Appendix C **THREATENED SPECIES EVALUATION**

An evaluation of threatened species known from the area from both the Environmental Reporting Tool (EPBC Act) and DECC Wildlife Atlas database (TSC Act) determined that several species have potential to occur at the subject site based on the known habitat requirements and their recorded distribution.

The EPBC Matters of National Environmental Significance Search Tool results are based on a 50km buffer around the approximate centre of the subject site (34° 46' 37" S, 148° 42' 12.62" E) (24.09.08). The NPWS Atlas search is based on 3 sub-regions from the Murrumbidgee CMA region; Murrumbateman (M), Upper Slopes (U) and Bondo (B). Marine and littoral fauna species have been excluded from this analysis due to the absence of suitable habitat.

The following definitions are used in this evaluation.

Presence of habitat	
Present	Potential or known foraging, roosting, nesting, refuge, movement corridor (including movement of genetic material) or other habitat is present within the study area
Absent	No potential foraging, roosting, nesting or other habitat is present within the study area
Likelihood of occurrence	
None	Species has a very low, or no, probability of occurrence
Vagrant	Species could occur on occasion as a vagrant or passing over/across the study area (usually applies to more mobile fauna species)
Possible	Species could occur and utilise resources in the study area
Present	Species was recorded during the field investigations
Possible impact	
No	The proposal would not impact this species or its habitats. No Seven-Part Test is necessary for this species.
Yes	The proposal could impact this species or its habitats. A Seven-Part Test for NSW threatened species or an EPBC Assessment of Significance has been undertaken for these species unless, in the case of easily recordable plant species, field survey has demonstrated that the species is absent from the site.

1. Threatened flora and ecological communities

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
SHRUBS							
Grevillea iaspicula Wee Jasper Grevillea TSC (E) EPBC (E)	Restricted to limestone outcrops in the Wee Jasper area and on the shores of Lake Burrinjuck c. 20km south of the site (DECC 2008a).	• Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands	Absent	Known M and B. EPBC search indicates likely to occur.	None	No	No
Grevillea wilkinsonii Tumut Grevillea TSC (E)	The Tumut Grevillea is found in two areas: one is a 4.5 km stretch of the Goobarragandra River, approximately 18 km south-east of Tumut; the other at a small site near Gundagai. Habitat is in dense riparian shrubland on steep rocky slopes or on alluvial terraces with sparse tree cover. Typical associated tree species are *E. blakelyi, E. macrorhyncha, E. bridgesiana* and *E. melliodora.*	• Southern Tableland Grassy Woodlands • Southern Tableland Wet Sclerophyll Forests	Absent	Known B and U.	None	No	No
Pomaderris cotoneaster Cotoneaster Pomaderris TSC (E)	This shrub grows in riparian and rocky areas, the latter often close to creeks. It is known from the Tumut area (Goobarragandra River), and Bungonia Gorge (J. Miles, pers. obs.), but not from near Yass.	• Southern Tableland Grassy Woodlands • Southern Tableland Wet Sclerophyll Forests	Absent	Known B, Predicted U.	None	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
FORBS							
Ammobium craspedioides Yass Daisy TSC (V) EPBC (V)	Perennial daisy growing in sclerophyll woodland, forest and roadsides, in Yass district and near Wagga Wagga. Numerous Atlas records in district including along Black Range Road, Burrinjuck Road and Hume Highway.	• Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Upper Riverina Dry Sclerophyll Forests • Western Slopes Dry Sclerophyll Forests • Western Slopes Grassy Woodlands	Present	Known from all 3 EPBC search indicates likely to occur.	Present	Yes	Yes
Calotis glandulosa Mauve Burr-daisy TSC (V) EPBC (V)	A low perennial forb which grows in montane or subalpine grassland or grassy woodland on the tablelands and slopes, including disturbed areas.	Not indicated in DECC CMA search or EPBC search.	Present	Not indicated	Possible	No	No
Cullen parvum Small Scurf-pea TSC (E)	A small erect or trailing perennial pea flowering in summer. Plants tend to die back over summer and resprout with rain in winter or spring; survives below-ground in dry years (DECC 2008a). Recorded in grassy woodland on the slopes/tablelands and in the Riverina.	Not indicated in DECC CMA search.	Present	Not indicated	Possible	No	Yes
Leucochrysum albicans ssp *albicans* var *tricolor* Hoary Sunray EPBC (E)	Perennial daisy growing in natural and secondary grasslands and grassy woodlands, often colonising disturbed sites such as road verges, but does not persist well in grazed situations Flowers spring-summer. May be locally common on the Southern Tablelands, and is not listed as threatened in NSW. Not recorded in the region.	Not indicated in DECC CMA search.	Present	EPBC search indicates likely to occur.	Possible	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
Rutidosis leptorhynchoides Button Wrinklewort TSC (E) EPBC (E)	A multi-stemmed perennial herb restricted to natural grassland and margins of grassy woodland. Recorded near Sutton, c. 30km SE of the site.	Not indicated in DECC CMA search or EPBC search.	Present	Not indicated	Possible	No	No
Senecio garlandii Woolly Ragwort TSC (V) EPBC (V)	Largely restricted to dry forests on western slopes of NSW, growing on rocky outcrops and exposed ridges. Main distribution is well west of the site, but a record exists near Burrinjuck Dam c. 25 km south-west of the site.	• Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Upper Riverina Dry Sclerophyll Forests • Western Slopes Dry Sclerophyll Forests • Western Slopes Grassy Woodlands	Present	Known from B and U, predicted M	Possible	No	No
Swainsona recta Small Purple Pea TSC (E) EPBC (E)	A small perennial pea recorded on the central and south west slopes and the ACT/Queanbeyan area. It occurs in grassy woodland on undulating terrain, often stony hillsides and flowers in spring (peaking Oct).	Not indicated in DECC CMA search or EPBC search.	Present	Not indicated	Possible	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
Swainsona sericea Silky Swainson-pea TSC (V)	Recorded in Natural Temperate Grassland, Snow Gum Woodland and Box-Gum Woodland on the Monaro, Northern Tablelands and Southern Tablelands, and inland on the slopes and plains. Not recorded in the region.	• Floodplain Transition Woodlands • Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Subalpine Woodlands • Tableland Clay Grassy Woodlands • Temperate Montane Grasslands • Upper Riverina Dry Sclerophyll Forests • Western Peneplain Woodlands • Western Slopes Dry Sclerophyll Forests • Western Slopes Grassy Woodlands	Present	Known M and U.	Possible	No	Yes
Thesium australe Austral Toadflax TSC (V) EPBC (V)	A sprawling perennial herb growing in grassland and woodland, semi- parasitic on grasses, particularly kangaroo grass. Found in small populations across eastern NSW, along the coast and from the Northern to Southern Tablelands. Shows a preference for moist areas. Not recorded in the region.	• Coast and Tableland Riverine Forests • Montane Bogs and Fens • Southern Escarpment Wet Sclerophyll Forests • Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Southern Tableland Wet Sclerophyll Forests • Subalpine Woodlands • Tableland Clay Grassy Woodlands • Temperate Montane Grasslands	Present (marginal)	Known from B, predicted M. EPBC search indicates likely to occur.	Possible	No	Yes

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
ORCHIDS							
Caladenia sp Burrinjuck Burrinjuck Spider Orchid (Formerly included in *Caladenia concolor sens. lat.*) TSC (V) EPBC (V)	An undescribed terrestrial orchid recorded growing in dry open forest (including *E. goniocalyx, E. dives, E. macrorhyncha, E, mannifera, E. rossii*) with a shrubby understorey, in Burrinjuck Waters State Park and Nature Reserve, c. 20 km south-west of the site. Flowers late August-October.	Not indicated in DECC CMA search or EPBC search. *Caladenia concolor* indicated for: • Upper Riverina Dry Sclerophyll Forests • Western Slopes Dry Sclerophyll Forests	Present	Known U and B, Predicted M EPBC search indicates likely to occur (*Caladenia concolor*).	Possible	No	Yes
Diuris pedunculata Small Snake Orchid TSC (E) EPBC (E)	Terrestrial orchid favouring grassland, often in stony soils on low ridges or moist flats. Recorded in south-east tablelands at higher elevations (>1000m ASL) at Adaminaby, Bago State Forest and Snowy Plains. Flowers August-September on the Northern Tablelands (Bishop 1996), but flowering in late November at Snowy Plains (J. Miles, pers. obs.).	Not indicated in DECC CMA search.	Absent	Not indicated	None	No	No
Diuris tricolor (syn. D. *sheaffiana*) Pine Donkey Orchid, Tricolour Diuris TSC (V) EPBC (V)	Sporadically distributed from Narrandera across the western slopes to northern NSW, usually in grassy *Callitris* woodland on sandy soils in flat country or on top of small hills. Not recorded in the region.	• Floodplain Transition Woodlands • Upper Riverina Dry Sclerophyll Forests • Western Peneplain Woodlands • Western Slopes Dry Sclerophyll Forests	Absent	Known from U. EPBC search indicates may occur.	None	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
Prasophyllum petilum Tarengo Leek Orchid TSC (E) EPBC (E)	Recorded from grassy woodland in Hall cemetery, c. 55km south-east of the site, Booroowa 45km north of the site and Captains Flat, in Natural Temperate Grassland, Box-Gum Woodland or moist grassy flats, with kangaroo grass or wallaby grasses (*Austrodanthonia* spp), in silty clay-loam. The Hall and Captains Flat populations occur in areas with high watertables. Flowers Oct-Nov.	• Southern Tableland Grassy Woodlands • Tableland Clay Grassy Woodlands • Temperate Montane Grasslands	Present	Predicted M and U.	Possible	No	No
FERNS AND FERN ALLIES							
Austral Pillwort *Pilularia novae-hollandiae* TSC (E)	Recorded from suburban Sydney, Khancoban, the Riverina between Albury and Urana in shallow swamps and waterways, often among grasses and sedges, in drying mud and in roadside table drains. Recorded in the ACT in a subalpine grassy plain. Not recorded in the region.	• Floodplain Transition Woodlands • Inland Riverine Forests	Absent	Predicted U	None	No	No
ECOLOGICAL COMMUNITIES							
Aquatic ecological community in the natural drainage system of the lower Murray River catchment (TSC)				Known all 3	None	No	No
Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Peneplain; Nandewar and Brigalow Belt South Bioregions (TSC)				Known U	None	No	No
Natural Temperate Grassland of the Southern Tablelands of NSW and the ACT (EPBC)				Known all three EPBC search indicates likely to occur.	None	No	No
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC, TSC)				Known M and U, predicted B EPBC search indicates likely to occur.	Present	Yes	Yes

Threatened flora evaluation summary

Based on the above analysis, eleven threatened species have some possibility to be present at the subject site, based on known distribution or habitat requirements:

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

Of these species, only *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Cullen parvum, Swainsona sericea* and *Thesium australe* are considered to have a realistic potential to be present at the subject site, considering site quality, disturbance history, distribution ranges and the results of the field surveys.

Most of the species listed above inhabit box gum woodland communities. Targeted searches for threatened species were undertaken in the box gum woodland stands in best condition at the subject site in September and November. *Calotis glandulosa, Leucochrysum albicans, Rutidosis leptorhynchoides* and *Senecio garlandii* - are perennial and conspicuous and should have been readily recordable during field survey. *Swainsona recta* may be more difficult to detect when not flowering but its known highly restricted distribution pattern, the distance of records from the subject site, coupled with site habitat quality and disturbance history, makes the probability of its presence at the site very low.

Prasophyllum petilum is known only from ungrazed remnants of high native species diversity. At the Tarengo TSR, the Tarengo Leek Orchid grows in remnant *Themeda triandra-Bothriochloa macra* grassland (NPWS 2002). Potential habitat at the subject site was surveyed during the November flowering period for this species (it was flowering at Hall Cemetery during the survey period) and was not recorded. The potential for its presence elsewhere at the subject site is very low.

Caladenia sp Burrinjuck has moderate potential to be present in dry shrub/grass forest stands at the subject site, particularly the Broad-leaved Peppermint – Brittle Gum community in the south of cluster 7, and may not have been recordable during the survey period. The survey was conducted during the late August to October flowering period and the species was not detected, though it is unlikely to flower reliably every year, or could flower later than the survey period (16-21 September).

Three woodland species - *Swainsona sericea, Cullen parvum* and *Thesium australe* – have moderate potential to be present in less disturbed woodland at the subject site. *Ammobium craspedioides* was recorded at three of the turbine cluster ridges. *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Cullen parvum, Swainsona sericea* and *Thesium australe* have been included in the Assessment of Significance (Appendix E).

2. Threatened fauna

The Threatened Species Evaluation assesses the potential for threatened species to be present at the proposal site, based on available habitat, known ecological requirements, local distribution records and the results of online database searches. The impact risk rating is derived from the cumulative scores of eight risk factors:

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

All factors were weighted equally, except for presence of local records as this was considered to be important to filter out species with known distribution ranges outside the study area. The risk assessment is based on the proposed works described in section 4 and the expected vegetation and habitat loss quantified in section 8. Importantly, the assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 identified in section 9.

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Amphibians						
Green and Golden Bell Frog *Litoria aurea* E TSC V EPBC	Formerly, had a wide distribution across most of NSW, although since 1990 recorded populations have become largely restricted to small, coastal or near coastal populations. This species has been recorded in a wide variety of natural and man-made waterbodies such as coastal swamps, marshes, lagoons, permanent farm dams and other excavations capable of capturing water (DEC 2005a). Habitats are generally permanent, still or slow-flowing, unpolluted waterbodies with a complexity of vegetation structure and abundance of refuge sites, although without heavy shading (DEC 2005a).	Marginal. Farm dams are accessible to stock, with little or no aquatic or fringing vegetation, and generally eroded	Has not been recorded within 20km of the site	Unlikely	Yes, farm dams near the turbines would be filled to prevent attracting birds and bats to the site, this would have impacts on amphibian species present on the site	**4**
Booroolong Frog *Litoria booroolongensis*	Occurs predominantly along the western-flowing streams of Great Dividing Range. It occurs in permanent rocky streams with fringing	Absent	This species has been recorded in	None	No	**2**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
E TSC E EPBC	vegetation cover such as ferns, sedges or grasses (DECC 2008a). Adults shelter under rocks adjacent to streams and lay their eggs under small in-stream rocks and rocky margins (Regan 2002). The majority of records are from the Tumut area.		the region, near Burrinjuck Dam.			
Yellow-spotted Bell Frog *Litoria castanea* E TSC E EPBC	Not recorded in the wild since the 1970s (DECC 2008a). It occurs in highland habitats and has only two known populations, in the New England Tableland and on the southern highland ranges from Lake George to Bombala. It occurs between 1000 and 1500 AHD in permanent ponds, wetlands and slowly moving streams with abundant emergent bulrushes and other vegetation (NPWS 2001).	Absent	Has not been recorded in the region	No	No	**0**
Southern Bell Frog *Litoria raniformis* *E TSC* V EPBC	Formerly distributed along the Murray and Murrumbidgee Rivers and their tributaries; however its current distribution is limited to isolated populations in the Coleambally Irrigations area, the Lowbidgee floodplain and around Lake Victoria (DECC 2008a). This species is found in permanent swamps or billabongs along floodplains and river valleys.	Absent	Has not been recorded in the region	None	No	**0**
Birds						
Speckled Warbler *Pyrrholaemus saggitatus* V TSC	Occurs in a wide range of eucalypt woodland communities in the hills and tablelands of the Great Dividing range. Habitats typically are structurally diverse with a grassy understorey, a sparse shrub layer and an open canopy (DECC 2008a; Watson et al. 2001). Declines have been linked to habitat fragmentation as the species appears to be locally extinct in districts where no habitat fragments larger than 100ha remain (Watson et al. 2001). Further, larger remnants (about 300ha) may be required for populations to be viable (Gardner 2002a). The species is sedentary and nests and forages on the ground. Nests are built directly on the ground amongst leaf litter and understorey vegetation and are vulnerable to predation by large birds such as Currawongs (Gardner 2002b).	Present	Recorded at subject site (cluster 4). Also recorded in Mundoonen Nature Reserve near Gunning.	Presence confirmed	Yes; the development would occur adjacent to remnant woodland habitats.	**6**
Square-tailed Kite *Lophoictinia isura* V TSC	Has a large and sparsely populated range throughout mainland Australia (Griffin and Clarke 2002) and is a breeding migrant to the south east from July to December. It occurs primarily in coastal and sub-coastal open forest, woodlands and mallee. It has been recorded inland along timbered watercourses and adjacent areas	Present	This species has been recorded in the region, in the Mundoonen Nature Reserve	Possible	Yes, this species may be impacted by removal of woodland habitat and blade-strike	**8**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	(NPWS 1999e). The species hunts small passerines, especially honeyeaters in the tree canopy. Resident pairs have large hunting ranges of greater than 100 km² (DECC 2008a). Nests are a platform of sticks up to 90cm in diameter in a fork of a tall tree in forest or woodland (DEC 2004).		near Gunning.			
Blue Billed Duck *Oxyura australis* V TSC	Widespread in NSW although is most common in the southern Murray-Darling Basin area. During spring and summer birds travel up to 300km from non-breeding areas on the Murray River system and coastal lakes to breed in deep swamps of inland NSW (NPWS 1999b). They are often seen in coastal areas in summer and during drought (DECC 2008a). Feeding occurs in permanent freshwater wetlands and swamps with deep water and dense aquatic vegetation. Nesting occurs in Cumbungi over deep water or in dense wetland vegetation.	Not present, however species may fly between Lake Burrinjuck inland to breed	This species has been recorded in the region near the Murrumbidgee River, Bundarbo, c. 25km south west of the site.	Vagrant	Yes, habitat is not present, however the species has been recorded in the region and may be at risk of blade-strike	**5**
Freckled Duck *Stictonetta naevosa* V TSC	Occurs on wetlands of inland NSW. Large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina are a breeding stronghold (DECC 2008a). The species is partially migratory and may move to coastal habitats during severe inland drought. The species inhabits a variety of plankton-rich wetland types, including swamps, lakes farm dams, sewerage ponds and floodwaters that are heavily vegetated with Cumbungi, Lignum, Canegrass or Tea-tree (DECC 2008a).	Absent, however may move across the site to Lake Burrinjuck during drier periods	Has been recorded from Lake George (c. 80km east of the site)	Vagrant	No, although there is potential for blade strike, the species has not been recorded in the region and is unlikely to pass over the site.	**3**
Australasian Bittern *Botaurus poiciloptilus* V TSC	Widespread although uncommon over south-eastern Australia (DECC 2008a). It favours permanent shallow freshwater or brackish wetlands and swamps with dense vegetation including rushes (particularly bulrushes Typha spp.), sedges and reeds (Garnett and Crowley 2000; NPWS 1999a). This species are mainly sedentary although sightings are occasionally irruptive (suddenly occurring in great numbers) after heavy rains.	Absent	Known from Lake George	Unlikely	No, habitat is not present and the species has not been recorded from the locality. Local movements would be more likely restricted to wet habitat corridors and wetlands which occur adjacent to the site.	**3**
Bush Stone-curlew	Has a broad distribution although has suffered severe declines	Present, however	Not recorded	Unlikely	No, this species is	**4**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Burhinus grallarius E TSC	throughout its range, particularly in disturbed and fragmented areas and where foxes are common (DEC 2006a). In NSW, it is not found on the escarpments but on lower elevation grassy woodlands of the coast or west of the divide. The area bounded roughly by Albury, Wagga Wagga, Hay and Wentworth is regarded as the stronghold for the species in NSW (DEC 2006a). This species inhabits open forests and grassy woodlands where it builds nests directly on the ground (DECC 2008a). It requires logs, fallen trees and branches, course litter and some shrubs for shelter. Foraging may occur over a wide area within woodlands, paddocks, grasslands, residential gardens and saltmarsh (DEC 2006a). Breeding pairs are generally sedentary within home ranges estimated to be 250-600ha for foraging year round, with a core of 10-25ha during breeding. It is very vulnerable to predation by exotic predators, the clearing of native woodlands, habitat degradation and even trampling by stock.	no records from region	from the region. Records are from the coast or Wagga Wagga		sedentary and has not been recorded from the locality. Therefore it is unlikely to be impacted by the proposal	
Gang-gang Cockatoo *Callocephalon fimbriatum* V TSC	In NSW, distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the ACT. It feeds in pairs or small flocks on seeds of eucalypts and wattles, and occurs primarily in heavily timbered and mature wet forest, but occasionally in towns, farming areas (DECC 2008a). It is often a seasonal altitudinal migrant, moving to lower altitudes and more open forests and woodlands (particularly Box-Ironbark assemblages for winter. This species requires large hollows in which to breed (Gibbons and Lindenmayer 2000)	Present, however habitat is open	This species has been recorded in the region, south of Binalong, c. 9km east of the site.	Possible	Yes. Breeding (hollow-bearing trees) and foraging habitat is present within the development envelope. Potential for collision with turbine blades.	**9**
Brown Treecreeper (eastern subspecies) *Climacteris picumnus Victoriae* V TSC	Occurs in eucalypt woodlands, mallee and drier open forest on inland slopes and plains of the Great Dividing Range (DECC 2008a). Populations have declined over much of their range, particularly in fragments smaller than 300 hectares that have been isolated or fragmented for more than 50 years (Barrett et al. 1994; DECC 2008a). Declines in NSW have been attributed primarily to habitat fragmentation which limits dispersal and recruitment (Cooper and Walters, 2002; Walters et al. 1999). The species occurs in eucalypt woodlands dominated by stringybarks or other rough-barked eucalypts with an open canopy and sparse understorey and shrub layer (DECC 2008a). It is sedentary and gregarious and nests in tree	Present, however woodland habitats on the site are highly fragmented	This species has been recorded in the region near the Murrumbidgee River, Bundarbo; west of the Burrinjuck Dam.	Possible	Yes, Although continuous woodland habitat is not present within the development envelope, some collision risk	**5**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	hollows. It forages for insects on tree trunks and on the ground amongst fallen timber and leaf litter.					
Diamond Firetail *Stagonopleura guttata* V TSC	Widely distributed in NSW, occurring predominantly west of the Great Dividing Range, although populations are known from drier coastal areas near Sydney, the Hunter Valley and the Bega Valley. Habitat is grassy eucalypt woodlands, including Box-Gum and Snow Gum assemblages (DECC 2008a). The species may also occur in open grassy forest, mallee, Natural Temperate Grassland, secondary grassland and lightly wooded farmland. The species is gregarious and primarily sedentary. It forages on the ground for grass seeds and other plant material and nests in shrubby understorey and will nest in mistletoe (Cooney and Watson 2005; DECC 2008a).	Present	Recorded at the Marilba Hills subject site (east of cluster 3 and east of cluster 4)	Presence confirmed	Yes, grassy woodland habitat is present within the development envelope.	**7**
Brolga *Grus rubicunda* E TSC	Formerly found across Australia, except for the south-east corner. It inhibits large open wetlands, grassy plains, coastal mudflats and irrigated croplands. Breeding and foraging habitat includes shallow (< 50 cm) wetlands, mudflats and margins of deeper waterbodies with emergent vegetation (e.g. canegrass, lignum or sedges) (DECC 2008a).	Absent	Has not been recorded from the region, records are clustered inland from Wagga Wagga and Forbes	None	No	**3**
Painted Honeyeater *Grantiella picta* V TSC	Primarily occurs on the inland slopes of the Great Dividing Range, although is nomadic and may occur in low densities in other parts of NSW in suitable habitat. It inhabits dry open forests and woodland including Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark open forests, also paperbark and casuarinas (DECC 2008a; Pizzey et al. 2006). It is a specialist feeder on mistletoe, particularly of genus *Amyema*, and generally requires 5 or more mistletoes per hectare (DECC 2008a). Seasonal migrant, movements are linked to the fruiting of mistletoe.	Present	Closest records are from Cootamundra and north of Young, c. 55km west of the site.	Vagrant	Yes, woodland habitat is present within the development envelope. Potential for collision impacts.	**6**
Black-chinned Honeyeater (Eastern Subspecies) *Melithreptus gularis gularis* V TSC	Widespread west of the Great Dividing Range, although has declined throughout its range due to removal and fragmentation of habitat. It inhabits the upper levels of drier open forests or woodlands most often dominated by box and ironbark eucalypts, particularly Mugga Ironbark, White Box, Grey Box, Yellow Box and	Present, however may be marginal in view of woodland fragmentation	This species has been recorded in the region near Harden-Murrumburrah c.	Vagrant	No, although woodland habitat is present, this habitat has been fragmented and disturbed, which reduces	**5**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	Forest Red Gum (DECC 2008a). A gregarious species usually seen in pairs and small groups of up to 12 birds and occupies large home ranges of at least 5 hectares. Local populations appear not to persist in remnants less than 200 ha in area (NSW Scientific Committee 2001).		35km west of the site (1992) Frogmore (60km north) and Goulburn.		the likelihood of this species occurring on the site.	
Regent Honeyeater *Anthochaera phrygia* E TSC E EPBC M EPBC	Formerly widely distributed across NSW, although has since greatly declined in numbers and range extension due to land clearing. There are now only a small number of known breeding sites in NSW, the most important of which are: Warrumbungles NP, Pilliga NR, Barraba district, central coast around Gosford, Hunter Valley, and Capertee Valley (NPWS 1999d). Most records are from box-ironbark eucalypt associations and it appears to prefer wetter fertile sites within these associations (Menkhorst et al. 1999). It is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Yellow Gum, Blakely's Red Gum and White Box (Menkhorst et al. 1999). It also occurs in riparian forests of River She-oak and wet lowland coastal forests dominated by Swamp Mahogany and Spotted Gum and (DECC 2008a; NPWS 1999d). The species can undertake large-scale nomadic movements in the order of hundreds of kilometres.	Foraging habitat present	This species has been recorded in the region, south of Binalong, c. 9km northwest of the site.	Possible	Yes, species is nomadic; potential for collision impacts. Feed tree species are present within and adjacent to the site	**9**
Gilbert's Whistler *Pachycephala inornata* V TSC	Sparsely distributed over much of the arid and semi-arid zone of inland southern Australia, west of the western slopes of NSW (DECC 2008a). There are only three separate populations left in NSW. Most of the eastern population occurs in an area enclosed by a line joining Gilgandra to Cobar, then south to Narrandera, east to Wagga Wagga, north to Wellington and back to Gilgandra. In NSW the species occurs mostly in mallee shrubland in association with Spinifex and low shrubs. It also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. In woodland habitats, the species requires a dense shrubby understorey (DECC 2008a).	Absent	No close records in region.	None	No	**1**
Hooded Robin (South eastern form)	Sparsely distributed throughout much of NSW, and is rarely found on the coast. It is sedentary and occurs in open eucalypt woodland	Present	This species has been recorded in	Possible	Yes, habitat is present within the development	**6**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Melanodryas cucullata cucullata V TSC	and scrub, often in or near cleared areas (DECC 2008a). The species generally occurs in woodland remnants with high habitat complexity (Watson et al. 2001) and uses stumps, posts or fallen timber for nesting and locating prey on the ground. Territories range from 10 to 30ha (DECC 2008a).		the region, near Blakney Creek.		envelope and has been recorded from the region	
Grey-crowned Babbler (Eastern Subspecies) *Pomatostomus temporalis temporalis* V TSC	In NSW occurs west of the Great Dividing Range and on the coast near the Hunter Valley and several locations on the north coast of NSW. It prefers Box-Gum Woodlands although also inhabits open forests, scrub lands, even farmlands and suburbs (DECC 2008a; Pizzey et al. 2006). The species is gregarious and forage on the ground on invertebrates on tree trunks and branches and by foraging amongst litter and tussocks. Territories of family groups range from one to fifty hectares (DECC 2008a).	Present	This species has been recorded from Boorowa (2000); c. 45km north of the site. Most records are west of the line between Cowra and Albury.	Unlikely, given the lack of records from the region	No, species has not been recorded from the region, no potential for collision	**4**
Swift Parrot *Lathamus discolour* E TSC E EPBC	Breeds in Tasmania, migrating to south and eastern NSW in autumn/winter where it inhabits eucalypt forests and woodlands, particularly Box-Ironbark Forests of central Victoria and southern NSW (DECC 2008a; Smales 2005). Mostly occurs on the south-west slopes. It feeds on nectar flowers of eucalypts and lerp-insects, also soft fruits and berries sometimes foraging in grass (Pizzey et al 2006). Favoured feed trees include winter flowering species such as Swamp Mahogany, Spotted Gum, Red Bloodwood, Mugga Ironbark, and White Box (DECC 2008a).	Present, foraging only	This species has been recorded near McMahons Reef (1997, within 10km of the site)	Possible	Yes, foraging habitat is present within the development envelope, potential collision risks	**7**
Turquoise Parrot *Neophema pulchella* V TSC	In NSW, typically recorded west of the escarpment in the tablelands and on the western slopes, extending to the coastal districts through the Hunter Valley (NPWS, 1999f). It occurs in grassy woodland and open forest carrying a mixed assemblage of White Box, Yellow Box, Blakely's Red Gum, Red Box and Red Stringybark (NPWS 1999f). The species will also utilise the edges of woodland, timbered ridges and creeks in farmland and nests in tree hollows, logs or posts (DECC 2008a). The species lives in pairs or small groups and forages on the ground.	Present	Records are west of the line between Cowra and Albury (45km west of the site).	Possible, although records are from west of the site	Yes, although the species has not been recorded locally, woodland habitat is present within the development envelope, collisions risks may also apply	**6**
Superb Parrot *Polytelis swainsonii*	TFound throughout eastern inland NSW. On the South-western slopes the core breeding area is roughly bounded by Cowra and	Present	Recorded at the subject site (west	Present	Yes. The species was recorded on the site	**8**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
V TSC V EPBC	Yass in the east, and Grenfell, Cootamundra and Coolac in the west (DECC 2008a). It inhabits Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. The species nests in the hollows of large trees (dead or alive) in open Box-Gum Woodland or isolated paddock trees. Species known to be for used for nesting are Blakely's Red Gum, Yellow Box, Apple Box and Red Box (DECC 2008a). It forages on the ground in grassy woodland, also on fruit, seeds and blossoms of acacias, eucalypts and mistletoes (Pizzey et al 2006).		cluster 4b) and beside Illalong Road west of the site during surveys.		within habitat that occurs within the development envelope, collision risks also apply	
Barking Owl *Ninox connivens* V TSC	Found throughout Australia except for the central arid regions and Tasmania. It has declined across much of its range across NSW and is most frequently recorded on the western slopes and plains (DECC 2008a). It occurs in dry box-dominated forest and woodlands and roosts in dense foliage of *Acacia, Casuarina* or *Eucalyptus* species. It nests in large hollows (20-46 cm diameter) of large, old eucalypts including River Red Gum, White Box, Red Box and Blakely's Red Gum (DECC 2008; NPWS 2003d). Nest and roost sites are usually near watercourses or wetlands (NPWS 2003d). The species have also been recorded in remnants of forest and woodland and in clumps of trees at farms, towns and golf courses (NPWS 2003d). Have large territories of 30 to more than 200 hectares (DECC 2008a; NPWS 2003d).	Present	This species has been recorded in the region near Jugiong Reservoir and the Burrinjuck Nature Reserve.	Possible	Yes, woodland habitat and hollow-bearing trees and present within the development envelope, nocturnal collision risks may also apply	**7**
Powerful Owl *Ninox strenua* V TSC	Occurs primarily in tall, moist productive eucalypt forests of the eastern tableland edge and the mosaic of wet and dry sclerophyll forests occurring on undulating, gentle terrain nearer the coast (DEC 2006b). Only scattered, mainly historical records are from the western slopes and plains (DECC 2008a). The species requires old hollow eucalypts in unlogged, unburnt forests for nesting, and roosts in dense mid-canopy trees or tall shrubs (She-oaks, wattles or rainforest species). Nesting and roosting habitat occurs in sheltered gullies, or within 100m of streams, creekflats or minor drainage lines (DEC 2006b). Hollows greater than 45 cm diameter and greater than 100 cm deep are required. Breeding pairs of this species defend large (300-1500hectare), permanent territories. Optimal habitat includes a tall shrub layer with abundant hollows and	Absent	This species has been recorded in the region, near Burrinjuck Dam and Burrinjuck Nature Reserve.	Unlikely	No	**3**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	supporting high densities of arboreal marsupials (DEC 2006b).					
Painted Snipe or Australian Painted Snipe *Rostratula benghalensis* E TSC V EPBC M EPBC CAMBA	In NSW, recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. It is most common in the Murray-Darling Basin (DECC 2008a). It inhabits inland and coastal ephemeral and permanent freshwater wetlands, especially where there is a cover of vegetation. It has been recorded on the margins of wetlands, dams and even sewage ponds, also found in wet pastures, marshy areas, irrigation systems, tea tree scrub and adjacent open woodlands (Pizzey and Knight 2003). The species is likely to be nomadic in response to suitable conditions, such as floods (NPWS 1999c).	Absent	This species has not been recorded in the region. Canberra (1964)	Unlikely/vagrant	No, habitat is not present and the species has not been recorded from the locality. Local movements would be more likely restricted to wet habitat corridors and wetlands which occur adjacent to the site.	**2**
White-bellied Sea-Eagle *Haliaeetus leucogaster* M EPBC CAMBA	Resident from India through southeast Asia to Australia. It occurs around coastal areas, islands and estuaries, but is also found in inland areas where there are from large rivers, wetlands and reservoirs (Pizzey et al 2006). This species is known from the area and is thought to use terrestrial as well as riparian corridors to access inland areas (R. Falconer pers. comm. 2005).	Absent	This species has been recorded along the Murrumbidgee River system near the site at Burrinjuck Dam and Yass.	Vagrant	Yes. If present at site, risks may be high, although the likelihood of presence is low.	**4**
Fork-tailed Swift *Apus pacificus* Marine overfly area M EPBC CAMBA JAMBA ROKAMBA	Breeds from central Siberia eastwards through Asia and winters south to Australia. Uncommon in eastern Australia. It spends most of its time in the air feeding on insects, occasionally roosting on cliffs or in large trees (Pizzey et al. 2006). It spends most of its life in the air feeding on insects. It occurs throughout mainland Australia, mostly west of the divide.	Present, although generally occur west of the divide	This species is uncommon in eastern Australia (Pizzey et al., 2006) Closest record is from Junee (100km west of the site, in 1980)	Vagrant	No, the site is outside this species migratory range and therefore it is highly unlikely to occur.	**4**
White-throated Needletail *Hirundapus caudacutus* M EPBC CAMBA JAMBA	Noted as one of the world's fastest birds, this species has been recorded in the airspace above woodlands, forests and farmlands (Pizzey et al 2006). It is a regular summer migrant to eastern Australia and returns to the northern hemisphere in mid-April to breed. It is often seen 'patrolling' favoured feeding grounds above ridges and hilltops. It feeds on flying insects and has been recorded	Present	This species has been recorded in the region in the Bungongo State Forest (c. 30km south of the site).	Possible	Yes, the species has been recorded locally and is at risk of collision with turbine blades	**6**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	flying at c.1000-2000m ASL over the Australian Alps (Pizzey et al. 2006).					
Rainbow Bee-eater *Merops ornatus* M EPBC	Inhabits open woodlands with sandy, loamy soil (Pizzey et al 2006); also occurs in riverbanks, sandspits, road cuttings, beaches and golf courses. It builds a burrow in sandy ground or bank cuttings. The species is a summer breeding migrant (Sept-Apr) to south-eastern Australia, but winters in northern Australia, Solomon Islands, PNG and Indonesia, moving in large flocks.	Present	This species was observed on the site and has been recorded near Jugiong Creek.	Present	Yes, Although habitat would not be impacted, the species is migratory and is therefore at risk of collision	**7**
Satin Flycatcher *Myiagra cyanoleuca* M EPBC	Normally found in heavily vegetated gullies in tall forests, woodlands wherever a shrub layer is present (Pizzey et al 2006). During migration it is often found in coastal forests, woodlands and trees in open country. It breeds mostly in south-east Australia, nesting on a dead branch 5-25m high under live foliage (Pizzey et al 2006), regularly returning to the same locality to breed. The species moves northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring.	Marginal foraging habitat. Breeding habitat unlikely.	Recorded at the site.	Possible	Yes but unlikely because breeding habitat and optimal habitat (dense gullies) are not present	**5**
Great Egret *Ardea alba* V EPBC M EPBC CAMBA, JAMBA	Occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. They prefer shallow water in rivers, estuaries, tidal mudflats, freshwater wetlands, sewerage ponds, irrigation areas and larger dams etc (Pizzey et al., 2006). They nest in treetop canopy over water in swamp woodland or mangroves (Pizzey et al., 2006).	Absent	This species has not been recorded in the region.	Unlikely	No, habitat is not available onsite. Any long-distance movements would follow wetland corridors and thereby avoid the site.	**3**
Cattle Egret *Ardea ibis/Bubulcus ibis* M EPBC CAMBA JAMBA	Found in grasslands, woodlands and wetlands. It also utilises pasture lands, paddocks and croplands where drainage is poor, often in association with cattle and other stock; wetlands, tidal mudflats and drains (Pizzey et al., 2006). Nests in swamp woodlands in groups. Originally found in Africa, Europe and Asia, the Cattle Egret is now found on nearly every continent. Occurs on the north and east coast of Australia. Partially migratory.	Present	This species has been recorded near Murrumbidgee west of the site.	Possible, on lowland pasture and dams	Yes, minor impacts would occur in lowland areas. Removal of dams may impact this species. Collision risks also apply	**7**
Latham's Snipe *Gallinago hardwickii* M EPBC JAMBA	Breeds in northern Japan and migrate to eastern Australia in during the Australian summer. The species is generally coastal and sub-coastal, although also move inland through Murray-Darling regions (Pizzey et al., 2006). It usually inhabits open, freshwater wetlands with low, dense vegetation for shelter (e.g. swamps, flooded	Absent	This species has not been recorded in the Murrumbidgee CMA catchment.	Vagrant	No, habitat is not available onsite. Any long-distance movements would follow wetland corridors and thereby	**3**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	grasslands or heathlands, around bogs and other water bodies) although can also occur in habitats with saline or brackish water, and in modified or artificial habitats including pasture, ploughed paddocks, irrigation channels and drainage ditches (DEWHA 2008). It requires areas of mud and some form of vegetative cover for feeding (DEWHA 2008).				avoid the site.	
Mammals - marsupials						
Eastern Pygmy-possum *Cercartetus nanus* V TSC	In NSW found from the coast inland as far as the Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes. It prefers woodland and heath although has been recorded in a broad range of habitats including rainforest and sclerophyll (including Box-Ironbark) forest (DECC, 2008). This species feeds largely on nectar and pollen from banksias or other proteaceous or myrtaceous shrubs incl. Melaleucas, Tea-trees and Callistemons (DECC 2008a). This species requires hollows, cracks or fissures > 2.0 cm diameter in trees, stumps or logs, bark or disused bird's nests for breeding (DECC 2008a).	Absent, woodland doesn't have shrubs	Closest record is from Mundoonen Nature Reserve near Gunning (1996).	None	No	**2**
Spotted-tailed Quoll *Dasyurus maculatus* V TSC E EPBC	Found in a variety of forest types such as rainforest, wet and dry sclerophyll forest, woodland, coastal heath and scrub, sometimes Red Gum forest along inland waterways (Menkhorst and Knight 2004). It utilises hollow-bearing trees, fallen logs, rock caves and crevices as denning and breeding sites (DECC 2008a). Mostly nocturnal it hunts mammals, birds and large arthropods. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creeklines.	Absent	This species has been recorded in the region, near Burrinjuck Dam, and Burrinjuck Nature Reserve.	Unlikely, given absence of suitable habitat	No	**2**
Yellow-bellied Glider *Petaurus australis* V TSC	Found along the eastern coast to the western slopes of the Great Dividing Range (DECC 2008a). It occurs in tall mature wet and damp eucalypt forest with high rainfall and nutrient rich soils and feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein (DECC 2008a; Menkhorst and Knight, 2004). A large number of eucalypt species are used as sap trees throughout the range (NPWS 2003f). Have large home ranges between 20 to 85 ha to encompass	Absent	This species has been recorded in the region, near Burrinjuck Dam. Burrinjuck Nature Reserve.	None	No	**2**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	dispersed and seasonally variable food resources. Trees with hollows >10 cm diameter are required for nesting in eucalypt forests.					
Squirrel Glider *Petaurus norfolcensis* V TSC	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas (DECC 2008a). It prefers mixed species stands with a shrub or Acacia understorey although will occur in areas where no understorey if there is more than one species of Eucalypt. Feeds on insects, nectar and exudates from leaves and trees (*Eucalyptus* and *Acacia*) and requires abundant tree hollows greater than 5cm diameter. It can use patches less than 1 ha & isolated trees if within 75 m of other patches (DECC 2008a). Has a mean home range of 1.4–2.8 ha (Quin, 1995; Ree and Bennett 2003).	Present	This species has been recorded in the region, near Burrinjuck Dam. and Bungongo State Forest	Possible	Yes, potential woodland habitat is present within the development envelope	**6**
Brush-tailed Phascogale *Phascogale tapoatafa* V TSC	Found in a variety of forest types although prefers dry sclerophyll forest with a sparse groundcover (DECC, 2008a). It generally occurs in areas where the annual rainfall exceeds 500mm. Have large overlapping territories between 20 – 100 hectares. It requires tree hollows with openings 25-40mm wide for nesting and utilises multiple trees throughout its lifetime. Prefer large trees and are most abundant where there are more than 2 trees per ha greater than 60cm DBH. It requires remnants greater than 25ha in dry forests and ridges.	Present, although marginal due to fragmentation	No records from the Murrumbidgee CMA	Unlikely	No	**4**
Koala *Phascolarctos cinereus* V TSC	Was historically abundant in the south of NSW, although now occurs in sparse and possibly disjunct populations. It occurs in woodland communities, coastal forests, woodlands of the tablelands and western slopes and the riparian communities of the western plains (NPWS, 2003e). May also utilise isolated paddock trees (NPWS, 2003e). Primary feed tree species listed for the central and southern tablelands are Ribbon Gum and River Red Gum, secondary species include Candle Bark, Blakely's Red Gum, White Box, Yellow Box and Brittle Gum (NPWS 2003e).	Present	This species has been recorded c. 8km east of the site (2004)	Possible	Yes, secondary feed tree species are located within the development envelope	**6**
Mammals – micro bats						
Little Pied Bat	Though the species is recorded in a wide variety of habitats, they	Present, although	This species has	Unlikely	No, the species is not	**0**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Chalinolobus picatus V TSC	are mainly found in arid inland areas. Prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998,DECC 2005, DECC 2008a). It roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. It often forages along watercourses (Menkhorst and Knight 2003) where it feeds on moths and possibly other flying invertebrates. Foraging occurs within the canopy (or subcanopy), as with most of the Vespertilinidae in Australia. A sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 kilometres to gain access to water in more arid environments (Queensland Murray Darling Basin Commission, 2008).	very marginal	been recorded in the region north of Yass.		likely to occur at the site.	
Eastern False Pipistrelle *Falsistrellus tasmaniensis* V TSC	Occurs on the south-east coast and ranges of NSW. It tends to prefer moist forests with tall trees. It roosts in tree hollows, under bark, or in buildings. The species hibernates in winter (DECC 2008a)	Marginal	Recorded at Carroll's Ridge to south, and Cuumbeun Nature Reserve, near Queanbeyan	Possible	Yes but low likelihood dur to marginal range and habitat.	**4**
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis* V TSC	A common although a vulnerable species that is likely to be widely distributed throughout the region. It roosts and raises its young in caves and mine tunnels (Strahan 1995). The species appears to forage above the forest canopy in a diverse range of forest types (Strahan 1995).	Foraging habitat is present on the site	**Recorded on the site.** Wee Jasper Caves is a known breeding site, c. 35km south of the site.	Present	Yes, collision and barotrauma risk is present. Foraging habitat is located within the development envelope	**7**
Greater Long-eared bat (south-eastern form)/ Eastern Long-eared Bat *Nyctophilus timoriensis* V TSC V EPBC	The species prefers more arid regions, the distribution of the south eastern form approximately coincides with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. This species inhabits a variety of vegetation types, including mallee, bulloke but more commonly box/ironbark/cypress-pine communities that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (DECC 2008a). It is a slow flying agile species and forages in the lower parts of the canopy, even amongst the shrub layers and on the ground (Menkhorst and Knight 2001) and often over water bodies. The	Present, although very marginal	This species has not been recorded in the region. Closest records are from south of Tumut, more than 70km from the site	Unlikely	No, the species is not likely to occur at the site.	**0**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	species roosts in tree hollows, and under loose bark.					
Large-footed Myotis *Myotis macropus* V TSC	Found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers (DECC 2008a). It forages on the surface of water bodies such as rivers, lakes and swamps. It roosts in small groups in caves, mine, tunnels and old buildings (Hall & Richards 1979).	Foraging habitat (dams and Jugiong Creek) is present on the site	**Possible record at site.** Most records of this species are from west of the dividing range although there is a single record from Wee Jasper c. 35km south of the site.	Vagrant, given that the site is more than 100km from the coast	Yes, potential foraging habitat (dams) would be impacted. Collision and barotrauma risk also exists.	**6**
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* V TSC	A wide-ranging species across northern and eastern Australia. It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (DECC 2008a). The species is sedentary and possibly territorial. Southern populations probably migrate northwards in winter (Strahan 1996). A fast flying species with low maneuverability, it favours a range of insect species, mainly beetles (Churchill 1996; Richards 2001). The species may favour habitat in large tracts that has extensive understorey flora (shrubs)(Richards 2005).	Present, although marginal	**Possible record at site.** Known from U Recorded at Carroll's Ridge to south	Possible	Possible	**9**
Mammals - rodents						
Smoky Mouse *Pseudomys fumeus* E TSC E EPBC	In NSW, there are 3 records from Kosciuszko National Park and 2 records adjacent to the park in Bondo and Ingbyra State Forests; the remainder are centred around Mt Poole, Nullica State Forest and the adjoining S. E. Forests National Park. The species has been recorded on heathy ridge tops and slopes within sclerophyll forests, heathland and open forest from the coast to sub-alpine regions (DECC 2008a). It forages o seeds and fruits from leguminous shrubs, some invertebrates and fungi.	Absent	Not recorded in the region	None	No	**0**
Reptiles						
Little Whip Snake *Suta flagellum* V TSC	Found within an area bounded by Crookwell in the north, Bombala in the south, Tumbarumba to the west and Braidwood to the east (DECC 2008a). It occurs in Natural Temperate Grasslands and grassy woodlands, including those dominated by Snow Gum or Yellow Box	Present	Not recorded in the region.	Unlikely, beyond the known distribution	Unlikely	**4**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	as well as secondary grasslands derived from clearing of woodlands. It is commonly found on well-drained hillsides with loose scattered rocks.					
Pink-tailed Legless or Worm Lizard *Aprasia parapulchella* V TSC V EPBC	Known only from the Central and Southern Tablelands, and the South Western Slopes (Osborne and Jones 1995). This species inhabits sloping, open woodland areas with predominantly native grass groundlayers, particularly those dominated by Kangaroo Grass (*Themeda australis*). Typically these areas are well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks in burrows below these rocks; the burrows usually have been constructed by and are often still inhabited by small black ants and termites (Osborne and Jones, 1995). This species feeds on the larvae and eggs of these ants (DECC 2008a).	Present, however most rocky habitat is heavily grazed	The closest record is from Boorowa (2001), c. 35km north of the site.	Possible	Yes, potential habitat (rock outcrops) is located within the turbine development envelope	**6**
Striped Legless Lizard *Delma impar* V TSC V EPBC	Populations are known in the Goulburn, Yass, Queanbeyan, Cooma and Tumut areas. It inhabits temperate lowland grasslands, secondary grasslands and occasionally in open Box-Gum Woodland. It has been recorded at sites dominated by introduced species (such as *Phalaris aquatica, Nasella trichotoma* and *Hypocharis radicata*) and sites with a history of grazing and pasture improvement (Smith and Robertson, 1999). Shelters in grass tussocks, thick ground cover, soil cracks, under rocks, spider burrows, and ground debris such as timber. The key to their survival in rural areas may be the availability of shelter during disturbance events (Smith and Robertson, 1999).	Present	This species has been recorded in the region near Yass (1997).	Possible	Yes, potential habitat (rock outcrops) is located within the turbine development envelope	**6**
Rosenberg's Goanna *Varanus rosenbergi* V TSC	Occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. It is found in heath, open forest and woodland. It is known to nest in termite mounds and feeds on carrion, birds, eggs, reptiles and small mammals. Individuals require large areas of habitat.	Absent	This species has not been recorded in the region	Unlikely	No	**0**
Grassland Earless Dragon *Tympanocryptis pinguicolla* E TSC	Historical range in NSW is from Bathurst to Cooma, although now the only known populations are in the ACT and at Queanbeyan, Cooma and Nimmitabel. Inhabits natural grassland dominated by	Present (marginal)	This species has not been recorded in the	Unlikely, beyond the known extant distribution	No	**4**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
E EPBC	*Austrodanthonia* spp, *Austrostipa* spp, *Poa sieberiana*, *Bothriochloa macra* and occasionally *Themeda triandra*, particularly open structured sires with bare patches. Has been captured in secondary grassland (DECC 2009). Feeds on invertebrates, shelters in spider holes and under rocks.		region			
Fish						
Macquarie Perch *Macquaria australasica* V TSC E EPBC	A riverine, schooling species. It prefers deep, rocky holes with considerable cover and a substrate of small boulders, pebbles and gravel. Occurs within rivers, dams and tributaries in Southern NSW (Ecology Lab 2003), but mainly in the upper reaches of rivers and streams where siltation levels are low. The species appears to prefer pools with cover.	Absent	Recorded from Yass	None	No	**0**
Murray Cod *Maccullochella peelii peelii* V EPBC	Occurs throughout most of the Murray-Darling system, mainly in slow-flowing turbid rivers often among submerged trees and flood debris (Allen 1989).	Absent	-	None	No	**0**
Invertebrates						
Golden Sun Moth *Synemon plana* E TSC CE EPBC	Distributed in an area of NSW between Queanbeyan, Gunning, Young and Tumut (DECC 2008a). It occurs in grassy Box-Gum woodlands and natural temperate grasslands, typically low, open and dominated by several wallaby grass species. Also may be associated with spear-grasses (*Austrostipa* spp.) or Kangaroo Grass (*Themeda australis*).	Present	Closest record is from Queanbeyan	Unlikely, site is beyond the known distribution of the species	No	**2**

