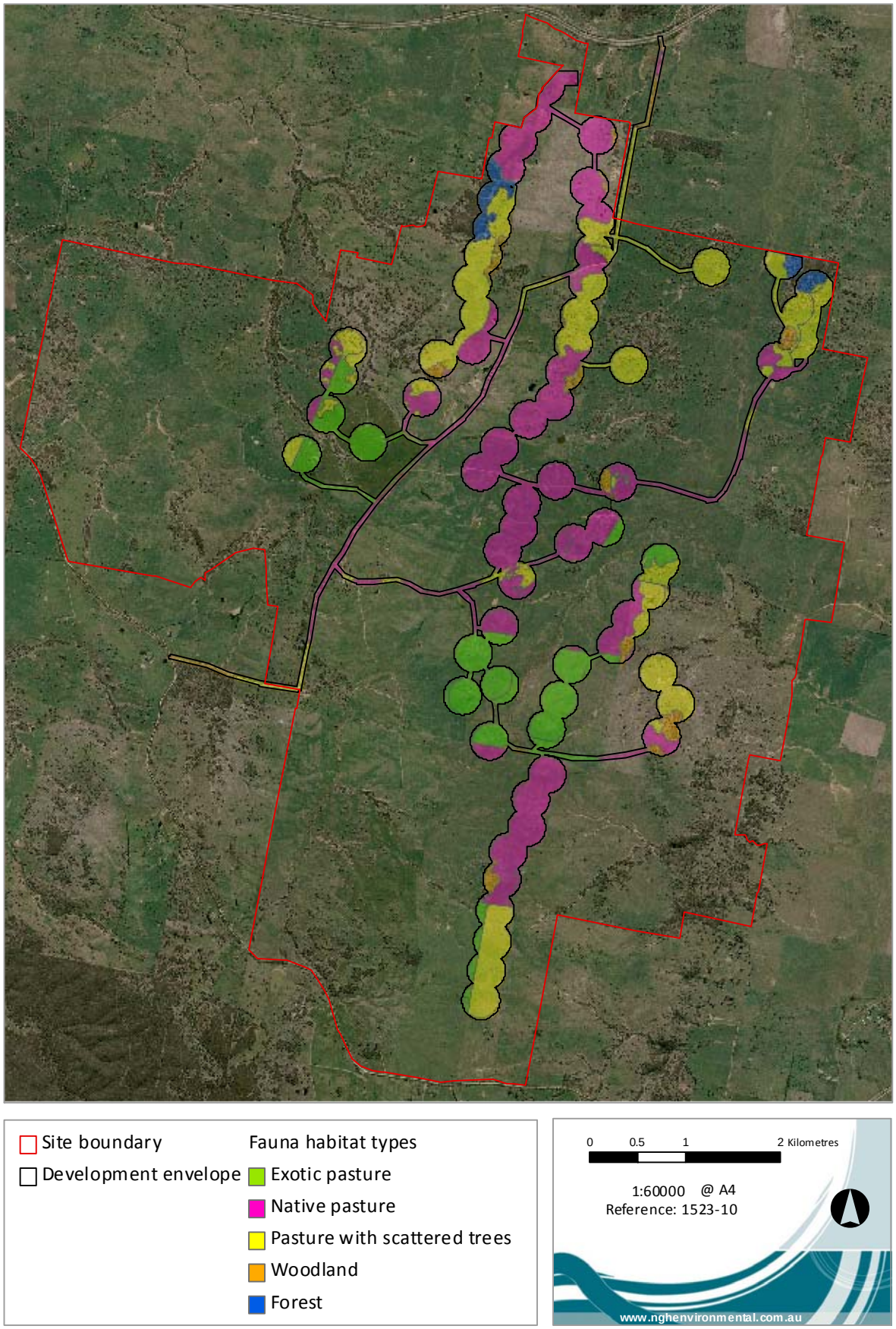

Figure 4-1 Fauna habitat types within the development envelope

Pasture with scattered trees

This takes the form of cleared land with remnant trees scattered throughout paddocks. The trees present either in a fairly uniform distribution of trees across an area, or in small clumps. This pasture habitat has been found to be important for a range of fauna as both habitat and for connectivity within a wider habitat matrix. Remnant paddock trees are often older than surrounding regenerated woodland and forest and thus provide an important source of hollow-bearing trees, on which many of Australia's fauna are dependent. Amongst the fauna to utilise this habitat type are microbats (Greater Broad-nosed Bat, Gould's Wattled Bat), birds (such as Superb Parrot, Yellow-rumped Thornbill, and Willie Wagtail), possums and wombats.

Woodland

The site contains Box-Gum Woodland and dry forest remnants with a woodland structure. Both are dry sclerophyll communities with a mixture of rough and smooth barked trees, some hollow-bearing trees and usually contain mistletoe. Mistletoes are parasitic plants that grow on other trees and provide important resources for a range of birds including nomadic honeyeaters (e.g. Painted Honeyeater, Regent Honeyeater; Cooper and McAllen 1999). The structure of Box-Gum Woodland is generally simple with the canopy dominated by eucalypts, and a grassy groundcover.

Forest

Areas of dry forest have similar habitat features to those present in the woodland, as well as additional understorey strata, such as a small tree layer and shrubby mid storey. Dry forest may carry a similar structure to woodland but usually forms a more closed canopy and features a more developed understorey. The line between pasture with scattered trees and woodland, and woodland and forest, is based on qualitative assessment of the degree of canopy cover and understorey structure. In many cases, the habitat in the study area intergrades between habitat types without clear distinction.

It can be observed from the mapping that habitat types do not directly correlate with the vegetation community type. This is because habitat type is more a product of structure, while community type is also based on floristic composition. Depending on hollow availability and connectivity/size of patch, woodland and forest patches provide habitat for a range of fauna including possums, gliders, rats, microbats and birds (such as Brown Treecreeper, Southern Boobook, White-throated Gerygone and wood swallows).

Native pasture

Areas of native pasture provide habitat for a range of reptiles (such as Legless Lizards) and resources for many birds (such as Diamond Firetails). Native pasture did not form one of the main stratification units for hollow-bearing tree, bird or nocturnal surveys. However, reptile surveys were targeted in this habitat type (see Appendix E and F for full details).

Additional habitat units

Additional habitat units may occur within any of the above units and include rocky outcrops and aquatic areas.

Rocky outcrops

Rocky outcrops are particularly important for reptiles as they provide shelter and cover, as well as a habitat for insects, which are a food source. In the project area two main types of outcrop occur: granite boulders and broken basalt. Granite outcrops may feature 'onion skin' exfoliation which provides cracks and crevices particularly favoured by skinks. Often boulders are mostly embedded. Basalt outcrops are often small to medium loose to partially embedded rocks, and depending on surrounding habitat (e.g. grassland versus forest), may be suitable for Pink-tailed Worm-lizards, skinks and snakes.

Aquatic areas (dams, watercourses)

Aquatic areas are habitat for fish, frogs and waterbirds. Any water source is an important habitat component for all fauna, including microbats. Several creeks are present throughout the site, in areas where roads would cross and close to four of the proposed turbine Clusters. Creeks appear to be ephemeral and can be categorised as Class 4 (first and second order streams). Some of these creeks contain evidence of severe gully erosion (e.g. Clusters 2 and 6). Riparian vegetation along creeklines typically contains scattered eucalypts and exotic-dominated grasses.

Instream habitat features in the creeks include snags, bedrock and emergent vegetation, though all features are present in low abundance. Given the highly degraded nature of the creeks and their low classification, it is unlikely that they would provide habitat for fish other than common, disturbance tolerant species.

4.2.2 Habitat condition

Habitat quality at the proposal site was variable during site surveys due to fluctuations in weather at different times of the year impacting on the condition of habitat resources. Findings from field surveys in 2009 found that for the most part, habitat resources in the proposal area were generally poor for threatened and migratory fauna species, due to fragmentation and simplification of habitat from clearing and grazing

However, rain in the months prior to the March field trip improved the condition of many areas previously considered as poor. The 2010 surveys were focussed on the areas of habitat that were in moderate to good condition at the time. These areas roughly correlate with the vegetation community condition, which is discussed in Section 3.2. Habitat condition also depends on the availability of micro-habitat resources, such as hollow-bearing trees, and habitat extent and connectivity to other areas. These factors are less influenced by seasonal weather conditions. Surveys were focused in these areas because this is where the proposal is likely to have an impact on local fauna through habitat clearing. Details as to where each habitat type occurs in the development envelopes; where the habitat is dominant and, where it occurs in moderate to good condition are illustrated in Figure 4-1. Habitat descriptions are given in Appendix E.

Table 4-1 Details of habitat types in the development envelope and the Clusters (C) where each type occurs, dominates and is in moderate to good condition

Habitat type	Clusters where habitat type occurs	Clusters where habitat type is dominant	Clusters where habitat type in moderate to good condition
Pasture with scattered trees	C 1, 2, 3, 4, 5, 6,	C 2, 4	C 3, 4, 6
Woodland	C 1, 3, 4, 5 6	Nil	C 4, 6
Forest	C 1, 4,	Nil	C 4
Native pasture	C 1, 3, 4, 5, 6	C 3	C 1, 3, 4, 5, 6
Aquatic and riparian	C 1, 2, 3, 6	Nil	Nil

4.2.3 Species evaluation

Threatened species returned from database searches were evaluated for their potential to occur on site based on habitats present (Appendix B). Species considered known or likely, or to have a possibly to occur, are listed in Table 4-2.

Table 4-2 Evaluation results of species that are known to, likely to, or could possibly, occur based on habitat in or near the proposal area and nearest records. (M) Indicates species that are listed as migratory only, rather than threatened.

Species evaluation results		
Known or likely to occur		
Gang-gang Cockatoo	Brown Treecreeper	Hooded Robin
Flame Robin	Scarlet Robin	Varied Sittella
Little Eagle	White-bellied Sea-eagle (M)	Powerful Owl
Superb Parrot	Speckled Warbler	Painted Honeyeater
Diamond Firetail	Regent Honeyeater	White-throated Needletail (M)
Rainbow Bee-eater (M)	Cattle Egret (M)	Yellow-bellied Sheathtail Bat
Eastern False Pipistrelle	White-fronted Chat	
Possibility of occurrence based on presence of potential habitat		
Blue-billed Duck	Freckled Duck	Glossy Black Cockatoo
Square-tailed Kite	Spotted Harrier	Barking Owl
Masked Owl	Little Lorikeet	Grey-crowned Babbler
Black-chinned Honeyeater	Pied Honeyeater	Squirrel Glider
Koala	Pink-tailed Worm-lizard	Little Whip Snake
Rosenberg's Goanna	Striped Legless Lizard	Golden Sun Moth

Squirrel Glider

Marginal potential habitat for the Squirrel Glider occurs in Clusters 3 and 4 as dry eucalypt forest with hollow-bearing trees. During preliminary work, these areas were identified as having a small tree or shrub layer of young eucalypts and wattles. Areas identified as having potential to support Squirrel Gliders were mapped and provided to the Proponent as a preliminary constraint to the proposal (December 2009), with a recommendation to avoid such areas and thereby avoid the requirement to undertake target trapping surveys.

The project proposal avoids these better quality areas and therefore targeted trapping for Squirrel Glider was not considered warranted. Surveys in March and November 2010 evaluated the habitat potential of areas that would be impacted by the proposal. Within those forest and woodland areas, habitat assessments found that the habitat on site was sub optimal for Squirrel Gliders as it contained hollows but lacked an Acacia or shrub mid storey, a feature of preferred habitat for the species (OEH threatened species profile accessed 18/4/11).

Pink-tailed Worm-lizard and Little Whip Snake

The November 2010 timing of the surveys was not considered to effect the probability of detection as the preceding period was mild and wet, ensuring the sub rock conditions were moist and unlikely to force Pink-tailed Worm-lizards to shelter deep within the ant nests. Conditions during tiles surveys between September and November 2011 were also favourable. These surveys failed to detect either species and habitat was considered unsuitable for Pink-tailed Worm-lizards in terms of availability of surface rocks based on the documented habitat preferences of this species in the ACT area. Therefore, although there is a possibility of these species occurrence, it is considered unlikely.

Striped Legless Lizard

Habitat assessments detected several areas of suitable secondary grassland habitat and reptile surveys were undertaken in these areas, including tile surveys. The species was not detected. Striped Legless Lizard is considered unlikely to occur, due to:

- The absence of native temperate grassland (Murray Evans, Senior Wildlife Ecologist, ACT Government, pers. comm. March 2011).
- The high disturbance of many grassland areas (especially in Cluster 5) from land use (cropping, burning, grazing).
- The isolation of the grassland areas (especially in Cluster 5) from potential source populations of the species.

Other threatened species with potential habitat in development envelopes

Spotted Harrier and Square-tailed Kite are considered to have potential to occur and potential to be impacted. They have been included in the assessments of significance. Other species have no or few local records and/or habitat would be marginal and therefore they are not considered likely to occur or to have potential to be impacted by the proposal. These species are not considered further.