Threatened fauna evaluation summary

The assessment presented in Table C2 has identified that 25 threatened or migratory fauna species have potential to be present at the subject site and score a risk rating of at least 5.

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

Species with an impact rating of 5 and above have been assessed for their potential to be significantly impacted by the proposal (Appendices E and F).

The potential impact of the proposal on these species is assessed in an Assessment of Significance presented in Appendix E.

Appendix D **BIRD AND BAT IMPACT RISK ASSESSMENT**

D.1. Threatened species risk potential matrix

This risk assessment incorporates all bird and bat species listed as threatened or migratory under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* which have been recorded in the CMA sub-regions or are included on the EPBC Act Matters of National Environmental Significance search report. A number of non-threatened species have been added which are known from the area and considered to be potentially at risk.

The impact risk rating is derived from the cumulative scores of eight risk factors. Factors were weighted equally, except for presence of local records as this was considered to be important to filter out species with known distribution ranges outside the study area. Species with cumulative risk scores of 5 and above are included in the relevant Assessments of Significance in Appendices E and F.

The risk assessment is based on the proposed works described in section 3 and the expected vegetation and habitat loss quantified in section 7. The assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 (refer mitigation measures in section 8).

Threatened bird and bat species risk potential matrix

Species	Impact type	Risk factors								Cumulative risk score
		Occurs locally (2 points)	Breeding habitat present	Breeding habitat potentially impacted	Foraging habitat present	Foraging habitat potentially impacted	Use of turbine ridge airspace	Flocking or gregarious	Migratory or nomadic	
Gang-gang Cockatoo	Collision risk Habitat removal	2	1	1	1	1	1	1	1	**9**
Regent Honeyeater	Collision risk Habitat removal	2	1	1	1	1	1	1	1	**9**
Square-tailed Kite	Collision risk Habitat removal	2	1	1	1	1	1	0	1	**8**
Superb Parrot	Collision risk Habitat removal	2 Recorded at subject site	1	1	1	1	1	1	0	**8**
Diamond Firetail	Collision risk Habitat removal	2 Recorded at subject site	1	1	1	1	0	1	0	**7**
Black-chinned Honeyeater	Collision risk Habitat removal	0	1	1	1	1	1	1	1	**7**
Swift Parrot	Collision risk Habitat removal	2	0	0	1	1	1	1	1	**7**
Barking Owl	Collision risk Habitat removal	2	1	1	1	1	1	0	0	**7**
Rainbow Bee-eater	Collision risk	2	1	0	1	0	1	1	1	**7**
Cattle Egret	Collision risk	2	0	0	1	1	1	1	1	**7**
Speckled Warbler	Habitat removal	2 Recorded at subject site	1	1	1	1	0	0	0	**6**
Brown Treecreeper	Habitat removal	2	1	1	1	1	0	0	0	**6**
Painted Honeyeater	Collision risk Habitat removal	0	1	1	1	1	1	1	0	**6**
Hooded Robin	Habitat removal	2	1	1	1	1	0	0	0	**6**
Turquoise Parrot	Collision risk Habitat removal	0	1	1	1	1	1	1	0	**6**
White-throated Needletail	Collision risk	2	0	0	1	0	1	1	1	**6**
Blue-billed Duck	Collision risk	2	0	0	0	0	1	1	1	**5**
Bush Stone-curlew	Habitat removal	0	1	1	1	1	0	0	0	**4**
Grey-crowned Babbler	Habitat removal	0	1	1	1	1	0	0	0	**4**
White-bellied Sea-Eagle	Collision risk	2	0	0	0	0	1	0	1	**4**

Species	Impact type	Risk factors								Cumulative risk score
		Occurs locally (2 points)	Breeding habitat present	Breeding habitat potentially impacted	Foraging habitat present	Foraging habitat potentially impacted	Use of turbine ridge airspace	Flocking or gregarious	Migratory or nomadic	
Fork-tailed Swift	Collision risk	0	0	0	1	0	1	1	1	**4**
Satin Flycatcher	Collision risk	2	0	0	1	0	1	0	1	**5**
Freckled Duck	Collision risk	0	0	0	0	0	1	1	1	**3**
Australasian Bittern	Collision risk	0	0	0	0	0	1	1	1	**3**
Brolga	Collision risk	0	0	0	0	0	1	1	1	**3**
Powerful Owl	none	2	0	0	0	0	1	0	0	**3**
Great Egret	Collision risk	0	0	0	0	0	1	1	1	**3**
Latham's Snipe	Collision risk	0	0	0	0	0	1	1	1	**3**
Australian Painted Snipe	Collision risk	0	0	0	0	0	1	0	1	**2**
Gilbert's Whistler	none	0	0	0	0	0	1	0	0	**1**
Eastern False Pipistrelle	Collision risk Habitat removal	2	0	0	0	0	1	1	0	**4**
Large-footed Myotis	Collision/barotrauma risk	2	0	0	1	1	1	1	0	**6**
Yellow-bellied Sheathtail-bat	Collision/barotrauma risk Habitat removal	2	1	1	1	1	1	1	1	**9**
Eastern Long-eared Bat	Collision/barotrauma risk	0	1	1	1	1	1	0	0	**5**
Little Pied Bat	Collision/barotrauma risk Habitat removal	2 (unlikely at site)	1	1	1	1	1	1	0	**8**
Eastern Bentwing-bat	Collision/barotrauma risk	2	0	0	1	1	1	1	1	**7**

D.2. Vulnerable bird group risk assessment

This assessment focuses on vulnerable bird groups considered to be particularly vulnerable to wind farm developments; raptors, waterbirds and migratory species, and rare or threatened species. Threatened species potentially at significant risk have been identified in the matrix in section D.1 and the significance of potential impacts to these species is assessed in Appendix E.

The assessment identifies and evaluates risk of significant impact posed by the proposed wind farm development at Marilba Hills Precinct in terms of:

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

This risk assessment is qualitative, combining assessments of likelihood and consequence to produce a final risk assessment of low, moderate or high risk for selected species. Likelihood incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and bladestrike in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status. The risk rating assumes the implementation of relevant mitigation measures identified in section 8 of the Biodiversity Assessment.

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

The impacts of the proposal on habitat and habitat utilisation are further addressed in chapter 7 of the Biodiversity Assessment. Chapter 7 also briefly reviews experiences at wind farms in Australia and overseas and identifies the bird fauna present and likely to be present at the subject site.

A number of factors may operate which affect risk by contributing to either the likelihood of collision with blades, or the significance of the consequence of bladestrike. These factors may be related to particular species, sites or development designs. Some biological/behavioural, population, environmental and development design risk factors are outlined in Box 8.1 in the Biodiversity Assessment.

RAPTORS, OWLS AND FROGMOUTHS

Wedge-tailed Eagle (*Aquila audax*)
Risk factors: Observed at site Forages in open country at blade height Large home range Male diving displays Prey source present at turbine sites Low reproductive rate Limited agility
Behaviour and ecology: Widely distributed in a range of forest and plain habitats, sedentary. Constructs large stick nests in trees. During the survey, observed singly and in a pair displaying courtship behaviour at 10-80 metres above ground level. Feeds on birds, rabbits, small mammals. Rabbits and lambs are local food sources. Rabbit warrens are present on the turbine ridges. Mortalities for the related Golden Eagle in US due to presence of prey around turbines (Thelander *et al.* 2003). Turbines with lower blade reaches were most deadly to Golden Eagles. Summer and winter had highest mortality rates (Thelander

et al. 2003). Wedge-tailed Eagles have collided with turbines in Tasmania, South Australia and Victoria. Raptors continue to be present within 1 km of the Crookwell I turbines (URS 2004). At Toora (Vic.), Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, but not into them (Brett Lane and Associates 2005). During bird behaviour surveys at Codrington, Wedge-tailed eagles were observed to avoid turbines by flying horizontally around them (twice) and turning and not entering the turbine area (Biosis Research 2002). The species has also been observed flying safely between turbines at the Toora wind farm (Wonthaggi EES Panel 2003). Collisions are possible but are not expected to be frequent or in excess of the reproductive and dispersal capacity of the regional population.		
Likelihood of habitat avoidance: moderate		Habitat importance: moderate-high
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**moderate**
	Population	**moderate-high**

Little Eagle (*Hieraaetus morphnoides*)		
Risk factors: Forages in open country at blade height Diving display flights Prey source present at turbine sites		
Behaviour and ecology: Inhabits plains, open woodlands, usually near water, timber along watercourses and lakes (Pizzey et al 2006). Soars in tight circles. Builds stick nests in trees. Uncommon but widespread. Diet includes carrion and small mammals. Like the Wedge-tailed Eagle, has become dependent on rabbits in many areas. Recorded at the subject site and observed south of the subject site soaring c. 10-80 metres above the ground (**ngh**environmental 2006).		
Likelihood of habitat avoidance: moderate		Habitat importance: moderate
Collision likelihood: low		Collision consequence: minor-moderate
Overall risk levels	**Individuals**	**moderate**
	Population	**moderate**

White-bellied Sea-eagle (*Haliaeetus leucogaster)*		
Risk factors: Forages at blade height		
Behaviour and ecology: Sedentary or nomadic. Soars in slow majestic circles, rests on prominent trees over rivers, lakes shores. Occurs singly, in pairs or family parties. Hovers low and drops to take fish and waterfowl (Pizzey et al 2006). Likely habitat occurs well south of the site on Lake Burrinjuck and Yass River. May visit site but frequency is expected to be low.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

Square-tailed Kite (*Lophoictinia isura)*		
Risk factors: Forages in open country at blade height Prey source present at turbine sites Large home range, sparse distribution		
Behaviour and ecology:		

Scattered records indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems in NSW. It is found in a variety of timbered habitats including dry woodlands and open forests, showing a particular preference for timbered watercourses. It is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. It appears to occupy large hunting ranges of more than 100km^2. Breeding is from July to February, with nest sites generally located along or near watercourses (DECC 2008a). The study area, nearby cleared lands, forest remnants and conservation reserves and lake to the south provide foraging and nesting habitat for this species. Habitat is marginal over most of the subject site because of the extent of clearing. The species is generally absent from cleared pastoral or agricultural lands (Pizzey 2006). Ridges at the subject site may provide thermals for hunting. Clusters 3, 4, 6 and 7 have remnant forest patches which could provide nesting habitat and prey species. The proposal would not result in the loss of a significant area of woodland or forest cover. Given the large range of the species, the marginal nature of habitat over most of the subject site and the presence of similar habitat in the district, the proposal is not expected to significantly affect this species at the individual or population levels.		
Likelihood of habitat avoidance: moderate		Habitat importance: low-moderate
Collision likelihood: low		Collision consequence: low-moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Australian Kestrel (*Falco cenchroides*)		
Risk factors: Forages in open country at blade height Family parties play in air currents		
Behaviour and ecology: Sedentary or nomadic. Soars around city buildings and spires (Pizzey et al 2006). Nests in tree hollows; few hollow-bearing trees are present on the turbine properties, but are scattered in farmland and remnant patches in the district. Have been known to collide with aircraft when hunting at airports, but have a relatively rapid reproductive rate (URS 2004). The species is relatively common at the Woolnorth and Codrington wind farm sites and no collisions have been recorded at those sites. Should have the capacity to habituate to turbines over time.		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Brown Falcon (*Falco berigora*)		
Risk factors: Performs tumbling and diving flight displays Soars on thermals		
Behaviour and ecology: Nests in nest of crow or hawk, makes own stick nest or uses tree hollows. Makes sloping descent to catch prey on ground (Pizzey et al 2006). This species appears able to adapt and habituate to human developments. A Brown Falcon mortality has been reported from the Codrington wind farm (Biosis Research 2002).		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: moderate		Collision consequence: low
Overall risk levels	**Individuals**	**moderate**
	Population	**low-moderate**

Peregrine Falcon (*Falco peregrinus*)		
Risk factors: Chases prey and dives at high speed		
Behaviour and ecology: Habitat most commonly gorges and timbered watercourses, generally near rivers and swamps. Nests on rock crevice, bare ledge, tree hollow or old corvid nest, also on spires and tall buildings (Pizzey et al 2006). This species appears able to adapt and habituate to human developments. Habitat at the site may be marginal for this species.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Australian Hobby, Little Falcon (*Falco longipennis*)		
Risk factors: Forages in open country at blade height Fast determined pursuit of flying birds and insects		
Behaviour and ecology: Range of open habitats, typically woodland with large trees and timbered watercourses. Often seen over cities (Pizzey et al 2006). Builds stick nest in top of tall trees. Hunts small and medium sized birds (including ducks and herons) and flying insects. Appears able to adapt and habituate to developed environments.		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Spotted Harrier (*Circus assimilis)*		
Risk factors: Forages in open country at blade height		
Behaviour and ecology: Nomadic or migratory. Soars high and very low over open country. Constructs large stick nest in eucalypts. Observed at the subject site soaring c. 20-100 metres above the turbine ridges.		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: moderate		Collision consequence: low
Overall risk levels	**Individuals**	**moderate**
	Population	**low**

Barking Owl (*Ninox connivens*), Barn Owl (*Tyto alba)* and other owl species
Risk factors: Night-flying Forages in open country
Behaviour and ecology: The Barking owl is a top order predator with a varied diet and large home range. The species hunts for arboreal mammals and birds within the tree canopy and for rabbits and other prey on the ground (NPWS 2003c). Each pair occupies a 30-200 hectare territory, depending on habitat quality (Blakers et al. 1984), although this remains speculative (NPWS 2003c). Inhabits drier forest and woodland, and has been recorded persisting around human habitation. Requires

Barking Owl (*Ninox connivens*), Barn Owl (*Tyto alba)* and other owl species		
large tree hollows for nesting and an abundance of prey species. Declining in NSW (NPWS 2003c). Recorded in Black Andrew NR c.25km SW of the site. Not recorded at the site during call playback. The species may forage and nest in remnant forest on ridgetops at the subject site, although habitat is likely to be marginal for breeding because of a paucity of hollow-bearing trees. The Barn Owl inhabits open forests, woodlands and grasslands with stands of timber, including farmlands. Nests in tree hollows. Local populations fluctuate with mice and native rodent prey populations (Pizzey et al 2006). In the arid pastoral zone of north-eastern South Australia, the diet of the Barn Owl consisted of 82 per cent mammals (74% rodents), 8 per cent birds, 10 per cent lizards and less than 1 per cent insects by biomass. The introduced House Mouse was the predominant mammal, and only rodent, recorded (Debus et al 2004). Occasionally roosts or nests in buildings, forages in cities. Rodent populations on the turbine site are expected to be small, reflected in the survey trapping results. Barn owls are not expected to use the turbine ridges for foraging on a regular or frequent basis. Forest owls are generally confined to areas with tree cover, although dispersing juveniles may fly over open country. This is expected to be a rare event at the northern turbine sites, and infrequent at the southern turbine sites. There is some risk of bladestrike. Hunting flights are likely to be at ground and canopy level. The canopy height of forest and woodland remnants around the site range from 5 to 15 metres, well below the potential bladeswept zone of 34-126 metres. These species are unlikely to enter the bladeswept zone during hunting flights.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Tawny Frogmouth (*Podargus strigoides)*		
Risk factors: Night-flying		
Behaviour and ecology: Inhabits heavy forests to open woodlands, timber along watercourses in inland areas Nests in flimsy stick platforms on branches 5-10m high. Sedentary (Pizzey et al 2006). Active at dusk, takes prey from sitting position from ground surfaces such as roads. Feeding activities are more likely of the site in timbered lowlands, and would generally occur below blade height.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

WATERBIRDS AND MIGRATORY SPECIES

Painted Snipe (*Rostratula benghalensis*)
Risk factors: Migratory Potential habitat adjacent to site
Behaviour and ecology: Little is known of the behaviour of this cryptic waterbird. Possibly nomadic; has been observed occupying ephemeral wetlands. Seeds and invertebrates are foraged for on the waters edge. Breeding is thought to occur in response to local conditions between September and December (Pringle 1987). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in

Gippsland, Victoria, including migratory wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). Habitat is likely to be marginal at the site given the small and modified nature of local water sources. There are no local records. Local migration routes are not known. Flight paths between ephemeral habitats are likely to follow watercourses, drainage lines and lowland pastures. This species does not appear to congregate in large numbers and spends most of its time foraging on the water's edge. Hence, the risk of population level impacts from collision or resource avoidance impacts would not be expected to be high for this species.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*)		
Risk factors: Migratory Potential habitat adjacent to site		
Behaviour and ecology: This species nests annually in northern Japan, where it congregates in large numbers on the shores of local lakes (Schodde & Tideman 1995). Favoured habitats during the non-breeding season include wet paddocks or shallow water with good covering of tussocks or other growth, seepage below dams, from sea level to 2000m (Pizzey et al 2006), where they probe for aquatic invertebrate and seed (Green & Osborne 1994). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory wetland species such as Lathams Snipe, concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). Habitat is likely to be marginal at the site given the small, modified and ephemeral nature of local water sources and the species is not expected to be a regular inhabitant. There are no local records. Local migration routes are not known. Flight paths between ephemeral habitats are likely to follow watercourses, drainage lines and lowland pastures.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

White Ibis (*Threskiornis molucca*)		
Risk factors: Nomadic or migratory Night-flying		
Behaviour and ecology: Occurs singly or in large flocks, typically in pastures and swamps. Flies in lines or v formations with quick wing beats and glides. Nests over water in dense trees or swamp growth. Highly nomadic, migratory or dispersive (Pizzey et al 2006). Australian White Ibises and other waterbird species demonstrate crepuscular peaks of abundance (Hamilton et al. 2004). In the Hunter Valley, the White Ibis was found to be one of the species most at risk of colliding with powerlines at night (Hunter Wetlands Research 1996 in URS 2004). In daytime bird behavioural studies at Codrington Wind Farm, where Straw-necked Ibises are abundant, 517 Ibises were observed. 476 birds adopted avoidance strategies of weaving between the turbines and 39 flew in a straight line through the site in a path that kept them well away from the turbines. There were no observed Ibis collisions and no Ibis		

carcasses have been found (Biosis Research 2002). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). White Ibises used Lake Burrinjuck, south of the site, for breeding until the recent drought (pers. comm. C. Davey CSIRO, retired, 4/11/2005). With the breaking of the drought, breeding would be expected to resume and Ibis numbers in the study area may increase. Ibis and other waterbirds may travel between Lake Burrinjuck and the large waterbodies in Canberra. They would also be expected to disperse to forage in farmland north of Lake Burrinjuck, including the study area. Flight paths between ephemeral habitats are likely to follow watercourses, drainage lines and lowland pastures. Birds moving during the day are likely to use avoidance behaviours. Because of low local habitat utilisation rates, the distance of prime habitats, and the widespread and common status of the White Ibis, the risk of night collisions is considered low.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Australian Wood Duck (*Checonetta jubata*)		
Risk factors: Swift flight, possibly with poor manoeuvrability		
Behaviour and ecology: Typically in better-watered lightly timbered pastoral country with plentiful dams. Follows courses of creeks through timber. Nests in hollow of live tree (Pizzey et al 2006). Regionally abundant, recorded in dams near the turbine ridges. Local migration routes are not known. Flight paths between between dams are likely to follow watercourses, drainage lines and lowland pastures. Unlikely to pass through the bladeswept area with high frequency.		
Likelihood of habitat avoidance: rare		Habitat importance: minor
Collision likelihood: rare		Collision consequence: minor
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

White-faced Heron (*Ardea novaehollandiae*)		
Risk factors: May form winter flocks Tendency to perch on high trees or posts		
Behaviour and ecology: Common, sedentary and nomadic, found almost wherever there is shallow water, including dams. Builds stick nest in tree (5-12 m above ground), usually near water or some distance away. May perch on dead trees and telephone posts (Pizzey et al 2006). Flight paths between between dams are likely to follow watercourses, drainage lines and lowland pastures. A recent assesssment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory and wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006).		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

White-throated Needle-tail, Spine-tailed Swift (*Hirundapus caudacutus*)		
Risk factors: Migratory High-flying Vertical flight and diving displays May form large flocks		
Behaviour and ecology: Summer migrant to Australia from Asia, mid-October to mid-April. Feed on flying insects. Occurs over cities. Roosting habits not known. Risk is lessened by limited time spent at the site and capacity to habituate to humanised landscapes. Local migration routes are not known. Recorded in Wee Jasper Nature Reserve, 30 kilometres to the south. A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory species such as the White-throated Needletail, concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006).		
Likelihood of habitat avoidance: low-moderate		Habitat importance: low
Collision likelihood: low		Collision consequence: low-moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Satin Flycatcher (*Myiagra cyanoleuca*)		
Risk factors: Migratory High-flying Vertical flight and diving displays May form large flocks		
Behaviour and ecology: Occurs singly or in pairs, usually in tops of taller trees. Breeds in SE Australia arriving from NG Aug-Oct, departing Feb-April. When breeding favours heavily vegetated gullies and taller woodlands. During migration, uses coastal forests, woodlands, scrubs, trees in open country (Pizzey et al 2006). Habitat is likely to be marginal over most of the site due to the extent of clearing. The Satin Flycatcher was recorded in Long-leaved Box woodland at the subject site (cluster 6).		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low-moderate		Collision consequence: low
Overall risk levels	**Individuals**	**Low-moderate**
	Population	**low**

THREATENED SPECIES (PASSERINES AND PARROTS)

Diamond Firetail (*Emblema guttata)*		
Risk factors: Seasonal flock aggregations Declining		
Behaviour and ecology: Sedentary. Restricted largely to ungrazed or lightly grazed woodland remnants of grassy eucalypt woodlands and sometimes lightly wooded farmland. Feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde & Tidemann 1986), nesting in pairs or communally in shrubs and small trees. May form large flocks during winter and autumn. *Recorded c.14km NE of the site (Atlas) and Wee Jasper (Bionet). Recorded at the subject site on a midslope east of cluster 3) in moderate condition box gum woodland, and a lower slope east of cluster 4 in poor-*		

moderate condition woodland. These areas are outside the development envelope and would not be impacted by the works. Research in grazing landscapes in southern NSW suggests that granivores prefer to move along densely vegetated areas (Fischer and Lindenmayer 2002a). Diamond Firetails are considered to have poor dispersal abilities and are likely to be less common away from tree cover. The cleared, exposed habitat over most of the turbine ridges is marginal.		
Likelihood of habitat avoidance: low		Habitat importance: moderate
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low**
	Population	**low**

Speckled Warbler (*Pyrrholaemus saggitatus)*		
Risk factors: Flocking behaviour Declining		
Behaviour and ecology: A sedentary, ground-dwelling bird inhabiting grassy communities including rocky ridges and gullies (DECC 2008a). Population declines exceed 40% in areas where remnants less than 100ha in size remain (Watson et al. 2001) – the species requires large, relatively undisturbed remnants (DECC 2008a). Larger remnants (about 300ha) may be required for populations to be viable (Gardner 2002a). Permanent breeding ranges occupy around 10 ha. The contiguous area of remnant woodland at cluster 4 at the subject site totals around 143 ha, in moderate and moderate-good condition. The typical habitat featuring scattered tussock grasses and sparse shrub layer, an open eucalypt canopy with some regrowth is a close match for cluster 4. The species was recorded in moderate condition woodland on an upper slope at cluster 4b. It may form mixed species feeding flocks in winter, with thornbill species. The Speckled Warbler feeds and nests on the ground, is non-migratory and is unlikely to use airspace within the turbine bladeswept zone. The proposed works would be largely confined to cleared paddock areas on the cluster 4 ridgeline and would not remove a significant area of habitat for this species at the cluster 4 site.		
Likelihood of habitat avoidance: low		Habitat importance: moderate
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low**
	Population	**low**

Regent Honeyeater (*Xanthomyxa phrygia*)		
Risk factors: Flocking Declining		
Behaviour and ecology: Forms breeding colonies or nomadic flocks of dozens (Pizzey et al 2006). Inhabits eucalypt forests and woodlands (Blakers et al. 1984), timber along watercourses, shelterbelts, gardens, mostly coastal and sub-coastal (Pizzey et al 2006). A generalist forager, feeding mainly on the nectar from a wide range of eucalypts (particularly prolifically flowering box and ironbark species) and mistletoes but also eats invertebrates and exotic fruits (Blakers et al. 1984). Key eucalypt species include Yellow Box and Blakely's Red Gum, Red Box and Red Stringybark, which occur locally. Nectar and fruit from *Amyema* mistletoes are also eaten during the breeding season. Potential habitat is present at the site, although confined to remnant woodland/forest areas. Recorded at Binalong, c.10km NW of the site *(Atlas) and east of Yass c.33km E of the site (Bionet).* Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and using the same route for return journeys (Fischer and Lindenmayer 2002a).		
Likelihood of habitat avoidance: low		Habitat importance: low

Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Superb Parrot (*Polytelis swainsonii)*

Risk factors:

Migratory (seasonal)

Limited flocking

Declining

Behaviour and ecology:

Nesting habitat on SW Slopes is often open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. Nests in tree hollows September-January in small colonies, often with more than one nest in a single tree. Blakely's Red Gum is the main source of nesting hollows (Davey 1997). At the microscale, distribution and abundance is influenced by tree cover and species composition. Nest trees tended to be older, often affected by dieback with little regeneration (Manning 2004).