4.3 SPECIES RECORDED

In total, 129 species of fauna were recorded in the project area (combining results of the PEI and this survey). The complete list is given in Appendix E. This comprises seven amphibians, 85 birds, 25 mammals (13 microbats) and 13 reptiles. Eleven threatened species and one migratory listed species were recorded.

4.3.1 Amphibians

The following amphibians were recorded opportunistically, during frog listening surveys and during reptile searches:

- Common Froglet *(Crinia signifera).*
- Peron's Tree Frog *(Litoria pearsonii).*
- Plains Froglet *(Crinia parasignifera).*
- Smooth Toadlet *(Uperoleia laevigata).*
- Southern Brown Tree Frog *(Litoria ewingii).*
- Spotted Marsh Frog *(Limnodynastes tasmaniensis).*
- Tyler's Toadlet *(Uperoleia tyleri).*

These common species were found around dams and under shelter, such as rocks, in pasture and pasture with scattered trees. As with most amphibians, these species require wet areas and areas of shelter including vegetation, logs, rocks and litter. These habitat features are unlikely to be substantially altered by the proposal.

4.3.2 Birds

A diverse range of birds were recorded opportunistically and during surveys. The full list is given in Appendix E, and examples are given below:

Waterbirds

- Australasian Grebe *(Lepus capensis).*
- Australian Pelican *(Pseudocheirus peregrinus).*
- Australian White Ibis *(Macropus giganteus).*
- Pied Cormorant *(Phalacrocorax varius).*

Raptors

- Brown Falcon (*Falco berigora).*
- Brown Goshawk (*Accipiter fasciatus).*
- Peregrine Falcon (*Falco peregrinus).*
- Wedge-tailed Eagle (*Aquila audax).*

Passerine and non-passerines

- Australian Magpie (*Gymnorhina tibicen).*
- Crested Pigeon (*Ocyphaps lophotes).*

- Laughing Kookaburra (*Dacelo novaeguineae).*
- Rainbow Bee-eater (*Merops ornatus).*
- Scarlet Honeyeater (*Myzomela sanguinolenta).*

For the majority of species habitat loss is the key potential impact of this proposal, with some notable exceptions. Raptors are considered key taxa to be considered under the EPHC Guidelines, and waterbirds are another suite often considered at higher risk of collision impacts at wind farms (see Section 5 for further discussion).

Habitat requirements of threatened species are considered in Section 4.2 and recommendations to ensure these are retained are given in Section 7.

4.3.3 Mammals

Consideration of mammals in this report has been broken into two groups: terrestrial mammals and microbats. Considerations for terrestrial mammals will be retention of habitat and connectivity, while for microbats collision and habitat avoidance impacts must also be considered.

Terrestrial

A suite of common terrestrial mammals was recorded opportunistically and during targeted surveys:

- Common Brushtail Possum *(Trichosurus vulpecular).*
- Common Ringtail Possum *(Pseudocheirus peregrinus).*
- Common Wombat *(Vombatus ursinus).*
- Eastern Grey Kangaroo *(Macropus giganteus).*
- Short-beaked Echidna *(Tachyglossus aculeatus).*
- Sugar Glider *(Petaurus breviceps).*
- Swamp Wallaby *(Wallabia bicolor).*

Microbats

Thirteen microbat species have been recorded from the Collector study area. Microbats are a key risk group because additional to the risk of habitat loss and death by collision with turbine infrastructure, microbats suffer from decompression, where rapid air pressure changes around the moving turbine blades causing haemorrhaging of the lungs (Baerwald et al. 2008; Horn et al. 2008). Further, rates of microbat collision appear to be higher than for birds (Arnett 2005).

In an assessment of the bat fauna for the Capital Wind Farm, located nearby on the eastern side of Lake George, a low number of bat calls were recorded in habitat with little or no trees, including no threatened species. In nearby 'good' habitat, significantly more species and more calls per species were recorded, including the threatened Eastern Bentwing-bat and Yellow-bellied Sheathtail Bat *(Saccolaimus flaviventris)* (Richards 2005). This pattern was also evident in the Collector proposal area. Both these species have been recorded in the proposal area.

At Cullerin Wind Farm (approximately 7km north of the proposal area), the threatened Large-footed Myotis *(Myotis macropus)* was recorded during surveys (NSW Government 2007). This species is likely to utilise Lake George for foraging when the lakes holds water, and was recorded in apparently

low numbers (only five passes) at Clusters 3 and 4, where it may have been foraging over the small water bodies (dams) that occur throughout the proposal area.

Eastern Bentwing Bat was recorded in forest and woodland in three of the Clusters surveyed (1, 3 and 4) and in Cluster 7 of an outdated layout (near the escarpment). East Coast Freetail Bat was recorded in moderate to good condition forest and woodland area and in exotic pasture near woodland in Cluster 4. Large-footed Myotis and Yellow-bellied Sheathtail Bat were recorded in Clusters 1 and 4 respectively; again these habitat areas have been identified as moderate to good condition (Section 4.2.2). Considerations in the assessment of risk to microbats are:

- The height at which each species generally flies at.
- Whether the species regularly forages in open areas rather than within the canopy of forest and woodland.
- Species that migrate: during migration, microbats are believed to cease echolocation, effectively navigating on 'autopilot' using topography. Thus, migrating bats are of most concern.

Of the bats that have been recorded in the proposal area, their risks can be characterised by these factors.

Table 4-3 Wind farm risk characteristics of microbats recorded from the proposal area (information from Churchill 2008). Shaded rows indicate threatened species.

Microbat	Fly in sweep zone	Forage in the open	Seasonally migrate
Chocolate Wattled Bat	×	✓	×
Eastern Bentwing Bat	✓	✓	✓
Eastern Broad-nosed Bat	?	?	×
Eastern Freetail Bat	×	×	×
East Coast Freetail Bat	×	✓	×
Gould's Wattled Bat	×	✓	×
Large Forest Bat	×	×	×
Large-footed Myotis	×	✓	×
Little Forest Bat	×	×	×
Long-eared Bats[7]	×	✓	×
Southern Forest Bat	×	×	×
White Striped Free tail Bat	✓	✓	✓
Yellow-bellied Sheathtail Bat	✓	✓	✓

[7] *Nyctophilus* species can be very difficult to differentiate by echolocation recorded calls. Two species are likely to occur in the area, and their characteristics are used here: Lesser Long-eared Bat *(N. geoffroyi)* and Gould's Long-eared Bat *(N. gouldi).*

The Eastern Bentwing-bat, White-striped Freetail Bat and the Yellow-bellied Sheathtail Bat have potential for collision because they forage and/or travel in the blade-sweep zone. Richards (2005) states *"...turbines in primary bat habitat could ... lead to an increased risk to high flying bats ... and would [be] of concern for the conservation of the Eastern Bentwing Bat"* (2005 p. 13). According to Richards (2005) carcass monitoring at the Codrington and Toora Wind Farms, Victoria, found a low number of total microbats killed by turbines (0.04 and 0.14 per turbine per year, respectively), but the common White-striped Freetail Bat was the species most affected in that area.

Feral

A range of feral species were recorded in the study area including Red Fox (*Vulpes vulpes*), European Rabbit *(Oryctolagus cuniculus)* and Brown Hare *(Lepus capensis)*. These species are not considered further in this report, except as prey for native animals such as raptors and owls.

4.3.4 Reptiles

Reptiles recorded include those found under shelter in native grassland, around dams and species from rocky outcrops in woodlands:

- Blotched Blue-tongued Lizard *(Tiliqua nigrolutea).*
- Common Long-necked Tortoise *(Chelodina longicollis).*
- Cunningham's Skink *(Egernia cunninghami).*
- Eastern Brown Snake *(Pseudonaja textilis).*
- Eastern Three-lined Skink *(Bassiana duperreyi).*
- Olive Legless Lizard *(Delma inornata).*

Reptiles generally have poor dispersal abilities and can be vulnerable to habitat loss, including loss of shelter from clearing ground refuse such as logs and rocks. The species recorded during surveys are common and unlikely to be negatively impacted by the proposal.

Table 4-4 shows the results for each array on each date of the survey. The results show that only three reptiles were observed over a total number of 150 tile lifts. There were no positive identifications of the Striped Legless Lizard or Pink-tailed Worm-lizard at the site. The dash (-) indicates no reptile sightings.

Table 4-4 Survey results

Array	Cluster	Date		
		28 September 2011	19 October 2011	21 November 2011
1	6		-	-
2	6	Tile 5 – *Delma inornata*	-	Tile 1 – unidentified reptile. Species moved from tile sight immediately tile was lifted.
3	5	-	-	-
4	5	-	-	-
5	1	-	-	-

6	3	-	-	-
7	1	-	-	-
8	3	Tile 8 – Eastern Three-lined Skink	-	-
9	3	-	-	-
10	4	-	-	-

The reptile that was not identified at Array 2 on 21 November 2011 moved from under the tile and escaped the wooden box prior to an identification being possible. The shape of the tail, the way the species moved and the position it was sitting when the tile was lifted (not coiled), suggests it was unlikely to be a Striped Legless Lizard. The scale pattern excludes the possibility of the species being a Pink-tailed Worm-lizard.

4.4 MIGRATORY AND MARINE LISTED SPECIES

The EPBC Act includes species listed as migratory and protected by international conventions such as the Bonn Convention. Potential impacts to these species must be considered under the impact guidelines. The EPBC Act also lists 'marine species' by family group which must be protected, but for whom there are no guidelines for impact assessment. Species from both lists were recorded in the study area. Further discussion of raptors is given in Section 5.1.7.

Table 4-5 Species listed under the EPBC Act that were recorded in the project area

Family	Common name
Migratory	
Meropidae	Rainbow Bee-eater
Marine	
Accipitridae	Brown Goshawk
Falconidae	Nankeen Kestrel
Cuculidae	Pallid Cuckoo
Strigidae	Southern Boobook
Campephagidae	Black-faced cuckoo-shrike
Corvidae	Little Raven
Hirundinidae	Tree martin Welcome swallow

4.5 THREATENED SPECIES

Ten species listed under the EPBC Act or TSC Act as threatened species are 'key species' or 'key taxa'[8] in this assessment. Five *vulnerable* birds and five *vulnerable* microbats were detected in the study area:

- Brown Treecreeper.
- Diamond Firetail.
- East Coast Freetail Bat.
- Eastern Bentwing-bat.
- Gang-gang Cockatoo.
- Large-footed Myotis.
- Superb Parrot.
- Varied Sittella.
- White-fronted Chat.
- Yellow-bellied Sheathtail Bat.

Discussion on habitat requirements for each of these species is given below. The locations of threatened bird sightings are shown on Figure 4-2. The key to avoiding significant impact to the threatened birds is retention of woodland and forest patches as well as maintaining paddock trees in a configuration that retains habitat connectivity between patches.

Brown Treecreeper

The Brown Treecreeper was detected in Cluster 4 and in an area outside the development envelope (south of the site). It is a medium-sized insectivorous bird that occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories, breeding in pairs or communally in small groups (Noske 1991). The species has suffered serious declines over the last few decades. Important habitat elements for this species are litter and dead timber, which provide habitat for invertebrate prey.

Brown Treecreepers are threatened by clearance and the fragmentation of the woodland habitat including removal of dead timber, which causes habitat loss and reduces dispersal ability (NSW Scientific Committee 2008). This species appears unable to maintain viable populations in remnants less then 200ha and its abundance decreases as remnant size decreases (Barrett et al. 1994). Fragmentation also leads to isolation and a skewed sex ratio in Brown Treecreeper populations because female birds are unable to disperse to isolated remnants (Walters et al. 1999).

Diamond Firetail

The Diamond Firetail was detected in two spots, both areas featured a small tree and shrub layer. It forages for seeds and insects on the ground in open grassy Eucalyptus dominated communities (Garnett & Crowley 2000). The habitat components considered important to this species are water and shelter near feeding areas during the day and dense shrubbery for roosting by night (Schodde and Tidemann 2007).

[8] Refer to *Terminology used in this report* on page i

Diamond Firetails have been recorded in degraded agricultural landscapes (personal observation); however, their decline may be linked to the loss of key food plants as a result of invasion by exotic grasses. Competition from flock-foraging Red-browed Finches may be a disadvantage for this species. Isolation and reductions in remnant areas inhibit dispersal and increase their vulnerability to local extinction via stochastic events. Further, Diamond Firetail populations appear unable to persist in areas which lack remnants of native vegetation larger than 200ha (NSW Scientific Committee 2001). Recovery of this species appears to depend on retention and appropriate management of woodland remnants on private land (Garnett & Crowley 2000).

East Coast Freetail Bat

The East Coast Freetail Bat was recorded in Cluster 4, which provides ideal habitat for this species. They inhabit dry eucalypt forest and woodland, utilising open spaces within and between the forest areas with a preference for the upper slopes rather than riparian areas. They forage in openings, gaps and flyways in forest areas and roost in tree hollows (especially hollow spouts) (Churchill 2008).

Eastern Bentwing-bat

Eastern Bentwing-bats require forested areas to forage in, flying above the canopy to capture insects on the wing feeding mostly on moths (Churchill 1998). The species also forage along flyways (along clear areas such as tracks or streams), and are known to utilise cleared paddocks during dispersal. This species was recorded at the site in both November 2009 and March 2010 surveys. All of the records from November 2009 were from Cluster 4, while they were recorded across the forested survey locations in 2010.

Female Eastern Bentwing-bats migrate to specific cave sites in approximately October-November each year to give birth in December and raise a single young (Churchill 1998). These are very large breeding and roosting colonies from 100 to 150,000 individuals. Staging caves are also used as stops enroute to the maternity cave, similarly by large numbers of individuals. One such staging cave is located just south of Mount Fairy about 35km north-west in Euclidean distance from the southern end of the proposal area (Mount Fairy is located in red on Figure 1-2). Eastern Bentwing-bats are present at this cave between mid-February and mid-March each year when they are en route to and from the maternity cave at Wee Jasper, although timing is likely to be also be influenced by seasonal climatic conditions (Richards 2005, Richards personal communication via Nick Graham-Higgs, 2010). Collision impacts are likely during this period when the species is foraging or commuting. Very little information is available about the migration or the use of the Mount Fairy cave, however, Richards (2005) found that high rates of collisions could result near good quality foraging habitat.

Gang-gang Cockatoo

This species was detected in the Box-Gum Woodland remnant (a travelling stock route) that was used as a control survey site for the bird utilisation surveys during the PEI survey. This is outside of the proposal area. At least two individuals were heard calling repeatedly, although they were not sighted. Gang-gang Cockatoos are seasonal altitudinal migrants and are thought to retreat to wet sclerophyll forests of the Dividing Range over summer to breed. However, they have been recorded breeding on the Southern Tablelands. Hollows are present in this remnant and breeding may occur in the local area.

Large-footed Myotis

Large-footed Myotis will utilise most habitat types as long as there is water nearby. They do however show a preference for still bodies of water over flowing streams, low elevation and flat or undulating country and usually occur in areas that are vegetated rather than cleared (Churchill 2008). The bats forage for aquatic prey including invertebrates and small fish by flying low over water bodies. They require roost sites near water utilising tree hollows, caves, abandoned bird nests, thick vegetation, tunnels, stormwater drains and road culverts (Churchill 2008).

Superb Parrot

A single individual of the species was observed opportunistically along Gunning Road during the PEI survey. The proposal area is close to the Important Bird Area established for the Superb Parrot[9]. This species is sedentary and breeds in tree hollows. It is known to make use of isolated paddock trees for roosting and breeding, flying out to forage during the day on the native grassy understorey of woodland communities.

Varied Sittella

The Varied Sittella is an arboreal bird that forages for invertebrates in bark along upper branches of trees (Noske 1984). They prefer habitat with open forest or woodland structure, and rough-barked trees. Varied Sittellas may appear locally nomadic but are actually sedentary within a large home range (Schodde and Tidemann 2007). Home ranges may be as large as 200 ha in poor quality habitat (Paton et al. 2010)

Varied Sittellas breed and roost communally in family groups of 5-20 individuals and usually build nest in or near dead branches (Noske 1984; Schodde and Tidemann 2007). They are dependent upon mature trees (for dead wood and foraging) and occur less frequently in regenerating forest (Clarke et al. 2010). The survival and viability of a local population is sensitive to habitat isolation, reduced patch size and habitat simplification. They may even be adversely impacted by small-scale clearing for fence lines and road verges (NSW Scientific Committee 2010a). They have been classed as moderately sensitive to remnant size, habitat complexity and isolation. The probability of occurrence in simplified remnants of 5ha is 0%, compared to 50% in 100ha of complex forest (Watson et al. 2001)

White-fronted Chat

White-fronted Chats were observed opportunistically in a grassy paddock outside of the proposed development envelope, near the southern end of Cluster 1. This species is usually found in damp, open habitats including inland open grassy plains and are often found near waterways, sometimes in low shrubs. White-fronted Chat nests are open-cup structures on average 23 cm above the ground. They breed between late July and early March Threats to this species include human disturbance, reduction in habitat size and quality and nest predation (NSW Scientific Committee 2010b).

[9] Important Bird Areas (IBA) are sites of global bird conservation significance (Birds Australia 2009). IBAs in Australia have been established by Birds Australia together with Bird Life International. The *South-west Slopes of NSW IBA* has been based upon core distribution and breeding records for the Superb Parrot. For further information on this IBA, refer to PEI.

Yellow-bellied Sheathtail Bat

Yellow-bellied Sheathtail Bat was recorded in relatively high numbers in forest at Clusters 4 and 7, although they are known to utilise a wide range of habitat types including wet forest. They migrate to southern Australia over summer and during this time, the females give birth to a single young. Migration does not appear to involve congregation as for the Eastern Bentwing Bat. Yellow-bellied Sheathtail Bat are manoeuvrable on the wing and fly fast and straight over the canopy, although generally fly closer to the ground in open spaces (Churchill 2008).

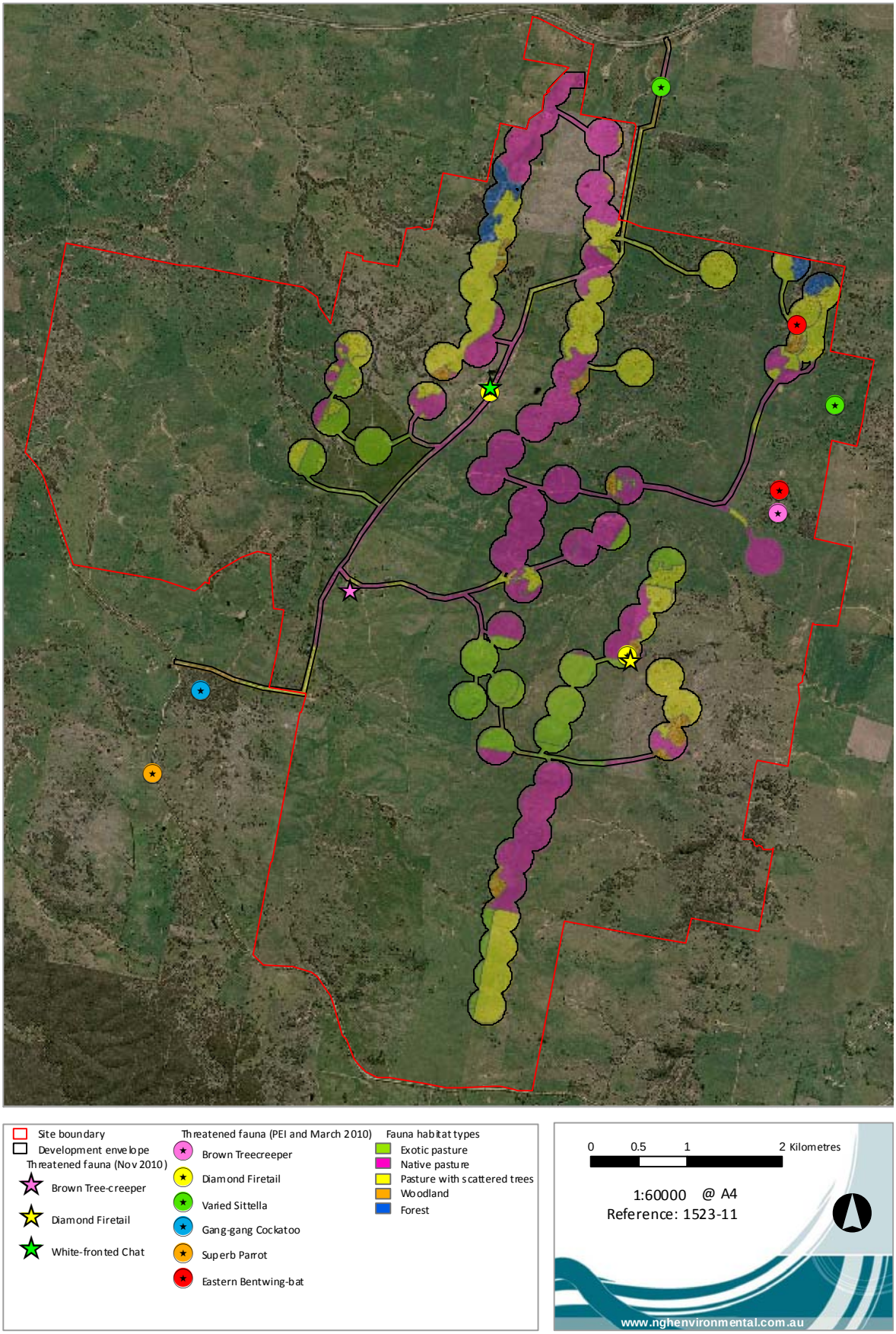

Figure 4-2 Threatened species recorded in the proposal area, and habitat types

5 ADDITIONAL INVESTIGATIONS

5.1 PROXIMITY TO LAKE GEORGE

The proposal area sits north-west of Lake George. Additional investigation into potential for impact specific to birds and bats was undertaken. In particular, this focused on the southern Clusters (Clusters 7 and 8[10]) which were in close proximity of the escarpment that impounds the lake (Figure 5-1). During the process of biodiversity assessment, the design of the proposal has been refined taking into account biodiversity constraints. This has included removal of turbines proposed along Lake George escarpment to avoid raptor and birdlife habitats.

5.1.1 What is Lake George

The Lake George basin was created by the geological processes of uplift and subsidence around 30,000 years ago (Grant 2000; Woodford 2002). For the lake's size, it has a small catchment (around 90, 000 ha) and with porous silt soils, the lake has throughout recorded history been periodically dry (Grant 2000, Braithwaite 1982). Uplifting created an escarpment that forms the western boundary of the basin, which is around 150m high (Grant 2000). The western side of this range slopes away gently.

When full, Lake George is a wetland around 15,000 ha in size, with a maximum depth of four metres. The lake has high salt concentrations and high variability in salinity. The water is generally turbid due to the silts and clays that form the lake's beds and therefore algal blooms are common (Braithwaite 1982). The algal blooms form the basis of the food chain at Lake George, and water birds are an important part of the local ecology.

Lake George is associated with two other wetlands in the local area: Lake Bathurst and The Morass. Lake Bathurst is smaller and deeper than Lake George. The sandy substrate creates clearer water and a different suite of aquatic plants (Braithwaite 1982). Lake Bathurst is separated from The Morass by a sand barrier approximately one kilometre wide (Pattison et al. 2008). Both lakes are ephemeral, although The Morass is full less often that the lake.

All three waterbodies are associated with small ephemeral creeks such as Collector Creek (Lake George) and Chain O Ponds Creek (Lake Bathurst), and provide different waterbird habitats: Lake George is salty, Lake Bathurst is brackish and The Morass is fresh. Periodic filling and drying of Lake George and Lake Bathurst is parallel, although complete synchronic drying is rare (Braithwaite 1982). Individual birds appear to utilise both lakes within a season or between seasons (Braithwaite 1982, Perkins 2006; COG personal communication 2010).

[10] These Clusters have now been excluded from the development envelope and site boundary.