A general dispersal north from Victoria after the breeding season (DNRE 1992). Migrates north in winter to the upper Namoi and Gwydir Rivers. Local migration routes are not known.

If disturbed by human activity near the nest, the Superb Parrot may display agitation and avoid entering the nest hollow (Webster 1988). It is therefore important to avoid disturbance at known nest sites during the breeding season. Egg incubation appears to be highly synchronised amongst the population, suggesting that any disruption to breeding is unlikely to be compensated by the production of a second clutch. The species is faithful to traditional nest sites (Webster 1988). Superb Parrot nest trees tend to be close to watercourses (Webster 1988).

West of Yass forms part of core breeding population in region. *Numerous Atlas and Bionet records exist around the subject site. The species was recorded at the subject site (on a midslope west of cluster 4b) and observed on numerous occasions beside Illalong Road 3 kilometres west of the site.*

In a recent survey of road verges on the NSW south-western slopes, there were 2.5 possible nesting trees per kilometre whilst just prior to the start of the breeding season there were 0.62 birds per kilometre (Davey, C. and Purchase, D. 2004).

The species feeds in trees and understorey shrubs and on the ground. Food items are mainly flowers, fruits and seeds. Forage species include Yellow Box (*E. melliodora*), Box Mistletoe (*Amyema miquelii*) and insect parasites such as lerps. Understorey food species include Common Wallaby-grass (*Austrodanthonia caespitosa*), numerous wattle species, and introduced plants including cereal grains, barley-grasses (DNRE 1992).

Records of flocks of between 20 and 50 birds were made in the Yass region only three times during spring and early summer of 1998; most records were of single birds or pairs (ACT Government 1999). The total breeding population is estimated to be less than 5000 pairs. Loose nesting colonies are often found, and form around clusters of nest trees (ACT Government 1999).

The species may forage up to 10 km from nesting sites (Webster 1988; Garnett1992a), although at some sites, including those north of Canberra, the nesting and foraging areas coincide and the birds move very little distance at all during breeding (Webster and Ahern 1992, Martin 1996, Davey 1997 in Act Government 1999). The Superb Parrot avoids open areas on foraging flights, hence simple fragmentation of the habitat can be devastating (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999).

Because of the extent of clearing and fragmentation, the majority of the turbine sites are unlikely to provide quality foraging habitat for the Superb Parrot. Little is known about seasonal migration routes; it is assumed that they move west and then north after the breeding season (A. Manning, CRES ANU, pers. comm.). No flight height data is available for this species; a variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Flights between roost/nest and foraging areas are likely to be at tree canopy level. Superb Parrots have been observed flying high over open areas in the South-West Slopes. However, they do tend to occur more in the lower elevation/relief parts of the landscape where the Box-

Gum Woodlands, including scattered paddock trees, are located - this is where nest trees and food is likely to occur (A. Manning, CRES ANU, pers. comm.). The frequency of parrots flying high over the turbine ridgetops is likely to be low. The absence of intact woodland vegetation with hollow-bearing trees and watercourses in close proximity to the turbines would mean that the risk of nest abandonment due to visual or noise disturbance would be low.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Swift Parrot (*Lathamus discolor)*		
Risk factors: Migratory (seasonal) Flocking Fast flying Declining		
Behaviour and ecology: Breeds in Tasmania and Furneaux Group islands, migrating to mainland in Feb-April, where it becomes nomadic in response to the availability of blossoms and other food (Pizzey et al 2006). Wintering flocks may remain in a district for weeks, returning as a flock to the same tree each night for roosting. A non-breeding winter migrant to southern and eastern NSW, where it inhabits eucalypt forests and woodlands (Blakers *et al* 1984). Feeds on eucalypt blossom and psyllids, particularly large prolifically flowering trees. Food sources and distribution varies year to year. Habitat is marginal over most of site due to clearing. Forest remnants provide potential habitat where the winter-flowering Long-leaved Box provides a potential food source. Recorded in Booroowa Shire to the north (NPWS 2002). The species may use habitat in the far south of the site, although Long-leaved Box stands are generally regrowth and heavily fragmented. Better habitat is likely to be present in timbered lowland areas. No flight height data is available for this species; a variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Flights between roost and foraging areas are likely to be at tree canopy level. The frequency of flights over the turbine ridges is likely to be low. A recent cumulative assessment of 39 wind farms located in the distribution range of the Swift Parrot concluded that the combined bladestrike impact of all of these wind farms would not be significant (Biosis Research 2006).		
Likelihood of habitat avoidance: rare		Habitat importance: insignificant
Collision likelihood: rare		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Gang-gang Cockatoo (*Callocephalon fimbriatum)*	
Risk factors: Declining	
Behaviour and ecology: Feeds in pairs or small flocks on seeds of eucalypts and wattles, primarily in forest, but occasionally towns and farming areas for artificial food resources such as berry-bearing exotic shrubs. It is a seasonal altitudinal migrant. Nesting is in large tree hollows. Marginal forage habitat is present in forest and woodland remnants in the study area, and nesting habitat may be present in surrounding areas. Recorded at Binalong, c. 10km NW of the site and Burrinjuck NR c.17km to the SW *(Atlas). Unlikely to use the turbine ridges for foraging due to scarcity of eucalypts. May pass over ridgelines at blade height on longer-distance flights. Frequency of visit to site likely to be low.*	
Likelihood of habitat avoidance: low	Habitat importance: low

Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

D 3. Impact potential for microbat species at the subject site

This assessment focuses on microbat species which have some potential to be present at the subject site. Threatened microbat species which are potentially at significant risk have been identified in the matrix in section D.1 and the significance of potential impacts to these species is assessed in Appendix E.

Species	Ecology	Potential for impact	
Goulds Wattled Bat *Chalinolobus gouldii* ID confidence: positive Recorded habitats: forest	Abundant. Forages below the canopy for slow-flying insects, particularly along waterways, seldom more than 20 metres above the ground. Roosts in tree holes or buildings.	**Individual**	Low
		Population	Low
Chocolate Wattled Bat *Chalinolobus morio* ID confidence: positive Recorded habitats: forest, dam	Common. Highly agile, feeding mainly on small moths. Roosts in tree hollows. Colonies range from 20 to several hundred. Starts hibernation later than other species.	**Individual**	Low-moderate
		Population	Low
Little Pied Bat *Chalinolobus picatus* Not recorded at site	Primarily an arid and semi-arid species. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. Needs access to nearby open water. Feeds on moths and possibly other flying invertebrates. Unlikely to be present at site.	**Individual**	Low
		Population	Low
Eastern Bentwing Bat *Miniopterus schreibersii* ID confidence: probable Recorded habitats: ridgetop	Abundant. Range of habitats, typically well timbered habitats, feeding above the canopy. Constrained by requirement for caves for breeding. Each population uses a single maternity site. Other caves extending for several hundred kilometres from the maternity site are used the rest of the year (ABS 2000). Maternity caves located at Wee Jasper, 30km to the south (ABS 2000). Also r*ecorded south of Lake Burrinjuck, c.10km S of the site (Atlas)* and Booroowa Shire to the north (NPWS 2002). Refer Appendix E NSW Assessment of Significance for more discussion.	**Individual**	Moderate
		Population	Requires further assessment
Mormopterus sp.no.4 ID confidence: positive Recorded habitats[1]: forest, dam, woodland	Little known; presumed to be an agile, fast-flying predator feeding on flying insects above and beside the forest canopy and over water, roosting in hollows communally or singly.	**Individual**	Moderate
		Population	Low
Mormopterus sp.no.3 ID confidence: probable Recorded habitats[1]: forest, woodland	Little known; presumed to be an agile, fast-flying predator feeding on flying insects above and beside the forest canopy and over water, roosting in hollows communally or singly.	**Individual**	Moderate
		Population	Low
Eastern Freetail Bat *Mormopterus norfolkensis* Not recorded at site	Appears to be a fast-flying predator, hunting above and below the canopy and over water. Roosts singly or small colonies in tree holes, rock crevices or roofs.	**Individual**	Moderate
		Population	Low
Large-footed Myotis *Myotis macropus* Not recorded at site	Comparatively rare over limited range. Forages for aquatic invertebrates and small fish over water bodies. Roosts in small colonies in caves, mines, buildings and under bridges. May forage and migrate in groups. Also recorded near Wee Jasper, c.30km S of the site (Bionet). Refer Appendix D NSW	**Individual**	Low
		Population	Low

	Assessment of Significance for more discussion.		
Long-eared Bat *Nyctophilus geoffroyi/gouldi complex* ID confidence: positive Recorded habitats: forest, dam, woodland	Possibly the most wide-ranging bat in Australia, abundant throughout range, adapted to human presence, even inner city environments. Roosts in variety of locations such as under barks, roofs, hanging awnings. Short-range echo-location system and hunts very near to the ground. Maternity colonies form in spring of 10-100 individuals.	**Individual**	Low
		Population	Low
Inland Broad-nosed Bat *Scotorepens balstoni* ID confidence: positive Recorded habitats: forest, dam	Common (*S. greyii*). Habits of both species similar. Inhabit open woodlands and plains; water holes and creeks are favoured feeding areas. Takes occasional drinks by skimming surface of still waters. Requires nightly access to drinking water. Roosts mainly in tree hollows or disused buildings. Colonies range in size from a pair to about 20 individuals.	**Individual**	Low
Little Broad-nosed Bat *Scotorepens greyii* ID confidence: positive Recorded habitats: forest, dam		**Population**	Low
Yellow bellied Sheathtail Bat *Saccolaimus flaviventris* Possible record at site	Rare in widespread habitat. Seldom trapped, presumed to forage high and fast above the tree canopy, lower in open country. A fast flying species with low maneuverability. Roosts in tree hollows, mammal burrows in treeless areas, usually solitary, occasionally in colonies of up to 10 individuals. Appears to defend an aerial territory. Southern populations probably migrate northwards in winter (Strahan 1996). Recorded in Booroowa Shire to the north (NPWS 2002) and a possible record during Marilba Hills survey.	**Individual**	Moderate
		Population	Requires further assessment
White-striped Freetail bat *Tadarida australis* (*syn. Nyctinomus australis*) ID confidence: positive Recorded habitats: woodland	Common to uncommon in widespread habitat. Forages on the ground for terrestrial insects and above the canopy, particularly along waterways for flying insects, including high-flying moths. Roosts in tree holes.	**Individual**	Moderate
		Population	Low-moderate
Large Forest Bat *Vespadelus darlingtoni* ID confidence: positive Recorded habitats: forest, dam	Inhabits alpine heaths to rainforests. Flies fast below the canopy. Roosts in tree holes and similar crevices, in colonies up to 50.	**Individual**	Low
		Population	Low
Southern Forest Bat *Vespadelus regulus* ID confidence: positive Recorded habitats: forest, dam	Common, limited. Agile fast-flying bat feeding on flying insects (especially moths). Roost in tree holes, in colonies of up to 9 individuals, often with other species. Maternity colonies form in late spring.	**Individual**	Low
		Population	Low
Little Forest Bat *Vespadelus vulternus* ID confidence: positive Recorded habitats: forest, dam	Common, limited in some areas. Agile, feeds on flying insects just under tree canopy to 2 metres above the ground. Roost in tree holes or old buildings, solitary or in colonies of up to 50.	**Individual**	Low
		Population	Low
Eastern False Pipistrelle or Great Pipistrelle *Falsistrellus tasmaniensis* Not recorded at site	Widely distributed in eastern NSW on the Dividing Range and to the east (Parnaby 1992; Strahan 1992), in a range of habitats including dry and wet sclerophyll forest, appearing to prefer wet sclerophyll (Hall and Richards 1979). Roosts in large trees and occasionally caves and buildings. Apparently hibernates during winter months and probably forages mostly above the forest canopy, in open woodland or over water (Strahan et al. 1995). Range and habitat probably marginal at site. Recorded near forest at Carroll's Ridge to south.	**Individual**	Low
		Population	Low

Appendix E **ASSESSMENT OF SIGNIFICANCE (NSW)**

Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) specifies seven factors to be taken into account in deciding whether a development is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

The following Assessment of Significance assesses the significance of the likely impacts associated with the Marilba Hills Precinct wind farm proposal on Endangered Ecological Communities and threatened flora and fauna species declared under the *Threatened Species Conservation Act 1995*..

Endangered ecological communities

The Endangered Ecological Community White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) was recorded in a range of condition classes at all of the clusters at the subject site (refer Map Set 2).

Threatened flora species

The threatened species evaluation presented in Appendix C concluded that *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Cullen parvum, Swainsona sericea* and *Thesium australe* have a realistic potential to be present at the subject site, considering site quality, disturbance history, distribution ranges and the results of the field surveys.

Threatened fauna species

The threatened species evaluation in Appendix C and the Bird and Bat Impact Risk Assessment (Appendix D) have identified 21 threatened fauna species that have potential to be present at the subject site and that score a risk rating of at least 5. These species comprise 2 arboreal marsupials, 3 microchiropteran bats, 14 bird species and 2 reptiles. Ecological, distribution and habitat information for these species is summarised in Appendices C and D.

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

FLORA

Yass Daisy (*Ammobium craspedioides*)

The Yass Daisy is a rare perennial herb, 30-60 centimetres high, inhabiting sclerophyll woodland, forest and roadsides (Harden 1992). It bears yellow button-like flowers in spring, and early summer in wet years. The Yass district is the centre of distribution for this species (Fallding 2002), and most records are confined to the district. Other records exist from near Crookwell (DEC 2005a) and in Livingstone State Forest, 20 kilometres south of Wagga Wagga (Burrows 1999).

The species has been recorded in dry forest, Box-Gum Woodland and secondary grassland derived from clearing of these communities. Associated eucalypts include *Eucalyptus blakelyi*, *E. bridgesiana*, *E. dives*, *E. goniocalyx*, *E. macrorhyncha*, *E. mannifera*, *E. melliodora*, *E. polyanthemos* and *E. rubida.* It appears to be unaffected by light grazing, with some populations persisting in grazed sites (DEC 2005a). In surveys conducted in the Booroowa Shire to the north, all of the occurrences of this species were on land characterised by a light grazing regime (NPWS 2002).

Current threats to the species include agricultural developments, intensification of grazing regimes, invasion of weeds, road works (particularly widening or re-routing) and inappropriate mowing or slashing in cemetery sites (DEC 2005a). The principal recovery actions required involve:

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

- the protection of known populations from changes to land use, road works, pasture modification, increased grazing pressures, weeds and inappropriate mowing regimes;
- marking sites and potential habitat onto maps used for farm, development and conservation planning and management; and
- searching for new populations in potential habitat (after DEC 2005a).

The species was recorded at clusters 4, 6 and 7 at the subject site. At each site, Yass Daisy colonies were sizeable (hundreds).

The cluster 4 site is fenced and apparently ungrazed. Some Yass Daisy plants were recorded in grazed pasture at this site, but only within 10 metres of colonies on ungrazed land. This suggests that the species has the capacity to colonise bare ground in grazed paddocks from a protected seed source, but may not be able to persist in the long term in heavily grazed open paddocks in the absence of such a seed source. Some plants occurring in native pasture in this area may be removed during the construction phase.

At clusters 4 and 6, and in the Coppabella Hills to the west, this species appears to favour sheltered south-facing slopes, although this may be the result of reduced clearing and grazing pressure on these aspects. The location of Yass Daisy records is shown in Map Set 2, and listed in Appendix A.

In contrast, the cluster 7 colony occurs in cleared secondary grassland on an upper valley floor and sideslopes. Several other grazing-sensitive species are present, suggesting a light grazing history.

The proposed turbine, substation, access track and powerline works would generally be sited to avoid direct and indirect impacts to the Yass Daisy colonies. A small area (0.14 ha) of woodland understorey habitat in good condition in cluster 4b (refer Map Set 2) would be cleared to provide a 350 metre long and 4.5 metre wide access track and cable trenching. The Yass Daisy colony at this site was centred some distance from the route of the proposed track (refer Map Set 2). Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The cluster 7 remnant would be excluded from the development envelope and protected from direct and indirect impacts during the works. The natural soil surface and groundcover would be retained and the track width reduced to 4.5 metres for the 350 metre long access track passing through the cluster 4b site.

Work sites adjacent to the Yass Daisy colonies would be revegetated with native tussock grasses to provide continuing potential habitat for this species. The works are not expected to adversely affect the life cycle of the Yass Daisy such that a viable local population of the species is likely to be placed at risk of extinction.

Burrinjuck Spider Orchid (*Caladenia* sp Burrinjuck)

This species has potential habitat in dry shrub forest remnants dominated by *E. goniocalyx*, *E. dives* and *E. mannifera* at clusters 4, 6 and 7. This community is very broadly analogous to known habitats in Burrinjuck Nature Reserve to the south (NPWS 2003a), particularly the Broad-leaved Peppermint – Brittle Gum community on sediments in the south of cluster 7. Forest remnants in the north of the subject site (north of the highway) occur on higher fertility volcanic substrates, rather than the infertile sediments at Burrinjuck, which may reduce habitat suitability for this species. The disturbance and grazing history further reduces the likelihood of its presence in many parts of the site.

A targeted search of the cluster 7 remnant was undertaken as part of the September fieldwork. While the fieldwork was undertaken within the late August - October flowering period for this species, it may not have been flowering or recordable at the time of survey. It is unlikely to flower reliably every year, or could flower later than the survey period (21 September). The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present at the site, works would be re-sited to avoid impacting this species. The works are not expected to adversely affect the life cycle of the Yass Daisy such that a viable local population of the species is likely to be placed at risk of extinction.

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

Small Scurf-pea *(Cullen parvum*)

Silky Purple Pea (*Swainsona sericea*)

Austral Toadflax (*Thesium australe*)

These species are restricted to box gum woodland remnants in good condition, with no or very light grazing history. Box gum woodland in relatively good condition was recorded at cluster 7 (as grazed derived grassland) and cluster 4b (ungrazed intact understorey over regenerating Blakely's Red Gum woodland). While the threatened woodland species were not recorded during the survey and are unlikely to be present at the site, they may have been inconspicuous during the survey period.

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

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

The Silky Purple Pea is an erect perennial to 10 centimetres high, flowering October-December. As noted above, grazing at the subject site over many decades is likely to have resulted in a general reduction in the density of native legumes, and the loss of some grazing-sensitive species.

Thesium australe is a sprawling perennial herb growing in grassland and woodland. It is semi-parasitic on grasses, particularly Kangaroo Grass, and shows a preference for moist areas. It is found in small populations across eastern NSW, along the coast and from the Northern to Southern Tablelands, but has not been recorded in the region. The woodland remnants at the subject site (clusters 4b and 7) have a patchy sward of Kangaroo Grass and therefore some potential to support *Thesium australe*. This species was not detected at these sites despite targeted searches. The cluster 7 remnant would be excluded from the development envelope and protected from direct and indirect impacts during the works. The natural soil surface and groundcover would be retained and the track width reduced to 4.5 metres for the 350 metre long access track passing through the cluster 4b site. The works are not expected to adversely affect the life cycle of these species such that viable local populations are likely to be placed at risk of extinction.

FAUNA

Waterbirds

Blue-billed Duck

This species is at risk primarily because of migratory and flocking behaviour. The species disperses between ephemeral and/or permanent water bodies within the region. There are several large water bodies within a 200km radius, including Lake Burrinjuck to the south, and birds travelling between them may pass over the turbine ridges and risk blade-strike. Flocking birds are most at risk of population scale impacts. The Blue-billed Duck is known to travel great distances (>300km) between water bodies, has been recorded within 100km and travels in flocks. However, Wildlife Atlas records indicate the species is more likely to follow river systems than ridges between water bodies. The proposal is unlikely to place any viable local population at risk of extinction.

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

Raptors

Square-tailed Kite, Barking Owl

The risks to these species relate to foraging behaviour and habitat. Neither of these species was detected in the study area. However, they have been recorded within potential home range distance of the study area and foraging habitat is present on site.

Square-tailed Kites occur at low densities over a very large area. The study area, nearby cleared lands, forest remnants and conservation reserves and lake to the south provide foraging and nesting habitat for this species. Habitat is marginal over most of the subject site because of the extent of clearing. The species is generally absent from cleared pastoral or agricultural lands (Pizzey 2006). Ridges at the subject site may provide thermals for hunting. Clusters 3, 4, 6 and 7 have remnant forest patches which could provide nesting habitat and prey species. The proposal would not result in the loss of a significant area of woodland or forest cover. Given the large range of the species, the marginal nature of habitat over most of the subject site and the presence of similar habitat in the district, the proposal is not expected to affect the life cycle of this species such that a viable local population would be placed at risk of extinction.

Barking Owls prey on mammals, birds and invertebrates, and prefer dense vegetation along watercourses. While generally confined to areas with tree cover, dispersing juveniles may fly over open country. This is expected to be an infrequent event at the subject site. The forest remnants located at and near the subject site provide foraging habitat, but are unlikely to support large numbers of arboreal prey species. Owls tend to use a perch and pounce method of foraging rather than soaring at height. Hunting flights are likely to be at ground and canopy level. The canopy height of forest and woodland remnants around the site range from 5 to 15 metres, well below the potential bladeswept zone of 34-126 metres. This species is unlikely to enter the bladeswept zone during hunting flights.

The proposal is not expected to affect the life cycle of this species such that a viable local population would be placed at risk of extinction.

Woodland Birds

Speckled Warbler, Diamond Firetail, Hooded Robin, Brown Treecreeper

The Speckled Warbler, Diamond Firetail and Hooded Robin forage for seeds and insects on the ground in *Eucalyptus* dominated communities with a grassy understorey and sparse shrub layer (Garnett & Crowley 2000; Hogendyk 2008; NSW Scientific Committee 2008). The Hooded Robin also utilises perches, while the Brown Treecreeper forages for invertebrates on tree trunks and on the ground amongst fallen timber and leaf litter (DECC, 2008; Hogendyk 2008). These species are sedentary and persist only in large woodland areas (100-300 ha) containing structurally diverse habitat (Barrett et al., 1994; Hogendyk 2008; NSW Scientific Committee 2008; TAMS 2005). All four species generally occur in low densities, although the Diamond Firetail and Brown Treecreeper are gregarious (Cooney & Watson 2005; DECC 2008a). The proposal would not significantly affect nesting or foraging habitat for these species. These species are unlikely to regularly or frequently use cleared, heavily grazed ridgetop habitat for foraging.

Diamond Firetails have been recorded travelling 5km during dispersal (Olsen et al. 2005). This species feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde & Tidemann 1986), nesting in pairs or communally in shrubs and small trees. They may form large flocks during winter and autumn. Research in grazing landscapes in southern NSW suggests that granivores prefer to move along densely vegetated areas (Fischer and Lindenmayer 2002a).

The Diamond Firetail (in moderate condition box gum woodland on a midslope east of cluster 3 and in poor-moderate condition woodland on a lower slope east of cluster 4) and the Speckled Warbler (in moderate condition woodland on an upper slope at cluster 4b) were recorded at the subject site. Habitat may be marginal for the other species which may require higher quality groundlayer habitat for invertebrate food sources.

While most time is spent foraging on or close to the ground, the tendency of the Diamond Firetail to flock when dispersing may place local populations at risk of collision with wind turbines. Winter-autumn would be the time of greatest risk when individuals tend to amalgamate and flocks are at their largest. Given the open nature of the

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

proposed turbine ridges, the frequency of this species entering the bladeswept zone as a flock is likely to be very low.

The Speckled Warbler was recorded in moderate condition woodland on an upper slope at cluster 4b at the subject site. It is a sedentary species which feeds and nests on the ground, and is unlikely to use airspace within the turbine bladeswept zone. This species has declined more than 40% in areas where remnants less than 100ha in size remain (Watson et al. 2001). Larger remnants (about 300ha) may be required for populations to be viable (Gardner 2002a). Warblers appear to be averse to open canopy areas, and have poor dispersal ability between fragments (Garnett & Crowley 2000). The contiguous area of remnant woodland at cluster 4 totals around 143 ha, in moderate and moderate-good condition. The proposed works would be largely confined to cleared paddock areas on the cluster 4 ridgeline and would not remove a significant area of habitat for this species or significantly add to habitat fragmentation at the cluster 4 site. Special measures would be implemented to minimise the impacts of road and powerline construction at this cluster (refer section 8).

The proposal is not expected to affect the life cycle of these woodland bird species such that viable local populations would be placed at risk of extinction.

Black-chinned Honeyeater, Regent Honeyeater, Painted Honeyeater

These arboreal honeyeaters are found at low densities in eucalypt open forests or woodlands, particularly ironbark-box and box-gum assemblages. Nomadic movements are linked to flowering events of favoured feed species (Garnett & Crowley 2000; NSW Scientific Committee, 2008).

The Regent Honeyeater prefers wetter, more fertile sites along creek flats, broad river valleys and lower slopes. It forms breeding colonies or nomadic flocks of dozens (Pizzey 2006). Inhabits eucalypt forests and woodlands (Blakers et al. 1984), timber along watercourses, shelterbelts, gardens, mostly coastal and sub-coastal (Pizzey 1985). It is a generalist forager, feeding mainly on the nectar from a wide range of eucalypts (particularly prolifically flowering box and ironbark species) and mistletoes but also eats invertebrates and exotic fruits (Blakers et al. 1984). Key eucalypt species include Yellow Box and Blakely's Red Gum, Red Box and Red Stringybark, which occur locally. Regent honeyeaters are known to undertake irruptive nomadic movements hundreds of kilometres between coastal and inland resources (DECC 2008a). It has been recorded at Binalong, north of the site.

The Painted Honeyeater occupies open eucalypt forest and woodland, and timber along watercourses. Painted Honeyeaters feed almost exclusively on mistletoe, particularly of genus *Amyema*, and generally require 5 or more mistletoes per hectare (DECC 2008a; TAMS 2005b). *Amyema* mistletoes are scattered at the subject site, and may achieve densities greater than 5/ha in some parts of the site.

The Black-chinned Honeyeater occupies taller drier eucalypt woodlands and forests and timber along watercourses, often without understorey, typically in ironbark forests (Pizzey 2006). Black-chinned honeyeaters probe for insects and glean nectar (Lollback *et al.* 2008). They tend to occur in the largest woodland patches. Feeding territories are large (at least 5 hectares) making the species locally nomadic. Stands of suitable species growing on high quality sites where nectar production is copious and relatively predictable appear to be critical to the survival of the species (Menkhorst *et al.* 1999).

Despite their mobility, local populations of these species appear not to persist in small remnants (less than 200 ha) (Garnett & Crowley 2000; NSW Scientific Committee 2008). The largest remnant at the subject site (cluster 4) is around 140 ha. Habitat at the site may be suitable, but marginal given the level of clearing and fragmentation.

None of these species were recorded in the study area. The painted honeyeater is considered unlikely to be impacted by the proposal due to low abundance of *Amyema* species over the study area. The age of regrowth trees and levels of stress of box trees in many parts of the subject site will reduce the availability of nectar for the other two species.

Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and using the same route for return journeys (Fischer and Lindenmayer 2002a).

The low quality and fragmentation of available habitat at the subject site and the low probability of these species passing through the bladeswept zone over the turbine ridges makes it unlikely that the proposal would affect the life cycle of these bird species such that viable local populations would be placed at risk of extinction.

Gang-gang Cockatoo, Swift Parrot, Superb Parrot, Turquoise Parrot

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

These parrots occupy eucalypt forest and woodland and are long lived with low fecundity. The Turquoise Parrot appears to be non-migratory, while the other species undertake nomadic and seasonal movements for breeding and foraging (Garnett and Crowley 2000).

The Turquoise Parrot lives in small groups or pairs (DECC 2008a). Nesting sites are located within a few kilometres of foraging grounds usually in tree hollows, in forests within 100 m from cleared land and 250 m from surface water (Higgins 1999). The species forages mostly on the ground for seeds of grasses and herbaceous plants, or browses on vegetable matter (Garnett and Crowley 2000).

The Gang-gang Cockatoo moves between tall mature wet sclerophyll forest for breeding (summer) and dry open eucalypt forests (winter). It feeds mostly in the canopy on seeds of eucalypt trees and shrubs and may also eat invertebrates (Cameron 2007). It nests in large hollows (NSW Scientific Committee 2008) between October and January, usually in tall mature sclerophyll forests that have a dense understorey, and occasionally in coastal forests. Nests are most commonly recorded in eucalypt hollows in live trees close to water (Beruldsen 1980). Gang-gangs tend to travel in family groups rather than large flocks.

The Swift Parrot is an annual migrant to the southern mainland from Tasmania, where it breeds. It is a specialist nectar- and pollen-feeder. Flowering events of *E. globulus* may only be sufficient to support breeding in three years out of every ten (Garnett and Crowley 2000; Hingston et al. 2004). On the mainland, Swift Parrots inhabit eucalypt forests and woodlands, particularly box-ironbark forests, with a preference for sites along drainage lines (Higgins 1999). The Swift Parrot is a, particularly favouring *E. globulus*, and also eats psyllids and exotic fruits (Hingston et al 2004; Blakers et al. 1984, Emison et al. 1987).

Superb Parrots utilise box-woodland for foraging and breeding (summer), mostly nesting in dead trees (Manning et al. 2006; Webster 1988). In winter they move into woodlands to feed on lerp, mistletoe berries, eucalypt flowers and grass seed (Higgins, 1999). The superb parrot forages on the ground or in trees, feeding on lerp, mistletoe berries, eucalypt flowers and grass seed (Higgins 1999). Understorey food species include Common Wallaby-grass (*Austrodanthonia caespitosa*), numerous wattle species, and introduced plants including cereal grains, barley-grasses (DNRE 1992). A general dispersal north from Victoria occur after the breeding season (DNRE 1992), migrating along the upper Namoi and Gwydir Rivers. Little is known about seasonal migration routes; it is assumed that they move west and then north after the breeding season (A. Manning, CRES, pers. comm.). Local migration routes are not known. Records of flocks of between 20 and 50 birds were made in the Yass region only three times during spring and early summer of 1998; most records were of single birds or pairs (ACT Government 1999).

The total breeding population is estimated to be less than 5000 pairs. Nesting habitat on SW Slopes is often open Box-Gum Woodland or isolated paddock trees. Blakely's Red Gum is the main source of nesting hollows (Davey 1997), but Yellow Box, Apple Box and Red Box are also used. It nests September-January in small colonies, often with more than one nest in a single tree. Nest trees tended to be older, often affected by dieback with little regeneration (Manning 2004). Loose nesting colonies are often found, and form around clusters of nest trees (ACT Government 1999). The species is faithful to traditional nest sites (Webster 1988). Superb Parrot nest trees tend to be close to watercourses (Webster 1988). In a recent survey of road verges on the NSW south-western slopes, there were 2.5 possible nesting trees per kilometre whilst just prior to the start of the breeding season there were 0.62 birds per kilometre (Davey, C. and Purchase, D. 2004).

The species may forage up to 10 km from nesting sites (Webster 1988; Garnett 1992a), although at some sites, including those north of Canberra, the nesting and foraging areas coincide and the birds move very little distance at all during breeding (Webster and Ahern 1992, Martin 1996, Davey 1997 in Act Government 1999). The Superb Parrot avoids open areas on foraging flights, hence simple fragmentation of the habitat can be devastating (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999, Garnett and Crowley 2000).

If disturbed by human activity near the nest, the Superb Parrot may display agitation and avoid entering the nest hollow (Webster 1988). It is therefore important to avoid disturbance at known nest sites during the breeding season. Egg incubation appears to be highly synchronised amongst the population, suggesting that any disruption to breeding is unlikely to be compensated by the production of a second clutch.

West of Yass forms part of core breeding population in region. Numerous Atlas and Bionet records exist around the subject site. The species was recorded at the subject site (on a midslope west of cluster 4b) and observed on

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

numerous occasions beside Illalong Road 3 kilometres west of the site.

Much of the proposal site is heavily cleared and provides low quality habitat for these species. Remnant forest patches are often composed of regrowth eucalypts with few hollows, and usually some distance from water. The subject site is unlikely to be frequently used for foraging or nesting, but the Swift Parrot, Gang-gang and Superb Parrot may fly over the turbine ridges during migrations or moving between habitat areas. No flight height data is available for these species. A variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that level (Biosis Research 2006). Flights between roost/nest and foraging areas are likely to be at tree canopy level. Superb Parrots have been observed flying high over open areas in the South-West Slopes. However, they do tend to occur more in the lower elevation/relief parts of the landscape where the Box-Gum Woodlands, including scattered paddock trees, are located - this is where nest trees and food is likely to occur (A. Manning, CRES, pers. comm.). The frequency of parrots flying high over the turbine ridgetops is likely to be low.

The absence of intact woodland vegetation with hollow-bearing trees and watercourses in close proximity to the turbines would mean that the risk of nest abandonment due to visual or noise disturbance would be low.

The low quality of available habitat at the subject site, the distance from nest habitat, and the low probability of these species passing through the bladeswept zone over the turbine ridges makes it unlikely that the proposal would affect the life cycle of these bird species such that viable local populations would be placed at risk of extinction.

Marsupials

Koala, Squirrel Glider

Both these species occupy woodland and forest and appear able to occupy moderately disturbed environments although it is questionable whether these species can persist in fragmented habitats over time (Ahern; DECC 2008a; Gordon et al. 1988; McAlpine et al 2006; Wintle et al. 2008). Both species have been recorded in the local area.

Squirrel gliders have been found to travel over a large area to forage (up to 2.6km), while koalas are less able to travel between fragments due to their low energy diet (Ahern & van der Ree 2003; Menkhorst 2004). Important habitat parameters for Squirrel Gliders are the presence of Yellow Box, Long-leaved Box, and Red Stringybark species, mature hollow-bearing trees, and vegetated corridors if in a fragmented landscape (showing a preference for lowlands and gullies) (Ahern & van der Ree 2003; DECC 2008a). Squirrel Gliders feed on insects, nectar and exudates from leaves and trees (*Eucalyptus* and *Acacia*).

Koalas are specialised foragers and regionally utilise Ribbon Gum and River Red Gum as primary habitat and Candle Bark, Brittle Gum, White Box and Yellow Box as secondary habitat (NPWS, 2003e). Connectivity is important to koala persistence in an area. Secondary habitat has been found to be highly important, as it is more common and aids dispersal (McAlpine et al 2006). In Booroowa Shire to the north, koalas have been recorded at very low densities recorded in Scribbly Gum (*E. rossii*), Red Stringybark (*E. macrorhyncha*) and Bundy (*E. goniocalyx*) forest.

Potential habitat is present at the site, but very marginal due to scarcity of hollows and habitat fragmentation. The remnants with highest potential for these species at cluster 4 would be avoided and protected during the works. The loss of a relatively small area of remnant woodland within the development envelope would not be likely to affect the life cycle of these species such that viable local populations would be placed at risk of extinction.

Microbats

Eastern Bentwing-bat, Large-footed Myotis, Yellow-bellied Sheathtail-bat

The Eastern Bentwing-bat is a cave dependant species. Females migrate to specific cave sites in October-November each year to give birth in December and raise one young. Post weaning, females leave maternity sites in late February-March (Dwyer in Strahan 1983), with young dispersing from the sites approximately two weeks later (late March) (G. Richards pers.comm). The species utilize other structures for roosting such as mines, and occasionally buildings, when caves are in short supply. Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church Cave (at Wee Jasper) and Drum in southern NSW.

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

Church Cave is c. 35 kilometres south-east of the subject site and the maternity colony size is estimated at 60,000 when juveniles are flying with mothers. This number may have been subject to more recent decline (Dimitri Young pers. comm., DECC). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy). Dwyer (1968) suggests that the nursery colony at Church Cave was the maternity centre for the Murrumbidgee, Lachlan and Moruya drainages, plus some of those from the Shoalhaven drainage (Mt Fairy and Major's Creek).

The exact migration route taken by females to reach or disperse from Church Cave is unknown, though supposed by Dwyer (1968) to be strongly related to topography- both waterways and divides, with the species flying along ridges or waterways, rather than over them, using them as navigation aides. Home ranges are not confined to river basin areas (Wilson 2003). In light of the fact that the species would migrate to and from coastal areas, impacts from the proposed Marilba Hills wind farm, located to the north-west of the maternity cave at Wee Jasper, are considered unlikely.

However, the presence of large numbers of females during the maternity season creates a potential risk to the population. Male movements do not often exceed distances of 160 kilometres (Dwyer 1968, Wilson 2003). Females would travel further to reach maternity caves, and may travel further afield than males in order to meet nutritional requirements of lactation. When not breeding however, most movements are local for foraging for both males and females. The 35km distance of the Marilba subject site from Wee Jasper would be well within the foraging distance of the species each night. Eastern Bentwing-bats require forested areas to forage in, flying above the canopy and to some height over the canopy to capture insects on the wing. The species will utilize "flyways"- tracks or roads- to forage also. There is no evidence that they have a strong affiliation with gradient, being recorded on ridges, midslopes and gullies. Dwyer (1964) found that the species emergence from roost sites correlates strongly with sunset, though re-entry was not so precise. The Eastern Bentwing Bat was recorded at the subject site during the survey.

The Large-footed Myotis is known to use tree hollows, caves, mines, under bridges and storm water drains for roosting. Foraging is dependent on water bodies, both riparian and artificial such as dams; the species gleans insects from the surface and just below, as well as aerial prey. The species may forage and migrate in groups. Only one record exists in the area at Wee Jasper.

The Yellow-bellied Sheathtail-bat ranges across northern and eastern Australia. It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (DECC 2008a). The species is sedentary and possibly territorial. Southern populations probably migrate northwards in winter (Strahan 1996). It is a fast flying species with low maneuverability, feeding on insects, mainly beetles (Churchill 1996; Richards 2001). The species may favour habitat in large tracts that has extensive understorey flora (shrubs)(Richards 2005). It was recorded near intact forest at Carroll's Ridge to the south.