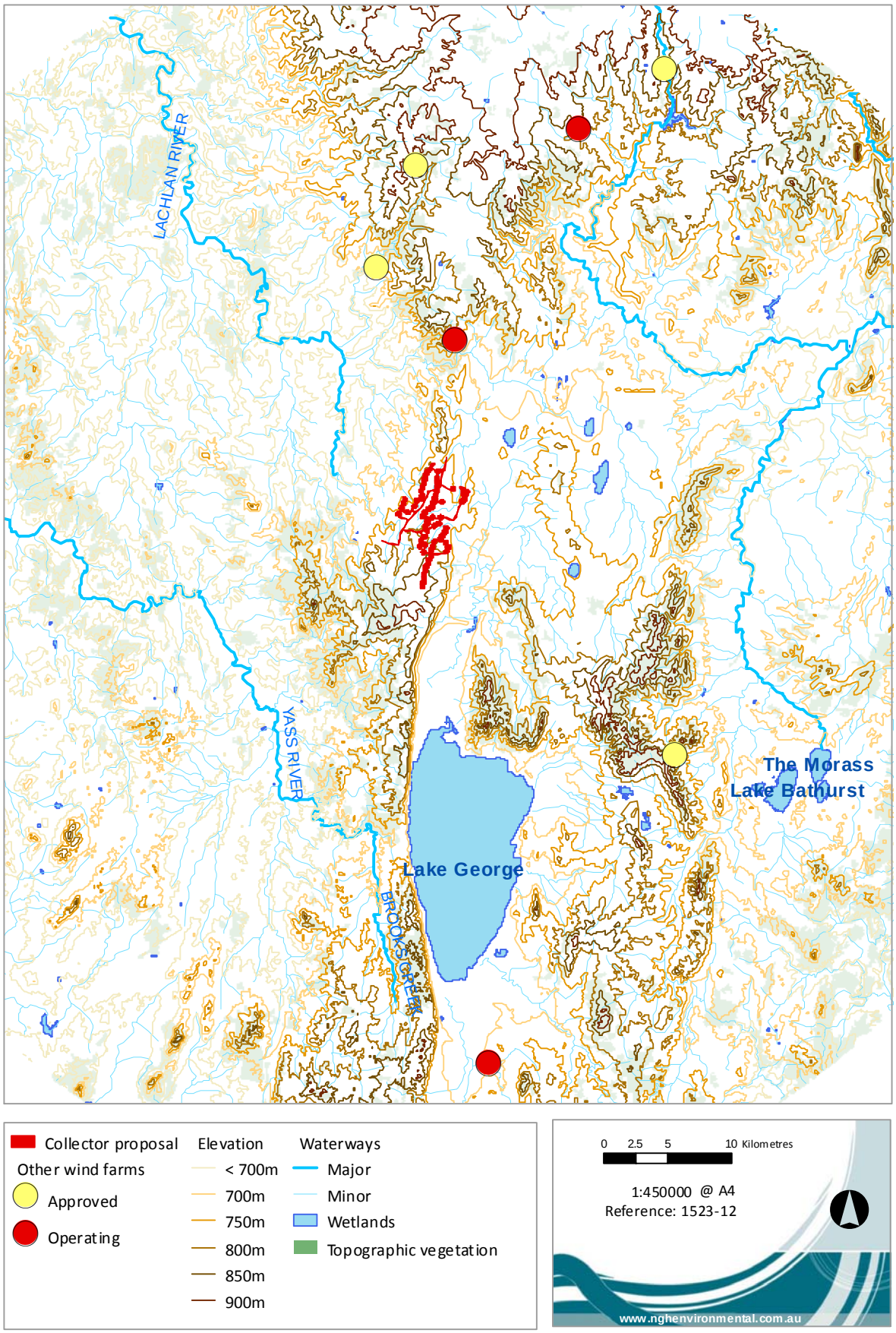

Figure 5-1 The Collector proposal in context of other wind farms, water ways, Lake George and topography (Data source: Geoscience Australia http://www.ga.gov.au/renewable/ accessed 2009)

All three wetlands are listed in the Australian Wetlands Database as nationally important wetlands. The criteria for the inclusion of Lake George includes (DEWHA 2009):

- *It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their lifecycles, or provides a refuge when adverse conditions such as drought prevail (criteria 3).*
- *The wetland supports native plant or animals taxa... which are considered endangered or vulnerable at the national level (criteria 5).*

5.1.2 Lake George area as habitat

There are four main areas of habitat that are used by birds in the Lake George basin. Three areas provide water bird habitat: the south end of the lake (sand banks); the north end where Collector Creek runs in (reeds) and; along the eastern shore (mud flats and ponds). The fourth area is the escarpment along the western shore (COG personal communication 2010). These areas are shown on Figure 5-2 as high use bird areas.

In terms of potential impacts of a wind farm, there are unlikely to be any impacts to waterbird habitat within Lake George itself. However, turbines located on or near the bordering escarpment may impact birds in the following ways:

- When birds are flying from or into the lake (e.g. water birds).
- When birds are using the escarpment as a navigational aid during commute or migration.
- When birds are soaring in the updraughts along the escarpment.

These impacts are discussed further below.

5.1.3 Types of water birds using Lake George

Since recording began in the early 1800s, Lake George has been dry six times. The main lakebed was dry in the 1840s, 1859, 1904-1915, 1929-1949, 1986 and the most recent period of drying from 2002-2010 (Braithwaite 1982, Woodford 2002, Jensen 2010, COG personal communication 2010). During wet periods, there have been many surveys of the birds congregating at Lake George. Historically, thorough surveys were undertaken in the 1960s and 80s, and Canberra Ornithological Group continues to regularly monitor birds at the Lake (Lamm 1965, Braithwaite 1982; COG 2009).

Many of the birds that utilise Lake George are nomadic and the prevailing water levels influence both the species composition and abundance (Lamm 1965). Birds are quick to take advantage of conditions when the lake fills again. After the heavy rain early this year, COG surveys in March recorded around 500 Mountain Ducks (*Tadorna tadornoides*), 500 other ducks and almost 50 White-faced Herons (*Egretta novaehollandiae*) around the ponds near Taylors Creek (eastern edge of the lake) (COG personal communication 2010).

When the lake holds water over consecutive years, there is a seasonal pattern to occupation. For example, migrant waders are more common during periods of low waters when mud flats are exposed – historically during winter. At this time, duck populations are usually low, swelling again in spring and summer (Lamm 1965). Waterbirds tend to congregate at creek entries at the north and

south ends of the lake. The Canegrass swamp at the northern end near Collector Creek often hosts thousands of birds, including bitterns (Lamm 1965, COG personal communication 2010). For example, surveys in 1992 estimated between 15 and 33 species of water birds at Lake George during the course of the year, with estimates of individual birds reaching a maximum of 7800 in March (COG 1992). This is significantly less than congregate at Lake Bathurst (in the order of 18,000 – COG 1992).

Large proportions of threatened waterbird populations, such as Blue-billed Duck, congregate at Lake George and Lake Bathurst when conditions are suitable (COG personal communication 2010). Potential impacts of the proposal need to be considered in the context of high use bird patterns that prevail during wet years.

5.1.4 Important congregations of waterbirds

A number of species are known to breed at Lake George, including common species such as Australian Pelicans (*Pelecanus conspicillatus*), Black Swans (*Cygnus atratus*) and less common species such as Little Grassbird (*Megalurus gramineus*) (Lamm 1965, van Tets and Vestjens 1969). Populations of breeding birds may be particularly vulnerable to impacts such as blade-strike because the death of an individual may result in the death of eggs, nestlings or fledglings. Juveniles learning to fly are also vulnerable to blade-strike (Follestad 2007). This would be of concern if large numbers of birds were being killed, or if the subject species was threatened. Breeding records contribute to the listing of Lake George as a nationally important wetland, as well as the moulting Mountain Duck congregation (DEWHA 2009).

Mountain Ducks (also known as Australian Shelduck) have been recorded gathering at Lake George annually (when there is water) since the 1960s. The congregation of thousands of Mountain Ducks appears to be part of an “annual moult migration”, with birds arriving in small groups or pairs from all over south-eastern Australia to moult between February and May; numbers usually peak between October and December (McKean and Braithwaite 1976; Lamm 1965). This phenomenon is still occurring today; the ducks were recorded moulting at Lake George in March this year (COG personal communication 2010). During moult the birds are unable to fly and therefore during this time would not be at risk from turbine collision.

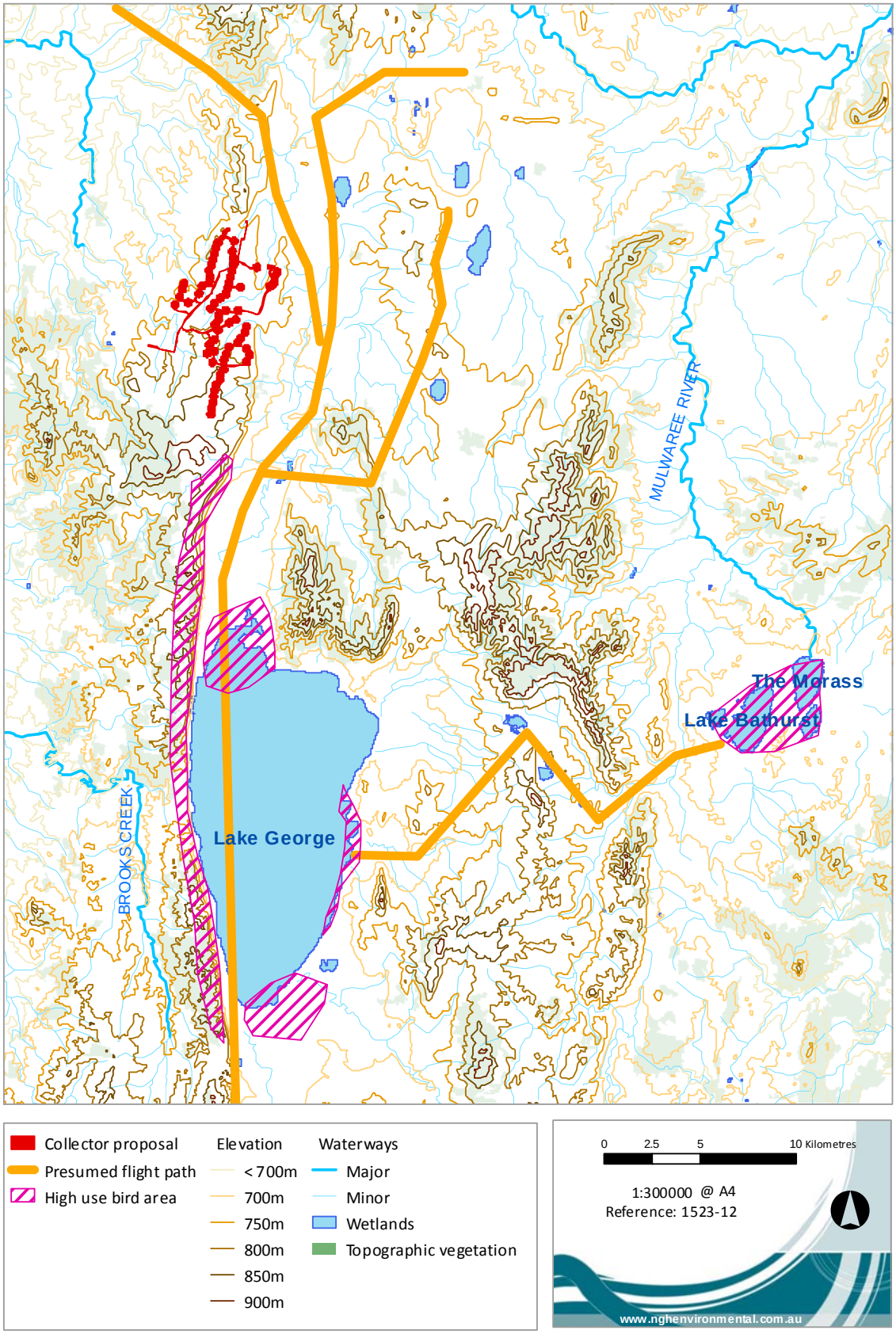

Figure 5-2 The proposal area in context of Lake George, high use bird areas (based on liaison with Canberra Ornithological Group - COG), and presumed flight paths (based on discussions with COG and review of topographic maps)

5.1.5 Bird movement corridor

Early in the assessment process, the far southern and eastern turbine clusters were identified as being near potential movement corridors for birds (and bats). The topography of the lake results in a wide basin with a narrow passage to the north. The topography suggests that birds using the Lake George basin would be funnelled through this passage (Figure 5-2). Other observations corroborate this, with birds appearing to be concentrated in the narrow passage, both on land and in the air (COG personal communication 2010). Travelling birds tend to follow the western ridgeline; smaller birds do so low to the ground and larger birds travel along the ridge using the updraught for efficiency. Birds observed travelling along the ridge include Australian Pelican and a variety of raptor species (COG personal communication 2010). This observation is in agreement with studies that have found birds use topographic features such as ridges and valleys as navigational aids while commuting (Limpens and Kapteyn 1991, in Erickson et al. 2002) and migrating (Timm 1989, in Erickson et al. 2002). Turbines in inappropriate locations, such as at the ends of linear ridges or in deep saddles, have been shown to cause the highest rates of collisions.

Turbines located along or near the northern (or the southern) passage entering Lake George basin, may increase the risk to migrating bird species, particularly those that travel in large flocks regularly or from time to time, such as Regent Honeyeater (regularly recorded around Lake George in the 1980s – ACT Government 1999). As already mentioned, other birds that may be at higher rates of collision risk are those using the updraught, such as raptors.

Another less quantifiable issue is the environmental conditions that occur around the Lake George Basin. The basin and surrounding ridges are regularly clothed in morning and evening fog, especially during winter (Chris Clarke personal communication, 24 March 2010). Many studies have shown that poor weather conditions increase the occurrence of turbine collisions. Weather conditions which reduce the ability of birds to perceive the turbine blades or avoid collisions, such as fog, add to risks for susceptible species. Inclement weather has also been shown to increase risk to microbats, with fatalities increasing before and after the passing of storm fronts, when microbat activity spikes (Erickson et al. 2002). Sites that experience these conditions at higher frequency may be correspondingly riskier for these species (Canadian Bird Studies 2002; Hydro Tasmania 2003).