Both the Large-footed Myotis and the Yellow-bellied Sheathtail-bat possible records at the Marilba subject site.

The subject site provides potential foraging habitat for all three species. The proposal would not involve the removal of maternity, over-wintering or roosting habitat for the Eastern Bentwing Bat, but would result in the loss of tree hollows and fissures which may provide roosting habitat for the other two species.

The proposal has the potential to introduce a threat from bladestrike and barotraumas for these species. It is also possible that the noise and turbulence around turbines may preclude the species from using adjacent areas or may interfere with the echolocation used to navigate.

Impacts to these species require further assessment – additional surveys were undertaken in January 2009 and have been used to support a more detailed assessment of impacts to microbats in a separate report attached to the Yass Wind Farms Environmental Assessment (nghenvironmental 2009). The report includes a specialist Assessment of Significance for microbats.

Reptiles

Pink-tailed Legless Lizard, Striped Legless Lizard

The Pink-tailed Known only from the Central and Southern Tablelands, and the South Western Slopes (Osborne and

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

Jones 1995), including Canberra in the ACT, and Tarcutta and Bathurst in NSW. This species inhabits sloping, open woodland areas with predominantly native grass groundlayers, particularly those dominated by Kangaroo Grass (*Themeda triandra*). Typically these areas are well-drained, with rocky outcrops or scattered, partially-buried rocks (Osborne and Jones 1995). The species is commonly found beneath small, partially-embedded rocks which are exposed to sunlight, in burrows usually constructed by and are often still inhabited by small black ants and termites (Osborne and Jones, 1995). This species feeds on the larvae and eggs of these ants (DECC 2008a). The species shows a preference for sunny aspects, avoiding south facing slopes (Barrer 1992). Most sites have relatively open vegetation (Osborne and McKergow 1993), including grassland sites supporting no native grasses.

Populations of the Striped Legless Lizard are known in the Goulburn, Yass, Queanbeyan, Cooma and Tumut areas. It inhabits temperate lowland grasslands, secondary grasslands and occasionally in open Box-Gum Woodland. It has been recorded at sites dominated by introduced species (such as *Phalaris aquatica, Nasella trichotoma* and *Hypocharis radicata*) and sites with a history of grazing and pasture improvement (Coulson 1995; Dorrough 1995, Smith and Robertson, 1999). The species feeds on arthropods, most commonly wolf spiders, jumping spiders, crickets, grasshoppers, Lepidopteran larvae and cockroaches (Smith and Robertson 1999). The key to their survival in rural areas may be the availability of shelter during disturbance events (Smith and Robertson 1999). It shelters in grass tussocks, thick ground cover, soil cracks, under rocks, spider burrows, and ground debris such as timber.

The majority of the site has either no surface rock or outcropping bedrock which would not provide suitable habitat. Some areas, notably crests at clusters 1 and 2, have surface rock and potential habitat with largely exotic forb vegetation cover. Some cluster 1 crests are dominated by large weeds such as Scotch Thistle and European Nettle which provides dense ground level shading and are unlikely to provide suitable habitat for these species. Neither species was detected during targeted searches in potential habitat during the survey. Given the marginal nature of habitat over most of the subject site, the absence of nearby records and the limited area affected by the proposal, the proposal is not expected to affect the life cycle of these species such that viable local populations would be placed at risk of extinction.

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

No populations have been listed for the local area under Part 2 of Schedule 1 of the TSC Act or Part 2 of Schedule 4 of the FM Act.

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

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

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

Box gum woodland remnants are present at all cluster sites, and is the dominant vegetation on most of the ridge crests, saddles and upper slopes in the survey area. Condition ranges from good in areas with no or low grazing pressure where a range of forb species are present in the understorey, including threatened and regionally significant species, to poor on crests where sheep camp, where virtually no native understorey species remain. Small areas in moderate-good condition occur at cluster 3 and between clusters 5 and 6, and larger moderate-good and good condition areas occur on the western side of clusters 4a and 4b. Most stands however are in poor-moderate or moderate condition, with the understorey dominated by native grasses with relatively low diversity of native forb species. Woodland trees are generally mature, and regeneration is limited to areas with light grazing pressure (mainly cluster 4).

In addition, much of the native pasture in the study area is derived from the box gum woodland community, usually in depauperate form with low native forb diversity, and forms part of the EEC. The diverse secondary grassland at the

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

potential substation sites near cluster 7 is also likely to be derived from this community, although no diagnostic tree species remain at or near the site.

All box gum woodland remnants in moderate-good or good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. This includes the midslope stands at cluster 3, the large remnant on the western side of cluster 4, the small stand on the south-western side of cluster 6 and the derived grassland west of cluster 7.

Some parts of the site may have some recovery potential if grazing pressure were reduced. Some areas, generally in saddles where native groundcover species tend to be more dominant, may be capable of producing some tree regeneration and improved native groundcover diversity. Other areas, mostly heavily grazed or sheep camp areas on the highest points, seem likely to be incapable of recovery. Many native grassy understorey species do not appear to form a long term seed bank in the soil. This is supported by the results of experiments with daisy and lily species (Lunt 1990) and by the loss of species diversity which results from the absence of fire for periods greater than 7-10 years (Scarlett and Parsons 1990). In some dieback affected areas, trees may too be stressed to produce seed, and if grazing pressure were reduced exotic groundcovers would simply become more dominant.

Many of the lowland woodland areas on the potential powerline routes have scattered mature Yellow Box and Blakely's Red Gum trees and virtually no native understorey. Given the general absence of native species in the groundlayer and the long history of grazing and pasture improvement involving ploughing, sowing of exotic pasture and fodder crops and fertilising, it is considered that the potential for any native seed bank in these areas is exceedingly low.

The proposal would permanently remove up to 12.01 ha of box gum woodland, an endangered ecological community, including up to 1.47 ha in good, moderate-good or moderate condition. This vegetation is locally common and dominant on ridges and slopes and this loss would not be significant in terms of area. Some of the powerline routes will overlap with tracks, reducing the overall area of disturbance.

The proposal would also involve the clearing of a small area of woodland in good condition in cluster 4b (refer Map Set 2). A small area (0.14 ha) would be cleared for a 350 metre long and 4.5 metre wide access track and cable trenching. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The proposal would not place the EEC at this location at risk of extinction, or modify the composition of remaining stands such that they are placed at risk of extinction. At worst it would result in the removal of some trees, within a landscape where woodland is already fragmented, and result in an increase in weed cover in limited areas of native pasture. The amount of tree removal cannot be precisely quantified at this stage, and some adjustment to the siting of infrastructure may be achievable to minimise it.

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

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

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

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

FLORA AND ECOLOGICAL COMMUNITIES

Yass Daisy habitat was recorded in box gum woodland remnants at clusters 4, 6 and 7 at the subject site. These sites also provide potential habitat to the Small Scurf-pea, Silky Purple Pea and Austral Toadflax. These remnant habitat areas would be excluded from the development envelope and protected from direct and indirect impacts during the

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

works. Some Yass Daisy plants were recorded in grazed pasture adjacent to the fenced cluster 4 remnant. Some of this native pasture habitat may be removed during the construction phase. These plants area restricted to within 10 metres of the core population in the fenced cluster 4 remnant, and are unlikely to be sustainable without ongoing dispersal from this source population. Impacts to this marginal pasture habitat would not threaten the core population at the site. While the Yass Daisy appears capable of colonising native pasture, the local population is fragmented by grazing pressures and exotic plant competition. The proposal is unlikely to significantly add to these fragmentation processes. Work sites adjacent to the Yass Daisy colonies would be revegetated with native tussock grasses to provide continuing potential habitat for this species.

The proposal would permanently remove up to 12.01 ha of box gum woodland, an endangered ecological community, including up to 1.47 ha in good, moderate-good or moderate condition. Track, powerline, turbine and substation locations have been modified to reduce impact on the EEC (refer Section 7). Up to 50 ha of pasture would be cleared during construction of the turbines, access tracks and substation. The majority of this is likely to be native pasture derived from box gum woodland (EEC) in generally poor-moderate condition. 16.42 ha of pasture would be reinstated following removal of the construction facilities.

This vegetation is locally common and dominant on ridges and slopes and this loss would not be significant in terms of area. With the exception of a small area of good condition woodland at cluster 4b (refer Map Set 2), all box gum woodland remnants in moderate-good or good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. Special measures would be implemented to minimise impacts to the woodland stand at cluster 4b (refer section 8.1.1). The proposal would not place the EEC at this location at risk of extinction, or significantly add to the existing high level of habitat fragmentation. Given the condition, use history and fragmented nature of the box gum woodland remnants that would be affected, the proposal would not be likely to significantly affect the extent, security or conservation value of the EEC at the subject site. Measures would be adopted to prevent indirect or peripheral impacts to higher conservation value stands.

A small dry forest remnant in the south of cluster 7 provides marginal potential habitat for the Burrinjuck Spider Orchid. The species was not recorded during a targeted search undertaken in September 2008. The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present at the site, works would be re-sited to avoid impacting this species. The works are not expected to adversely affect the life cycle of the Yass Daisy such that a viable local population of the species is likely to be placed at risk of extinction.

FAUNA

Key threatened fauna habitat features in the study area include woodland and forest remnants, pasture dominated by native grasses, rocky outcrops and modified wetland habitats. The proposal would not result in the removal of a significant area of these potential threatened fauna habitat features (refer section 8.1.1). Specific measures would be implemented to protect remnant forest and woodland vegetation and hollow-bearing trees present at the subject site.

The operation of the wind turbines has the potential to create a barrier between habitat areas, exacerbating existing levels of habitat fragmentation. The threatened woodland bird species which have potential to be present at the site are dependent on remnant woodland habitats, and are unlikely to frequently use the cleared high ridge habitats occupied by the turbines for foraging or dispersal. Precise bird and microbat migration routes in the study area are not known, but woodland species dependent on tree cover (such as the Diamond Firetail, Regent Honeyeater, Gang-gang Cockatoo and Superb Parrot) could be expected to use riparian corridors or scattered trees and patches in lowland areas as 'stepping stones'. Similarly, waterbirds are likely to favour lowland routes when dispersing from large waterbodies such as Lake Burrinjuck; this assumption is supported by Atlas of NSW Wildlife records for these species. Given the very limited areas of native vegetation affected, the proposal is unlikely to significantly add to the existing levels of habitat fragmentation in the study area.

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

No areas of critical habitat have been declared within the district.

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

A draft recovery plan has been prepared for the Burrinjuck Spider Orchid (*Caladenia* sp Burrinjuck) (NPWS 2003a). Proposed recovery objectives and actions include the rehabilitation and protection of known populations, monitoring and researching known populations, and surveying for additional populations in the Burrinjuck reserves and adjacent private property. The proposal would not conflict with these objectives and actions.

A draft Recovery Plan has been prepared for the Barking Owl (DEC 2006; NPWS 2003b). The plan assumes that all cases or individual mortality and nest failure are significant for the population. Actions in the plan include survey and research, protecting the more productive, lower lying areas of the landscape from further clearing, protecting substantial-sized blocks of mature forest and woodland and smaller forest fragments within a few kilometres of such blocks, and nest site protection. The proposal, the assessment process and mitigation measures are consistent with the objectives and actions contained in this plan.

A national recovery plan has been prepared for the Swift Parrot (Swift Parrot Recovery Team 2001). Among other things, the plan aims to reduce the incidence of collisions with man-made structures. Collisions with chain-link fences, cars and windows are a significant cause of mortality during the breeding season (Swift Parrot Recovery Team 2001). These collisions occur mainly in urban areas where concentrated foraging occurs at native and introduced flowering eucalypts, particularly when natural food supplies are low because of drought or other factors. These conditions would not apply at the proposed wind farm site, where foraging would occur well below blade height and foraging resources would not be so concentrated. To date, no wind farms have been implicated in Swift Parrot collisions (Biosis Research 2006). The proposal would not conflict with this or other elements of the recovery plan.

The Recovery Plan for the Koala identifies clearing of native vegetation and loss of vegetation structure and composition as key threatening processes. The proposal would not significantly exacerbate these threatening processes in the study area.

The DECC Threatened Species Priorities Action Statement (PAS) outlines the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threatened species, population and ecological communities and manage key threatening processes. The proposal would not conflict with any of the priority actions identified for threatened species which have potential to be present at the subject site.

No current Threat Abatement Plans are relevant to the proposal.

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

Six listed Key Threatening Processes are relevant to this proposal:

1. **Bush Rock Removal.** Includes removal of rocky outcrops or rock within areas of native vegetation. Impacts of bush rock removal includes loss or disturbance of native flora and fauna species habitat, including those described (e.g. *Delma impar).* The subject site is unlikely to support threatened fauna dependent on bush rock (refer a) above) and similar habitat is likely to be widespread in the district. The loss of small areas of rocky outcrop at the subject site is not expected to significantly exacerbate bush rock removal as a threatening process in the study area.
2. **Clearing of native vegetation**. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer increased habitat for invasive species and off-site impacts such as downstream sedimentation. The proposal would not contribute significantly to the operation of clearing as a threatening process at the local or regional level, since the bulk of the subject site is already cleared. The clearing likely to result from the proposal has been quantified in section 8.1.1. The proposal would remove up to 12.01 ha of box gum woodland, an endangered ecological community, including up to 1.47 ha in good, moderate-

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

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

The proposal would also result in the clearing of up to 50 ha of pasture dominated by native grasses. These assemblages are depauperate and are likely to be abundant on ridges and slopes elsewhere in the district. 'Clearing' of the groundcover is reversible over time, unless highly invasive exotics are introduced to the site during the works. Given the limited area of clearing involved and the condition of vegetation to be cleared, the proposal is not likely to contribute significantly to the operation of clearing as a threatening process at the local or regional level.

3. **Loss and/or degradation of sites used for hill-topping by butterflies**. Hill-topping in butterflies is a very complex behaviour that often facilitates meeting of the sexes. Factors which determine whether an area is suitable can be subtle so that even small changes may cause butterflies to abandon the area. Disturbance of plants on, or topography of, the hill-top, or to its slopes and immediate surroundings, may render it unsuitable to butterflies as a hill-topping site. In the absence of other hill-topping sites, butterflies may disappear entirely from a district. Loss of hill-top habitats throughout NSW would affect butterfly species which rely on such sites and some local extinctions have undoubtedly occurred due to hill-top alteration. Loss of hill-topping sites due to habitat alteration, may lead to loss of resting sites for male butterflies, loss of focal points for mating and thus local extinctions. 'Habitat alteration' includes loss of vegetation for agriculture, urban development, forestry, tourist development, communication towers or power transmission lines.

   The ridge crests of the subject site are generally cleared of woodland tree cover with a degraded understorey and no shrub layer. The site is likely to provide marginal habitat for butterflies and are unlikely to represent important hill-topping habitat. The proposal is not expected to significantly exacerbate this threatening process in the study area.

4. **Loss of hollow-bearing trees.** In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 85 birds, 32 reptiles and 16 frogs (Gibbons and Lindenmayer 1997, Gibbons and Lindenmayer 2002). Of these, 45 species are listed as threatened. Hollow-nearing trees are in decline for reasons including lack of recruitment and clearing. Trees bearing large hollows in particular are increasingly rare. Generally hollow-bearing trees near riparian habitat are most valuable. No large hollows were observed at the subject site, although medium and small hollows are present in woodland and isolated trees at the site. The trees to be removed generally have no regeneration and tree cover is likely to be lost when the current generation die. With the exception of cluster 4, seedling recruitment is generally uncommon throughout the subject site. While some small-medium hollows may be lost during clearing required for the proposal, hollows of this size do not appear to be locally limiting. Powerline and access track routes and turbine placement would avoid hollow-bearing trees wherever practicable. The limited clearing required is not expected to significantly exacerbate this threatening process in the study area.

5. **Removal of dead wood and dead trees.** The removal of standing or fallen dead wood removes hollows as well as forest floor litter. The forests and woodlands of Western Slopes are considered most at risk from this process mainly due to firewood collection. Standing dead timber is present at most cluster sites, and is still relatively common on ridges throughout the district. The limited clearing required is not expected to significantly exacerbate this threatening process in the study area.

6. **Invasion of native vegetation by exotic perennial grasses.** The Box-Gum Woodland EEC is vulnerable to the introduction and spread of perennial grasses such as African Love Grass, Serrated Tussock, Phalaris, Cocksfoot, Yorkshire Fog and Paspalum. Unnecessary disturbance of areas adjacent to the works should be avoided so as not to increase risks of spreading exotic grasses. Washing of vehicles and plant prior to arrival on the site would help to ameliorate this impact, by preventing the introduction of additional weeds. Section 8 identifies further safeguards to minimise risks from weeds, and the proposal is not expected to significantly increase the impact of this Key Threatening Process in the study area. Few perennial exotic pasture grasses appeared to be present within the site at the time of the survey, with most exotic grasses being annuals, such as Barley Grass (**Hordeum leporinum*). It seems unlikely that exotic perennial grasses will increase as a result of the disturbance, though exotic forbs such as thistles may well do so, at least in the short term.

Conclusion

Flora and ecological communities

This assessment concludes that impact to generally poor and poor-moderate condition stands of the EEC White Box - Yellow Box –Blakely's Red Gum Grassy Woodland will occur as a result of the development, but will not be significant in the local context, since degraded remnants of the community are still relatively common in the local area. Stands in moderate-good and good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. Similarly, the core populations of the Yass Daisy and potential habitat for other threatened woodland flora species would be excluded from the development envelope, and the proposal would not produce impacts to these species such that local populations would be placed at risk of extinction.

Fauna

The construction of the wind farm would result in the loss of a small area of marginal habitat for threatened woodland bird and reptile species. The habitat affected is generally degraded and woodland habitat in similar condition is relatively abundant in the study area. The operation of the wind farm would create risks of bladestrike for some threatened bird and microbat species and additional risks of barotrauma for bat species. While a degree of uncertainty remains regarding specific responses from these species, current knowledge regarding the behaviour and ecology, and experiences at other wind farms suggest that impacts will not significantly affect local populations of these species.

Specifically, the proposal would not be likely to:

- reduce the long-term viability of a local population of threatened species, populations or ecological communities;
- accelerate the extinction of the species, population or ecological community or place it at risk of extinction; or
- adversely affect critical habitat.

This conclusion is provisional, subject to the further assessment of potential impacts to threatened microbats. This assessment, based on additional surveys undertaken in January 2009, has been prepared as a separate specialist report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

Specific safeguards have been identified in Section 8 to avoid and minimise impacts to these values, including the finescale siting of components, the protection of forest remnants and hollow-bearing trees, weed hygiene and control, soil and water quality protection, appropriate rehabilitation measures, and structural and operational measures to reduce risks to birds and bats.

Appendix F **ASSESSMENT OF SIGNIFICANCE (COMMONWEALTH)**

A proponent must refer a proposal to the Commonwealth Minister for the Environment if they believe that the proposal will have, or is likely to have, a significant impact on a matter of national environmental significance, unless the proposal is covered by an exemption specified in the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPBC Act Principal Significant Impact Guidelines (DEH 2005a) identify a series of criteria to be taken into account in deciding whether a development is likely to significantly affect threatened species and communities, and migratory species listed in the Act. The Draft Supplementary Significant Impact Guidelines 2.1.3 (DEH 2005b) provide additional guidance in relation to wind farm proposals.

The following assessment is based on the requirements of the EPBC Act and relevant policy guidelines. The assessment should be read in conjunction with the Assessment of Significance under the NSW EP&A Act (Appendix E), and the separate Bird Impact Risk Assessment report which contain background in relation to species ecology, species and community distribution and scale, specific development impacts, and impact risks.

The Threatened Species Evaluation in Appendix C assesses the potential for threatened species to be present at the proposal site, based on available habitat, known ecological requirements and local distribution records. Species which have at least moderate potential to occur at the proposal site are included in the Assessment of Significance.

This assessment of significance addresses:

- the Critically Endangered Ecological Community (CEEC) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ('box gum woodland');
- the threatened flora species *Ammobium craspedioides, Caladenia* sp Burrinjuck (syn *C. concolor* sens lat.) and *Thesium australe;*
- threatened and migratory fauna species with potential to be present at the subject site.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

a) reduce the extent of a community,

The proposal would result in the clearing of a small area of box gum woodland comprising intact understorey and an open regenerating Blakely's Red Gum tree layer in cluster 4b (refer Map Set 2) which forms part of CEEC. A small area (0.14 ha) would be cleared to provide construction access and to instal underground cabling in a 0-5-1 metre wide trench. Specific measures to minimise impacts to this area are included in section 8.1.5 Impact avoidance and mitigation. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

b) fragment or increase fragmentation of the community, for example by clearing vegetation for roads or transmission lines;

The box gum woodland community is heavily fragmented and degraded in the locality. The minor clearing of poor and poor-moderate condition ridgetop native pasture and generally poor—moderate and moderate condition woodland required for the proposal would not add significantly to the existing level of fragmentation. The powerline and turbines have been sited to avoid the need for tree clearing wherever possible.

c) adversely affect habitat critical to the survival of an ecological community which consists of, or includes, fauna species;

The development would have relatively minor impacts on fauna habitat and would not significantly affect habitat critical to the survival of the community. The area of vegetation likely to be cleared or modified is relatively small and in generally poor-moderate condition. The proposal is not likely to significantly affect any fauna species which perform critical ecological functions for the CEEC.

d) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;

Soils and nutrient balance in cleared parts of the subject site are already highly disturbed due to grazing impacts. It is apparent from differences in soil levels across some fences on ridge crests within the site that there has been substantial soil loss from some areas due to exposure of the soil from overgrazing and sheep trampling, and wind erosion. Elevated nutrient levels are clearly present in areas favoured as sheep camps, with vegetation dominated by thistles and nettles. Some modification of surface water drainage patterns has undoubtedly also occurred due to soil compaction and loss of vegetation cover. Salinisation is active in some parts of the site.

The ridgeline turbine and road construction activities have potential to cause soil erosion, sedimentation and chemical pollution in the adjacent CEEC stands. The stands located close to the development area would be protected from indirect impacts such as soil erosion and sedimentation. The limited scale of clearing and soil disturbances, timely restoration of landform and vegetation and the adoption of best practice soil and water conservation measures should mean that any indirect physical impacts to the CEEC are minimal.

Special measures to minimise impacts to soils at the cluster 4b CEEC include minimising road width, siting to avoid the need for road battering, clearing trees and shrubs by hand and using the natural soil and vegetation surface for the road driving surface.

e) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;

The development would have localised effects on composition of the CEEC at the cluster 4b site, by removing the tree layer over the powerline corridor. This is not likely to cause a decline or loss of functionally important species such as Kangaroo Grass, which are adapted to open woodland conditions.

f) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - assisting invasive species, that are harmful to the listed ecological community, to become established; and - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community;

The construction phase of the proposal has the potential to introduce or assist the spread of invasive weed species. The invasion of native vegetation by exotic perennial grasses is a particular risk for the CEEC. Perennial exotic grasses appeared to be uncommon at the subject site during the survey. These risks would be reduced to acceptable levels through weed hygiene protocols, pre and post works weed

control, soil erosion and sedimentation control, effective and timely site rehabilitation and the avoidance of fertiliser use in areas adjacent to the CEEC.

Chemical pollution risks would be reduced using chemical spill kits, site sediment control structures and permanent bunding of the turbine sites. The works are not expected to result in significant impacts from weeds or pollutants.

Soil disturbance would be avoided at the cluster 4b site by clearing by hand, avoiding the need for road battering and using the natural soil and vegetation as the track driving surface.

g) interfere with the recovery of an ecological community.

Most CEEC remnants are excluded from the development envelope and would be protected from direct and indirect impacts. The proposal is not expected to affect the recovery of these remnants or exacerbate existing threatening processes affecting the parts of the CEEC (including grazing, fertiliser use, weed invasion, soil erosion). The cluster 4b remnant would have the regenerating tree layer remove over the 20 metre wide powerline corridor and track route, for a distance of around 312 metres. This will prevent the recovery of the tree stratum in this area, but would not interfere with the recovery of the groundlayer vegetation over the majority of the area.

Threatened flora and fauna species

a) Will the action lead to a long-term decrease in the size of a population of a species?

Threatened flora

The majority of the box gum woodland remnants which provide potential habitat to the Yass Daisy and Austral Toadflax have been excluded from the development envelope and would be protected from direct and indirect impacts. The proposed clearing of a small area of box gum woodland (0.14 ha) in cluster 4b (refer Map Set 2) is located adjacent to a Yass Daisy colony.

Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works. This should ensure that the impacts to these species are minimal and would not affect the size of the local populations.

A small dry forest remnant in the south of cluster 7 provides marginal potential habitat for the Burrinjuck Spider Orchid (listed as part of *Caladenia concolor*). The species was not recorded during a targeted search undertaken in September 2008. The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present, works would be excluded from the habitat area of this species. The works are not expected to result in a decrease in the size of the population of this species if present at the site.

Threatened fauna

Regent Honeyeater

There is a potential risk that a Regent Honeyeater population may be affected by collisions with turbines and associated infrastructure. The Regent Honeyeater feeds mainly on the eucalypt nectar (particularly prolifically flowering box and ironbark species), but also eats invertebrates and exotic fruits (Blakers *et al*. 1984). Local feed species include Yellow Box, Blakely's Red Gum and Red Stringybark. Potential foraging habitat in the study area is confined to remnant woodland/forest areas, and is unlikely to

include the largely treeless ridges of the northern turbine sites. Yellow Box trees are sparsely scattered in lowland pasture areas and ridge slopes, saddles and crests in the study area.

Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and using the same route for return journeys (Fischer and Lindenmayer 2002a). On current knowledge, the Regent Honeyeater is considered unlikely to fly high above the turbine ridges, and therefore the risk of bladestrike would be low.

Superb Parrot

There is a potential risk that a local Superb Parrot population may be affected by collisions with turbines and associated infrastructure. West of Yass forms part of the core breeding population of the Superb Parrot. This species nests in September-January in small colonies, using tree hollows in open Box-Gum Woodland or isolated paddock trees. Blakely's Red Gum is the main source of nesting hollows (Davey 1997). Superb Parrot nest trees tend to be close to watercourses (Webster 1988).

The Superb Parrot disperses north in winter to the upper Namoi and Gwydir Rivers (DNRE 1992). Local migration routes are not known.

The species feeds in trees and understorey shrubs and on the ground. Food items are mainly flowers, fruits and seeds, including Yellow Box (*E. melliodora*), Box Mistletoe (*Amyema miquelii*), insect parasites such as lerps, grasses such as Common Wallaby-grass (*Austrodanthonia caespitosa*), numerous wattle species, and introduced plants including cereal grains, barley-grasses (DNRE 1992). Most records in the Yass region are of single birds or pairs. The species may forage up to 10 kilometres from nesting sites (Webster 1988; Garnett1992a), although north of Canberra the nesting and foraging areas coincide and the birds move very little distance at all during breeding (Webster and Ahern 1992, Martin 1996, Davey 1997 in ACT Government 1999).

The Superb Parrot avoids open areas on foraging flights (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999).

A variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Superb Parrots have been observed flying high over open areas in the South-West Slopes. However, they do tend to occur more in the lower elevation/relief parts of the landscape where the Box-Gum Woodlands, including scattered paddock trees, are located - this is where nest trees and food are likely to occur (A. Manning, CRES ANU, pers. comm.).

Because of the extent of clearing, the ridgetop turbine sites are unlikely to provide quality foraging or migration habitat for the Superb Parrot. The frequency of parrots flying high over the turbine ridgetops, and the risk of bladestrike, are likely to be low.

The scarcity of intact woodland vegetation with hollow-bearing trees in close proximity to the turbines would mean that the risk of nest abandonment due to visual or noise disturbance would be low.

Swift Parrot

There is a potential risk that a Swift Parrot population may be affected by collisions with turbines and associated infrastructure. The Swift Parrot breeds in Tasmania and Furneaux Group islands, migrating to the mainland in Feb-April, where it becomes nomadic in response to the availability of blossoms and other food (Pizzey et al 2006). In southern and eastern NSW, it inhabits eucalypt forests and woodlands (Blakers *et al* 1984), feeding on eucalypt blossom and psyllids, particularly large prolifically flowering trees. Food sources and distribution varies year to year. Marginal habitat is present in the winter-

flowering Long-leaved Box remnants scattered on sideslopes in the study area which provide a potential food source. The Swift Parrot has been recorded in Booroowa Shire to the north (NPWS 2002).

The species may use forest habitat at the site, although the Long-leaved Box stands are generally regrowth and heavily fragmented. Better habitat is likely to be present in timbered lowland areas.

No flight height data is available for this species; a variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Migratory routes and durations of residency are likely to be variable depending on food supplies. Flights between roost and foraging areas are likely to be at tree canopy level. The frequency of flights over the turbine ridges is likely to be low.

A recent cumulative assessment of 39 wind farms located in the distribution range of the Swift Parrot concluded that the combined bladestrike impact of all of these wind farms would not be significant (Biosis Research 2006).

General

A monitoring and adaptive management program would be implemented to provide timely and appropriate responses to any mortality of threatened fauna (refer section 5.3).

b) Will the action reduce the area of occupancy of the species?

Threatened flora species

The actual and potential area of occupancy for the Yass Daisy and Austral Toadflax within box gum woodland remnants have generally been excluded from the development envelope and would be protected from direct and indirect impacts. The access track and underground cable proposed for the cluster 4b remnant will reduce the capacity to support these species over a small area (0.14 ha).

Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The Yass Daisy colony was centred some distance from the proposed track route (refer Map Set 2) and habitat for the Austral Toadflax is marginal at this site. The proposal would not result in a substantial decrease in the area of occupancy for these species (refer NSW seven part test).

A small dry forest remnant in the south of cluster 7 provides marginal potential habitat for the Burrinjuck Spider Orchid (listed as part of *Caladenia concolor*). The species was not recorded during a targeted search undertaken in September 2008. The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present, works would be excluded from the habitat area of this species. The works are not expected to result in a decrease in the size of the population of this species if present at the site.

Threatened fauna

The proposal would not remove local threatened fauna habitats, including intact box gum woodland understorey. In view of the distance between the turbine sites and potential woodland bird habitats, the proposal is considered unlikely to alienate or fragment woodland habitats, or alter natural life cycle behaviours of woodland fauna species.

c) Will the action fragment an existing population into two or more populations?

The action would be very unlikely to significantly add to existing levels of habitat fragmentation for the three threatened flora species. The grassy woodland species already have a highly fragmented distribution due to past clearing and farming activities in the district.

The proposal would not add to the existing level of fragmentation of threatened flora populations. The wind turbines have the potential to create a barrier between habitat areas for bird species, exacerbating existing levels of habitat fragmentation. Woodland habitat of varying quality exists north, east and west of the proposal site.

The Regent Honeyeater, Superb Parrot and Swift Parrot are highly mobile, but dependent on remnant forest and woodland habitat. Precise migration routes at the site are not known, but woodland species dependent on tree cover (such as the Regent Honeyeater and Superb Parrot) could be expected to use scattered trees and remnant patches as 'stepping stones' during migratory or foraging movements.

There are valley areas with scattered trees providing east-west and north-south connectivity within 5 kilometres of the site. Black Range Road to the south and Illalong Road/Illalong Creek to the west provide linear remnants with tree cover that may be used for woodland bird foraging and dispersal. The heavily cleared nature of the involved properties, and the turbine ridges in particular, would appear to make their frequent use for bird migration unlikely.

d) Will the action adversely affect habitat critical to the survival of a species?

The subject site area that will be impacted by the proposal is not habitat critical to the survival of threatened flora or fauna species.

e) Will the action disrupt the breeding cycle of a population?

Impacts would not occur within the area of occupancy of the Yass Daisy or Austral Toadflax or remove a significant area of potential habitat. If found to be present at the site, the Burrinjuck Spider Orchid habitat would also be protected. No disruption to the flowering or seeding processes of threatened flora are therefore anticipated.

The potential for bladestrike, decompression and habitat impacts to affect bird and bat populations is addressed in Appendix D. The assessment concludes that the proposal is not likely to significantly affect local bird or bat species at the population level.

The visual and noise impact of the wind turbines has the potential to disrupt nesting behaviour. Given the distance of the turbines from potential nesting habitats for woodland bird species, the risks of nest abandonment are considered low.

f) Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Yass Daisy and Austral Toadflax actual and potential habitats within box gum woodland remnants have generally been excluded from the development envelope and would be protected from direct and indirect impacts. The access track and cable trench proposed for the cluster 4b remnant will result in minor habitat impacts over a small area (0.14 ha). Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The Yass Daisy colony was centred some distance from the proposed track route (refer Map Set 2) and habitat for the Austral Toadflax is marginal at this site. The proposal is not expected to produce habitat impacts that would result in the decline of these species.

If found to be present at the cluster 7 forest remnant site, the Burrinjuck Spider Orchid habitat would also be protected. The works are therefore not likely to result in the decline of this species.

The powerline and turbines would be sited to avoid potential threatened species habitat. The clearing required by the proposal is not likely to result in the long term decline of threatened fauna species.

The proposal is not likely to be located on migration or dispersal routes for threatened fauna (refer c) above). This conclusion is provisional, subject to the further assessment of potential impacts to threatened microbats. This assessment, based on additional surveys undertaken in January 2009, has been prepared as a separate specialist report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

g) Will the action result in invasive species that are harmful to a critically endangered or endangered/vulnerable species becoming established in the endangered or critically endangered species/vulnerable habitat?

The proposal could have this impact, if seed of invasive plants were introduced on machinery or vehicles, or enabled to spread from nearby pasture as a result of disturbance of the groundcover or soil on the site. A dense infestation of weeds could reduce the amount of bare ground available for orchids or other native forbs, and lead to the local extinction of a population, should one occur on this site. However, given that the locations where the Yass Daisy currently occurs adjacent to the works site are not particularly weedy, despite intense disturbance from grazing and weeds nearby, it seems unlikely that the additional disturbance caused by this proposal will greatly affect the undisturbed habitat areas.

Weed risks would be reduced to acceptable levels through weed hygiene protocols, pre and post works weed control and monitoring, soil erosion and sedimentation control, effective and timely site rehabilitation and the avoidance of fertiliser use in areas adjacent to the CEEC and potential threatened species habitats.

h) Will the action interfere with the recovery of the species?

Yass Daisy and Austral Toadflax woodland habitats are generally excluded from the development envelope and would be protected from direct and indirect impacts. Impacts to the cluster 4b woodland habitat would be minimised by reducing road width, siting to avoid the need for road battering, clearing trees and shrubs by hand and using the natural soil and vegetation for the road driving surface. The proposal is not expected to affect the recovery of these species remnants or exacerbate existing threatening processes.

If found to be present at the cluster 7 forest remnant site, the Burrinjuck Spider Orchid habitat would also be protected. The works would not conflict with the objectives and actions contained in the recovery plan prepared for this species (NPWS 2003a).

The recovery plan has been prepared for the Regent Honeyeater lists the main causes for concern regarding this species:

- specialised habitat requirements,
- significant reductions in extent of habitat,
- demonstrable reduction in habitat quality throughout its range,
- apparent reliance on a small number of favoured sites,

- clear reduction in range in recent decades,
- low population level
- low population densities over a large proportion of the range with aggregations occurring for breeding.

The Plan states that only long-term changes to land management, on both public and private land, will lead to a significant improvement in the status of this species.

The development would not exacerbate known risks or be detrimental to recovery actions. Habitat suitable to the Regent Honeyeater would not be significantly removed or altered by the development.

A national recovery plan has been prepared for the Swift Parrot (Swift Parrot Recovery Team 2001). Among other things, the plan aims to reduce the incidence of collisions with man-made structures.

Collisions with chain-link fences, cars and windows are a significant cause of mortality during the breeding season (Swift Parrot Recovery Team 2001). These collisions occur mainly in urban areas where concentrated foraging occurs at native and introduced flowering eucalypts, particularly when natural food supplies are low because of drought or other factors. These conditions would not apply at the proposed wind farm site, where foraging would occur well below blade height and foraging resources would not be so concentrated. To date, no wind farms have been implicated in Swift Parrot collisions (Biosis Research 2006). The construction of a chain-link fence around the proposed substation would create a collision risk for local birds, although, given the size of the fence, this risk is not expected to be significant. The proposal would not conflict with the recovery plan.

MIGRATORY SPECIES

Of the four migratory terrestrial species indicated as having potential to be present within 50 kilometres of the proposal site by the Search Tool report, the White-throated Needle-tail (*Hirundapus caudacutus*), Regent Honeyeater (*Anthochaera phrygia*) and Satin Flycatcher (*Myiagra cyanoleuca*) have at least moderate potential to use aerial habitat at the proposal site. The significance of potential impacts to the Regent Honeyeater has been addressed above.

The White-throated Needle-tail is a summer migrant to Australia from Asia. It feeds on flying insects, and is frequently sighted over cities. Roosting habits and local migration routes are not known. The species has been recorded in Wee Jasper Nature Reserve, 30 kilometres to the south of the proposal site. The Satin Flycatcher was recorded in Long-leaved Box woodland at the subject site (cluster 6) and the risks to this species from the proposal are assessed in Appendix D. The small patch of regrowth woodland habitat at this site is considered marginal for this species.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species,

The development would not substantially modify, destroy or isolate an area of important migratory bird habitat, including White-throated Needle-tail and Satin Flycatcher habitat.

b) result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species,

The development would not result in the introduction or spread of any exotic species harmful to migratory species. Weed hygiene and control and monitoring would ensure that wetland areas are not degraded by weed species introduced during the works.

c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

There is potential for the wind turbine collisions to affect local populations of the White-throated Needle-tail and Satin Flycatcher. The risk of population level impact is heightened by the flocking behaviour in migrating birds. The White-throated Needle-tail appears readily capable of habituating to artificial structures and humanised landscapes. The Satin Flycatcher favours heavily vegetated gullies and taller woodlands during breeding, and uses woodlands, scrubs, trees in open country during migration (Pizzey et al 2006). The single bird sighted at Marilba may have been foraging or migrating south from Papua New Guinea. The site does not provide optimal habitat for this species and habitat use is expected to be infrequent. Mortality rates affecting the lifecycle of a significant proportion of the populations of these species are not anticipated. The risk assessment in Appendix D for these species indicates a low-moderate risk at the individual level and low risk at the population level.

A monitoring and adaptive management program would be developed and implemented to respond to any unforeseen impacts on this species, and other significant fauna (refer section 5.3).

Conclusion

Flora and ecological communities

One Critically Endangered Ecological Community (box gum woodland) and one threatened flora species (Yass Daisy) were recorded in the survey area. Two other flora species (Austral Toadflax and the Burrinjuck Spider Orchid) have some potential to be present at the site. This assessment concludes that the proposal would not significantly affect remnant stands of the box gum woodland CEEC at the subject site. Most box gum woodland stands in moderate-good and good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. Impacts to the cluster 4b woodland would be minimised by reducing road width, siting to avoid the need for road battering, clearing trees and shrubs by hand and using the natural soil and vegetation for the road driving surface.

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

Similarly, the core populations of the Yass Daisy and potential habitat for other threatened woodland flora species would be excluded from the development envelope. The potential Burrinjuck Spider Orchid habitat at the subject site would be intensively re-surveyed later in the flowering period and protected if this species is recorded. The proposal would not produce impacts to these species such that local populations would be placed at risk of extinction.

Fauna

There is at least moderate potential for three threatened bird species and two migratory bird species to occur within or close to the subject site and to be impacted by the proposal (refer Appendix C).

The relatively small area of clearing required by the proposal would not be likely to significantly affect threatened fauna species at the subject site. Threatened species habitat and CEEC areas at the subject site would generally be avoided or protected from indirect or peripheral impacts.

The proposal has the potential to introduce a hazard to aerial habitat, in the form of bladestrike risk for threatened and migratory bird species. Bladestrike and habitat impact risks for birds have been assessed in detail in Appendix D. In view of the assessed likelihood of these species being present at the site, their likely

responses to the wind turbines and the experiences of existing wind farms elsewhere in Australia, the potential for unacceptable mortality rates or habitat impacts is considered low.

A monitoring and adaptive management program would be developed and implemented to ensure appropriate and timely responses to unforeseen mortalities or habitat impacts (refer section 8).

Appendix G MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

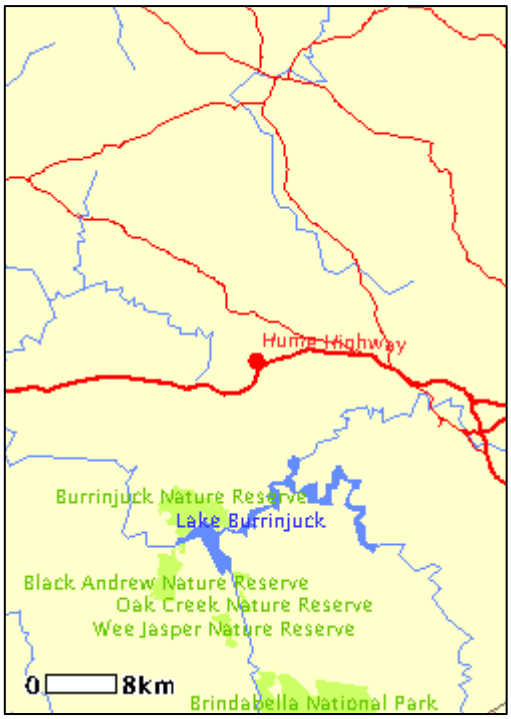
Matters of National Environmental Significance search report (biodiversity components)

- based on 50km buffer around proposal site

- report generated 21 August 2008

Summary

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	2
Threatened Species:	19
Migratory Species:	12
Commonwealth Lands:	2
Commonwealth Heritage Places:	None
Places on the RNE:	34
Listed Marine Species:	10
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None
State and Territory Reserves:	4
Other Commonwealth Reserves:	None
Regional Forest Agreements:	1



Full report

Wetlands of International Significance (Ramsar Sites)		
Fivebough and Tuckerbil Swamps		Within same catchment as Ramsar site
Threatened Ecological Communities	**Status**	**Type of Presence**
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area
Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory	Endangered	Community likely to occur within area
Threatened Species	**Status**	**Type of Presence**
Birds		
Lathamus discolor * Swift Parrot	Endangered	Species or species habitat may occur within area
Polytelis swainsonii * Superb Parrot	Vulnerable	Breeding likely to occur within area
Rostratula australis * Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Anthochaera phrygia * Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Frogs		
Litoria booroolongensis Booroolong Frog	Endangered	Species or species habitat likely to occur within area
Fishes		
*Maccullochella peelii peelii** Murray Cod, Cod, Goodoo	Vulnerable	Species or species habitat may occur within area
Macquaria australasica * Macquarie Perch	Endangered	Species or species habitat may occur within area
Insects		
Synemon plana * Golden Sun Moth	Critically Endangered	Species or species habitat likely to occur within area
Mammals		

Dasyurus maculatus maculatus (SE mainland population)	Endangered	Species or species habitat likely to occur within area
Nyctophilus timoriensis (South-eastern form) Eastern Long-eared Bat	Vulnerable	Species or species habitat may occur within area
Pseudomys fumeus * Konoom, Smoky Mouse	Endangered	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella * Pink-tailed Worm-lizard	Vulnerable	Species or species habitat likely to occur within area
Delma impar * Striped Legless Lizard	Vulnerable	Species or species habitat likely to occur within area
Plants		
Ammobium craspedioides * Yass Daisy	Vulnerable	Species or species habitat likely to occur within area
Caladenia concolor * Crimson Spider-orchid, Maroon Spider-orchid	Vulnerable	Species or species habitat likely to occur within area
Diuris sheaffiana * Tricolour Diuris	Vulnerable	Species or species habitat may occur within area
Leucochrysum albicans var. *tricolor*** Hoary Sunray	Endangered	Species or species habitat likely to occur within area
Grevillea iaspicula * Wee Jasper Grevillea	Endangered	Species or species habitat likely to occur within area
Thesium australe * Austral Toadflax, Toadflax	Vulnerable	Species or species habitat likely to occur within area
Migratory Species	**Status**	**Type of Presence**
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Anthochaera phrygia	Migratory	Species or species habitat likely to occur within area

Regent Honeyeater		
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Migratory Marine Species		
Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Listed Marine Species	**Status**	**Type of Presence**
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor	Listed - overfly	Species or species habitat may occur within area

Swift Parrot	marine area	
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area

Places on the RNE (natural)

Derringullen Creek Area NSW

Hattons Corner Area NSW

Lake Burrinjuck Grevillea iaspicula Site 1 NSW

Lake Burrinjuck Grevillea iaspicula Site 2 NSW

Upper Lake Burrinjuck Area NSW

State and Territory Reserves

Black Andrew Nature Reserve, NSW

Burrinjuck Nature Reserve, NSW

Hattons Corner Nature Reserve, NSW

Oak Creek Nature Reserve, NSW

Regional Forest Agreements

Southern RFA

Appendix H BOX-GUM WOODLAND EEC DETERMINATION

White box yellow box Blakely's red gum woodland - endangered ecological community listing (NSW Scientific Committee 2002)

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the White Box Yellow Box Blakely's Red Gum Woodland as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act. The Scientific Committee previously made a Preliminary Determination to support the proposal to list the White Box-Yellow Box Woodland. The Scientific Committee considers that the White Box Yellow Box Blakely's Red Gum Woodland is a more appropriate name for this Community.

The Scientific Committee has found that:

1. White Box Yellow Box Blakely's Red Gum Woodland is the name given to the ecological community characterised by the assemblage of species listed in paragraph 3. White Box Yellow Box Blakely's Red Gum Woodland is found on relatively fertile soils on the tablelands and western slopes of NSW and generally occurs between the 400 and 800 mm isohyets extending from the western slopes, at an altitude of c. 170m to c. 1200 m, on the northern tablelands (Beadle 1981). The community occurs within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes Bioregions.

2. White Box Yellow Box Blakely's Red Gum Woodland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - Eucalyptus albens (White Box), Eucalyptus melliodora (Yellow Box) or Eucalyptus blakelyi (Blakely's Red Gum). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common.

3. White Box Yellow Box Blakely's Red Gum Woodland is characterised by the following assemblage of species.

Acacia buxifolia
Acacia implexa
Acacia paradoxa
Allocasuarina verticillata
Alectryon oleifolius
Aristida behriana
Aristida ramosa
Asperula conferta
Atalaya hemiglauca
Austrodanthonia auriculata
Austrodanthonia bipartita
Austrodanthonia racemosa
Eucalyptus bridgesiana
Eucalyptus conica
Eucalyptus goniocalyx
Eucalyptus melliodora
Eucalyptus microcarpa
Eucalyptus nortonii
Eulalia aurea
Exocarpos cupressiformis
Geijera parviflora
Geranium solanderi
Glycine clandestina
Glycine tabacina

Austrodanthonia richardsonii
Austrostipa aristiglumis
Austrostipa blackii
Austrostipa nodosa
Austrostipa scabra
Bothriochloa macra
Brachychiton populneus
Brachyloma daphnoides
Bracteantha viscosa
Brunoniella australis
Bulbine bulbosa
Bursaria spinosa
Callitris endlicheri
Callitris glaucophylla
Capparis mitchellii
Cassinia longifolia
Cassinia quinquefaria
Cheilanthes sieberi
Chloris truncata
Chloris ventricosa
Chrysocephalum apiculatum
Cymbopogon refractus
Dianella longifolia
Dianella revoluta
Dichanthium sericeum
Dichelachne micrantha
Dichelachne sciurea
Diuris dendrobioides
Dodonaea viscosa
Echinopogon caespitosus
Ehretia membranifolia
Elymus scaber
Eremophila mitchellii
Eucalyptus blakelyi
Eucalyptus albens
Glycine tomentella
Gonocarpus elatus
Goodenia pinnatifida
Hibbertia linearis
Hibbertia obtusifolia
Hypericum gramineum
Jacksonia scoparia
Jasminum lineare
Jasminum suavissimum
Leptorhynchos squamatus
Lissanthe strigosa
Lomandra filiformis
Melichrus urceolatus
Microseris lanceolata
Notelaea microcarpa
Olearia elliptica
Olearia viscidula
Oxalis perennans
Pandorea pandorana
Panicum queenslandicum
Parsonsia eucalyptophylla
Pimelea curviflora
Plantago debilis
Plantago gaudichaudii
Poa labillardieri
Poa sieberiana
Rostellularia adscendens
Rumex brownii
Sida corrugata
Sorghum leiocladum
Stackhousia monogyna
Stackhousia viminea
Swainsona galegifolia
Templetonia stenophylla
Themeda australis
Wahlenbergia communis

The total flora and fauna species list for the community is considerably larger than that given above, with many species present in only some sites or in very small quantity. In any particular site not all of the assemblage listed above may be present. At any one time, seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site, recent rainfall or drought conditions, its disturbance history and geographic and topographic location. The community is an important habitat for a diverse fauna (vertebrates and invertebrates), but detailed records are not available from most stands and the invertebrate fauna is poorly known.

4. Woodlands with Eucalyptus albens are most common on the undulating country of the slopes region while Eucalyptus blakelyi and Eucalyptus melliodora predominate in grassy woodlands on the tablelands. Drier woodland areas dominated by Eucalyptus albens often form mosaics with areas dominated by Eucalyptus blakelyi and Eucalyptus melliodora occurring in more moist situations, while areas subject to waterlogging may be treeless. E microcarpa is often found in association with E. melliodora and E. albens on the south western slopes. Woodlands including Eucalyptus crebra, Eucalyptus dawsonii and Eucalyptus moluccana (and intergrades with Eucalyptus albens), for example in the Merriwa plateau, Goulburn River

National Park and western Wollemi National Park, are also included. Intergrades between Eucalyptus blakelyi and Eucalyptus tereticornis may also occur here.

5. Latitudinal and climatic gradients in the patterns of species present are found across the range of the community (eg. see Prober 1996 for variation in White Box). This is reflected in a gradual change in herb and grass species from northern to southern NSW (eg. Prober 1996). Within White Box Yellow Box Blakely's Red Gum Woodland, species such as Rostellularia adscendens, Chloris ventricosa, Austrodanthonia racemosa, Brunoniella australis, Cymbopogon refractus, Swainsona galegifolia, Notelaea microcarpa, Stackhousia viminea, Olearia elliptica, Jasminum suavissimum, Plantago gaudichaudii, Dichanthium sericeum, Plantago debilis and Wahlenbergia communis are generally more restricted to more northern areas (eg. Prober 1996). Some other species in White Box Yellow Box Blakely's Red Gum Woodland were generally restricted to southern areas. These include Gonocarpus elatus, Austrostipa blackii, Aristida behriana, Bracteantha viscosa, Austrodanthonia auriculata and Austrostipa nodosa (Prober 1996).

6. White Box Yellow Box Blakely's Red Gum Woodland includes vegetation described as Eucalyptus albens alliance and E. melliodora / E. blakelyi alliance in Beadle (1981), the Eucalyptus albens alliance in Moore (1953a,b), the grassy white box woodlands of Prober and Thiele (1993,1995) and Prober (1996) and the Grassy white box woodland of the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999. In the southern tablelands and parts of the southwest slopes, White Box Yellow Box Blakely's Red Gum Woodland are described in Thomas et al. (2000).

7. Related communities are the Eucalyptus microcarpa, Eucalyptus pilligaensis Grey Box/ Eucalyptus populnea Poplar Box communities of the western slopes and plains and the Eucalyptus moluccana, Grey Box, communities of the Clarence, lower Hunter Valley and Western Sydney. These are not covered by this Determination. Similarly the natural temperate grasslands and the Eucalyptus pauciflora grassy woodlands of the cooler parts of the southern tablelands are not covered by this Determination.

8. White Box Yellow Box Blakely's Red Gum Woodland has been drastically reduced in area and highly fragmented because of clearance for cropping and pasture improvement. Austin et al. (2000) found the community had been reduced to less than 1% of its pre-European extent in the Central Lachlan region. Comparable degrees of reduction have been documented for NSW south western slopes and southern Tablelands (estimated <4% remaining, Thomas et. al. 2000), and for the Holbrook area (estimated <7% remaining, Gibbons and Boak (2000). Gibbons and Boak (2000) found remnants of woodlands dominated by Eucalyptus albens, E. melliodora and E. blakelyi were severely fragmented. Further remnants of the community are degraded as a consequence of their disturbance history. Some remnants of these communities survive with the trees partly of wholly removed by post European activities, and conversely, often remnants of these communities survive with these tree species largely intact but with the shrub or ground layers degraded to varying degrees through grazing or pasture modification. Remnants are subject to varying degrees of threat that jeopardise their viability. These threats include: further clearing (for cropping, pasture improvement or other development); deterioration of remnant condition (caused by firewood cutting, increased livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance and increased nutrient loads); degradation of the landscape in which remnants occur (including soil acidification, salinity, and loss of connectivity between remnants).

9. The understorey may be highly modified by grazing history and disturbance. A number of native species appear not to tolerate grazing by domestic stock and are confined to the least disturbed remnants (Dianella revoluta, Diuris dendrobioides, Microseris lanceolata, Pimelea curviflora, Templetonia stenophylla (Prober & Thiele 1995). Dominant pasture species typically change from Themeda australis, Austrostipa aristiglumis and Poa spp. to Austrostipa falcata,

Austrodanthonia spp. and Bothriochla macra as grazing intensity increases (Moore 1953a). This may reflect differences in palatability of these species and their ability to tolerate grazing pressure. Light grazing and burning may also be a problem and lead to Aristida ramosa dominance (Lodge & Whalley 1989).

10. The condition of remnants ranges from relatively good to highly degraded, such as paddock remnants with weedy understories and only a few hardy natives left. A number of less degraded remnants have survived in Travelling Stock Routes, cemeteries and reserves, although because of past and present management practices understorey species composition may differ between the two land uses. Some remnants of the community may consist of only an intact overstorey or an intact understorey, but may still have high conservation value due to the flora and fauna they support. Other sites may be important faunal habitat, have significant occurrences of particular species, form part of corridors or have the potential for recovery. The conservation value of remnants may be independent of remnant size.

11. Disturbed remnants are still considered to form part of the community including remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact.

12. The community is poorly represented in conservation reserves. There are small occurrences of White Box Yellow Box Blakely's Red Gum Woodland in Border Ranges National Park, Goobang National Park, Goulburn River National Park, Manobalai Nature Reserve, Mt Kaputar National Park, Oxley Wild Rivers National Park, Queanbeyan Nature Reserve, Towari National Park, Warrumbungle National Park, Wingen Maid Nature Reserve and Wollemi National Park. The community also occurs in the following State Conservation Areas, Copeton State Conservation Area, Lake Glenbawn State Conservation Area and Lake Keepit State Conservation Area.

13. Fauna species of conservation significance found in some stands of White Box Yellow Box Blakely's Red Gum Woodland include,

Aprasia parapulchella - Pink-tailed Legless Lizard
Burhinus grallarius - Bush Stone-curlew
Cacatua leadbeateri - Major Mitchell's Cockatoo
Climacteris picumnus victoriae - Brown Treecreeper
Dasyurus maculatus - Spotted-tailed Quoll
Delma impar - Striped Legless Lizard
Grantiella picta - Painted Honeyeater
Hoplocephalus bitorquatus - Pale-headed Snake
Lathamus discolor - Swift Parrot
Lophoictinia isura - Square-tailed Kite
Melanodryas cucullata cucullata - Hooded Robin
Melithreptus gularis gularis - Black-chinned Honeyeater
Neophema pulchella - Turquoise Parrot
Ninox connivens - Barking Owl
Petaurus norfolcensis - Squirrel Glider
Phascolarctos cinereus - Koala
Polytelis swainsonii - Superb Parrot
Pomatostomus temporalis temporalis - Grey-crowned Babbler
Pyrrholaemus sagittata - Speckled Warbler
Saccolaimus flaviventris - Yellow-bellied Sheathtail-bat
Stagonopleura guttata - Diamond Firetail
Synemon plana - Golden Sun Moth
Tyto novaehollandiae - Masked Owl

Varanus rosenbergi - Rosenberg's Goanna
Xanthomyza phrygia - Regent Honeyeater
A number of plant species of conservation significance are likely to occur in White Box Yellow Box Blakely's Red Gum Woodland
Ammobium craspedioides
Bothriochloa biloba
Dichanthium setosum
Discaria pubescens
Diuris spp.
Prasophyllum petilum
Pterostylis spp.
Rutidosis leptorhynchoides
Swainsona spp.

A number of key threatening processes also occur in White Box Yellow Box Blakely's Red Gum Woodland. These include: Clearing of native vegetation, Predation by the European Red Fox Vulpes vulpes, Predation by the Feral Cat, Felis catus.

14. In view of the small size of existing remnants, and the threat of further clearing, disturbance and degradation, the Scientific Committee is of the opinion that White Box Yellow Box Blakely's Red Gum Woodland is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate and that listing as an endangered ecological community is warranted.

Proposed Gazettal date: 15/03/02
Exhibition period: 15/03/02 – 19/04/02

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Appendix I **YASS DAISY PROFILE**

Yass Daisy – DECC species profile

Scientific name: *Ammobium craspedioides*
Conservation status in NSW: Vulnerable
National conservation status: Vulnerable

Description

The Yass Daisy is a rosette-forming perennial. Leaves are spoon-shaped, to 12 cm long and 17 mm wide, hairy on top and white and woolly underneath. The spring flowerheads are hemispherical buttons, to 20 mm wide, and surrounded at the base by papery leaf-like structures (bracts). The solitary flowerheads are borne on unbranched stems to 60 cm tall; the stems are sparsely leafed, and edged with narrow "wings". Rosettes die off after fruiting.

Foliage and buds,
Image: John Briggs
© John Briggs

Location and habitat

Distribution

Found from near Crookwell on the Southern Tablelands to near Wagga Wagga on the South Western Slopes. Most populations are in the Yass region.

Flower, Yass Daisy
Image: Colin Totterdell
© Colin Totterdell

Habitat and ecology

Found in dry forest, Box-Gum Woodland and secondary grassland derived from clearing of these communities.

Grows in association with a large range of eucalypts (*Eucalyptus blakelyi*, *E. bridgesiana*, *E. dives*, *E. goniocalyx*, *E. macrorhyncha*, *E. mannifera*, *E. melliodora*, *E. polyanthemos*, *E. rubida*).

Apparently unaffected by light grazing, as populations persist in some grazed sites.

Found in a number of cemeteries in the region.

Threats

Agricultural developments, intensification of grazing regimes, invasion of weeds, road works (particularly widening or re-routing), inappropriate mowing or slashing in the cemetery sites where species occurs.

Management actions

Protect known populations from changes to land use.

Do not undertake road works, pasture modification or other changes in land use that may affect populations.

Do not increase grazing pressures on sites where populations persist -

reduce grazing pressures where possible.

Undertake weed control in and adjacent to populations, taking care to spray or dig out only target weeds.

Maintain traditional cemetery mowing regimes, taking care not to mow during the species' active period in spring and summer.

Mark sites and potential habitat onto maps (of the farm, shire, region, etc) used for planning (e.g. road works, residential and infrastructure developments, remnant protection, rehabilitation).

Search for new populations in potential habitat.

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Habitat during flowering, Yass Daisy
Image: Colin Totterdell
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Appendix J **PHOTOGRAPHS OF THE SITE**

1. Cluster 1 crest dominated by weeds (Scotch Thistle, European Nettle)

2. Cluster 2 – exotic groundcover in foreground, Long-leaved Box woodland over native grasses in background

3. Cluster 2 - White Box with exotic understorey on crest

4. Cluster 2 – rocky crest reptile habitat

5. Cluster 4a/4b – remnant woodland in valley, with EEC/CEEC and Yass Daisy colonies

6. Cluster 4b – Blakely's Red Gum regeneration on ridge with diverse woodland understorey (EEC, CEEC)

7. Cluster 4a – Yellow Box on saddle over native grass understorey

8. Cluster 6 – Long-leaved Box remnant with Yass Daisy

9. Cluster 7 – diverse grassland likely to be derived from box gum woodland

10. Cluster 7 – diverse grassland (note circular remnant Kangaroo Grass patch)

11. Yellow-footed Antechinus – inhabitant of dry grass forest

12. Threatened Yass Daisy in grassland at cluster 7

13. Broad-leaved Peppermint – Brittle Gum dry forest at the southern end of cluster 7

Appendix K **WINDFARM RISKS TO BIRDS AND BATS**

Please see Attachment 3.3 of the Yass Valley Wind Farm Environmental Assessment

Appendix 3.3 Wind Farm Risks to Birds and Microbats

EPURON

POWER FOR PORTFOLIOS

Proposed Yass Wind farm

WINDFARM RISKS TO BIRDS AND MICROBATS

MAY 2009

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Contents

1 INTRODUCTION

Wind farm development has been steadily increasing over recent decades in many countries. However there are few Australian examples from which to draw upon when assessing the potential impact of wind farms on Australian birds and microchiropteran bats (microbats). By drawing on overseas examples and applying the specific ecological attributes of Australian native species, this addendum builds a base upon which to assess the risks of wind farm development to birds and bats in an area bridging the Southern Tablelands / South West Slopes and Plains of NSW where three wind farm precincts are proposed for development.

This addendum examines relevant background information in the areas of:

- Collision with wind turbines: mortality caused by direct collision with turbine blades and by birds and microbats being swept down by the wake behind a turbine blade.
- Sudden decompression: Rapid or excessive air-pressure change near moving turbine blades has been linked to microbat fatalities as a result of hemorrhaging of the lungs (pulmonary barotrauma) (Baerwald et al., 2008).
- Behavior modification, for example, avoidance of foraging areas due to the presence of the turbines and associated infrastructure.

A literature review is followed by a discussion of implications for this proposal and of monitoring and design of management and mitigation measures, specific to three proposed wind farm precincts west of Yass, NSW.

2 LITERATURE REVIEW

2.1 BIRDS

2.1.1 Quantifying mortalities at existing wind farms

There are a growing number of studies and monitoring programs in Australia and overseas which provide some insight into the nature and scale of potential risks to birds from wind farms.

Internationally

A review of overseas wind farms showed low mortality rates for most wind farms (Langston and Pullen 2002). On average for all birds, new generation projects in the US (outside California) have recorded three fatalities per megawatt per year (Erikson *et al.* 2001). A review of European and North American wind farms indicates that most wind farms in agricultural settings affect between 2 and 4 birds per turbine per year (Lane and Associates 2004). In Washington, America the estimated mortality was 3.59 birds per turbine per year (Erickson et al., 2003). However, the most commonly recorded bird group to collide with European and North American turbines were night-migrating songbirds, of which there are comparatively few in Australia.

In Europe, Winkelman (1994) produced an estimated average of 0.04 to 0.09 mortalities per turbine per day, or 14.6 to 32.9 mortalities per turbine per year. Forty-three percent of these were killed by being swept down by the wake behind a blade, 36% flew directly into a blade, and for 21% the cause of death was unknown. At Altamont Pass in the United States, 55% of raptors were killed by striking a blade, 8% from electrocution, 11% from wire collision and 26% from unknown causes (Orloff and Flannery 1992, cited in Canada Bird Studies 2001). Winkelman concluded that the number of birds killed per unit of energy produced is low compared to other human-related causes of bird death. A review of bird fatalities at 32 wind farms in North America produced an average of 1.4 birds per turbine per year, with a range of zero to 4.3 (Barclay et al., 2007).

Australia

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

Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds killed by wind turbines to date. Searches for dead birds around seven turbines at the Codrington Wind farm (Victoria) showed three bird deaths attributable to impact with wind turbines (Biosis Research, 2006). The species concerned were the introduced skylark (1), Richard's pipit (1) and Australian magpie (1). Incidental carcass finds showed a further adult Brown Falcon death. The estimated total number of deaths likely from Codrington's 14 turbines over one year is 18 to 38 birds, or 1.2 to 2.7 birds per turbine per year (Brett Lane and Associates 2005).

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

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

A summary of the average number of recorded bird fatalities from literature reviewed is provided in Table 2-1, where possible represented as birds per turbine per year.

Table 2-1 Average number of bird fatalities in reviewed literature

Location	Author	Average fatalities
North America	Erikson *et al*. 2001	3 per MegaWatt per year
Europe/North America	Lane and Associates 2004	3 per turbine per year
Europe	Winkelman 1994	23.5 per turbine per year
North America	Erickson *et al.* 2003	3.59 per turbine per year
North America	Barclay *et al*. 2007	1.4 per turbine per year
Victoria, Australia	Brett Lane Associates	2 per turbine per year
Tasmania, Australia	Hydro Tasmania 2003	2.3 per turbine per year

2.1.2 Risk factors for bird impacts

It is logical to assume that there may be a number of factors which affect the risk of birds colliding with wind farm infrastructure, and that some of these relate to the ecology of a species, site-specific features or to the design and location of the infrastructure.

Species-specific risks

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

- Foraging in the bladesweep area
- Flocking or colonial movements
- Awkward flight characteristics
- Migrating at night

Night-flying waterbirds have been identified as a risk group for wind farm developments. Small numbers of waterbirds were recorded throughout the proposed Yass Wind farm, in dams and wet drainage lines. Short-range foraging journeys by these species may follow chains of small wetland habitats scattered over the lowland areas of the district. Major migration routes for these species are not known.

Experience elsewhere in Australia suggests that Wedge-tailed Eagle mortality is a possibility, although there are examples of this species habituating to, and co-existing with wind turbines. Of greater concern may be the alienation of hunting habitat ('behaviour modification'), and the longer term affect on Wedge-tailed Eagle breeding success.

Species which are rare or declining, or which are naturally distributed at low density (such as top order raptors) may be at greater risk. While collision rates may be low, each mortality has a higher significance. Similarly, species with low reproductive rates, or poor capacity to disperse and recolonise

habitats may be at greater risk of significant impacts from blade collisions or avoidance behaviour at the population level.

Environmental risks

Many studies have shown that poor weather conditions increase the occurrence of turbine collisions (Canada Bird Studies 2001). Weather conditions which reduce the ability of birds to perceive the turbine blades or avoid collisions (such as fog and strong gusty winds) add to risks for susceptible species. Hence, sites which experience these conditions at higher frequency may be correspondingly riskier for these species. The relative location of key habitat areas (such as updraft zones, prey populations, wetlands and nesting sites) and natural diurnal and seasonal migration routes also affects risks to birds.

Structural characteristics of the development

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

2.1.3 Behaviour modification

In Europe, the effects of wind farms on habitat utilisation are considered to have a greater impact on birds than collision mortality (Strickland 2004). Bird abundance data from 19 globally-distributed windfarms found a significant negative impact on bird abundance (Stewart *et al.* 2007). Howeverit was unclear whether this related to a decline in population abundance or a decline owing to avoidance behavior. European studies suggest that most habitat displacement involves migrating, resting and foraging birds. Studies have reported displacement effects ranging from 75 metres to as far as 800 metres from turbines (Strickland 2004, Winkelman 1994). This is likely to reduce the risk of bird mortality, but may affect populations where the alienated habitat is particularly important or limiting.

Wind farm developments can alter resource availability and distribution by removing or creating water bodies, removing vegetation and hollows for foraging and roosting, creating an obstacle, increasing or decreasing prey activity. Construction impacts such as clearing may increase edge effects and fragmentation which for some species may represent a barrier to dispersal or movement (Lindemayer & Fischer 2006). The activity patterns of local bird species may also alter based on food resource movements (Kunz et all 2007, Grindal & Bingham 1998).

2.2 MICROBATS

There has been little study of wind farm impacts on microbat species Most papers, both in Australia and overseas, are focused on identifying species presence and qualifying possible impacts. Sterner et al (2007) claim that study in the USA to c.2007 were post operation of wind energy centres. Many of the scientific programs in the USA designed to test impacts have been hampered by operational requirements at wind farms (Kunz et al 2007).

Without this information, assumptions must be made using what we know of species ecology and limited case studies and investigations. The difficulty in estimating impact to microbats is compounded by the fact that relatively little is known about their ecology and behaviour.

2.2.1 Quantifying mortalities at existing wind farms

Compared to available data on bird mortalites, microbat collision events appear to be greater in number. Migratory microbats comprise the majority of mortalities in all wind farm studies to date (Erickson *et al.* 2002, Arnett 2005).

Fatalities at USA wind-energy facilities went as high as 53.3bat/MW/year at the Buffalo Mountain Wind Energy Centre for small Vestas V47 turbines producing 0.66-MW and 38.7 bats/MW/year for larger Vestas V80 turbines producing 1.8MW(Kunz et al 2007). Erickson *et al.* (2003) found an estimated mortality of 3.21 bats per turbine per year in North America.

Erickson *et al.* (2002) in a North American study, state that based on available data, microbat collisions during the breeding season are virtually non-existent. Further, North American research has shown that most microbat collisions have occurred with adults, hence collisions in this area were not thought to be attributed to dispersing juveniles (ABS 2005).

A review of 32 North American wind farm monitoring studies demonstrates a trend between turbine height and mortality numbers, with higher towers appearing to cause more bat deaths. The same review shows an average of 5.9 bat fatalities per turbine per year, with a range of zero to 42.7, when towers are at or greater than 65 metres in height (Barclay et al., 2007) . The variation of impact to microbats would appear dependent on the nature of the receiving environment and the siting of turbines.

While microbat fatalities in the USA at wind farms have been high, extrapolation of this data to Australian conditions would be inappropriate. This is mainly because climatic patterns are quite different, in the USA where 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 identifies 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 data in an Australian context. Fatalities may however be higher, but this would be dependent on habitat quality and proximity of significant bat roosts.

2.2.2 Risk factors for microbat impacts

In addition to the collision and habitat avoidance risks as described for birds, decompression, or pulmonary barotrauma, has been identified as a significant mortality causing factor for microbats.

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

Barotrauma potentially poses significant risks to microbats at wind farms as microbats are unable to detect rapid pressure reductions, even though echolocation may allow microbats to detect and avoid turbine blades.

Species-specific risks

There are a number of factors which make Microchiropteran order as a whole susceptible to negative impacts from wind farm developments. These include:

- Low reproductive rates
- Foraging patterns in response to weather conditions and resource pulses
- Flocking or colonial movements

All species of microbat have a low fecundity with most producing only 1 young per year (Law 1996). Species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk of significant impacts from blade collisions at the population level. This suggests that populations would recovery slowly from one-off large scale mortality events, or perhaps not recover at all from an ongoing threat (Racey and Entwhistle 2003 in Arnett 2005).

Many microchiropteran bat species hibernate or aestivate during cold periods to reduce their energy requirements when resources are low. In a compilation of survey results for wind farms in the United States, most microbat mortality documented occurred in late summer and autumn (nearly 90% from mid-July through mid- September) (Erickson *et al.* 2002). Resource abundance at this time would be expected to be high and bats requiring fat stores for aestivation would need to take advantage of the resource pulse. This higher rate of activity is likely to be the reason for a greater number of collisions.

Horn *et al.* (2008) noted direct collision with moving turbine blades during their study at the Mountaineer Wind Energy Centre, West Virginia. Many microbats actively investigated turbine structures when blades were both moving or stationary, be it for possible roosting, stop-over roosting in migration or as a mating site.

It is not known whether particular groups of microbats are more vulnerable than others, however risk factors are likely to include:

- Long distance migration (nocturnal)
- Foraging within the blade-sweep area

Current theory suggests that in the eastern United States, the microbats most likely to be impacted by wind energy turbines are long-distance migratory species (USGS 2008; Reynolds 2006). In Australia, long-distance migrating microbats include the Eastern Bentwing-bat and Yellow-bellied Sheath-tailed Bat, both recorded in the Carrolls Ridge Precinct proposal area. During migration, microbats may cease the use of echolocation to conserve energy (Keeley et al 2001 cited in Sterner et al 2007). Echolocation has been assessed as functional only over small distances of c.20 metres (Grindal & Bringham 1998). Navigational aids such as rivers, waterbodies, tracks and ridges may also be used by microbats during foraging or migration movements (Grindal & Bringham 1998; Vestjens and Hall 1977; Richards 2001). Tracks and riparian areas facilitate movement through the canopy (Law & Chidel 2002).

Foraging behaviour is a key risk factor to consider when determining species risk. The majority of microbats rely on forested areas for hollow bearing trees for roosts, and/or aggregations of insects to prey upon. Different species utilise different levels of the forest canopy, though Law & Chidel (2002) found that activity levels dropped in heavily cluttered regrowth areas or thick understorey rainforest.

It is considered that species which fly along the edges or above the canopy during foraging are most at risk from turbine impacts, compared to those that forage close to the ground or within the forest. These species include Eastern Bentwing-bat, Yellow-bellied Sheath-tailed Bat, Gould's Wattled Bat.

While most microbats are known for their highly manoeuvrable flight , some species are less mobile than others. Species which utilise open areas and tend to forage above the canopy may have limited manoeuvrability, such as the Eastern Free-tailed Bat and Gould's Wattled Bat (Van Dyck and Strahan, 2008).

Environmental risks

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

Evidence suggests that microbat collisions with structures during migration are common, and that these are normally associated with inclement weather (Erickson *et al.* 2002). US studies show that bats tend to be killed on low wind nights, when blade speeds were at or close to full operational speed (17 rpm) (Arnett 2005). Fatalities tended to increase just before and just after the passage of storm fronts, when microbat activity would increase in response to insect abundance, in a similar manner to swallows during the day. This study also found that microbat activity was greatest during the first two hours after sunset, which may also be a relatively high risk time for collisions. However, based on echolocation recordings within the three precincts, it appears that different species are more active at different times of the night, rather than all active during a short period.

Structural characteristics of the development

German studies have shown higher collision rates from turbines located near hedgerows, suggesting turbine placement adjacent to or within forest patches may increase risk to microbats (Australian Bat Society 2005). Further, many species use linear vegetation or topographic features while commuting (Limpens and Kapteyn 1991, in Erickson *et al.* 2002) and migrating (Humphrey and Cope 1976, Timm 1989, in Erickson *et al.* 2002).

Lights on turbines may increase the probability of microbat collisions, as insect abundance is higher under lights (Erickson *et al.* 2002). However, similar mortality rates at sites lit by aircraft lighting and sites which had no lights was found by Arnett, 2005. As a precaution where lighting is required, mitigation may involve the use of red flashing lights that are less likely to attract insects, which are generally not sensitive to the red end of the spectrum.

Table 2-2 Risk factors based on microbat ecology and turbine structures

Turbine Structure Risk Factors	Microbat Risk factor
• Lattice design appears most attractive for roosting • Turbine height and blade length • Turbine number	• Low fecundity, limited ability to recover from stochastic events • Long distance migration • Curiosity/attraction to turbine structures

Turbine Structure Risk Factors	Microbat Risk factor

• Constructed along forested ridges
 	
• Lighting
  ▪ May attract night migrating species
  ▪ May attract insects (prey)
	• Forage and roost in forested ridgetops, including about the canopy
	
	• Periods of high activity:
	  ▪ Just before and just after storm fronts
	  ▪ First two hours after sunset (unsubstantiated)
	  ▪ Summer
	  ▪ Low wind conditions
	  ▪ During resource pulses
	
	• Utilise flyways and topographic features (such as ridges) for navigation
	
	• Different species forage at different levels of forest, including above the canopy

2.3 SUMMARY

Good design and turbine placement is the first step to minimising bird and microbat mortalities. Key risk factors identified from the literature review were:

- Between areas of forest or waterways (animals will cross the turbine areas to move between fragments
- Along forested ridge or waterways (often used as navigational aids by birds and bats
- Abutting forest or remnants (increased foraging activity along edges)
- Reducing the attractiveness of turbine areas for birds and bats by minimising perching opportunities (e.g. guy lines) and lighting.