During the process of biodiversity assessment, the design of the proposal has been refined taking into account biodiversity constraints. This has included removal of these southern turbine clusters proposed along Lake George escarpment to avoid raptor and birdlife habitats and bird movement corridors.

5.1.6 Raptors at Lake George

Raptor habitat

The escarpment is a locally unique topographic feature. It creates an area of strong updraught favoured by raptors, pelicans and White-throated Needle-tails (as well as hang-gliders), who soar over the air currents created by the topography. The escarpment itself provides breeding habitat for a high diversity and abundance of raptors (COG 1970a, COG 1970b, COG 1992, Olsen personal communication 2010). The habitat for raptors provided by the Lake George basin and escarpment is

unique in the local area. Regionally, similar habitat qualities occur along the Murrumbidgee river corridor and in the ranges south of Canberra. The escarpment provides:

- A steep slope facing into the prevailing wind (providing good updraught).
- Good nesting habitat, that is, a steep slope with deep gullies, large trees, shade and an updraught zone.
- The escarpment includes a variety of microhabitat types that are good for hunting including rocky outcrops, gullies, ridges and diverse vegetation communities and habitat structures.

Thus, the escarpment has long been occupied by a number of breeding raptor territories (Olsen personal communication 2010; Fuentes et al. 2007, Leopold and Wolfe 1970; Fuentes and Olsen 2005). Raptors known to breed in the area include (Lamm 1965, Olsen et al. 2006, Fuentes et al. 2007, Olsen personal communication 2010):

- Wedge-tailed Eagle *(Aquila audux).*
- White-bellied Sea-eagle *(Haliaeetus leucogaster)* – listed as Migratory under EPBC Act.
- Little Eagle *(Hieraaetus morphoides)* – listed as Vulnerable under the TSC Act.
- Whistling Kite *(Haliastur sphenurus).*
- Peregrine Falcon *(Falco peregrinus).*
- Australian Hobby *(Falco longipennis).*

Potential turbine impacts to raptors

Together with waterfowl, raptors are a group at highest risk from collisions with turbines (Lucas et al 2004). Alienation of habitat where turbines are located is an additional risk. Whether potentially high rates of collision translates to population scale impacts appears to be site- and species-specific, with results around the world being highly variable (Lucas et al 2004, Follestad 2007).

Although adult birds may habituate to turbines, as has been observed elsewhere (Brett Lane & Associates 2005), inappropriate placement of turbines can result in ongoing mortality of fledgling and juvenile birds. Many studies note that such deaths are considerably less in number than annual bird mortalities caused by other anthropogenic sources including collision with vehicles and overhead powerlines (Sagrillo 2003, AusWEA 2002, Winkelman 1994). Nonetheless, in some areas blade-strike has lead to unacceptably high rates of raptor deaths.

An example is at Smøla, Norway, where a wind farm was erected within the territories of several breeding White-tailed Sea-eagle pairs. Monitoring of the population between 2003 and 2006 detected the following impacts (Follestad 2007):

- Habitat avoidance/displacement – at least five pairs have abandoned their territories.
- High rates of mortality – 10 fatal collisions over an 18 month period, including four in one week leading up to breeding season. Fatalities include adults and juveniles.
- Reduced breeding success.
- Reduced breeding population size.

An Australian example is the Woolnorth Wind Farm, Tasmania. Initial collision risk modelling prior to construction suggested that the Wedge-tailed Eagle (endangered in Tasmania) would have a 95-99%

avoidance rate[11], with the latter being most likely. The estimated rate of collision deaths for the species was 2.5-1.0 birds per year (with 1.0 for 99% avoidance) (Smales and Muir 2005).

In fact, during 8 years of operation of Stage 1 (operational since 2002) and Stage 2 (operational since 2007), there have been 16 Wedge-tailed Eagles killed by collisions (Smales 2010). Between both stages, this is an annual rate of 3.5 Wedge-tailed Eagle deaths (Smales 2010). Other sources report the death of a 17th eagle after it was put down following injury to its wing from blade-strike (Duncan 2010; Brown 2008, ABC 2006, Bevilacqua 2006). The collision risk modelling has now been updated with the Wedge-tailed Eagle appearing *"to exhibit a lower avoidance rate than most species"*: 90% (Smales 2010 p.4). Wedge-tailed Eagles are not threatened in NSW, however, amongst the raptors recorded along the escarpment/basin area are the threatened Little Eagle and Spotted Harrier (COG 1982). The Spotted Harrier appears to be an uncommon visitor, however Little Eagles are local breeding residents (COG 1983). There does not appear to be publically available information about collision risks and actual impact rates for these two species.

Little Eagle – vulnerable species

While the Little Eagle has always occurred at low densities, records of the species have been steadily decreasing over the last decade (Olsen et al 2008, NSW Scientific Committee 2010). There are thought to be a number of contributing factors including habitat loss (Debus 2008). Extensive surveys for Little Eagle nests in and around the ACT in 2007 found only four breeding pair nest sites, compared to six in 2002-2003 and 11 in 1990-1992, suggesting a dramatic population decline (Olsen et al. 2008; NSW Scientific Committee). Given the low reproductive rate of 0.5-1.0 young per pair per year, maturity at two or three years, and a floating population of juvenile and immature eagles, mature individuals probably comprise less than three-quarters of the population (NSW Scientific Committee 2010). One of these four nest sites is located along the escarpment at Lake George (Olsen personal communication 2010). The nest is in the general vicinity of the rest area along the Federal Highway, approximately 10 kilometres south of Collector (Olsen personal communication 2012, Bianca Heinze pers.ob).

Based on the data from other wind farms already discussed, turbines located along the escarpment of Lake George may pose risk to Little Eagle from:

1. Ongoing collision mortalities: this raises concerns that new eagles moving in to occupy vacated territory may represent ongoing collisions, with the area becoming a population sink – this would be capable of affecting the local population.
2. Desertion of breeding territories: according to the NSW Scientific Committee (2010) loss of breeding sites due to displacement may bring the Little Eagle into "*increasing interspecific competition with the larger, dominant Wedge-tailed Eagle"*. This is considered a threat to its recovery.

Given there is potential for any turbines proposed in the 'high use bird area' (Figure 5-2) to pose a significant risk to the local Little Eagle population, **ngh**environmental has previously recommended

[11] Avoidance rate is *"a measure of the capacity for different species of birds to avoid collision with turbines"* (Smales 2010 p.3)

that all turbines be located clear of the Lake George escarpment proper (**ngh**environmental 2010a, 2010b).

5.1.7 Minimising the risk to birds

The majority of water birds that use Lake George appear to be at low risk from wind turbines, as they spend most of their time on the lake shores (rather than in the air), and arrive in small groups (COG personal communication 2010). Examples of such species include (Lamm 1965, COG 1970a, COG 1982, COG 1983, COG 1992):

- Sandpipers and stilts.
- Mountain Duck.
- Australian Wood-duck.
- Coots.
- Dotterels.
- Snipes.
- Freckled Duck.
- Pink-eared Duck.
- Cormorants.
- Grebes.
- Egrets, herons and bitterns.

However, there would be some key risk groups within transient water bird populations. This is based on the following characteristics:

- Travelling in large flocks, especially at night.
- Large body size.
- Flocks circling or soaring over the wetland prior to landing, especially using zones of updraught over the escarpment.

This includes (Lamm 1965, COG 1982):

- Australian Pelican.
- Australian and Straw-necked Ibis.
- Silver Gull.
- Black Swans.
- Some species of waterfowl (ducks).

For common species these risks are unlikely to be significant, however the wetland of Lake George is recognised as providing refuge during times of drought and other vulnerable periods in a birds' lifecycle, such as breeding (DEWHA 2009). Considering this, there is a risk that the number of injuries, mortalities or the extent of habitat isolation may be unacceptable during certain periods. The approaches discussed below for raptors are considered relevant to reduce risk to waterbirds.

Raptors risk management

In summary, there may be a high collision risk for raptors if turbines were to be placed along the escarpment. This is based on:

- Raptors are top-order predators and occur in low densities in the landscape. Therefore, impacts to individuals have the potential to impact populations.
- Lake George escarpment provides locally unique habitat features and therefore is important to populations of raptors.
- Lake George escarpment supports nesting territories for a number of species and breeding pairs of raptors.
- Little Eagles (Vulnerable) nest along the escarpment and the risk to them from proposed turbines, including habitat isolation and mortality, has the potential to be significant.

There are two main ways to avoid or minimise risk to the local raptor population:

1. **The 'buffer approach':** Wind farm planning guidelines, such as the EPHC (2009) recommend establishing *'adequate'* buffer distances from nest habitat and 'focal habitat resources'. This approach is unlikely to be effective due to scientific uncertainty (Olsen and Olsen 1989, Olsen et al 2010, Olsen personal communication 2010).
2. **The avoidance approach:** avoiding placing turbine clusters in areas where there is potential for a significant ecological impact may be the best approach. This is consistent with the precautionary principle. Further, it is likely to reduce the need for further investments in expert consultation, site-specific ecological studies and potential on-going management costs in the event of a significant problem.

The Proponent has opted for the avoidance approach: the proposal does not include any turbines along or near the escarpment – all turbines are proposed north of the Gunning-Collector Road. The most southern proposed turbine is approximately eight kilometres north of the Little Eagle nest location and well north of the escarpment. The proposal avoids raptor and waterbird habitats and bird movement corridors, effectively removing the risks discussed.

Nonetheless, for precautionary reasons the Little Eagle has been included in Assessments of Significance, Appendix C.

5.2 BATS RISKS

The most likely microbat group to be potentially impacted by the proposal are migrating bats (Cryan and Barclay 2009). An Eastern Bentwing staging cave near Mount Fairy is located approximately 35 kilometres south east of the wind farm site. The species are known to congregate in this cave in transit to Church Cave, a maternity cave located near Wee Jasper located approximately 60 kilometres south west of the proposal area. Church Cave is a significant maternity cave, utilised by a large number of female Eastern Bentwing Bats.

There is a risk of collision (and barotraumas) impact from bats moving to and from the staging cave during their migration to the maternity cave. The Mt Fairy cave may be within nightly foraging range from the proposal area. While the most direct route between Mount Fairy and Church Cave is south of the site, there is a risk to bats travelling to or from this staging cave to the north, such as from caves in the Blue Mountains.

Many researchers consider that migration of bats in North America plays a key role in the susceptibility of particular bats to wind turbine collision and barotraumas, and note that fatalities

peak during migration periods (Cryan and Barclay 2009). An additional reason for high rates of migrational bat mortalities is that migrating bats are less likely to use echolocation; rather they are thought to navigate over long distances using the Earth's magnetic field (Popa-Lisseani and Voigt 2009). Migrating bats may also use memory, stars, and geographical landmarks and linear features (Baerwald and Barclay 2009).

Recent studies in North America have identified that migrating bats appear to concentrate along particular routes rather than disperse across the landscape (Baerwald and Barclay 2009). Where geographical landmarks are being used as navigational aid, migrating bats may concentrate near prominent landscape features, such as rivers and mountains (Baerwald and Barclay 2009). The escarpment running along the western edge of Lake George basin is a prominent landscape feature and a potential movement corridor.

While microbat fatalities in the USA at wind farms have been high, extrapolation of this data to Australian conditions is likely to be inappropriate. This is mainly because climatic patterns are quite different. In the USA extreme changes occur during winter as the jetstream moves southwards, rendering much of the country unsuitable for bat foraging (Greg Richards pers. comm. May 2009). These extreme changes cause dramatic changes to the areas occupied by a number of bat species that move very long distances as they migrate, making them more susceptible to collision in much larger numbers (Greg Richards pers. comm. May 2009). Monitoring in Victoria, based on carcass monitoring, has identified fatality rates in the order of 1-2 bats per turbine per year (Brett Lane pers. Comm., via Greg Richards). This data from Victoria is likely to represent more accurate picture in an Australian context. Microbat fatalities may be potentially higher than for birds, but this would be dependent on habitat quality and proximity of significant bat roosts.

Several threatened microbats have been identified within the proposal area, including the migrating Eastern Bentwing-bat and Yellow-bellied Sheathtail Bat. During mid-February to mid-March, Eastern Bentwing-bats are known to utilise Mount Fairy staging cave and during January to April, for the Yellow-bellied Sheathtail Bat. This is discussed further in Section 6.

6 IMPACT ASSESSMENT

6.1 IMPACT TYPES

There are two main impact types associated with the development of wind farms:

- Loss and degradation of habitat from direct impacts such as:
    - Vegetation clearing.
    - Earth moving and landform reshaping.
    - Associated sediment, erosion, weed and pollution risks.

  These are most relevant to the construction phase. Additionally, decommissioning will require a smaller degree of habitat removal, largely in disturbed areas, as tracks and hardstand areas are re-established to remove above ground infrastructure.