Once built, ongoing management to reduce deaths during periods of high risk, such as those listed below, may be necessary:

- During peak foraging activity times
- Poor weather conditions (rainy, foggy, poor visibility)

3 A FRAMEWORK FOR MANAGEMENT

Monitoring habitat utilisation prior to finalising turbine layout is important to effectively manage potential impacts to birds and microbats, firstly through avoidance and minimisation. There are three main parts to a bird and microbat management plan (California Energy Commission and California Department of Fish and Game, 2007; DEH, 2005):

1. Impact avoidance and minimisation (monitor and avoid)
2. Impact mitigation and adaptive management (monitor and mitigate)
3. Operations monitoring and reporting (monitor, report and adjust)

Step 1 is about avoiding impacts in the first place, which is preferable to mitigating against impacts. Steps 2 and 3 are not discrete phases, but rather will constantly inform each other as part of an adaptive management cycle. Each step would be part of the Bird and Bat Management Plan for each of the Yass Wind Farm Precincts.

Central to the management of hazards to birds and bats are biologically appropriate triggers, informed by both pre-operation monitoring and ecological species information. A management plan will specify requirements to adjust management or mitigation measures if trigger points are met (e.g. x number of x species fatalities over x period of time), and provide realistic timelines for periodic review and adjustments to both monitoring and mitigation phases of the management plans (California Energy Commission and California Department of Fish and Game, 2007).

The management plans should utilise the principle of adaptive management. Adaptive management allows the initiation of a project in the absence of complete knowledge by providing a framework to incorporate new information as it comes to hand. With new information, management strategies can be adapted appropriately (Johnson, 1999). Adaptive management is similar to a "monitor-and-modify" approach, but is more flexible in response to new information (Johnson, 1999).

3.1 IMPACT AVOIDANCE AND MINIMISATION

The first principle is to avoid and minimise potential impacts. Further recommendations for monitoring and managing significant microbat species will come from the *Microbat Study,* and should be considered in concert with this addendum report. The actions described in Table 3-1 provide a framework for impact and avoidance at the Yass Wind Farms Precincts, although each action may not relevant to all the precincts.

Table 3-1 Impact aviodance and minimisation actions

Action to avoid/minimise impact	Detail
Minimise habitat disturbance and fragmentation	This can be achieved by creating detailed maps of habitat utilisation (through early monitoring) and then avoiding high use areas.
Establish buffer zones to minimise collision hazards	The appropriate extent of buffer zones can be determined based on high habitat value features (e.g. hollow-bearing trees or raptor nests) and biological and species-specific information.
Reduce impacts with appropriate wind farm siting	Wind farms should not be sited near habitat of listed threatened or migratory species, or areas of high bird or bat movement and activity. All associated infrastructure should avoid: • Wetlands • Important breeding, roosting or feeding habitat for threatened or migratory species
Reduce impacts with appropriate turbine design	Turbine selection should consider biodiversity constraints. For example: • Turbines that operate at low speeds may cause a greater number of microbat fatalities. • Guy lines should be avoided as known to pose a hazard to birds. If guy lines area necessary, bird deterrents such as markers should be part of the design.
Reduce impacts with appropriate turbine layout	It is assumed that careful siting of turbines could significantly reduce the risk of high bird and bat mortalities: • Turbines should not fragment areas of habitat, as this poses a greater hazard to birds and microbats passing between them. • Turbines should avoid core areas of microbat activity, such as winter hibernacula, important foraging areas and areas close to potential migration routes. • Turbines at the end of linear ridges have been identified as responsible for greater numbers of collisions, as animals appear to use topographical features as a navigational aids.
Avoid making turbine areas attractive for foraging	The proposal should not increase habitat for prey species such as insects and small mammals (e.g. rabbits).
Avoid lighting that attracts birds and bats	Red flashing lights with a long dark interval and short flash on-time is thought to be the safest lighting configuration for night flying birds (California Energy Commission and California Department of Fish and Game, 2007). Lighting at operation and maintenance facilities should be on sensors, hooded and directed to minimise skyward illumination (Horn *et al.* 2008). Bats do not appear to be attracted to lights,

Action to avoid/minimise impact	Detail
	although there has been little study on this.
Minmise power-line impacts	All powerlines should be underground rather than overhead where possible to minimise impacts to birds, unless this is considered to have a greater potential impact.
Decommission non-operational turbines	Remove non-operational turbines so they do not continue to present a collision hazard for birds (microbats appear not to collide with stationary turbines).
Offset	To achieve a 'maintain or improve' environmental outcome, a wind farm development would need to be accompanied by offsets to compensate for the loss of biodiversity values in the long term. Considering the key impacts are bird and microbat collisions, offset options are presented below: • Conservation of lands important to species at greatest risk (i.e. Eastern Bentwing-bat) • Proactively addressing DECC priority actions for species at greatest risk • Funding scientific research that would address information gaps and areas of uncertainty, i.e. barotrauma, low and high speed rates of movement for bats, modeling work based on microbat activity periods/weather conditions. Information should be passed into the public arena to assist in future assessments.

3.2 IMPACT MITIGATION AND ADAPTIVE MANAGEMENT

The first step is to avoid potential impacts. However, where this is not possible, mitigation actions can be undertaken. In all cases, mitigation is second best to good turbine design and layout (California Energy Commission and California Department of Fish and Game, 2007; DEH, 2005). Potential mitigation options include:

1. Appropriate timing of construction activities to minimise impacts to birds and microbats, i.e. outside of known nesting periods.
2. Maintenance activities or habitat modification to make the site less attractive as habitat
   a) Carcasses should be removed as soon as possible to avoid attraction of scavengers (e.g. Wedge-tailed Eagle)
   b) Acoustic deterrents, such as high frequency sonar emissions, are currently being investigated for their use in discouraging microbats from utilising areas around turbines. This method has been trialled in Australia for removing flying-fox colonies from urban areas.
3. Seasonal changes to cut-in speed. Pre-operational monitoring will help to determine peak activity periods (seasonal or event-based) for birds and bats, such as:

a) Before and after storm fronts (bats – high activity)

b) Prior to migration (bats – high activity)

c) During times of high insect abundance (bats and insecivorous birds – high activity)

d) Periodic feathering of turbines during low wind nights during migratory or peak activity periods (for example, the Eastern Bentwing-bat will not fly in wind speeds greater than 20-25km/hr; birds tend to fly less in high wind also)

4. Removal of particular turbines or seasonal shut-down if high levels of fatalities (exceed trigger values and mitigation methods ineffective to reduce mortality rates).

3.3 OPERATIONS MONITORING AND REPORTING

The rationale for operations monitoring at the Yass Wind Farm Precincts is to collect bird and bat fatality data and habitat utilisation data. Monitoring options were discussed in detail in Section 3. Before and after monitoring information is required to evaluate, verify, and report on effectiveness of avoidance and minimisation measures. At a minimum, the primary objectives for operations monitoring are to determine (California Energy Commission and California Department of Fish and Game, 2007):

- Whether the avoidance, minimisation, and mitigation measures implemented for the project were adequate or whether additional corrective action or compensatory mitigation is warranted
- Whether overall bird and bat fatality rates are low, moderate, or high relative to other projects

4 MONITORING

Monitoring of birds and microbats around wind farms should be undertaken during two discrete phases: during the planning phase (prior to construction and preferably prior to final layout determination) and during the operational phases.

The accepted experimental design for monitoring the impacts of a proposal is the 'Before-After-Control-Impact' (BACI) design. This involves establishing monitoring sites both where impact is expected (impact site) and where the proposal would not have an effect (control site). Monitoring data from the operational phase at both points is compared to the baseline (planning phase data), with the control site helping to account for effects of environmental variables (such as unusual seasonal conditions) (Brett Lane & Associates, 2005).

The Interim standards for assessing the risks to birds from wind farms in Australia recommend planning phase surveys at three levels, described below, depending on the level of risk (Brett Lane & Associates, 2005). Level One investigations have been undertaken for each of three Precincts.

Level One — Initial risk assessment. Where risk is low or can be reduced to low through planning, management and/or mitigation measures, no further investigation is required; otherwise, Level Two investigation are recommended

Level Two — More intensive surveys are undertaken to determine whether or how risk can be reduced to low; otherwise Level Three investigations are recommended.

Level Three — More intensive surveys provide baseline data for use in design and planning to avoid risks as well as to inform monitoring during the operational phase. Risk assessment at this level is more rigorous and may include estimates of collision impacts (i.e., x number of birds/bats per turbine per year), which will be re-evaluated after operational monitoring.

The 'population source-sink' model may provide a context to guide the design of monitoring to measure local populations and activity both before and after development. Monitoring of a good quality habitat patches close to proposed turbine sites may give an indication of the level of use (see Richards, 2005). Conversely, pre-construction monitoring in areas of degraded habitat (potential sink-habitat areas), may provide an indication of the robustness of nearby source populations (Jonzen et al., 2005). An effective monitoring program will utilise a range of methods to ensure data collection is robust.

4.1 BEFORE: MONITORING IN THE PLANNING PHASE

Monitoring programs should have multiple methods of data collection, to increase the reliability of data. Kunz *et al.* (2007) found that reliance on one method alone did not give adequate risk predictions for operational aspects of wind energy facilities. Appropriate monitoring options during the planning phase include the following and are shown in Table 4-1 below:

- Anabat recording and/or harp trapping to determine species present
- Habitat utilisation monitoring to determine habitat use
- Roaming surveys
- Raptor nest searches

Table 4-1 Methods used for monitoring potential impacts of wind farms to birds

	Investigation level	Direct impacts	Indirect impacts
Pre-operational risk assessment	Level One	• regional overview • indicative bird utilisation survey • roaming surveys	• regional overview • indicative bird utilisation survey • roaming surveys
	Level Two	• continuing bird utilisation studies • gradient studies • roaming surveys • risk modelling	• continuing bird utilisation studies • gradient studies • roaming surveys • risk modelling
	Level Three	• population assessment • population viability analysis	• population assessment • population viability analysis

Source: (Brett Lane & Associates, 2005)

4.1.1 Descriptions of monitoring methods for Levels One to Two

Combinations of the following monitoring methods are suggested for use in the planning or pre-operation phase of wind farm monitoring to determine the level of risk to birds and bats from the proposal. The information obtained would also inform the Bird and Bat Management Plan.

Habitat utilisation monitoring (Level 1/2)

Habitat utilisation is used to provide baseline data on bird and bat species composition, occurrence, frequency, and behavior to compare with operations use and fatality data, inform micrositing decisions, provide estimates of potential collision risk based on time spent in rotor-swept area and provide an estimate of spatial and temporal use of site by all bird and bat species. Monitoring should be undertaken regularly over a full year to establish seasonal patterns (California Energy Commission and California Department of Fish and Game, 2007).

For microbats, acoustic detectors can be located on wind monitoring towers and set to record information every night, ideally within the proposed rotor-swept zone (California Energy Commission and California Department of Fish and Game, 2007)

Habitat utilisation monitoring aims to answer the following questions (Brett Lane & Associates, 2005):

- Which bird and bat species use the site?
- With what frequency does each species occur at the site?
- At which height do birds and bats of each species fly?
- What is the distribution of bird and bat species across the site?

Roaming surveys (Level 1/2)

Roaming surveys are practical to survey particular diurnal birds, such as rare or threatened species. The purpose is to describe the usage of the proposal area and the region by the target species in the context of regional population levels, as well determine management and mitigation options. This method is used (Brett Lane & Associates, 2005):

- Where there are known populations of a threatened species within or near (within around 5 kilometres) the proposal that could be potentially affected (e.g. Superb Parrot)
- Where there are known congregations of birds, such as on wetlands
- Where initial risk assessment has found a particular species, or groups of species (e.g. raptors) are at high risk from collision impacts

  (Brett Lane & Associates 2005)

Migration counts can be part of a roaming survey to provide a more complete picture of species composition, passage rates, and flight height if diurnal migrants are known to congregate at or near the proposal area, or if the proposal site is within a known or likely migration corridor (California Energy Commission and California Department of Fish and Game, 2007).

Raptor nest searches (Level 1/2)

Where initial surveys demonstrate that raptors are of concern, raptor nest searches can be used to boost habitat utilisation monitoring. These provide baseline data on location and activity level of nesting raptors in relation to proposed wind turbine sites (California Energy Commission and California Department of Fish and Game, 2007). This information can then be used to:

- Microsite turbines to reduce potential impacts to nesting raptors
- Develop appropriate buffer zones around breeding territories

Gradient studies (Level 2)

Gradient studies provide an extra level of information to habitat utilisation monitoring by ascertaining how bird and bat habitat useage changes across an environmental gradient, such as topography or time (Brett Lane & Associates, 2005). This method is appropriate where turbines are situated near important habitat features (such as Lake Burrinjuck near Carrolls Ridge) or known core breeding or foraging habitats for a species of concern (such as Eastern Bentwing-bat) at Carrols Ridge.

Reynolds (2006) conducted a spatial and temporal study of microbat activity at a proposed wind energy site in Northeastern USA, recording microbat activity through acoustics (Anabat) and mist netting. Dividing nights into three distinct phases, early (7pm to 10.59pm), middle (11pm to 2.59am) and late (3am to 7am), he measured activity over multiple areas (ie varying habitat types- riparian, trackways, dams, open fields, and closed and open forests). Anabats were stationed at three levels vertically (ground, 25metres, and 50 metres) to record microbats using different canopy levels (Reynolds 2006). Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species composition.

Collision risk modelling (Level 2)

The data from habitat utilisation, gradient studies and roaming surveys informs collision risk modelling, which basically provides a quantitative species-specific impact assessment. Modelling is useful where the proposal is considered likely to cause high risk to populations based on qualitative assessments. Modelling will help to inform turbine layout options as well as any operational adjustments (such as

restricted periods of operation) by providing an estimate of the number of bird and bat passes that may result in a collision based on variables including the following (Brett Lane & Associates, 2005):

- Turbine layout
- Turbine number
- Wind direction information
- Bird or bat species habitat utilisation data

4.1.2 Descriptions of monitoring methods for Level Three

If the risk to a population of bird or bat species is still deemed to be above low following Level One and Two investigations and a suite of management and mitigation measures, further study is recommended under the Interim Standards to more accurately gauge population scale risks. This would involve population assessments and population viability analyses. Once these studies are complete, another risk assessment should be undertaken, after which a decision on viability of the project can be made (Brett Lane & Associates, 2005).

Population assessments

This would involve desktops assessments to collate regional information about a species from a variety of scientific and other published sources, and entail detailed analysis of the nature and scope of impacts based on species life history and distribution data.

Population viability analysis

This is a detailed formal modelling study to determine the likelihood of a species' extinction based on the additional threat (additional to the range of threats faced by a threatened species) posed by the proposal. This would involve substantial research and consultation and would result in a range of impact scenarios being presented for a particular species.

4.1.3 Population source-sink

The source-sink model (Pulliam 1988) provides a model for population dynamics based on the quality of habitat patches. Patches of good quality habitat, known as sources, have a net positive population growth. Patches of poorer habitat, known as sinks, have a net negative population growth (Hill et al., 2005). The source is usually a large tract of forest, and the sink a series of patches in a developed landscape (Ferriere et al., 2004).

In the case of this proposal, large nearby tracts of forest (such as Burrinjuck Nature Reserve and privately owned forest in the area of Carrols Ridge Precinct) may provide a population source for species breeding in the area, such as Superb Parrot. Population sinks may be areas of heavily cleared farmland or the freeway, for example, where the habitat quality is degraded and ongoing species mortality occurs.

The aim of this proposal would be to ensure the precincts do not create a population sink due to habitat degradation and ongoing species mortality from either blade-strike, barotrauma or habitat loss (due to avoidance). Monitoring during operation, such as through carcass searches, will help to inform and refine management strategies. Monitoring of potential sink-populations is the most effective method for

detecting the affect on the source population, as migration to the sink depends on source populations breaching carrying capacity (therefore reflecting breeding health) (Jonzen et al., 2005).

Modelling of source-sink populations has shown that a small amount of habitat loss (10%) resulting from development could lead to significant reductions in populations (49%) through source-sink dynamics (Aurambout et al., 2005). However, alternative research suggests that populations may adapt to sub-optimal conditions in sink habitats, thereby stabilising these sink-populations (Ferriere et al., 2004). The ability of a population to adapt to habitat change would be species-specific and therefore it is important to gather site-specific data at the proposed Yass windfarm precincts.

4.2 AFTER: MONITORING DURING OPERATIONAL PHASE

Appropriate monitoring options during the operational phase of a wind farm include:

- Carcass searches (Kunz et al 2007; (Brett Lane & Associates, 2005)
- Indirect disturbance impact assessments (Brett Lane & Associates, 2005)
- Avoidance studies (Brett Lane & Associates, 2005)
- Radar (weather information radar recording has also been used in the USA to assist in identifying migration routes and timing, as well as peak activity times/movement patterns of microbat species in relation to wind turbines; Kunz et al 2007).

Carcass searches

In most cases reviewed, monitoring for bird and microbat strike at wind farms has relied principally on carcass searches under turbines. Carcass monitoring involves searches for dead birds and bats within a 50m radius around the base of each turbine, in circular transects. This may be undertaken twice weekly (Hydro Tasmania 2003) and should be done equally within each season and during peak activity time for target species (breeding periods, summer activity, pre aestivation activity).

However, carcass searches alone have not proven to be an efficient monitoring method, as it provides a poor measure of population size and health. Carcass monitoring tends to underestimate the bird and bat fatalities (CaliforniaEnergyCommissionandCaliforniaDepartmentofFishandGame., 2007). This is likely to be due to:

- High level of search effort and searcher error,
- Injured animals may move out of the monitoring area, or under cover and so not be recorded (Sterner et al 2007)
- Subsequent deaths of a young after a female is killed or injured go unrecorded
- Predation of carcasses by foxes, rats, mice, birds etc (Kunz et al 2007)

Erickson *et al.* (2003) estimate that the mean carcass removal time, that is, the time it takes for scavengers to remove or a carcass to break down, is approximately 11 days for small birds and 33 days for large birds (in America), suggesting that searches should be done at least weekly. Other studies suggest scavenging rates are as high as 50-75% over one to four weeks after death (Brett Lane & Associates, 2005).

Conversely, this method alone could also overestimate the fatality rates, attributing deaths from other sources (such as vehicles) to turbines. Both monitoring at the control site (BACI design) and pre-operation monitoring can assist remove 'background' fatalities by providing baseline data (California Energy Commission and California Department of Fish and Game, 2007). Maintaining the BACI design for carcass monitoring is particularly important where there is moderate to high risk for any species before the implementation of mitigation measures, as the data will be more accurate (Brett Lane & Associates, 2005).

Indirect disturbance impact assessment

Changes in habitat utilisation (caused by indirect disturbance) can be monitored using habitat utilisation surveys, gradient studies and roaming surveys. Experimental design must be using BACI for operational phase monitoring to be meaningful. Survey effort for both phases should be equal to allow for comparison and statistical analyses (Brett Lane & Associates, 2005).

Avoidance studies

Avoidance studies attempt to figure out how a bird (or bat) responds when encountering turbines as well the success of avoidance responses, resulting in an avoidance rate figure (e.g. Brown Falcon 97% avoidance rate – manages to avoid turbine blades 97% of the time it encounters them). This information would be used for wind farm assessments in the future. Avoidance studies do not determine whether an area of habitat is avoided by a species due to the presence of turbines (Brett Lane & Associates, 2005).

4.3 REPORTING

Monitoring assists the future development of wind farms in Australia by providing a pool of data, collected using methods consistent with other wind farms, that will improve planning on upcoming projects. Information about the occurrence, magnitude, and reasons for bird and bat fatalities will help to refine the development of avoidance, minimisation, and mitigation measures for wind farm projects. Hence, regular (e.g. annual) publically available monitoring reports are fundamental to the usefulness of data (California Energy Commission and California Department of Fish and Game, 2007).

5 CONCLUSION

The risks of collision with wind farm infrastructure for birds and microbats relate to species ecology, environmental conditions and structural characteristics of the infrastructure proposed. The extent to which species may modify their utilisation of habitat may be influenced by a number of factors including; the pattern of infrastructure placement, the degree to which indirect and offsite impacts are managed, the distribution of habitat features before and after site development (for example, water bodies or perch opportunities) as well as species ecology.

A Bird and Bat Management Plan would be adopted for each of the Yass Wind Farm Precincts, recognising that the issues would likely be different at each precinct with regard to both target species and magnitude. Monitoring would be part of the Bird and Bat Management Plan. Any bird and microbat monitoring program should include a combination of techniques to measure impact. Monitoring should be well planned and designed as a Before –After – Controlled - Impact (BACI) study to collect valuable baseline data from which to compare future results.

The recommendations of this addendum report are:

1. Pre-operational monitoring of habitat utilisation by birds and microbats in order to acquire baseline data, acurately assess risk and calculate potential mortality rates
2. Impact avoidance and minimisation through good design and layout (informed by pre-operational monitoring data) and offsets (preferable to mitigation)
3. Impact mitigation and adaptive management where avoidance has not been possible. Mitigation strategies should be informed by pre-operational monitoring findings and be adaptive and responsive to findings during operational monitoring.
4. Operational monitoring of habitat utilisation and mortalities to calculate actual mortality rates and compare data to the precinct's baseline information and other wind farms
5. Annual reporting during the period of monitoring (one or more years) with reports publicly available for use in future wind farm developments

Further recommendations for monitoring and managing significant microbat species will come from the *Microbat Study,* and should be considered in concert with this addendum report.

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Appendix 3.4 Microbat Study: Proposed Yass Valley Wind Farm

EPURON
POWER FOR PORTFOLIOS

Microbat Study

PROPOSED YASS WIND FARM :

CARROLLS RIDGE, MARILBA AND COPPABELLA PRECINCTS

MAY 2009

nghenvironmental

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1 INTRODUCTION

Epuron is seeking project approval for the proposed Yass wind farm. The proposed Yass wind farm consists of three separate precincts; Carrols Ridge, Coppabella and Marilba. The Bird and Bat Risk Assessment within Biodiversity Assessments for these development sites identified that several threatened microbat species could be present. A known maternity cave for the threatened Eastern bentwing Bat (*Miniopterus orianae oceanensis*) with a maternity colony size estimated at 60,000 individuals (Dwyer 1968) is located 19 kilometres from the proposed Carrols Ridge Precinct. The Bird and Bat Risk Assessment concluded that additional study of the microbats of the locality was required to inform the likely impact of the proposal and any potential mitigation measures that could minimise these (**ngh**environmental 2009a).

This specialist study has several objectives. Firstly, it provides a comprehensive overview of the microbat diversity recorded at each of the three precincts. From this data, conclusions are drawn on each species including activity levels and landform use where appropriate. Specifically, as the survey was conducted within the known period of time when female Eastern bentwing bats are at the maternity site, information on the importance of each precinct is sought. The study also has an objective of informing recommendations for any proposed Bat Monitoring Program. Finally, this report builds on the knowledge base which to assess the risks of future wind farm development to microbats in the Southern Tablelands and South-west Slopes Bioregions of New South Wales.

2 METHODS

2.1 STUDY AREA

The study area comprises of three precincts; Carrols Ridge, Coppabella and Marilba west of Yass in southern New South Wales (Figure 1).

2.1.1 Marilba

The proposed Marilba Precinct is located on private farmland north and south of the Hume Highway, near Conroys Gap, approximately 17 kilometres west of Yass, New South Wales. The site extends along a number of north-south oriented ridgelines over a distance of 9 kilometres in a north-south direction and eight kilometres east-west.

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

2.1.2 Coppabella

The proposed Coppabella Precinct is located on farmland north the Hume Highway, approximately 35 kilometres west of Yass, New South Wales.

The site consists of one main north-west to south-east oriented ridgeline with surrounding hills. Areas that would be developed contain a combination of native and exotic pasture and remnant and regrowth woodland. The ridges most likely to contain turbines have been cleared and grazed for many decades and generally carry only scattered remnant trees or small isolated woodland patches. The area is characterised by undulating to hilly terrain with broken ridgelines, mostly on volcanic geology.

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

2.1.3 Carrols Ridge

The proposed Carrols Ridge Precinct encompasses cleared farmland, as well as woodland and forest areas on the northern edge of Lake Burrinjuck, approximately 25 kilometres west of Yass, New South Wales. The site extends along one main generally north – south ridgeline and includes four smaller ridge tops at the south-west end of the main ridge. It is characterised by undulating to hilly terrain, mostly on volcanic and metamorphic geology. Within the northern cluster, the ridge and upper slopes are partially cleared, with flanking forest and woodland. The southern portion of the development envelope is more wooded, with patches of cleared land.

There are no major watercourses present at the subject site however, several farm dams and steep ephemeral drainage lines are present and Lake Burrinjuck is directly south.

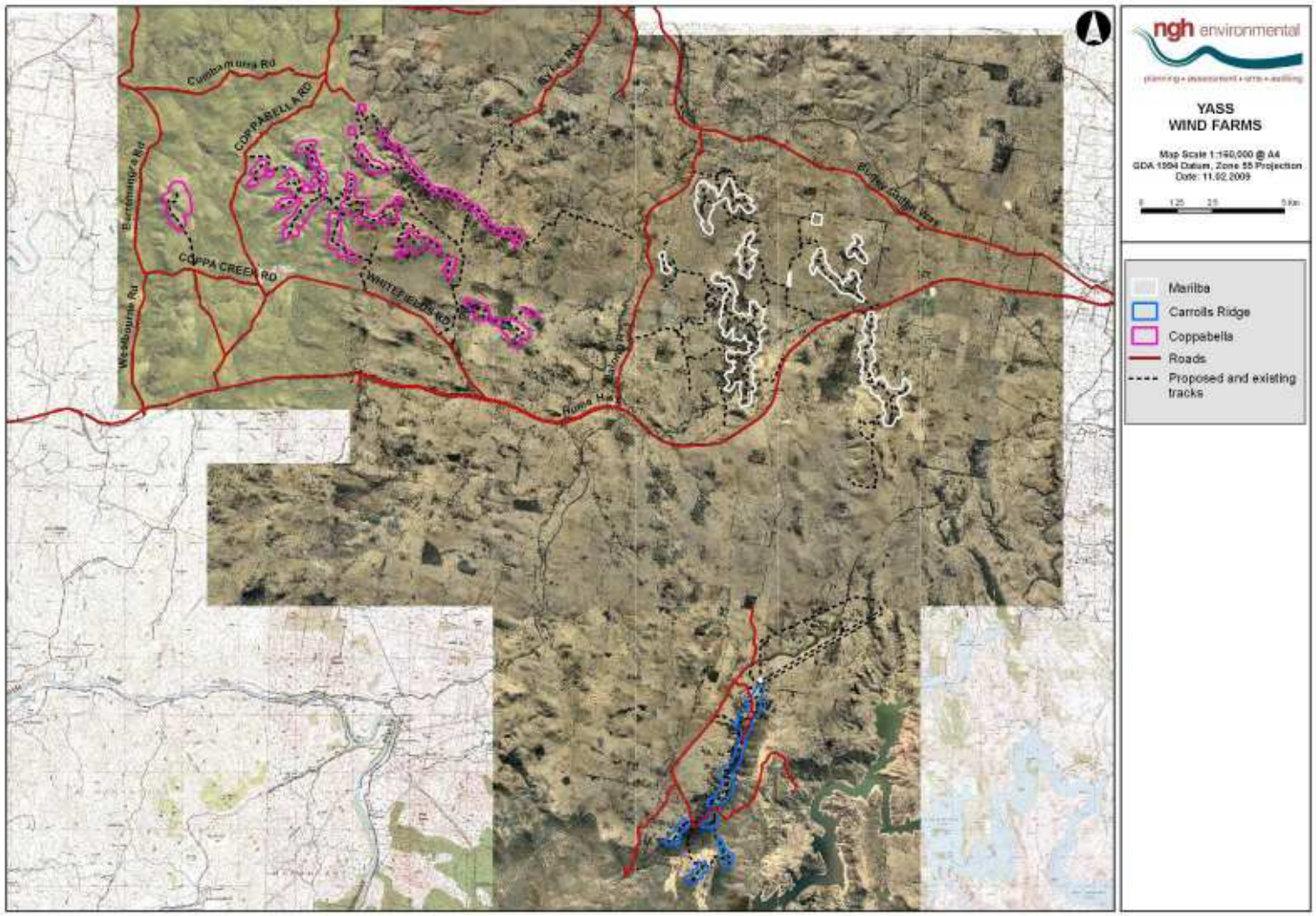

Figure 1: Locations of proposed Marilba, Carrols Ridge and Coppabella Precincts.

2.2 PREVIOUS MICROBAT SURVEYS

Previous fauna surveys undertaken in September and November 2008, collected echolocation calls of microbats using ultrasonic detectors. The microbat data and survey effort from these previous surveys is relevant to this study as it provides a temporal variation in microbat species richness for each of the study sites. The survey effort of these surveys is provided (Table 1).

Further information relative to these previous microbat surveys such as results and weather conditions should be sourced from the Biodiversity Assessment relevant to each precinct.

2.3 JANUARY MICROBAT SURVEYS

The microbat surveys for this study were undertaken between 19th January and 23rd January 2009 during weather conditions considered conducive to maximising the detection of microbat species (Table 2). Two recognised methods for detecting microbat species were used: Ultrasonic echolocation detection and Harp trapping (DEC 2004).

Table 1: Survey effort for microbats from previous biodiversity investigations at each of the study sites (**ngh**environmental 2009b; c; d)

Survey effort for previous surveys	
SITE	ANABAT
CARROLS RIDGE	6 nights in November 2008
COPPABELLA	4 nights in September 2008
MARILBA	3 nights in September 2008

Table 2: Weather Observations during the January field survey at Burrinjuck Dam (Source: Bureau of Meteorology, 2009). N/A= No information available.

Burrinjuck Dam			
DATE	MIN TEMP	MAX TEMP	RAINFALL (MM)
19.01.2009	15.4	35.8	0
20.01.2009	18.2	39.0	0
21.01.2009	19.5	37.0	7.5
22.01.2009	22.0	31.3	0
23.01.2009	20.1	33.1	25.8

2.3.1 Ultrasonic echolocation detection

The echolocation calls of insectivorous microbats were recorded using ultrasonic detectors, Anabat II Bat Detectors, coupled with Compact Flash Crossing Analysis Interface Modules (CF ZCAIMS, Titley Electronics, Ballina, NSW) and stored on compact flash (CF) memory cards for later subsequent analysis using ANALOOK Computer software. Ultrasonic echolocation recording is more likely to reveal high-flying species that are not detectable using trapping techniques (DEC 2004).

Calls analysis was undertaken using the latest guide to call identification (Pennay *et al.* 2004). All identified calls were ranked using a confidence rating (confident, probable, possible) (DEC 2004; Pennay *et al.* 2004). Where the call analysis indicates the possibility of a threatened species, the species was assumed present in accordance with DEC guidelines (DEC 2004).

The total survey effort using this method is expressed in the number of survey nights (Table 3) with site specific information also provided (Table 4). The locations of these survey sites, along with the survey sites outlined in section 2.2 are provided for Carrols Ridge (Figure 2), Coppabella (Figure 3) and Marilba (Figure 4).

2.3.2 Harp Trapping

While Ultrasonic echolocation detection recordings provide a non-invasive technique to determine microbat species richness, many species are either difficult to record as they have low intensity calls, fly at low heights or cannot be identified to species level alone (DEC 2004). Captured microbats were collected from the harp traps within one hour of sunrise (DEC 2004) and identified according to Churchill (1998), with the exception of female Vespadalus where Menkhorst & Knight (2001) was also used (Menkhorst and Knight 2001). All individuals were identified to species level, aged, sexed and reproduction condition recorded. The total survey effort expressed in the number of survey nights using this method is provided (Table 3) with site-specific details also provided (Table 5). The locations of these survey sites are provided for Carrols Ridge (Figure 2), Coppabella (Figure 3) and Marilba (Figure 4).

Table 3: The survey effort for January surveys across all study sites expressed

Survey effort for this study		
SITE	ANABAT	HARP TRAP
CARROLS RIDGE	4 survey nights	10 trap nights
COPPABELLA	2 survey nights	-
MARILBA	2 survey nights	-

2.3.3 Nomenclature

Nomenclature in this report follows that of Churchill (2008).

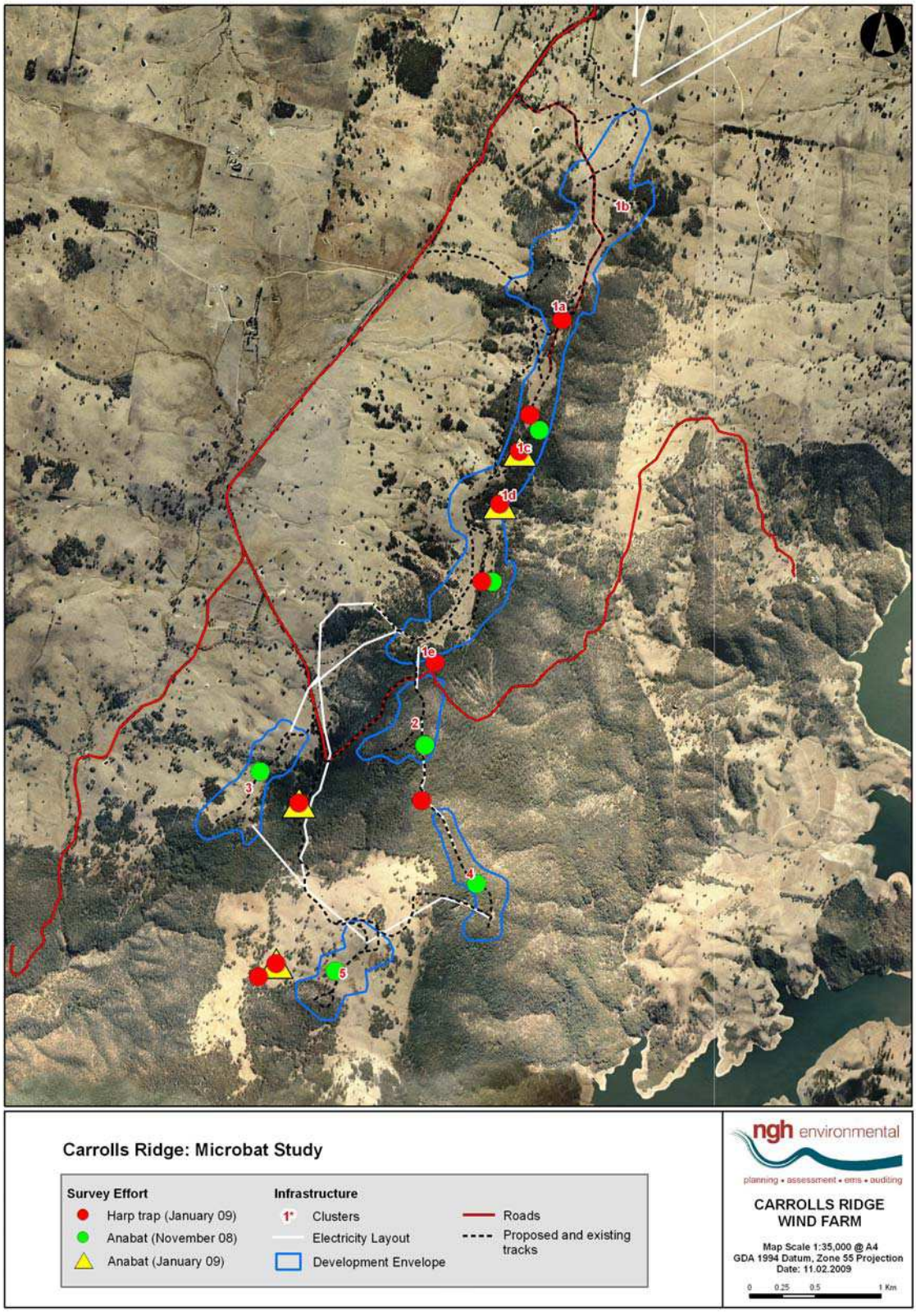

Figure 2: Locations of Anabat and Harp traps surveys at Carrols Ridge (This study and previous surveys).

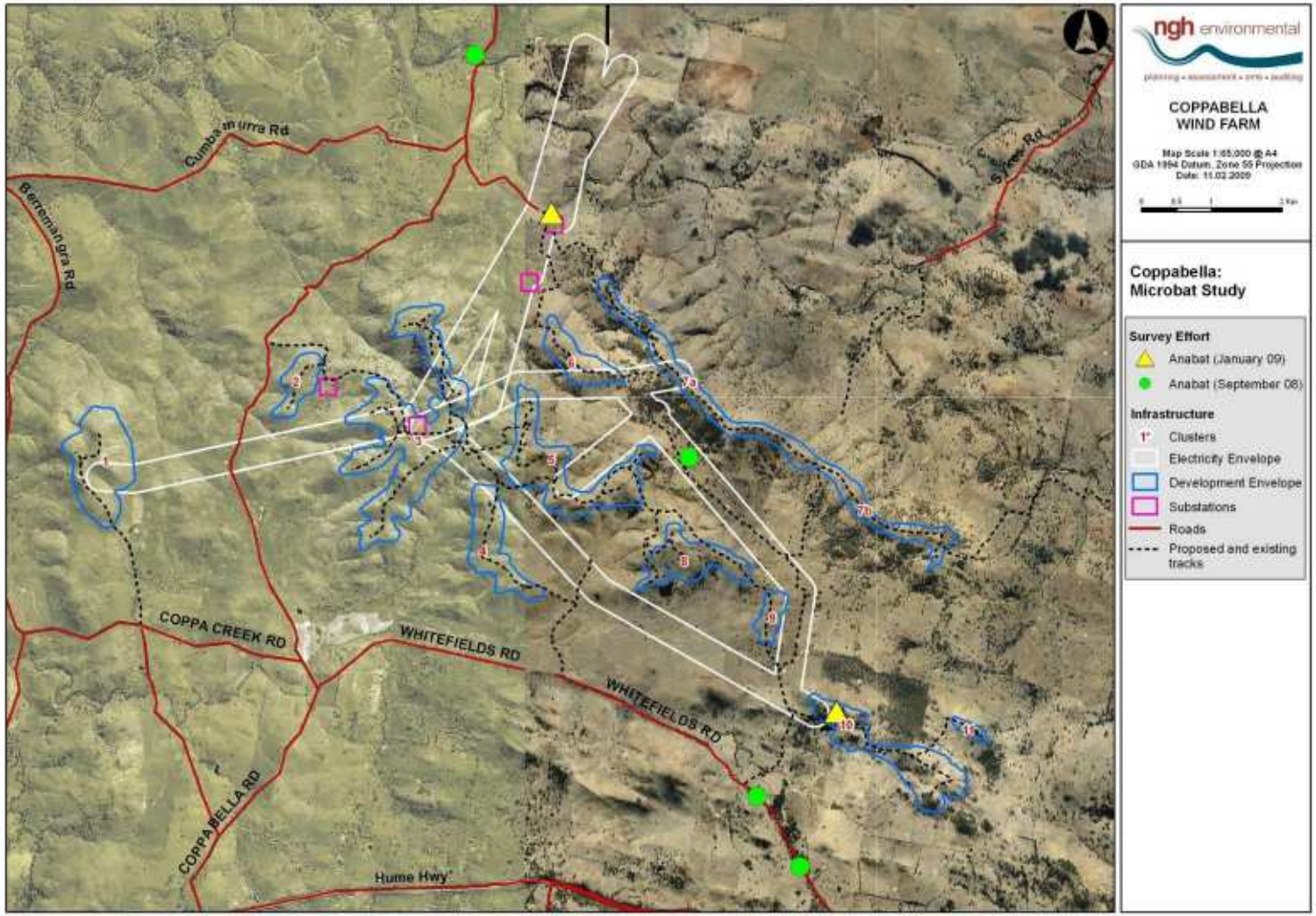

Figure 3: Locations of Anabat and Harp traps surveys at Coppabella (This study and previous surveys).

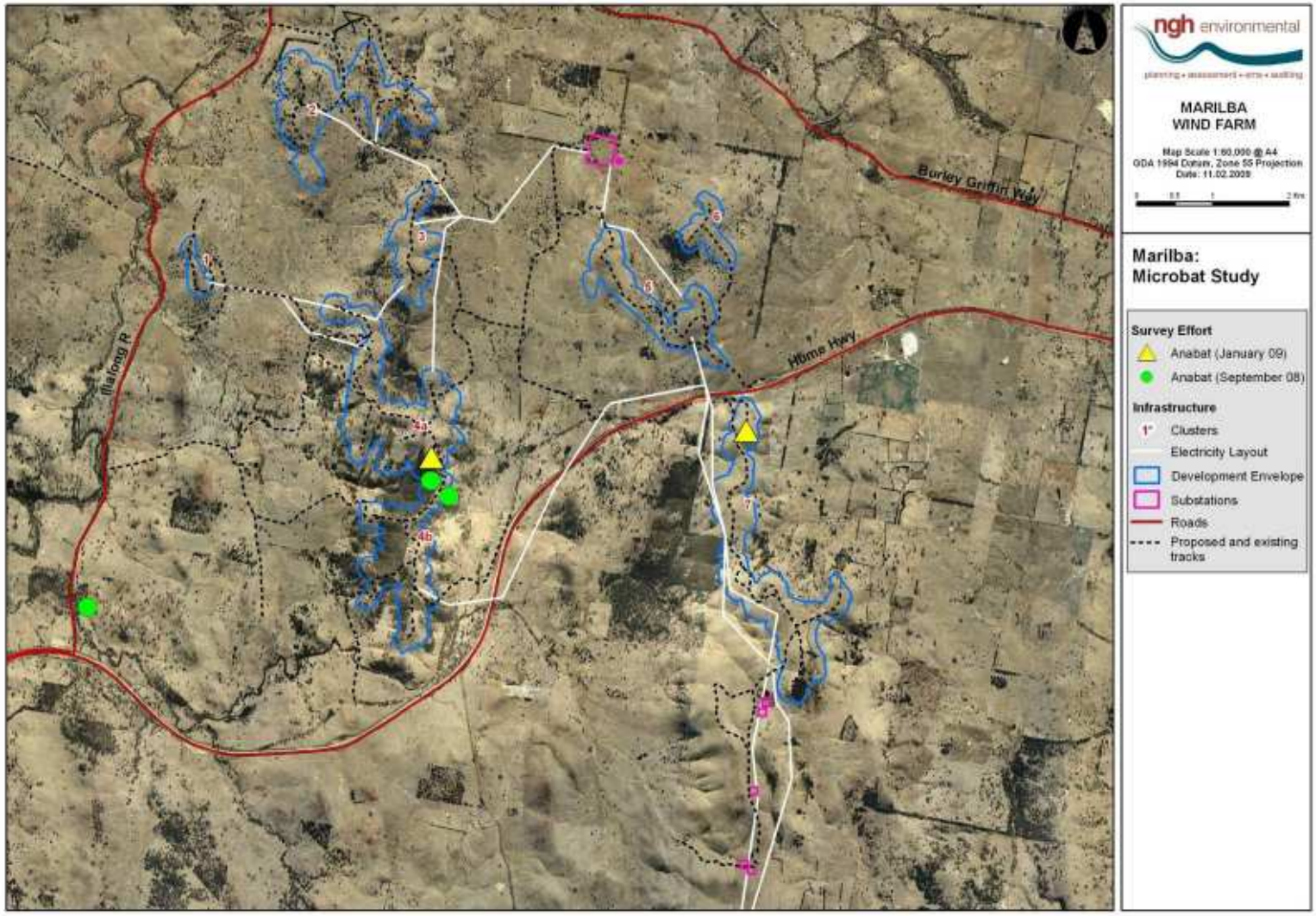

Figure 4: Locations of Anabat and Harp trap surveys at Marilba (This study and previous surveys).

Table 4: Details of Anabat echolocation survey sites undertaken during this study.

Site	Cluster	Method	Date	E	N	Habitat Description	Survey Nights
Coppabella	10	Anabat	21-Jan-09	644435	6150538	On rocky knob with clump of trees. Anabat facing south over edge of ridge (steep drop down). Degraded paddock, heavily grazed.	1
Coppabella	7	Anabat	22-Jan-09	640378	6157615	In paddock near dam and old house, on flat/gentle slope, in degraded cleared paddock, not much vegetation.	1
Marilba	4	Anabat	20-Jan-09	654126	6149516	On ridge, at very edge of woodland area facing extensive cleared area (grazed sheep paddock) with isolated trees.	1
Marilba	7	Anabat	22-Jan-09	658266	6149866	On knoll, looped through lower branches of wind monitoring tower, surrounded by heavily grazed and cleared paddock and Hume highway to the north (about 300m by flight)	1
Carrolls	1c	Anabat	19-Jan-09	653510	6134602	Set with harp trap in thick regen forest (hot fire) along ridge	1
Carrolls	5	Anabat	21-Jan-09	651649	6130685	Set in branches of isolated paddock tree mid slope (facing west) near harp trap	1
Carrolls	1d	Anabat	21-Jan-09	653358	6134199	Set in understorey on side of track in dense-ish forest, facing toward potential fly-way. Dam in paddock about 50m away. Set with harp trap.	1
Carrolls	Gully	Anabat	22-Jan-09	651825	6131913	Set on rocky outcrop over harp trap in gully/creek line. This creek runs alongside the track providing access to Clusters 2,4 and 5	1

Table 5: Details of Harp trapping survey sites undertaken during this study.

Site	Cluster	Method	Date	E	N	Description	Trap Nights
Carrolls	1e	Harp trap	22-Jan-09	652865	6132988	End of Cluster 1e along old track with intensive fire regrowth - on southern side of small knob. Forms part of the edge of the forest surrounding cleared paddocks.	1
Carrolls	Gully	Harp trap	22-Jan-09	651825	6131913	Set across creek (dry when set, small flow when checked) in gully between clusters. Regen (fires) blue gum and rocky outcrop. Set with anabat.	1
Carrolls	1c	Harp trap	21-Jan-09	653590	6134883	Under spreading branch of mature tree at edge of forest patch on upper slope of what is otherwise cleared paddock in moderate condition	1
Carrolls	5	Harp trap	21-Jan-09	651649	6130685	Set in open grassy area across slight gully with isolated paddock tree nearby and small dam below. Set with anabat	1
Carrolls	1d	Harp trap	21-Jan-09	653358	6134199	Set under spreading branch of large tree along old track in dense-ish forest. Dam in paddock about 50 m away. Set with anabat	1
Carrolls	1e	Harp trap	20-Jan-09	653224	6133607	Down in dam hole with water on one side and dam wall/bush on other side with slight potential fly-way between dam and old track in the bush. Open spaces to either side	1
Carrolls	C2-4	Harp trap	20-21 Jan	652763	6131931	Across track between Clusters 2 and 4 in Brittle gum forest (moderate fire effects), dry open forest. Set for night one across flyway and night two off to side	2
Carrolls	5	Harp trap	20-Jan-09	651516	6130582	Set between trees in small clump of trees near dam between bush patch and open paddock	1

Site	Cluster	Method	Date	E	N	Description	Trap Nights
Carrolls	1a	Harp trap	19-Jan-09	653835	6135612	Open grassy forest, with few mature trees and fire regrowth. Low level of grazing disturbance. Harp set across track under spreading branch of large tree	1
Carrolls	1c	Harp trap	19-Jan-09	653510	6134602	Set across track dense regrowth forest (fires) on ridge for two nights (first night with anabat), lots of standing dead timber around	2

3 RESULTS

3.1 MICROBAT SPECIES RICHNESS

3.1.1 CARROLS RIDGE

January surveys across the Carrols Ridge study site revealed high levels of microbat species richness. A total of 15 species were revealed from echolocation call analysis, while 7 species were recorded during harp trapping. Combining both methods, 16 microbat species were recorded (Table 6).

Table 6: Microbat species recorded at Carrols Ridge by Echolocation Analysis and Harp Trapping, January 2009. (Asterisk denotes Possible, Probable or Confident Echolocation Analysis or captured in Harp Trap)

Carrols Ridge **Microbat species recorded**		
SPECIES	ECHOLOCATION	HARP TRAPPING
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	*	
Eastern falsistrelle (*Falistrelle tasmaniensis*)	*	
Goulds longeared bat (*Nyctophilus gouldi*)		*
Goulds wattled bat (*Chalinolobus gouldii*)	*	
Inland broadnosed bat (*Scotorepens balstoni*)	*	
Eastern freetail bat (*Mormopterus ridei*)	*	
Large forest bat (*Vespadelus darlingtoni*)	*	*
Lesser longeared bat (*Nyctophilus geoffroyi*)		*
Little broadnosed bat (*Scotorepens greyii*)	*	
Little forest bat (*Vespadelus vulturnus*)	*	*

Carrols Ridge **Microbat species recorded**		
SPECIES	ECHOLOCATION	HARP TRAPPING
Long-eared bat (*Nyctophilus sp.)*	*	
Southern forest bat (*Vespadelus regulus*)	*	*
Southern freetail bat (*Mormopterus* Species 4)	*	*
White-striped freetail bat (*Austronomus australis*)	*	
Yellow-belled Sheathtail bat (*Saccolaimus flaviventris*)	*	
TOTAL	15 Species	7 species

Note- species in **bold** listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.1.2 COPPABELLA

January surveys across the Coppabella study site revealed moderate level microbat species richness with 8 species recorded from Echolocation analysis (Table 9). No threatened microbats were recorded.

Table 7: Microbat species recorded at Coppabella by Echolocation Analysis, January 2009.

Coppabella **Microbat species recorded**	
SPECIES	ECHOLOCATION
Chocolate wattled bat (*Chalinolobus morio*)	*
Goulds wattled bat (*Chalinolobus gouldii*)	*
Eastern freetail bat (*Mormopterus ridei*)	*
Large forest bat (*Vespadelus darlingtoni*)	*

Coppabella **Microbat species recorded**	
SPECIES	ECHOLOCATION
Little forest bat (*Vespadelus vulturnus*)	*
Long-eared bat (*Nyctophilus sp.)*	*
Southern freetail bat (*Mormopterus Species 4*)	*
White-striped freetail bat (*Austronomus australis*)	*
TOTAL	8 Species

3.1.3 MARILBA

January surveys across the Marilba study site revealed low microbat species richness with echolocation analysis identifying only 2 microbat species (Table 8). It should be noted that a large number (>500 files) consisted of noise or interference from an unknown source.

Table 8: Microbat species recorded at Marilba by Echolocation Analysis, January 2009.

Marilba **Microbat species recorded**	
SPECIES	ECHOLOCATION
Chocolate wattled bat (*Chalinolobus morio*)	*
Long-eared bat (*Nyctophilus sp.)*	*
TOTAL	2 Species

3.2 TEMPORAL VARIATION IN SPECIES RICHNESS

3.2.1 CARROLS RIDGE

Microbat surveys have been conducted at Carrols Ridge in November 2008 and January 2009. The November surveys resulted in 9 species of microbat recorded (**ngh**environmental 2009b) while in the January survey, a total of 16 species were recorded (Table 9).

Table 9: Temporal variation of microbats recorded at Carrols Ridge (Asterisk denotes recorded during survey).

Carrols Ridge **Temporal variation of microbats recorded**		
SPECIES	NOVEMBER 2008	JANUARY 2009
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	*	*
Eastern falsistrelle (*Falistrelle tasmaniensis*)		*
Goulds longeared bat (*Nyctophilus gouldi*)		*
Goulds wattled bat (*Chalinolobus gouldii*)	*	*
Inland broadnosed bat (*Scotorepens balstoni*)	*	*
Eastern freetail bat (*Mormopterusridei*)		*
Large forest bat (*Vespadelus darlingtoni*)	*	*
Lesser longeared bat (*Nyctophilus geoffroyi*)		*
Little broadnosed bat (*Scotorepens greyii*)		*
Little forest bat (*Vespadelus vulturnus*)	*	*
Long-eared bat (*Nyctophilus sp.)*		*
Southern forest bat (*Vespadelus regulus*)	*	*

Carrols Ridge **Temporal variation of microbats recorded**		
SPECIES	NOVEMBER 2008	JANUARY 2009
Southern freetail bat (*Mormopterus*Species 4)	*	*
White-striped freetail bat (*Austronomus australis*)	*	*
Yellow-belled Sheathtail bat (*Saccolaimus flaviventris*)		*
TOTAL	9 Species	16 species

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.2.2 COPPABELLA

Microbat surveys have been conducted at Coppabella in September 2008 and January 2009. The September survey resulted in only 4 species of microbat recorded (**ngh**environmental 2009c) while in the January survey, a total of 8 species were recorded (Table 10). Not all species recorded in the September surveys were recorded in January when weather conditions were conducive to maximising the detection of microbats.

Table 10: Temporal variation of microbats recorded at Coppabella (Asterisk denotes recorded during the survey).

Coppabella **Temporal variation of microbats recorded**		
SPECIES	SEPTEMBER 2008	JANUARY 2009
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Goulds wattled bat (*Chalinolobus gouldii*)		*
Inland broadnosed bat (*Scotorepens balstoni*)	*	
Eastern freetail bat (*Mormopterusridei*)		*
Large forest bat (*Vespadelus darlingtoni*)		*

Coppabella **Temporal variation of microbats recorded**		
SPECIES	SEPTEMBER 2008	JANUARY 2009
Little forest bat (*Vespadelus vulturnus*)		*
Long-eared bat (*Nyctophilus sp.)*	*	*
Southern freetail bat (*Mormopterus*Species 4)	*	*
White-striped freetail bat (*Austronomus australis*)		*
TOTAL	4 species	8 species

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.2.3 MARILBA

Microbat surveys have been conducted at Marilba in September 2008 and January 2009. The September survey resulted in 12 species of microbat recorded (**ngh**environmental 2009d) while in the January survey, only 2 species were recorded (Table 11). As stated in section 3.1.3, interference was recorded during the Anabat surveys resulting in large number of files that were not microbat calls.

Table 11: Temporal variation of microbats recorded at Marilba (Asterisk denoted recorded during the survey).

Marilba **Temporal variation of microbats recorded**		
SPECIES	SEPTEMBER 2008	JANUARY 2009
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	*	
Goulds wattled bat (*Chalinolobus gouldii*)	*	
Inland broadnosed bat (*Scotorepens balstoni*)	*	
Eastern freetail bat (*Mormopterus ridei*)	*	
Large forest bat (*Vespadelus darlingtoni*)	*	
Little broadnosed bat (*Scotorepens greyii*)	*	
Little forest bat (*Vespadelus vulturnus*)	*	
Long-eared bat (*Nyctophilus sp.)*	*	*
Southern forest bat (*Vespadelus regulus*)	*	
Southern freetail bat (*Mormopterus Species 4)*	*	
White-striped freetail bat (*Austronomus australis*)	*	
TOTAL	12 species	2 species

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.3 MICROBAT ACTIVITY

Data collected from the Echolocation call recording provides information on the number of passes of each species during a given time period at each of the study sites. While many individual passes can be made by an individual microbat, this data provides a baseline to infer levels of microbat activity.

3.3.1 CARROLS RIDGE

Echolocation call analysis revealed a total of 713 calls in the January surveys (Table 12). On a nightly basis, 42 passes were recorded on the 19th January 2009 (1 anabat recorder), 191 passes were recorded on the 21st January 2009 (2 anabat recorders) and 474 passes were recorded on the 22nd January 2009 (1 anabat recorder).

Of all microbat passes recorded at Carrols Ridge (713), 48% (342) could be attributed to bat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995.* Eastern bentwing bats passes comprised of around 80% (284 passes) of all threatened species recorded or 39% of the total number of microbat passes at Carrols Ridge. The number of passes each hour for the Eastern bentwing bat, other threatened microbat species, and non-threatened microbat species is detailed for each survey night at Carrols Ridge (Figures 5,6,7). The most common non-threatened microbat was the Large forest bat with 125 calls (17.5%) recorded.

Harp trapping resulted in the capture of 76 individuals from 7 species (Table 13). No threatened microbats were recorded using this method. The most commonly trapped microbats were the non-threatened Large forest bat and Southern forest bat with a total of 40 captures (19 and 21 respectively) accounting for 52.6% of the total captures.

3.3.2 COPPABELLA

Echolocation data was collected over two nights at Coppabella (21st, 22nd January 2009). A total of 40 passes by microbats were recorded (Table 14). On a nightly basis, 39 passes on the 21st and 1 pass was recorded on the 22nd January. The most common species was the non-threatened Goulds wattled bat with 17 calls (42.5% of calls).

Of all microbat passes recorded at Coppabella, none of these could be attributed to species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995.*

Table 12: Number and confidence ranking of echolocation calls recorded at Carrols Ridge, January 2009.

Carrols Ridge **Echolocation Call Analysis**				
SPECIES	POSSIBLE	PROBABLE	CONFIDENT	TOTAL
Chocolate wattled bat (*Chalinolobus morio*)	25	31	7	63

Carrols Ridge **Echolocation Call Analysis**				
SPECIES	POSSIBLE	PROBABLE	CONFIDENT	TOTAL
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	100	125	59	284
Eastern falsistrelle (*Falistrelle tasmaniensis*)	39	14	5	58
Goulds wattled bat (*Chalinolobus gouldii*)	10	6	4	20
Inland broadnosed bat (*Scotorepens balstoni*)	1	2	0	3
Eastern freetail bat (*Mormopterusridei*)	2	7	0	9
Large forest bat (*Vespadelus darlingtoni*)	62	57	6	125
Little broadnosed bat (*Scotorepens greyii*)	0	2	0	2
Little forest bat (*Vespadelus vulturnus*)	4	12	1	17
Long-eared bat (*Nyctophilus sp.)*	6	30	25	61
Southern forest bat (*Vespadelus regulus*)	16	26	9	51
Southern freetail bat (*Mormopterus*Species 4)	0	4	1	5
White-striped freetail bat (*Austronomus australis*)	1	2	3	6
Yellow-belled sheathtail bat (*Saccolaimus flaviventris*)	6	1	2	9

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

Table 13: A breakdown of the microbats recorded during harp trapping at Carrols Ridge.

Carrols Ridge **Harp Trapping results**

SPECIES	MALE	FEMALE	JUVENILE	TOTAL
Chocolate wattled bat (*Chalinolobus morio*)	12	1	0	13
Goulds longeared bat (*Nyctophilus gouldi*)	1	9	0	10
Large forest bat (*Vespadelus darlingtoni*)	1	14	4	19
Lesser longeared bat (*Nyctophilus geoffroyi*)	0	4	4	8
Little forest bat (*Vespadelus vulturnus*)	1	2	0	3
Southern forest bat (*Vespadelus regulus*)	11	9	1	21
Southern freetail bat (*Mormopterus* Species 4)	2	0	0	2

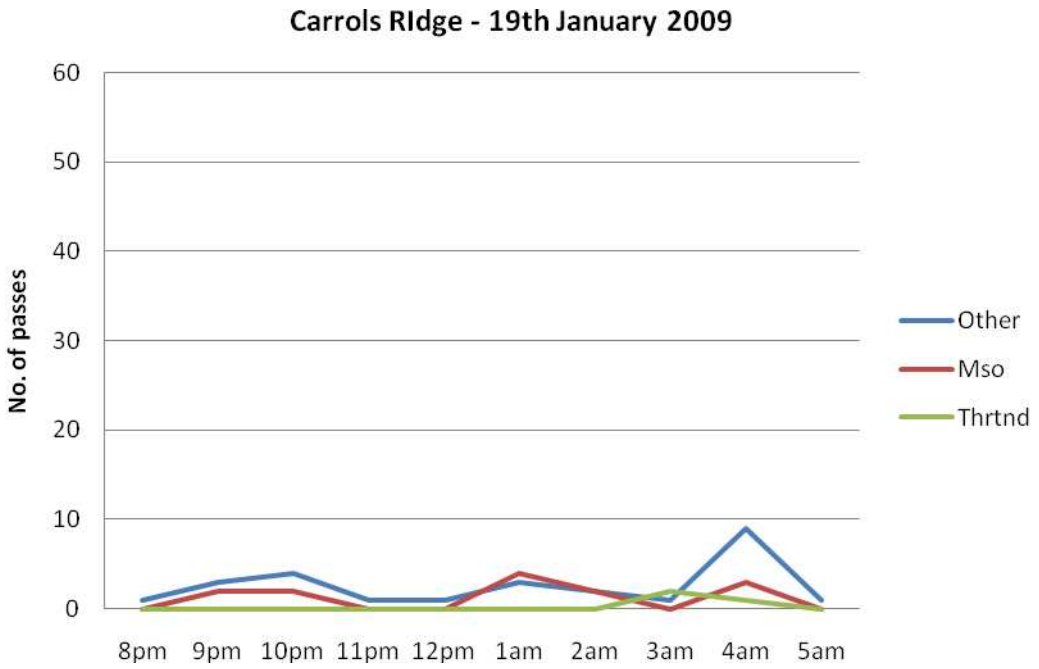

Figure 5: Number of passes each hour for the Eastern Bentwing Bat (Mso), other threatened microbat species (Thrtnd) and non-threatened microbat species (Other) at Carrols Ridge, 19th January 2009.

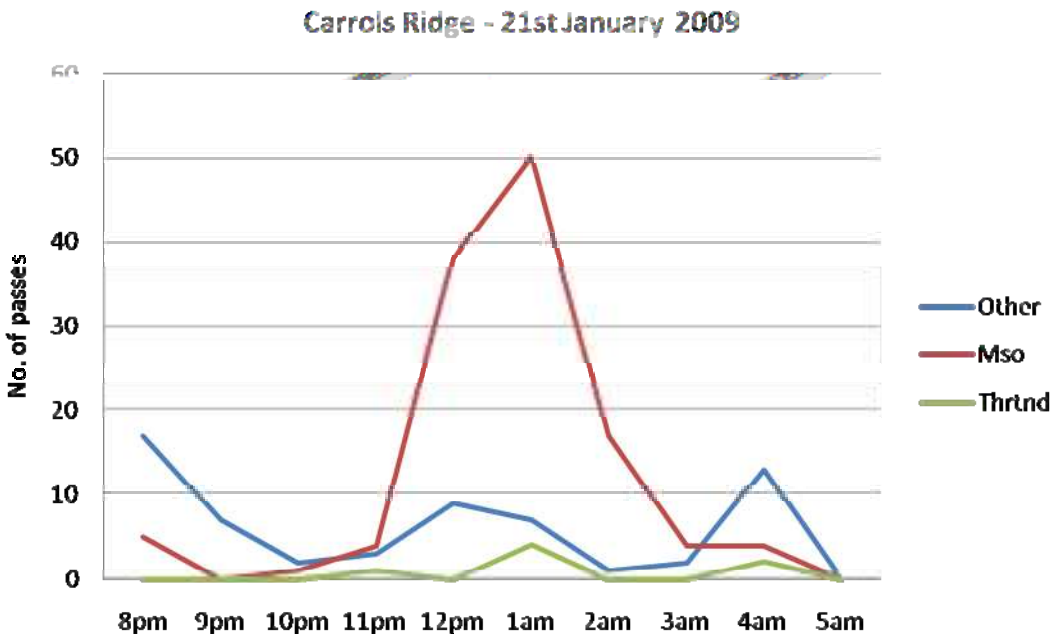

Figure 6: Number of passes each hour for the Eastern Bentwing Bat (Mso), other threatened microbat species (Thrtnd) and non-threatened microbat species (Other) at Carrols Ridge, 21st January 2009.

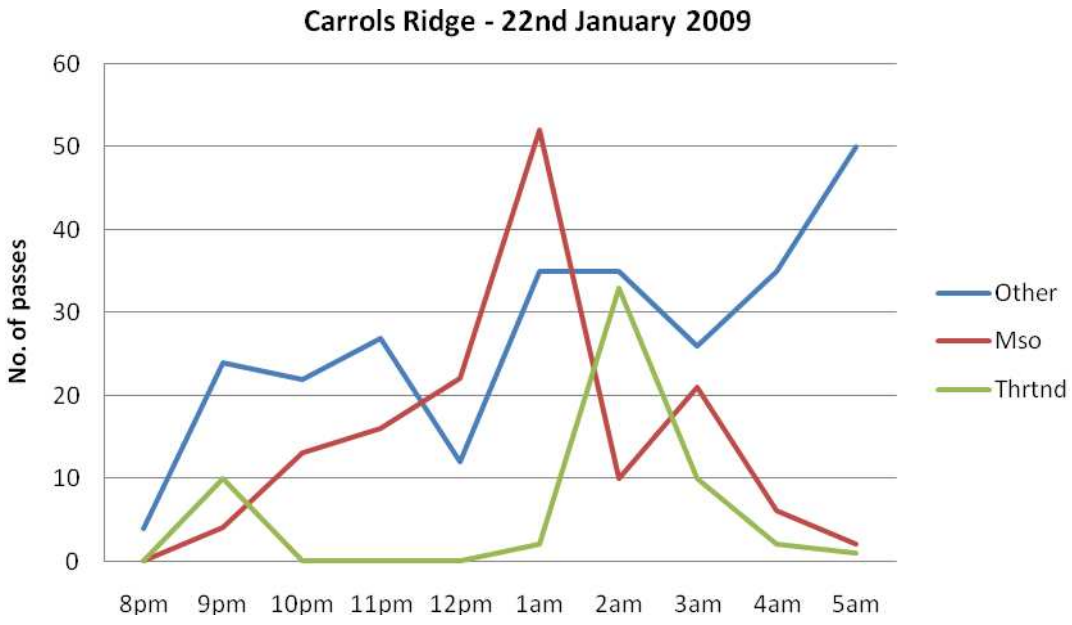

Figure 7: Number of passes each hour for the Eastern Bentwing Bat (Mso), other threatened microbat species (Thrtnd) and non-threatened microbat species (Other) at Carrols Ridge, 22nd January 2009.

Table 14: Number and confidence ranking of echolocation calls recorded at Coppabella by January 2009.

Coppabella **Echolocation Call Analysis**				
SPECIES	POSSIBLE	PROBABLE	CONFIDENT	TOTAL
Chocolate wattled bat (*Chalinolobus morio*)	5	3	0	8
Goulds wattled bat (*Chalinolobus gouldii*)	9	6	2	17
Eastern freetail bat (*Mormopterusridei*)	3	1	1	5
Large forest bat (*Vespadelus darlingtoni*)	2	1	0	3
Little forest bat (*Vespadelus vulturnus*)	0	1	0	1
Long-eared bat (*Nyctophilus sp.)*	0	1	0	1
Southern freetail bat (*Mormopterus*Species 4)	3	1	0	4
White-striped freetail bat (*Austronomus australis*)	0	0	1	1

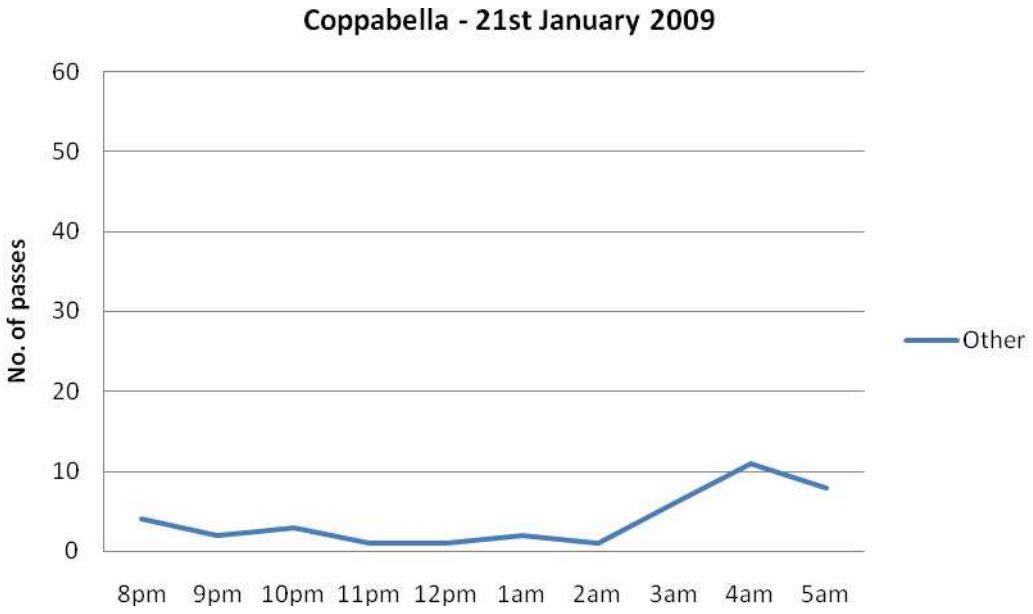

Figure 8: Number of passes each hour for non-threatened microbat species (Other) at Coppabella, 21st January 2009.

3.3.3 MARILBA

Echolocation data collection revealed a total of 4 passes by microbats (Table 15). No microbats listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* were recorded.

It should be noted that a large number (>500 files) consisted of noise or interference likely from insects.

Table 15: Number and confidence ranking of echolocation calls recorded at Marilba by January 2009.

Marilba **Echolocation Call Analysis**			
SPECIES	POSSIBLE	PROBABLE	CONFIDENT
Chocolate wattled bat (*Chalinolobus morio*)	0	2	1
Long-eared bat (*Nyctophilus sp.)*	0	0	1

3.4 LANDFORM COMPARISON OF MICROBAT ACTIVITY

Microbat activity from the number of calls is used to make this comparison by summing all passes of all species, species groups and unidentifiable bat calls. The low number of echolocation calls recordings collected at Coppabella and Marilba has resulted in no comparison being able to be completed for these two sites.

3.4.1 CARROLS RIDGE

Pooled data from the Echolocation Analysis resulted in data collected from two landform types: Ridge and Gully. Each landform was subject to two survey nights each using Anabat detectors.

This study has revealed that the highest level of microbat activity was recorded at gullies (67% of passes) when pooling the data from all three interest groups (Eastern Bentwing Bat, Other threatened microbat species, and Non-threatened microbat species). For some groups such as the non-threatened microbat species, 75% of all microbat activity was recorded in a gully location. Conversely, Eastern Bentwing Bat was evenly distributed across each landform, with 53% of all calls recorded in gullies and 47% recorded on ridges.

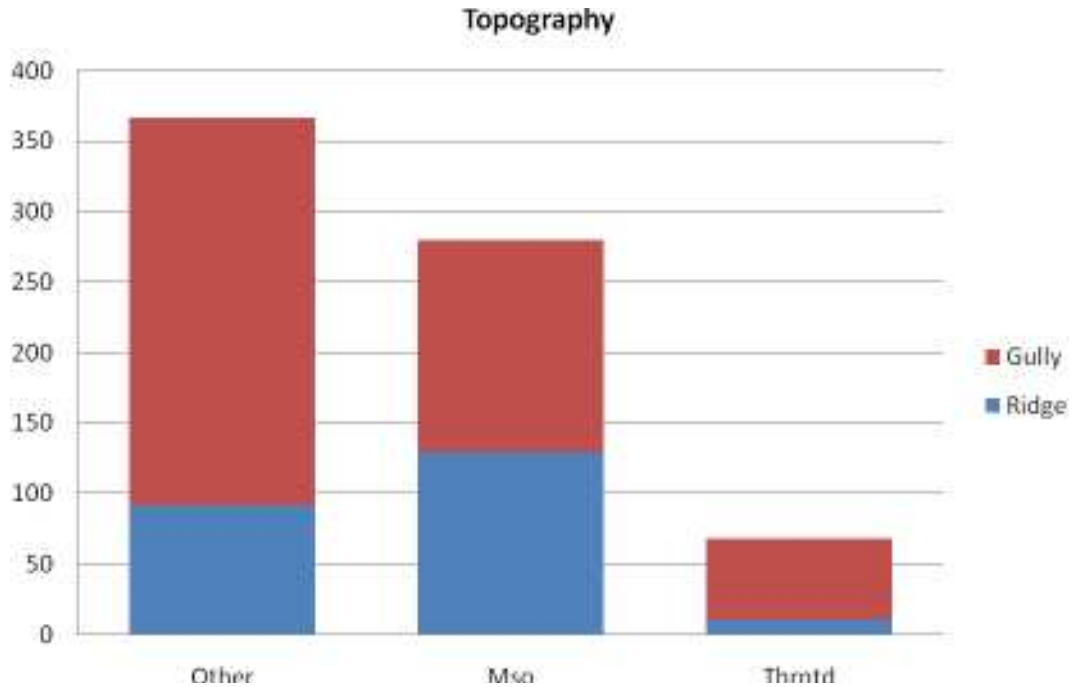

Figure 9: Number of microbat passes recorded on ridges and gullies at Carrolls Ridge of Eastern Bentwing Bat (Mso), other threatened microbat species (Thrntd) and non-threatened microbat species (Other).

3.5 EASTERN BENTWING BAT

Eastern bentwing bat has been recorded at two of the three study sites: Carrols Ridge and Marilba.

At Marilba, 22 echolocation calls were collected over two survey nights (average of 11 calls per survey night) in September 2008. However, the species was not recorded subsequently in the January 2009 surveys despite a further two survey nights using Anabat detectors.

At Carrols Ridge, 24 ecolocation calls were recorded during six survey nights (average of 4 calls per survey night) in November 2008. During the January 2009 survey, 284 echolocation calls were recorded during four survey nights (average of 71 calls per survey night). This increase in calls recorded represents a 1700% increase in Eastern bentwing bat activity above the November survey.

4 DISCUSSION

4.1 MICROBATS AND WINDFARMS

There has been few studies of wind farm impacts on microbat species and no long term studies that can be called "Before and After Controlled Impact (BACI) studies". Without this information, assumptions must be made using what is known of species ecology and limited case studies and investigations. The difficulty in estimating impact to microbats is compounded by the fact that relatively little is known about their ecology and behaviour. However, compared to available data on bird mortalities, microbat collision events appear to be greater in number. Migratory microbats comprise the majority of mortalities in all wind farm studies to date (**ngh**environmental 2009a).

Microbat fatalities in the USA at wind farms have been high (eg. Mountaineer Wind Energy Centre in West Virginia - 44 x 1.5 MW turbines - accounting for 4000 microbat deaths in the autumn of 2004), however extrapolation of this data to Australian conditions would be inappropriate. This is mainly because climatic patterns are quite different. In the USA where extreme changes occur during winter as the jetstream moves southwards, rendering much of the country unsuitable for bat foraging (Greg Richards pers. Comm.). 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.). Monitoring in Victoria, based on carcass monitoring, has identifies 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 data in an Australian context. Fatalities may however be higher, but this would be dependent on habitat quality and proximity of significant bat roosts.

The Bird and Bat Risk Biodiversity Addendum recently completed by **ngh**environmental, provides a greater review of the risks from wind farms to microbats (**ngh**environmental 2009a).

4.1.1 RISKS SPECIFICALLY TO MICROBATS

The recent literature review conducted by **ngh**environmental concluded that there are a number of risks specifically to microbats from wind farm development (**ngh**environmental 2009a). Conclusions that can be drawn from this review identify that risks specifically to microbats include:

1. Habitat avoidance.
2. Collision risks.
3. Pulmonary barotraumas (Rapid or excessive air-pressure change resulting in haemorrhaging of the lungs as fauna pass near moving turbine blades).
4. Species-specific risks (such as those species that fly above the forest canopy).
5. Environmental risks (**ngh**environmental 2009a).

The key risk factors relating directly to turbines placement and design identified within this review were:

1. Along forested ridge or waterways (often used as navigational aids by bats).
2. Abutting forest or remnants (increased foraging activity along edges).
3. Reducing the attractiveness of turbine areas by minimising lighting.