- Collision with infrastructure causing injury or fatality.

  This impact may include risks to stock and wildlife from construction traffic but is most relevant to the operation of wind turbines. Birds and bats are at ongoing risk from collisions with turbine blades resulting in injury and death (including barotrauma for microbats).

6.1.1 Loss and modification of habitat

Terrestrial habitat

Impacts to flora, ecological communities and ground dwelling animals are primarily due to vegetation clearing and soil disturbance required to install infrastructure. The degree of impact depends on the existing site condition and extent of clearing or modification proposed. Rare flora species and over cleared vegetation communities can be significantly impacted by direct removal or through loss or modification of habitat.

For fauna, additional considerations include the proximity of infrastructure to key habitat features, such as hollow-bearing trees, rocky outcrops or water bodies. Fauna can also be impacted by disturbance during the operational phase of a wind farm. Noise, light flicker and vibration may have impacts during sensitive periods, such as breeding, or lead to alienation of habitat. The extent of impact depends on turbine design, wind farm layout as well as ecological characteristics of particular species.

Aquatic habitat

Infrastructure would largely be sited to avoid waterways. Under the current infrastructure configuration however, five creek crossings would be required for road construction and an existing crossing would be upgraded.

Crossings would affect riparian and aquatic habitats during construction, a result of stream bank and stream bed disturbance. Crossings that impede fish passage are a danger to these species.

Removal of riparian vegetation at creek crossings would be largely limited to road construction and upgrades of existing roads. Impacts to riparian and aquatic vegetation would be minimised by minimising the disturbed area at creek crossings and micro-siting to avoid mature and native riparian vegetation. Additionally, several measures can be incorporated into the proposal to address these risks. Best practice erosion and sediment controls would be implemented during creek works, including silt fencing and avoidance of works during rain or high flows. The selection of the type of crossing and construction methods would comply with relevant DI&I (Fisheries) guidelines, to ensure that potential impacts would be minimised. Instream habitat would be left in place or relocated nearby. Fish-friendly culverts would be installed at each of the crossings.

6.1.2 Collision and alienation impacts

Research indicates that the greatest risk from wind turbines is to birds and bats. A growing number of studies in Australia and overseas provide some insight into the nature and scale of potential risks to birds and microbats posed by wind turbines (the focus is on microbats as fruit bats are not known to occur in the Upper Lachlan Catchment). The risks can be categorised as:

1. Fatality risks (includes risk of injury).
2. Alienation risks (behavioural avoidance of suitable habitat near infrastructure).

Fatality and injury are usually caused by collision with the moving blades or turbine infrastructure, such as guy lines. 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).

It should be noted that fauna can also become habituated to turbines and wind farm infrastructure and adapt to their new environment. Where birds adapt to turbine presence, they may be able to avoid collision with it ('avoidance') (Auswind 2006).

Fatality risks

Bird fatality at wind farms is generally low (Langston and Pullan 2003). Fatalities in North America and Australia indicate an average rate of 1.4 bird deaths per turbine per year (Barclay *et al*., 2007, Biosis Research 2006; Brett Lane and Associates 2005; Hull 2002). There is a correlation between tall turbines and higher mortality rates, although this may only relate to some species (Barclay *et al.* 2007).

Rates of microbat collision appear to be much greater in number than birds, although fewer studies have been undertaken to date. A review found an average of 5.9 bat fatalities per turbine per year. Migratory microbats comprised the majority of mortalities in all wind farm studies evaluated (Arnett 2005; Erickson *et al.* 2003). The correlation between turbine height and mortality numbers appears to be particularly strong with microbats, with higher towers causing many more bat fatalities. However, the literature review relates to microbat fatalities in the USA and Europe. Extrapolation of this date to Australian conditions may not reflect rates of microbat collision, due to different climatic and landscape conditions.

The leading cause of death in microbats (90% in one study) is decompression, or pulmonary barotraumas. This occurs as microbats come into contact with rapid or excessive air-pressure change

around the moving turbine blades. This rapid pressure change causes haemorrhaging of the lungs and death (Baerwald *et al* 2008; Horn et al 2008).

Habitat alienation versus adaptation

The effects of wind farms on avian habitat utilisation may have a greater impact on birds than collision mortality (Strickland 2004). 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 & Associates 2005).

Birds have been observed to take avoidance action when approaching turbines, by flying over, around or under the rotating turbine blades (Biosis Research 2006). Key species, such as Wedge-tailed Eagles have been observed to habituate to wind farms, continuing to use the area for hunting and commute by flying around or between turbines (Brett Lane and Associates 2005).

Factors contributing to impact

The factors that contribute to the likelihood and consequence of ecological impacts relate to the ecology of species (including movement or dispersal characteristics, population factors), site-specific features (such as topography and proximity to resources), the design of the infrastructure (guylines, location of turbines), as well as environmental conditions.

Species factors include:

- Flocking or colonial movements (increase risk of population level impact).
- Awkward flight characteristics (increase risk of individuals colliding).
- Migrating at night (increased risk of individuals colliding).
- Foraging patterns in response to weather conditions and resource pulses (increased risk of population level impact).
- Seasonal peaks in activity (increased risk of population level impact).
- Limited range (increased risk of individuals colliding).
- Lifecycle characteristics, such as time taken to mature (increased risk of population level impact).
- Species which are rare or declining, or which are naturally distributed at low density (such as threatened species and top order raptors) (increased risk of population level impact).
- Species with low reproductive rates (increased risk of population level impact).
- Species with poor capacity to disperse and recolonise habitats (increased risk of population level impact).

Good design and turbine placement is the first step to minimising ecological impacts. Key impact factors identified from the literature are set out in Table 6-1 (sourced from Kingsley and Whittam 2001; Erickson *et al.* 2001; Kerlinger and Kerns 2003; Kunz et al 2007).

Table 6-1 Environmental and structural factors which contribute to the fauna impact risk posed by wind turbines

Impact factor	Examples
Site impact factor	
Weather	Fog: low lying land, coast Wind: alpine, coast, ridges and headlands, storm front
Key habitat	Wetland, known hot-spots, updrafts, migration
Habitat availability	Waterbodies, hollows, prey, vegetation
Siting	Forested ridges
Infrastructure impact factor	
Guy lines, cables, lights	Perching, attraction, habitat feature
Operational speed	Full operational speed usually at moderate wind speeds and this is when many species are foraging e.g. microbats
Turbine height and blade length	Higher turbine towers and greater blade-sweep areas have higher mortality rates for birds and bats

6.2 CUMULATIVE IMPACTS

Cumulative impacts are those impacts that are the result of the incremental effects of a group of actions. For a single wind farm project, they may be the combined loss of habitat caused by:

- Clearing and earthworks.
- Noise and vibration.
- Operational towers.

These impacts in combination may deter some species from using the site, either to forage, roost or breed, depending on the tolerance to disturbance of the species considered.

Additionally, cumulative impacts may also result from the operation of a number of wind farms or other large industries that may affect the distribution or use of habitat by species. Of relevance to this proposal, are the Capital, Woodlawn and Cullerin wind farms.

The Capital Wind Farm is located approximately 22km south-east of the Collector site. It comprises 67 turbines, of approximately the same size as those proposed for Collector and has been operational since October 2009. It is situated in pasture with scattered trees, east and south-east of Lake George. The value of Lake George to birds has been discussed in Section 5.1 of this report.

The Cullerin Wind Farm is located immediately north of the Collector site, on the northern side of the Hume Highway. It comprises 15 turbines, of approximately the same size as those proposed for Collector and has been operational since July 2009. It is situated in pasture with scattered trees. To the west of the site, a corridor of woodland extends north and has been observed as having value as connected fauna habitat, in this largely modified regional context.

Impact types, with regard to the cumulative impact of these operational wind farms, include:

6.2.1 Loss and modification of habitat

Wind farm development requires relatively discrete areas of clearing to facilitate tracks, cabling and turbine footings. Many areas, such as excess track widths, site compounds and crane hardstand areas, are able to be revegetated post-construction. A cumulative loss of habitat impact would be most relevant to large ranging species. The siting of infrastructure at all three sites can be seen to avoid wooded areas, which are degraded and limited in this regional context, and of most value to large ranging species such as bats, birds and medium arboreal and ground dwelling mammals. This impact is not anticipated to be high for any vegetation community or species of flora or fauna.

6.2.2 Collision and alienation impacts

Collision impacts require that species are either using the site to forage or to move between required resources. These may include roosting or breeding areas and can affect species that may be resident (raptors and owls that establish large territories) or migratory (some bats, which move large distances to breed, such as the Eastern Bentwing Bat). As discussed previously (Section 5 of this report), collision and alienation risks to birds and bats are related to ecological characteristics of the species (such as manoeuvrability and breeding rate) and site characteristics (such as proximity to key habitat resources). Relevant issues that may therefore entail a cumulative impact between the Capital, Cullerin and Collector sites are considered to be:

- Proximity to Lake George, important water bird resource.
- Proximity to the escarpment east of the Collector site, likely to funnel bird and bat movements between Collector and Capital.
- Proximity to Mt. Fairy staging cave for the Eastern Bentwing Bat, approximately 35 kilometres south east of the Collector site.
- Risks related to these features were considered in detail in Section 5 of this report.

The location of the Collector site is considered unlikely to substantially increase any risk to birds that may congregate at Lake George, considering the location of the Capital Wind Farm. Early investigation of bird and bat risks has lead to the refinement of the Collector infrastructure layout. Turbines have been removed from the south and east of the site, to reduce risks to species utilising the escarpment as a movement corridor from or to Lake George.

Eastern Bentwing Bats are considered likely to forage up to 25km from a maternity site, based on activity patterns observed near the Wee Jasper region (unpublished surveys by **ngh**environmental 2008). The Mt Fairy cave may be within nightly foraging range from the proposal area, but it would be near to the extent of foraging distance and therefore would not be expected have very high activity levels. The most direct route between Mount Fairy and Church Cave is south of the site and it has been considered that by removing turbines from the near to the escarpment, a wooded corridor more likely to be used by bats, and the south of the site, the proposal has addressed the risk to migrating Eastern Bentwing Bats.

Recommendations have been made by this assessment to ensure that monitoring data collected at this site are able to confirm these assumptions.

6.3 ESTIMATED IMPACT AREA OF THE PROPOSAL

6.3.1 Construction footprint (removal of habitat)

The proposal would result in the removal of vegetation under the development footprint, including the turbine towers and surrounding hardstand and crane operation areas, substation and control building and access tracks. Electrical cabling would be installed in areas disturbed for the access tracks. Vegetation would be removed for the life of the wind farm (up to 30 years). Lerida Road is intended to be used for access. This is an established road which meets or exceeds the 6m width requirement for access tracks on the wind farm site. It is assumed that no further works will be required along Lerida Road aside from potentially widening highly disturbed areas at up to two cattle grids and one creek crossing. As such Lerida Road is not included in the impact area assessment; however, where farm tracks are to be used (and widened) these have been included in the assessment.

After the infrastructure is installed, grass cover may be able to be restored over much of the permanent access routes to assist track stability and reduce runoff. Additionally, the construction compound would be revegetated.

Estimates of permanent and temporary habitat loss for each of the affected vegetation types are presented in the tables below, based on the final indicative infrastructure layout provided by the proponent (several layout revisions have taken place to reduce impacts since the beginning of site investigations). Overall impact areas have been determined based on estimated infrastructure footprints provided by the proponent. Impact areas by vegetation type were calculated using GIS software however, it should be noted that some total habitat loss figures may be slightly overestimated due to overlaps of infrastructure, for example tracks crossing hardstand areas. Due to the two different methods of calculation there may also be some small (<0.01ha) discrepancy between the total calculated areas of permanent and temporary habitat loss determined by the two methodologies. Small errors (<0.01ha) may also be present due to numerical rounding. It should be noted that for the purposes of these calculations, exotic dominated pasture is not considered to constitute habitat.

The tables show that, in terms of total impact areas (Table 6-2):

- The area assessed in this study and within which infrastructure may be located (the DE) totals 898.5 hectares.
- Within this area, the permanent habitat loss would be 24.6 hectares, mostly attributable to the establishment of tracks (16.8 hectares). Most permanent habitat loss is within Derived Grassland (14.2 hectares) with Box-Gum Woodland accounting for an additional 7.7 hectares. There are small losses of habitat (≤2ha) within other vegetation types.

- Additional areas of disturbance to habitat total 15.5 hectares however, these areas are considered able to be rehabilitated post-construction (these include the construction compound,, track buffers and crane operation areas and hardstands where they occur in cleared native pasture or Derived Grassland). Most of this area is Box-Gum Woodland Derived Grassland (13.5 hectares).

In terms of vegetation of conservation significance (Table 6-3 and Table 6-4) the permanent habitat loss will include areas of moderate and good condition TSC Act EEC (high constraint):

- Box-Gum Woodland and Derived Grassland (8.2 hectares).
- Tablelands Snow Gum Grassy Woodland (1.6 hectares).

This permanent habitat loss includes areas of EPBC Act CEEC:

- Box-Gum Woodland and derived grasslands (3 hectares).

In addition, 13.7 hectares of habitat associated with poor condition Box-Gum Woodland and Derived Grassland EEC (moderate constraint) will also be permanently impacted.

In terms of fauna habitat types, estimated permanent impact areas are as follows:

- Native pasture – 12.3 hectares.
- Pasture with trees – 7.6 hectares.
- Woodland – 0.6 hectares.
- Forest – 0.1 hectares.

The density of hollow-bearing trees within wooded areas is as follows:

- Pasture with trees – 3 per hectare.
- Woodland – 35 per hectare.
- Forest – 60 per hectare.

Based on these densities, the maximum number of hollow-bearing trees that would be removed is 23 within pasture with trees, 19 within woodland and 4 within forest; a total of 46.

However, in order to minimise the impact on mature and hollow-bearing trees, an additional infrastructure layout revision was undertaken to demonstrate that within woodland and forest, micrositing of infrastructure could allow for the retention of the majority of trees that occur within the 50 x 50m crane operation area. That is, the turbine footing and hard stand area can be placed to minimise the loss of mature and hollow-bearing trees. Further, it is assumed that access tracks to these turbines can avoid most mature trees in woodland and forest and all mature trees in pasture. A count of the maximum number of trees likely to be removed was undertaken with reference to aerial photography using this new layout. This reduced the number of mature (and potentially hollow-bearing trees) to be removed to 37.

Note: The hollow bearing tree surveys often selected better areas in which to do quadrats, hence the averaged result is considered an upper limit of hollows. It should also be noted that:

- The numbers of hollows within the construction foot print are a small percentage of those available in the adjacent development envelope (approximately 10%).
- The majority of hollows were found in the dry forest were small in form, readily available in this forest type and are considered of lesser value than those in the box-gum woodland open forest (50% of large and 73% of extra large hollows were found in woodland).
- There is good opportunity to reduce the number of hollows required to be cleared by micro siting tracks and turbine installation within the open forest and pasture areas (as demonstrated above).
- The recommendation to avoid hollows where possible is reinforced by the requirement to offset vegetation and hollows to be removed.

It is acknowledged that in woodland and forest vegetation types, operational impacts such as noise and shadow-flicker may also constitute a degradation of fauna habitat, affecting the use of the areas immediately around turbines by birds and bats. Based on relevant wind farm monitoring nearby, it is the experience of the author that species richness is unlikely to be affected into the operational phase of this wind farm. As a precaution however, where turbines occur in woodland or forest vegetation types[12], a larger permanent impact area has been assumed (50 x 50m (the total area of turbine footings, hardstands and crane operation areas) instead of 25 x 25m; refer to (Table 6-2) to account for this impact.

[12] Vegetation types and not fauna habitat mapping is used to calculate impact areas in Table 6-2.

Table 6-2 Estimated impact area of the development by vegetation type

Legend:

BGW *Box-Gum Woodland*
DGL *Box-Gum Woodland Derived Grassland*
BBDGF *Brittle Gum – Broad-leaved Peppermint Dry Grass Forest*
WGF *White Gum Forest*
FHW *Tablelands Snow Gum Grassy Woodland*
NP *Native pasture*
EX *Exotic*

Infrastructure	Quantity	Width (m)	Length (m)	Area (ha)[1]	BGW (ha)[2]	DGL(ha)[2]	BBDGF(ha)[2]	WGF(ha)[2]	FHW(ha)[2]	NP(ha)[2]	EX(ha)[2]
Turbine footing [a]	68	25	25	4.25	0.81	2.25	0.00	0.13	0.25	0.06	0.75
Crane hardstand (in woodland and forest) [a]	19	15	32	0.91	0.62	0.00	0.00	0.10	0.19	0.00	0.00
Crane hardstand (in pasture areas) [b]	49	15	32	2.35	0.00	1.73	0.00	0.00	0.00	0.05	0.58
Additional crane operation area (woodland and forest) [a]	19	37.35	37.35	2.65	1.81	0.00	0.00	0.28	0.56	0.00	0.00
Additional crane operation area (pasture areas) [b]	49	37.35	37.35	6.84	0.00	5.02	0.00	0.00	0.00	0.14	1.67
Tracks (buffer during construction) [b]	1	2	35037	7.01	1.48	3.74	0.00	0.05	0.21	0.12	1.40
Tracks (permanent formed width)[a]	1	6	35037	21.02	4.44	11.23	0.00	0.18	0.62	0.35	4.21
Substation and control bldg [a]	1	50	150	0.75	0.00	0.75	0.00	0.00	0.00	0.00	0.00
Construction compound, staging and storage [b]	1	300	100	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
Development envelope				**898.49**							
Breakdown - habitat loss by impact type (*excludes exotic vegetation):											
a Permanent habitat loss (includes all footings, hardstands and operation areas in woodland and forest and permanent formed width of new tracks)				24.62	7.69	14.23	0.00	0.68	1.62	0.41	*
Percentage of habitat within the development envelope permanently impacted				2.74	0.86	1.58	0.00	0.08	0.18	0.05	*
b Temporary habitat loss (areas that can be rehabilitated post construction)				15.54	1.48	13.49	0.00	0.05	0.21	0.31	*
Percentage of habitat within the development envelope temporarily impacted				1.73	0.16	1.50	0.00	0.01	0.02	0.03	*

[1]Derived from estimated infrastructure footprints, [2]Derived from GIS vegetation mapping

Table 6-3 Estimated permanent impact areas by vegetation condition[14]

Collector Windfarm					
Vegetation types	**Permanent loss within each condition class**				**Total of each vegetation type within DE**
	Good	**Moderate**	**Poor**	**Total**	
Box-Gum Woodland	1.23	2.76	3.70	7.69	220.85
Box-Gum Woodland Derived Grassland	1.76	2.48	9.99	14.23	427.63
Brittle Gum/Broad-leaved Peppermint Dry Grass Forest	0.00	0.00	0.00	0.00	8.07
White Gum Forest	0.27	0.41	0.00	0.68	28.10
Tablelands Snow Gum Grassy Woodland	1.62	0.00	0.00	1.62	37.71
Native Pasture	0.00	0.41	0.00	0.41	7.64
Exotic/planted	0.00	0.00	4.96	4.96	168.72

Table 6-4 Estimated TSC Act EEC permanent impact areas by constraint class[13]

[13] All of the condition classes in Table 6-3 and 6-4 (good, 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 percent foliage cover greater than 25% of the lower value of the over-storey percent foliage cover benchmark of that vegetation type. Exotic dominated vegetation would equate to 'low' condition.

Collector Windfarm		
EEC	**Permanent habitat loss within each class**	
	High constraint EEC	**Moderate constraint EEC**
Box-Gum Woodland and Derived Grassland	8.24	13.69
Tablelands Snow Gum Grassy Woodland	1.62	0.00
Total area within the DE	**290.57**	**395.62**

6.3.2 Indirect and peripheral impacts

Vegetation surrounding the development footprint would be affected by vehicle access and parking, materials laydown and stockpiles. Peripheral impacts may include soil compaction, soil erosion and sedimentation. The works have the potential to introduce and spread weed species. Concrete would not be batched onsite, but concrete trucks may require a wash out area to rinse their shoots before exiting the site.

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, over the 12 month construction period. Dust deposition is not expected to significantly affect the habitat values of the site.

6.3.3 Threatened entity impacts

Endangered Ecological Communities

Box-Gum Woodland

Threatened Species Conservation Act (NSW) listed entity

The proposal would result in the removal of up to 21.9 hectares of Box-Gum Woodland EEC and Derived Grassland that is predominately in poor condition with little chance of recovery (Table 6-3). Main impacts include the direct clearing of habitat and the potential of weed ingress and spread. Higher quality remnants will be affected by the proposal however, extensive areas of these higher quality remnants exist within the site boundary and provide good opportunities for offsetting and maintaining or improving biodiversity values of these areas. Approximately 648.5 hectares of this community occurs within the development envelope and other examples of the community in similar condition to the bulk to be impacted are widespread in the locality. Recommendations are contained within this report to minimise the impacts to better quality remnants within the development envelope.

An assessment of significance (Appendix C) concluded that the removal of up to 21.9 hectares of this community is not considered to be significant with respect to its generally degraded state and the extent of similar vegetation in the locality.

Environmental Protection and Biodiversity Conservation Act (Commonwealth) listed entity

The proposal will result in the removal of up to 3 hectares of the Box-Gum Woodland CEEC (good condition Box-Gum Woodland) causing a localised reduction in the occurrence of this community. The proposal will not impact on the broader extent of the CEEC within the proposal site. A total of approximately 86.1 hectares of this community occurs within the development envelope and up to a potential further 371 hectares across the broader proposal site.

Localised disturbance to hydrological patterns that support the EEC will result from the proposal but will be predominately temporary and are not considered 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 7 of this report are adhered to. An offset plan is recommended by this report to ensure a 'maintain or improve' biodiversity outcome. Large areas exist within the site boundary that if properly managed can assist with the recovery of this community. With the implementation of the controls and recommendations of this report an Assessment of Significance (Appendix C) concluded the proposal is considered unlikely to have a significant impact on the Box-Gum Woodland CEEC and result in a net positive gain.

Tablelands Snow Gum Grassy Woodland

Up to 1.6 hectares of Tablelands Snow Gum Grassy Woodland will be removed as a result of the proposal. This is likely to be limited to the clearing of grassy understorey in good condition with areas with a more intact overstorey being retained. Given the extent of similar vegetation in the locality, the retention of areas with a more intact overstorey and the occurrence of approximately 37.7 hectares of this community within the DE, an Assessment of Significance (Appendix C) concluded that the removal of 1.6 hectares of understorey vegetation is not considered to be significant.

Threatened flora

Based on the threatened species evaluation conducted in Appendix B, seven threatened flora species had at least moderate potential to occur within the DE based on habitat quality, disturbance history, known distribution ranges and the results of the March 2010 and PEI field survey. Targeted searches for all these species were conducted in all areas of suitable habitat within the DE and at suitable times across the March and November 2010 surveys. One species, the Hoary Sunray (*Leucochrysum albicans* var. *tricolor*), listed as endangered under the EPBC Act, was detected within the DE on the verges of Lerida Road in the south-west of the proposal site (Figure 3-3). Where this species was detected, the width of Lerida Road meets or exceeds the 6m wide requirement for finished tracks within the wind farm site. As the road already meets the requirements, no works will be required in this area and the species will not be impacted by the proposal. Nearest records for the other six species are all 34 or more kilometres from the proposal site excluding the Double-tail Buttercup (*Diuris aequalis*). Records exist 10km to the east of the site for this species. The Double-tail Buttercup is a conspicuous species that would have been detected if flowering at the site. Flowering of the Double-tail Buttercup can be very limited however, this species always occurs with *Gompholobium* spp. (which it mimics) and no species of *Gompholobium* were detected.

Based on nearest records and the results of the targeted surveys the potential for threatened species other than the Hoary Sunray to occur on the site is considered low. It is unlikely that these species were overlooked and exist within the proposal area and are at risk of impact from the development. The Hoary Sunray population within the DE will not be impacted by the proposal and as such, assessments of significance pursuant to the TSC and EPBC Acts are not considered necessary.

Threatened fauna

The proposal would impact on threatened fauna habitat through the loss of hollow bearing trees and fallen timber, removal of woodland and forest and collision impacts from turbines. Potential impacts are largely to birds and bats. Habitat for threatened marsupials, reptiles and amphibians was found to be sub-optimal and there is a lack of historical records for these species on and around the site.

Given the low number and diversity of reptile species observed across the site, it would appear that the entire Collector wind farm site does not contain habitat that is favourable for many reptile species, including the Striped Legless Lizard and Pink-tailed Worm-lizard. The artificial shelter surveys indicate that the vegetation within and surrounding Array 2 (Cluster 6) appears to be the highest quality in terms of supporting reptile species, however, numbers still appear to be low with only two observations out of 15 tile lifts (13%).

TSC Act-listed species with the potential to be impacted by the proposal include raptors, woodland birds and microbats. EPBC Act-listed species with the potential to be impacted include the Vulnerable Superb Parrot and Migratory-listed White-bellied Sea Eagle. Seven-part tests and Assessments of Significance were undertaken for these species and are provided in Appendix C.

Collision impacts and habitat loss would have potential for adverse effects on the Spotted Harrier, Square-tailed Kite and Little Eagle. This species was not observed during field surveys though it may utilise the site for foraging. Based on field assessment, literature review and proposed layout to avoid the escarpment, it is considered that impacts to the Little Eagle and other raptors are not likely to be significant, though given the high potential for the Little Eagle to occur it is considered to be a key species of concern; ongoing monitoring should be utilised to confirm these assumptions.

Habitat loss, including loss of woodland/forest and loss of hollow-bearing trees would have impacts to small woodland birds including the Brown Treecreeper, Diamond Firetail, Varied Sittella and White-fronted Chat and to large forest birds including Superb Parrot, Gang-gang Cockatoo and Powerful Owl. All of these species were recorded at the site except for the Powerful Owl, which has the potential to occur with several records nearby. The Superb Parrot, Gang-gang Cockatoo and Powerful Owl rely on tree hollows for breeding and may be affected by clearing of woodland. The site averages a density of 12 hollows per hectare of wooded habitat. Recommendations to minimise the loss of hollow-bearing trees and standing dead timber through micro-siting and avoiding woodland with tree cover would retain the breeding resources. Additionally, hollows that must be removed would be replaced with artificial hollows.

Vegetation loss of good quality forest and woodland habitat across the site would be small, such that impacts to the Brown Treecreeper, Diamond Firetail and Varied Sittella would be minor. Disturbance to White-fronted Chat habitat, including native pasture and pasture with trees, would also be small and disturbance of groundcover would be kept to a minimum to reduce the risk of impacting this species. Vegetation offsetting would aim to minimise impacts from the loss of woodland and forest habitat across the site. Impacts to small and large diurnal birds are not considered likely to be significant.

Impacts to microbats are likely to be from habitat loss for the Large Footed Myotis and East Coast Freetail Bat. These species were recorded in low numbers and are unlikely to rely on resources at the site. Habitat loss is not anticipated to impact these species significantly. Impacts to the Eastern Bentwing Bat and Yellow-bellied Sheathtail Bat are more likely to be from collision with turbines or barotrauma. Yellow-bellied Sheathtail Bat is likely to occur in low numbers and therefore unlikely to be impacted at a population level. Potential impacts to this species are not likely to be significant. Impacts to the Eastern Bentwing Bat could occur as this species was recorded across the site. However, there is no evidence to suggest the site is important to local populations of this species; it is 35km from a nearby staging (Mt Fairy) and not in a direct line to between the staging cave and the

Wee Jasper maternity cave, which would be south of the site. It is therefore unlikely that the proposal would significantly impact on the Eastern Bentwing Bat, however, this species is noted as key species of concern; ongoing monitoring should be utilised to confirm these assumptions.

7 RECOMMENDATIONS

The following recommendations are considered to be required to manage the potential biodiversity impacts of the proposal within acceptable limits. With the effective implementation of these measures, significant impact is not considered likely for any threatened entity as a consequence of the works.

The guiding principles for proposals that would be assessed under Part 3A of the EP&A Act include:

- Maintain or improve biodiversity values (i.e. no net impact on threatened species or native vegetation).
- Protect areas of high conservation value.
- Protect the long-term viability of local populations of a species, population or ecological community.

This proposal is considered against the above principles. Measures to ameliorate impacts of the proposal are considered in a hierarchical order (Figure 7-1), as outlined in the *Guidelines* (DEC 2005).

Figure 7-1 Step 4 in the *Guidelines for Threatened species Assessment* (DEC 2005): first avoid impacts, and then mitigate impacts that cannot be avoided. Finally, offset impacts that cannot be mitigated.

7.1 MEASURES TO AVOID IMPACT

7.1.1 Measures undertaken during design of the proposal

During the process of biodiversity assessment, the design of the proposal has been refined taking into account biodiversity constraints. The proposal now has:

- A reduced number of turbines. Initially up to 80 turbines were being considered by the proposal. The final layout comprises 68 turbines.
- A reduced number of turbines in sensitive areas.

  - Four fewer turbines in forest to avoid threatened species habitat.
  - Four fewer turbines in woodland.
  - Three fewer turbines in EEC.
- Removal of turbines proposed along Lake George escarpment to avoid raptor habitat.
- Removal of hollow-bearing trees has been minimised through micrositing turbines and associated layout features away from paddock trees and outside of forest as much as possible.

7.1.2 Further recommendations: design and planning

- Micrositе infrastructure with input from an ecologist. Specifically:
  - Minimise locating infrastructure in:
    - Areas of moderate to good condition EEC or CEEC.
    - Areas of forest (Clusters 1, 3, 4, 5, 6).
    - Areas of woodland (Clusters 2, 3, 4, 6).
  - Minimise clearing of overstorey vegetation. Infrastructure would be preferentially sited in previously cleared and disturbed areas. This includes micro-siting of roads to avoid mature and native riparian vegetation at creeks
  - Track widths would be kept to a minimum when in CEEC areas.
  - Cabling would be laid in the road network to minimise additional impact area.
  - Hollow-bearing trees identified for removal would be removed subject to a management plan prepared by an ecologist. This would include but not be limited to tree-specific provisions for:
    - The timing of works (avoiding breeding periods).
    - Procedures to minimise impacts to resident fauna.
    - Procedures for relocating any resident fauna.
    - Recording the number and characteristics (size) of hollows to be removed and offset.
  - Works would avoid rock outcrops where possible, particularly in CEEC areas.

7.1.3 Construction phase

- Habitat elements would be retained during construction as follows:

- Avoid impacts to hollow-bearing trees that have not been specifically identified for removal (as set out in the management plan discussed above).
- Fallen timber would be left in place or moved to a nearby area to retain fauna habitat.
- Where rocky outcrops could not be avoided, a preclearance survey would search and relocate captured reptiles. Rocks would be placed in nearby areas, in consultation with an ecologist.
- Instream habitat along creeklines such as snags, bedrock and emergent vegetation would be retained, avoided or relocated as a last option.

7.2 MEASURES TO MINIMISE IMPACTS

7.2.1 Construction phase

- The construction compound would be established in highly disturbed areas. Highly disturbed areas are those that do not contain overstorey vegetation and are considered to be in poor condition as per the vegetation map in Section 3.
- Trenches would be filled as soon as possible. Any trenches to be left open overnight would be adequately covered or inspected at first light and any fauna trapped would be released in an appropriate location nearby.
- Fish passage would be maintained at all times.
- Disturbance would be kept to a minimum at creek crossings.
- Appropriate sedimentation and erosion controls would be in place particularly when working in drainage lines and creeks.
- Creek works would not be undertaken when rain is forecast and would be avoided where possible, when there is flow.
- Materials laydown and stock piling would make use of existing areas of disturbance or other areas of low biodiversity value, where possible.
- Weed controls would be undertaken as follows:
    - Noxious weeds within the development envelope would be controlled according to control plans and measures recommended by the Upper Lachlan Shire Council.
    - Vehicles and machinery would be cleaned prior to accessing the site. Vehicles and equipment operating in weedy areas would be cleaned prior to leaving these areas.
- Rehabilitation would be undertaken in all areas disturbed by the works:

- Rehabilitation would be undertaken progressively, as soon as practical.
- Local province native species would be sourced for all revegetation works within native vegetation. Selected species would be common to the vegetation community in which works occur.

- Creek crossings would be designed in accordance with:
  - *NSW Fisheries Policy and Guidelines for Fish Friendly Waterway Crossings* (2003).
  - *"Why do fish need to cross the road?" Fish Passage for Waterway Crossings* (2003).

7.2.2 Operational phase

- An adaptive management monitoring program for birds and bats would be prepared and implemented. This would include:
  - A more intensive period of monitoring should be undertaken in the first 6 months of operation, as birds and bats are in the process of habituating to the new development and sensitive species may experience higher levels of mortality during this period.
  - Surveys will include regular carcass searches, bird utilisation surveys, observation of bird avoidance behaviour and targeted surveys for species of concern.
  - Surveys should representatively sample the habitat and topography in which turbines are located.
  - Surveys should sample weather conditions, particularly periods of heavy fog.
  - The monitoring program should include identification of key 'at risk' species (species of concern) and triggers for taking action to reduce unacceptable impacts identified by the monitoring. These should include:
    - Little Eagle – searches for breeding activity and movements to the escarpment.
    - Eastern Bentwing Bat – monitoring during 'high risk' periods, when this species may be moving through or foraging in the area.
  - Reporting should be undertaken to identify any trends in the data and recommend management actions, as required. These recommendations should include the intensity and duration of ongoing surveys, as required.
  - Given the concentration of operational wind farms in the region, monitoring of bird and bat impacts should ideally be coordinated and consistent with monitoring programs conducted at other wind farms. The monitoring program should include a set of feasible management measures that can be implemented to reduce collision risks, if required.

7.3 MEASURES TO OFFSET IMPACTS

- Finalise an offset plan (in accordance with the Draft Principles for the use of Biodiversity Offsets in NSW) based on the final infrastructure design, prior to construction and in consultation with OEH.

In order to meet the 'maintain or improve' test for biodiversity values, the proposal must 'offset' areas of native vegetation to be removed by the work, relative to their value (determined by habitat values and level of clearing). The offset plan would detail appropriate offset ratios and measures to manage the areas for their preservation and improvement.

Areas of EEC in moderate to good condition are of very high value and therefore will be a critical component of the offset plan. The proposal would permanently remove 21.92 hectares of moderate to good condition Box-Gum Woodland EEC and 1.62 hectares of moderate to good condition Tablelands Snow Gum Grassy Woodland EEC as defined by the Biometric definitions. In terms of offsetting these impacts within the site boundaries, there are approximately:

- 3884.2 hectares of Box-Gum Woodland EEC.
- 67.6 hectares of Tablelands Snow Gum Grassy Woodland EEC.

A proposed offset area is mapped in Appendix F. An Offset Strategy has been prepared by nghenvironmental (December 2011) verifying the suitability and feasibility of meeting the offset requirements.

7.4 DECOMMISSIONING

- A biodiversity assessment would be required prior to decommissioning, to update the knowledge of site attributes and evaluate specific impact types (given the life span of the project is in the order of 30 years).
- Relevant mitigation measures implemented during the construction phase to contain impacts would also apply to decommissioning works.
- New measures to avoid and mitigate impacts may be required depending on the results of the assessment.

8 CONCLUSION

The proposal would involve the construction, operation and decommissioning of up to 68 turbines, substation, associated electrical connections, access tracks, hard stand areas, construction compound and sediment erosion controls.

A diverse range of vegetation communities and habitats are present in the proposal area, and the wider study area. These areas, and the flora and fauna they support, were evaluated and considered against the primary impact types associated with wind farms: habitat loss/alienation and collision with turbines (the latter being relevant to birds and bats only). This evaluation was undertaken in the context of threatened species legislation and various government department wind farm Planning Guidelines.

Vegetation of conservation significance occurs onsite (NSW and federally listed Endangered Ecological Communities: Box-Gum Woodland and NSW listed Tablelands Snow Gum Grassy Woodland). Threatened and migratory fauna species identified with the potential to be impacted by the proposed wind farm include: Little Eagle, Spotter Harrier, Square-tailed Kite, Brown Treecreeper, Diamond Firetail, Varied Sittella, White-fronted Chat, Gang-gang Cockatoo, Superb Parrot, Powerful Owl, Eastern Bentwing Bat, Yellow-bellied Sheathtail Bat, Large-footed Myotis, East Coast Freetail-bat and White-bellied Sea-eagle. Mitigation measures have been developed to reduce the risk of impacts to these species.

Through iterative development of the final proposal, concurrent with biodiversity constraints assessment and other studies, the proposal has been refined to:

Avoid many areas of high biodiversity conservation
High risk areas to birds and bats near to the escarpment at the south of the preliminary site layout have now been excluded from the development envelope.

Minimise impacts in these areas, where avoidance is not possible.
The development envelope has been reduced and a set of management prescriptions have been designed within this assessment to ensure that significant impacts are avoided.

Offsetting has been recommended to ensure a positive net overall environmental outcome.
Areas and appropriate management measures have been outlined to demonstrate that offsetting is feasible within the proposal site boundaries.

With the effective implementation of management measures within this report, and with reference to Step 5 of the Guidelines for Threatened Species Assessment (DEC 2005), the proposal is considered to:

- Be likely to maintain or improve biodiversity values.
- Be unlikely to reduce the long-term viability of a local threatened species population or ecological community.
- Be unlikely to accelerate the extinction of a species, population or ecological community or place it at risk of extinction.
- Not adversely affect critical habitat.

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APPENDIX A DIRECTOR-GENERAL'S REQUIREMENTS

APPENDIX B THREATENED SPECIES EVALUATIONS

B.1 FLORA EVALUATION – THREATENED SPECIES AND COMMUNITIES

B.2 FAUNA EVALUATION – THREATENED SPECIES

APPENDIX C ASSESSMENTS OF SIGNIFICANCE

C.1 ASSESSMENTS UNDER THE TSC ACT

C.2 ASSESSMENTS UNDER THE EPBC ACT

APPENDIX D FLORA RESULTS

APPENDIX E FAUNA SURVEY DATA

APPENDIX F ADDITIONAL MAPS

APPENDIX G HOLLOW-BEARING TREE REMOVAL PROTOCOL