4.2 STUDY SITES

4.2.1 CARROLS RIDGE

The Carrols Ridge study site has, to date, revealed 16 microbat species. Three threatened microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* have been recorded at Carrols Ridge. These being the Eastern bentwing bat, Eastern falsistrelle and Yellow-bellied sheathtail bat.

Some temporal variation of the assemblage of microbats recorded at Carrols Ridge was recorded. Five additional species were recorded in the January surveys that were not recorded in November. Weather conditions conducive to maximising the detection of microbats are likely to be the main factor attributing to this. These results also suggesting some level of site fidelity to foraging or roosting resources or movement corridors present at Carrols Ridge.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968).

The cave system known as Church Cave/Pylon 58 Cave at Wee Jasper is a known maternity cave site for the Eastern bentwing bat (Dwyer 1968). These caves are located less than 19kms to the south of Carrols Ridge and the presence of the Eastern bentwing bat during the first surveys of the site in November, lead to additional surveys to gain a greater understanding of the importance of the Carrols Ridge study site. Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968), which is south-west of Carrols Ridge. While exact migration routes are unknown, it could be assumed that any movement from Mt Fairy to Church Cave would avoid Carrols Ridge, which is 19kms to the north of the maternity cave.

High levels of microbat activity were recorded at Carrols Ridge during the January survey. Of all microbat passes recorded at Carrols Ridge (713), 48% (342) could be attributed to microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995.* Eastern bentwing bats passes comprised of around 80% (284 passes) of all threatened species recorded or 39% of the total number of microbat passes at Carrols Ridge.

Analysis of microbat activity across each evening presents some limited information on the activity of microbats during the survey. Higher levels of activity are present for the threatened Eastern bentwing bat from around 10pm on each survey night, peaking between Midnight and 2am before activity decreases. On two nights, a second 'mini' peak occurs between 3 and 4am.

The double peak in activity levels recorded over two separate evenings indicates that Eastern bentwing bat are also foraging elsewhere at an unsurveyed site in the locality using Carrols Ridge as a movement corridor. Increases in activity later in the night could be presumed individuals returning to Church Cave. Almost continual activity throughout each night during the survey confirms that the Carrols Ridge site is also foraging habitat for the species regardless if it is moving elsewhere. While no Eastern bentwing bat were recorded during the harp trap surveys, this high-flying species is difficult to catch using this method, with echolocation call recordings proving most successful. The results confirm that Carrolls Ridge is within foraging distance by females from the maternity site. However, activity levels are likely to vary throughout the breeding season. In a study on Eastern bentwing bat on the NSW North Coast, it was found that emergence was correlated strongly with astronomical sunset, though slight differences in caves was based on the light intensity it received (ie facing West or North etc) (Dwyer 1962). However, re-entry was not as precise and it was proposed that this was based more on food availability or that females would forage longer when lactating.

Associations with gully formations and riparian areas have previously been recorded in microbats (Law and Chidel 2002) and this study revealed the highest level of bat activity across all species within gullies except for the Eastern bentwing bat where this association did not exist, with there being an even distribution of calls across both gullies and ridges. This data may suggest that while some individuals were foraging on the site, this high flying species may be using the ridges of Carrols Ridge as a movement corridor to other foraging areas in the locality.

While the exact nature of the foraging pattern of Eastern bentwing bats from the maternity site is unknown, the data does show that the Carrols Ridge site should be a considered both a movement corridor and forage habitat during occupation of the Church Cave maternity site.

4.2.2 COPPABELLA

The Coppabella study site has, to date, revealed 10 microbat species with a relatively low level of microbat activity across the September 2008 and January 2009 surveys. No threatened microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* have been recorded at Coppabella.

A small temporal variation of the assemblage of microbats recorded at Coppabella was noticed with 5 species detected in January that were not recorded in September and one species recorded in September that was not recorded in January. The September absences are likely to be explained by cooler weather conditions lowering the activity levels of microbats such that the detection of these species by Echolocation was reduced. This deficiency has been amended by the January survey where survey conditions were conducive to maximising microbat detection. The January absence of the Inland broadnosed bat may be that Coppabella is used infrequently by this species. Coppabella is likely to be at the easterly extent of the inland distribution of the species (Churchill 1998) and that the sites resources in terms of foraging or roosting for this inland species are limited. The most commonly recorded microbat at Coppabella was the non-threatened Goulds wattled bat. This species is found across Australia where it roosts in tree hollows and forages in almost any habitat type (Churchill 1998).

In general terms, the very small number of microbat passes of all species recorded at Coppabella suggests that microbats were uncommon in the study site at the time of the surveys.

One of the aims of the current survey was to assess whether female Eastern bentwing bats were using the study sites during their known period of occupation at the Church Cave maternity site. The Eastern bentwing bat was not recorded in either the September 2008 (**ngh**environmental 2009c) or January 2009 surveys. The Coppabella site is 42kms (straight line distance) from Church Cave. While the exact foraging distance from Church Cave is unknown, it is unlikely that the species would forage as far as Coppabella in one evening.

The absence of Eastern bentwing bat at Coppebella may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate food resource at Coppabella combined with the extended distance from Church Cave is likely to support this theory.

4.2.3 MARILBA

The Marilba study site has, to date, revealed 12 microbat species with a relatively low level of bat activity across the September 2008 and January 2009 surveys. One threatened microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* was recorded at Marilba during the September survey, the Eastern bentwing bat (**ngh**environmental 2009d).

A large temporal variation of the assemblage of microbats recorded at Marilba was noticed with 10 species detected in September that were not recorded in January. A large number of files from echolocation recording in January 2008 were of insect origin suggesting that equipment failure was not attributing to the low numbers of microbats recorded. Rather, specific onsite conditions are the likely reason for the non-detection of microbats. It could also be suggested that Marilba forms part of a foraging range, that, during the time of the January survey, had very little microbat activity and therefore, were absent, or if present, were very uncommon at the study site at the time of the survey.

One of the aims of the current survey was to assess whether female Eastern bentwing bats were using the study sites during their known period of occupation at the known maternity site, Church Cave at Wee Jasper. The Eastern bentwing bat was not recorded in the January 2009 surveys. However, the species was detected during the September 2008 surveys from 22 passes (**ngh**environmental 2009d). Such a low number of passes suggests that Marilba was not important foraging habitat for Eastern bentwing bat at the time of the survey. Their absence in January further confirms this theory in that any females would have moved onto the Church Cave maternity site. The Marilba site is 34kms (straight line distance) from Church Cave. While the exact foraging distance from Church Cave is unknown, it is unlikely that the species would forage as far as Marilba in one evening. However, males would still have been detected if they were at Marilba. The data collected suggests they were absent, or if present, in very low numbers making detection difficult. This suggests that Marilba provides only a small portion of a wider foraging area that Eastern bentwing are unlikely to rely on.

The absence of Eastern bentwing bat at Marilba may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate resource at Marilba combined with the extended distance from Church Cave is likely to support this theory.

5 RECOMMENDATIONS

nghenvironmental recommends the following measures to address operational impacts of the proposed wind farms. Each location has been considered for their potential to impact on threatened microbats through an Assessment of Significance, and each, has a set of specific recommendations relative based on this.

The Assessment of Significance for each of the three wind farm locations provided (Appendix A,B,C) relies on the adoption and implementation of these recommendations to ensure that the proposed activity at each location, is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW *Threatened Species Conservation Act* 1995.

5.1 CARROLS RIDGE

Adaptive Bat Research and Monitoring Program (ABRMP)

It is recommended that an Adaptive Bat Research and Monitoring Program (ABRMP) would be implemented prior to construction and during the operation of the Carrolls Ridge Precinct, to monitor and research habitat use by microbats, including the Eastern Bentwing Bat (EBB) use and activity at this precinct.

The primary aim of the program would be to define high risk periods in relation to the EBB. Management strategies would be adaptive, in response to the ongoing findings of the ABRMP. The Proponent would develop and implement the ABRMP in consultation with the Department of Conservation and Climate Change (DECC) and the Department of Planning (DoP). Additionally, the program would have the objective of managing the risk that bat-strike or barotrauma from the proposal would result in a reduction in the EBB maternity population that utilises Church Cave.

The ABRMP would focus on use and activity of the EBB in relation to seasonal and climatic conditions, migration, and how these relate to the use of the Carrolls Ridge site. Opportunities to improve survival rates of maternity population and therefore abundance of bats utilising Church Cave would also be investigated. These may include providing assistance with recovery strategies (outlined at www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_profile.aspx?id=10534), such as site protection, control of foxes and feral cats around roosting sites, particularly maternity caves and hibernation sites.

Specific research questions that would need to be investigated as part of the ABRMP would include:

1. Use of the Carrolls Ridge Precinct by the EBB inside and outside of the period when Church Cave is known to be utilised as a maternity cave by the EBB.
2. Technologies available to;

   a) monitor use of the site and Church Cave to assist in developing future adaptive operational procedures of the turbines (ie. developing infrastructure that would allow shut-down of turbines if EBB activity reaches a predetermined threshold)

   b) deter bats from entering the blade sweep area and wake.
3. Use of the Carrolls Ridge site in relation to the migration to Church Cave, and forage activities at the site (between 1st October and 31st March). This would include;

a) investigation of the migration of the EBB to and from Church Cave (and Dip Cave) in relation to the use of Carrolls Ridge during this migration

b) frequency and seasonality of activity of the EBB at Carrolls Ridge, use of the site as a movement corridor and a forage resource.

4. Potential opportunities to provide offsets / benefits to the Eastern Bentwing Bat populations.

The approach would, where necessary, include input from a biometrician in relation to survey design and effort necessary to obtain sufficient data to assess seasonal correlates, in addition to developing methodologies for the analysis of the data.

Development of mitigation strategies

Adaptive management strategies would be informed by the data and research collected in the research Program. Specifically, appropriate operational criteria for the wind farm would be developed. These would include:

1. Operational limitations on turbine usage. The turbines should be switched off during periods identified as being high risk in relation to the maternity population that utilizes Church Cave (during the active months of the Eastern Bentwing Bat cave).
2. Offsite protection to EBB population. Implement outcomes of research program in relation to protection of bat populations at Church Cave. This may include feral animal control and other mitigation to reduce mortality at the cave.
3. Mitigation at site. Develop on-site mitigation that could provide deterrents to the EBB or systems that could shut down turbines automatically if pre-determined criteria in relation to the EBB are reached.

Recommendation

To meet these recommendations the following mitigation tasks should be incorporated into the proposed Statement of Commitment.

The Proponent would commit to developing and implementing an *Adaptive Bat Research and Monitoring Program* (ABRMP) prior to construction and during operation of the Carrolls Ridge Precinct. The ABRMP would comprise of the following measures:

1. Research and investigate the use of the Precinct by the EBB and develop appropriate operational criteria.
2. Operational limitations would be placed on the turbines. The turbines would be switched off during the periods identified as being high risk of population level impact in relation to the maternity population that uses Church Cave.
3. Investigate and implement on-site mitigation (including deterrents to the EBB to reduce risk, or systems that could shut down turbines automatically if pre-determined criteria in relation to the EBB are reached) to reduce risk to the EBB population to acceptable levels.
4. Identify potential offsets by implementing offsite protection to the Eastern Bentwing Bat (EBB) population at Church cave using the outcomes of the research program.

5.2 COPPABELLA AND MARILBA

1) An adaptive Bat Monitoring Program should be implemented prior to construction to monitor habitat use by microbats. This would continue into the operational phase and management strategies would be adaptive in response to monitoring findings. The efficacy of mitigation measures should be

documented and be publically available in order to add to the knowledge base on this subject. As a basis for this program, the following is recommended:

(a) Ensure specific recommended mitigation measures outlined in this report are implemented and their effectiveness reviewed.

(b) Specify on-going monitoring procedures of the assessment and documentation of all collision and barotrauma-related injury or mortality observed, focusing in particular on moderate and high risk species as detailed within the Biodiversity Assessments. Timing for monitoring should be specific to the most at-risk target species.

(c) Specify procedures to investigate and implement adaptive management measures to reduce impacts should injury or mortality occur. Ensure that all injuries and mortalities of any threatened or migratory species are reported to DECC.

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

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

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

5.3 GENERAL

1) Marker lights, if required, should be minimised in number and fitted to reduce their ability to attract insects. Red lights are preferred, with the least number of flashes per minute. It is understood that CASA requirements will prevail.
2) Infrastructure layout should be designed to minimise impact to remnant vegetation.
3) Infrastructure layout should be designed to minimise impact to remnant vegetation.
4) In the case of any hollow-bearing tree removal, a dedicated fauna specialist (with microbat experience and vaccinated for Lyssavirus) must be on hand to supervise the removal of this vegetation to ensure the safety of any microbats should they be present. Clearing of these features should be kept to a minimum as stated within the Biodiversity Assessments and should only occur during Winter (outside of known breeding seasons).
5) A Biodiversity Management Plan should be prepared and implemented prior to construction using the recommendations herein as a basis. The plan would aim to protect and minimise loss of native vegetation and native fauna habitat as a result of construction of the project.

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Appendix A **ASSESSMENT OF SIGNIFICANCE – CARROLS RIDGE**

In accordance with section 5A of the *Environmental Planning and Assessment Act 1979,* an Assessment of Significance has been prepared by using seven factors which must be considered when determining if the proposed activity '*is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats*' that are listed as under the Schedule 1 & 2 of the *Threatened Species Conservation Act 1995.* These seven factors must be taken into account by the consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species and hence if a Species Impact Statement is required. The following Assessment of Significance relates only to microbats the subject of this report.

The following species of threatened bat have been recorded at Carrols Ridge: Eastern bentwing bat, Eastern falsistrelle and Yellow-bellied sheathtail bat (Table 9). The previous biodiversity assessment also considered Large-footed myotis and Little pied bat for the Assessment of Significance based on habitat attributes and previous records in the locality (**ngh**environmental 2009b).

As such, this Assessment of Significance will be undertaken on these five microbat species.

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

Eastern bentwing bat

The distribution of this species covers a wide area along the east coast of Australia, with populations dispersed within 300 kilometres of each of the known maternity roosts (DECC 2009b). Eastern bentwing bat is a long-lived species with low fecundity. Churchill (1998) records an adult banded female being recaptured 18 years post banding.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968).

The Church Cave/Pylon 58 maternity site is located less than 19kms to the south of Carrols Ridge and the results of this study confirm use of the study site by this species in the November and January surveys. The study site is considered within foraging distance of the maternity site (Doug Mills, DECC, Personal communication, 13th February 2008).

Female Eastern bentwing bat migrate to specific cave sites in c.October-November each year to give birth in December and raise a single young (Churchill 1998). Post weaning, females leave maternity sites in late February-March (Dwyer in Strahan 1983), with young dispersing from the sites approximately two weeks later (late March) (G. Richards pers. comm via Vanessa Place, 2008).

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 (Dwyer 1968). There is no evidence that they have a strong affiliation with gradient, being recorded on ridges and gullies at Carrols Ridge.

In an analysis of 78,319 records from banding data, 95% of movements were 100kms or less (Wilson 2003). Dwyer (1968) documented distances far less. For females, he found that nearly half of all movements by adult females were less than 16km with 80% lower than 31kms.

The study also confirmed that female Eastern bentwing bat show strong fidelity as evidenced by seasonality data. The Church Cave/Pylon 58 Cave maternity site less than 19kms from Carrols Ridge is considered extremely important to the southern population of the Eastern bentwing bat (Dwyer 1968) and therefore, any impact on foraging females is likely to result in population-scale impacts.

Given its high-flying habits and even distribution across the ridges and gullies of the site, the risk of significant impacts from blade-strike and barotrauma on the species is likely to be high. Further, given the large proportion of the female population utilising the area around the maternity cave (some 30,000 individuals), a high mortality of foraging females would be considered significant. As the species is known to travel over a range of habitat types and was recorded at all surveys sites at Carrols Ridge, it is difficult to delegate these potential impacts to specific clusters within the proposal; the impact is likely to be throughout the subject site.

While our results show the species at Carrols Ridge in November, it is unlikely that the study site is used during migration given that the staging area for the southern population is at Mt Fairy, 100kms to the south-east (Dwyer 1968).

Flight speed has been recorded at 5.8metres/second or c.20kms/hour (Bullen and McKenzie 2008).

Considering the information relative to Carrols Ridge and the maternity site, the proposed Carrols Ridge wind farm could result in a population scale impact on the Eastern bent wing bat. However, in accordance with the recommendations outlined section 5.1 of this report, their is potential to reduce this impact is reduced such that the proposal is unlikely to have an adverse effect on the life cycle of the species and that the viable local population is unlikely to be placed at risk of extinction.

Little pied bat

The Little pied bat roosts in caves, mines, buildings, and tree hollows in small groups, though one colony of 40 individuals has been recorded (Churchill, 1998). It prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998; DECC 2009b). Little pied bats forage within the canopy (or sub-canopy), as with most of the Vespertilinidae in Australia. It often forages along watercourses (Menkhorst and Knight 2004) where it feeds on moths and possibly other flying invertebrates. It gives birth usually to two young in November.

Little pied bat is a sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 km to gain access to water in more arid environments. While this species was not recorded during this survey, or the 2008 surveys, a single record exists near Bowning from the DECC NSW Wildlife Atlas database (DECC 2009a). Considering the known ecology and habitat requirements of the species, the locality provides little, if any, potential habitat for the species. While the exact origin of this record is unknown, it could be suggested that it is an incorrect identification or entry into the database. Regardless, if it is correct, the species could only be considered a very occasional vagrant to the district as they are known from arid inland areas.

The study site is unlikely to provide suitable habitat for the species, as it contains dry sclerophyll forests and woodland. The dams on the site may provide marginal habitat although the species was not recorded on site. The proximity of Carrolls Ridge to Burrinjuck Dam may have an effect if a population occurred locally, but as the only record is some distance from the proposal site (and the dam) it is highly unlikely that the species occurs in the area.

Considering the information relative to the study site, the proposed Carrols Ridge wind farm is unlikely to have an adverse effect on the life cycle of the species and that a viable local population, if it exists, is unlikely to be placed at risk of extinction if the recommendations within section 5.1 of this report.

Eastern falsistrelle

The Eastern falsistrelle utilises tree hollows for roosting, and has also been found under loose bark and in buildings (DECC 2009b). Colonies are very small, ranging from 3 to 36 individuals often segregated by sex (Churchill 1998).

The Eastern falsistrelle relies on forested areas and forages within or just above the forest canopy. It is a relatively fast, manouverable flyer that hunts prey by pursuit. The species prefers tall wet sclerophyll forest with trees approximately 20 metres in height, though has been found in drier forests foraging. It travels medium distances to forage (c. 12km) (Churchill 1998). It is a winter hibernating species and it has been suggested that some highland populations migrate to the coast for winter (Parnaby in Strahan 1983), though by what route is unknown. Eastern falsistrelle give birth to one young in late Spring/Summer (December usually) and young are weaned by late February (Churchill 1998).

This species are known to occur within sclerophyll forests of the Great Dividing Range. The proximity of the site to Burrinjuck Dam (water source), Burrinjuck Nature Reserve and their presence in the study site confirms the presence of a local colony.

Considering the information relative to the study site, the proposed Carrolls Ridge wind farm is unlikely to have an adverse effect on the life cycle of the Eastern falsistrelle and that a viable local population, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.1 of this report.

Large-footed myotis

The Large-footed myotis is known to use tree hollows, caves, mines, under bridges, storm water drains, and vegetation such as Pandanus for roosting. Foraging is dependent on the presence of water bodies, both riparian and artificial such as dams (Churchill 1998). The species gleans insects from the waters surface and just below, as well as aerial prey. In NSW one young born per year in November / December (Churchill 1998). The relevant threats to this species are loss or disturbance of roosting sites and clearing adjacent to foraging areas (DECC 2008). Only one record exists in the locality at Wee Jasper near Burrinjuck Dam.

Generally, the species is found within 100km from the coast or major rivers and water bodies. While, there are no major water bodies or large dams within the study site, the nearest distance to Lake Burrinjuck is 1.8km (Cluster 4). The lake lies between the study site and the nearest record. Foraging moments are likely to be restricted to riparian corridors rather than along ridges, reducing the likelihood of frequent or sustained movement within turbine areas. However, the species may come into contact with turbines during travel between foraging grounds (Lake Burrinjuck) and potential roosting sites, however, given the extent of potential roosting sites closer to Lake Burrinjuck, it is unlikely that the species would use the study site.

Considering the information relative to the study site, the proposed Carrolls Ridge wind farm is unlikely to have an adverse effect on the life cycle of the Large-footed myotis and that a viable local population, if it exists, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.1 of this report.

Yellow-bellied sheathtail bat

Listed as vulnerable under the NSW TSC Act, this cryptic species is known to use a variety of habitats (DECC 2009b). Yellow-bellied sheathtailed bats roost solitarily or in small groups in hollows, old buildings or occasionally abandoned nests of other species such as Sugar Gliders (Churchill 1998). The species is sedentary and possibly territorial, though has been found in Southern Australia only between January and June (Churchill 1998) which may suggest some movement for hibernation. In the Murrumbidgee catchment, the species is thought to be associated with dry sclerophyll forests, although there are no records in the catchment (DECC 2009b). A fast flying species with low manoeuvrability, it favours a range of insect species, mainly beetles (Churchill 1998; Richards 2001). One young are born December to mid-March, though peak is likely to be December (Churchill 1998). The relevant threats to this species are loss of hollow-bearing trees and clearing and fragmentation of forest and woodland habitat (DECC 2009b).

Little is known about the migratory and foraging movements of the species, however, a small number of echolocation calls of this species were recorded in January 2009. Richards (2001) claims that the species may favour habitat in large tracts of vegetation with a dense understory. The forest and woodland in the study area generally have sparse understorey due to disturbance from grazing and fire, although Cluster 1e is a notable exception. The small number of calls suggests these habitat attributes are minimising the use of the study site by this species. The habitat preferences are more likely to be in the nearby Burrinjuck Nature Reserve and larger gazetted lands to the south.

Considering the information relative to the study site, the proposed Carrolls Ridge wind farm is unlikely to have an adverse effect on the life cycle of the Yellow-belled sheathtail bat and that a viable local population is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.1 of this report.

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

No microbats defined as an endangered population as listed under the NSW *Threatened Species Conservation Act 1995* occur in the vicinity of the proposal.

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

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

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

No microbats are listed under the NSW *Threatened Species Conservation Act 1995* as an endangered ecological community.

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

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

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

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

i) The total development envelope is 286ha. Within this envelope 8.8 ha of forest is likely to be removed, the remainder would be considered to be modified, if these species avoid turbines. The proposal would increase open areas (tracks along ridges between turbines) and thereby edge effects.

ii) Habitat within Cluster 1 is already fragmented or isolated to an extent (particularly slopes to the west). Works in Clusters 2 & 4 would result in habitat loss for species dependent on large tracts of forest. However, this is likely to be less important to highly mobile species such as microbats. Avoidance of the Carrols Ridge site by large number of foraging Eastern bentwing bat, may disrupt localised and perhaps specialist foraging paths.

iii) While seemingly suitable habitat is reserved nearby (Burrinjuck and Andrew Black Nature Reserves), and occurs adjacent to the study area, results of this study suggest that Eastern bentwing bat use Carrols Ridge during their occupation of the maternity site. The subject land is considered important to this species in terms at a population level scale.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the study site.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

At the time of writing, no recovery plan was in place for any microbat species considered in this assessment.

A number of priority actions are identified for threatened microbats, and are of relevance to the recommendations outlined in section 5.1 of this report. These are:

- Identification of important foraging areas and habitat around maternity caves
- Study of the ecological requirements of maternity colonies where foraging or potential movement corridors exist

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

Several key threatening processes are relevant to the proposed activity in relation to microbats. These include:

- *Clearing of native vegetation*
- *Loss of hollow-bearing trees*
- *Human caused climate change*

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Around 8.8ha of forest will be removed by this proposal which has been identified as habitat for a number of threatened microbats.

An unknown number of hollow-bearing trees will be removed within the 8.8ha of forest. These features are likely to provide habitat to non-threatened, and potentially threatened microbat species. The biodiversity assessment recommended the absolute minimum of hollow-bearing tree removal (**ngh**environmental 2009b). Based on these, the final area will be updated following the receipt of the final site layout.

Although the construction activities that would occur as part of site development may seem minor, they contribute to a global, cumulative impact on atmospheric greenhouse gas concentrations and potential for climate change impact. However, the operation of a wind farm is a renewable energy source that will contribute to the minimisation of green-house gas emissions and overall human caused climate change.

Conclusion

The proximity of the site to a known maternity cave for the Eastern bentwing bat introduces a high potential of the development and operation of a wind farm at Carrolls Ridge having a significant impact at a population level on this species. There is potential to reduce this risk via the implementation of mitigation measures discussed in section 5.1 above. Implementation of these safeguards would ensure the potential to impact on this species, and other microbats is minimised to the lowest possible risk. Based on the above assessment and the adoption and implementation of the recommendations (as per section 5.1) of this report, the proposed Carrols Ridge Precinct is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW TSC Act.

Appendix B **ASSESSMENT OF SIGNIFICANCE – COPPABELLA**

In accordance with section 5A of the *Environmental Planning and Assessment Act 1979,* an Assessment of Significance has been prepared by using seven factors which must be considered when determining if the proposed activity '*is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats*' that are listed as under the Schedule 1 & 2 of the *Threatened Species Conservation Act 1995.* These seven factors must be taken into account by the consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species and hence if a Species Impact Statement is required. The following Assessment of Significance relates only to microbats the subject of this report.

No species of threatened microbat have been recorded at Coppabella (Table 10). However, based on the threatened microbats that occurred at Carrols Ridge, the Assessment of Significance will be undertaken on four species: Eastern bentwing bat, Eastern falsistrelle, Yellow-bellied sheathtail bat and Little pied bat. The Large-footed myotis is not considered due to the absence of a large body of water.

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

Eastern bentwing bat

The distribution of this species covers a wide area along the east coast of Australia, with populations dispersed within 300 kilometres of each of the known maternity roosts (DECC 2009b). Eastern bentwing bat is a long-lived species with low fecundity. Churchill (1998) records an adult banded female being recaptured 18 years post banding.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968).

The Church Cave/Pylon 58 maternity site is located 42 kilometres to the south of Coppabella. Surveys in both September and January failed to reveal the presence of this species. Dwyer (1968) documented nearly half of all movements by adult females were less than 16km with 80% of all movements less than 31kms, well outside of the range of Coppabella. At least 84 kms would be required for an Eastern bentwing bat to travel to Coppabella and return, without any onsite foraging activity. Given the data of Dwyer (1968) this is very unlikely.

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). Few areas exist at Coppabella. The species also forage along flyways (along clear areas such as tracks or streams), and are known to utilise cleared paddocks during dispersal (Dwyer 1968). The lack of habitat at Coppabella and the distance from the Church Cave maternity colony make it unlikely that Eastern bentwing bat would occur there. Further, their absence may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate food resource at Coppabella combined with the extended distance from Church Cave is likely to provide an explanation to their absence.

Considering the information relative to Coppabella, the lack of potential habitat on the site and the distance from the maternity site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the species and that any viable local population, is unlikely to be placed at risk of extinction in-concurrence with the recommendations outlined in section 5.2 of this report.

Little pied bat

The Little pied bat roosts in caves, mines, buildings, and tree hollows in small groups, though one colony of 40 individuals has been recorded (Churchill, 1998). It prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998; DECC 2009b). Little pied bats forage within the canopy (or sub-canopy), as with most of the Vespertilinidae in Australia. It often forages along watercourses (Menkhorst and Knight 2004) where it feeds on moths and possibly other flying invertebrates. It gives birth usually to two young in November.

Little pied bat is a sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 km to gain access to water in more arid environments. While this species was not recorded during this survey, or the 2008 surveys, a single record exists near Bowning from the DECC NSW Wildlife Atlas database (DECC 2009a). Considering the known ecology and habitat requirements of the species, the locality provides little, if any, potential habitat for the species. While the exact origin of this record is unknown, it could be suggested that it is an incorrect identification or entry into the database. Regardless, if it is correct, the species could only be considered a very occasional vagrant to the district as they are known from arid inland areas.

The study site is unlikely to provide suitable habitat for the species, as it dominated by open pasture with occasional woodland. The dams on the site may provide marginal habitat although the species was not recorded on site.

Considering the information relative to the study site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the species and that a viable local population, should one exist, is unlikely to be placed at risk of extinction if the recommendations within section 5.2 of this report.

Eastern falsistrelle

The Eastern falsistrelle utilises tree hollows for roosting, and has also been found under loose bark and in buildings (DECC 2009b). Colonies are very small, ranging from 3 to 36 individuals often segregated by sex (Churchill 1998).

The Eastern falsistrelle relies on forested areas and forages within or just above the forest canopy. It is a relatively fast, manouverable flyer that hunts prey by pursuit. The species prefers tall wet sclerophyll forest with trees approximately 20 metres in height, though has been found in drier forests foraging. It travels medium distances to forage (c. 12km) (Churchill 1998). It is a winter hibernating species and it has been suggested that some highland populations migrate to the coast for winter (Parnaby in Strahan 1983), though by what route is unknown. Eastern falsistrelle give birth to one young in late Spring/Summer (December usually) and young are weaned by late February (Churchill 1998).

This species are known to occur within sclerophyll forests of the Great Dividing Range. However, the general lack of this vegetation type at Coppabella which is dominated by open pasture or grassland is unlikely to provide habitat for the species. This is confirmed by the lack of detection by Echolocation call analysis.

Considering the information relative to the study site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the Eastern falsistrelle and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.2 of this report.

Yellow-bellied sheathtail bat

Listed as vulnerable under the NSW TSC Act, this cryptic species is known to use a variety of habitats (DECC 2009b). Yellow-bellied sheathtailed bats roost solitarily or in small groups in hollows, old buildings or occasionally abandoned nests of other species such as Sugar Gliders (Churchill 1998). The species is sedentary and possibly territorial, though has been found in Southern Australia only between January and June (Churchill 1998) which may suggest some movement for hibernation. In the Murrumbidgee catchment, the species is thought to be associated with dry sclerophyll forests, although there are no records in the catchment (DECC 2009b). A fast flying species with low manoeuvrability, it favours a range of insect species, mainly beetles (Churchill 1998; Richards 2001). One young are born December to mid-March, though peak is likely to be December (Churchill 1998). The relevant threats to this species are loss of hollow-bearing trees and clearing and fragmentation of forest and woodland habitat (DECC 2009b).

Little is known about the migratory and foraging movements of the species, however, it has not been recorded in either the September or January surveys. Richards (2001) claims that the species may favour habitat in large tracts of vegetation with a dense understory. This habitat is not present at Coppabella. The lack of potential habitat and the non-detection of this species make it unlikely that the species occurs on site.

Considering the information relative to the study site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the Yellow-belled sheathtail bat and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.2 of this report.

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

No microbats defined as an endangered population as listed under the NSW *Threatened Species Conservation Act 1995* occur in the vicinity of the proposal.

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

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

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

No microbats are listed under the NSW *Threatened Species Conservation Act 1995* as an endangered ecological community.

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

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

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

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

The total development envelope is 2,143ha. At this stage of the proposal, although the design has not yet been finalized, around 2 ha of woodland is likely to be removed.

The study site is already extremely modified by clearing and fragmentation effects from extensive agricultural activities. Minimal fragmentation by the loss of 2ha is likely to be less important to highly mobile species such as microbats.

While 10 species of microbat have been recorded across two seasons, low bat activity and the lack of threatened microbats suggests that the Coppabella site is of little importance. However, locally it does contribute to general microbat diversity likely to occur across this largely agricultural landscape.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the study site.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

At the time of writing, no recovery plan was in place for any microbat species considered in this assessment.

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

Several key threatening processes are relevant to the proposed activity in relation to microbats. These include:

- *Clearing of native vegetation*
- *Loss of hollow-bearing trees*
- *Human caused climate change*

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Around 2ha of woodland will be removed by this proposal. No threatened species of microbat have been

recorded at Coppabella. An unknown number of hollow-bearing trees will be removed within the 2ha of woodland. These features are likely to provide habitat to non-threatened microbat species. The biodiversity assessment recommended the absolute minimum of hollow-bearing tree removal (**ngh**environmental 2009c).

Although the construction activities that would occur as part of site development may seem minor, they contribute to a global, cumulative impact on atmospheric greenhouse gas concentrations and potential for climate change impact. However, the operation of a wind farm is a renewable energy source that will contribute to the minimisation of green-house gas emissions and overall human caused climate change.

Conclusion

While the Coppabella study site does provide some habitat to common microbat species, the absence of any threatened microbats suggests it is of low importance to these species in the wider locality. Nonetheless, based on the above assessment and the adoption and implementation of the recommendations outlined in section 5.2 of this report, the proposed Coppabella Precinct is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW TSC Act.

Appendix C **ASSESSMENT OF SIGNIFICANCE - MARILBA**

In accordance with section 5A of the *Environmental Planning and Assessment Act 1979,* an Assessment of Significance has been prepared by using seven factors which must be considered when determining if the proposed activity '*is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats*' that are listed as under the Schedule 1 & 2 of the *Threatened Species Conservation Act 1995.* These seven factors must be taken into account by the consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species and hence if a Species Impact Statement is required. The following Assessment of Significance relates only to microbats the subject of this report.

Only one species of threatened microbat has been recorded at Marilba, the Eastern bentwing bat (Table 11). However, based on the threatened microbats that occurred at Carrols Ridge, the Assessment of Significance will be undertaken on three additional species: Eastern falsistrelle, Yellow-bellied sheathtail bat and Little pied bat. The Large-footed myotis is not considered due to the absence of a large body of water.

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

Eastern bentwing bat

The distribution of this species covers a wide area along the east coast of Australia, with populations dispersed within 300 kilometres of each of the known maternity roosts (DECC 2009b). Eastern bentwing bat is a long-lived species with low fecundity. Churchill (1998) records an adult banded female being recaptured 18 years post banding.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968). The Church Cave/Pylon 58 maternity site is located 34 kilometres to the south of Marilba.

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). Few areas exist at Coppabella. The species also forage along flyways (along clear areas such as tracks or streams), and are known to utilise cleared paddocks during dispersal (Dwyer 1968).

September 2008 surveys revealed 22 passes of this species. Such a low number of passes suggests that Marilba was not important habitat for Eastern bentwing bat at the time of the survey. Their absence in the January 2009 survey further confirms this theory in that any females would have moved onto the Church Cave maternity site by this time, and that the Marilba site did not form part of their foraging range. The distance of Marilba to the maternity site suggests that it is unlikely that the species would forage as far as Marilba in one evening. However, males would still have been detected if they were at Marilba. The data collected suggests they were absent, or if present, in very low numbers making detection difficult. This suggests that Marilba provides only a small portion of a wider foraging area that Eastern bentwing are likely to rely on, such as the habitat at Carrols Ridge.

The exact migration route taken by females to reach or disperse from Church Cave is unknown, though supposed by Dwyer (1968) to be strongly related to topography- both waterways and divides, with the species flying along ridges or waterways, rather than over them, using them as navigation aides. Home ranges are not confined to river basin areas (Wilson 2003). In light of the fact that the species would

migrate to and from coastal areas, impacts from the proposed Marilba wind farm, located to the north of the maternity cave, are considered unlikely. Dwyer (1968) documented nearly half of all movements by adult females were less than 16km with 80% of all movements less than 31kms. At least 68 kms of flight would be required for an Eastern bentwing bat to travel to Marilba and return from Church Cave, without any onsite foraging activity.

The absence of Eastern bentwing bat at Marilba in the January surveys may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate resource at Marilba combined with the extended distance from Church Cave is likely to provide an explanation to their absence during peak breeding.

Considering the information relative to Marilba, and the distance from the maternity site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the species and that any viable local population, is unlikely to be placed at risk of extinction in-concurrence with the recommendations outlined in section 5.3 of this report.

Little pied bat

The Little pied bat roosts in caves, mines, buildings, and tree hollows in small groups, though one colony of 40 individuals has been recorded (Churchill, 1998). It prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998; DECC 2009b). Little pied bats forage within the canopy (or sub-canopy), as with most of the Vespertilinidae in Australia. It often forages along watercourses (Menkhorst and Knight 2004) where it feeds on moths and possibly other flying invertebrates. It gives birth usually to two young in November.

Little pied bat is a sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 km to gain access to water in more arid environments. While this species was not recorded during this survey, or the 2008 surveys, a single record exists near Bowning from the DECC NSW Wildlife Atlas database (DECC 2009a). Considering the known ecology and habitat requirements of the species, the locality provides little, if any, potential habitat for the species. While the exact origin of this record is unknown, it could be suggested that it is an incorrect identification or entry into the database. Regardless, if it is correct, the species could only be considered a very occasional vagrant to the district as they are known from arid inland areas.

The study site is unlikely to provide suitable habitat for the species, as it dominated by open pasture with occasional woodland. The dams on the site may provide marginal habitat although the species was not recorded on site.

Considering the information relative to the study site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the species and that a viable local population, should one exist, is unlikely to be placed at risk of extinction if the recommendations within section 5.3 of this report.

Eastern falsistrelle

The Eastern falsistrelle utilises tree hollows for roosting, and has also been found under loose bark and in buildings (DECC 2009b). Colonies are very small, ranging from 3 to 36 individuals often segregated by sex (Churchill 1998).

The Eastern falsistrelle relies on forested areas and forages within or just above the forest canopy. It is a relatively fast, manouverable flyer that hunts prey by pursuit. The species prefers tall wet sclerophyll forest with trees approximately 20 metres in height, though has been found in drier forests foraging. It travels

medium distances to forage (c. 12km) (Churchill 1998). It is a winter hibernating species and it has been suggested that some highland populations migrate to the coast for winter (Parnaby in Strahan 1983), though by what route is unknown. Eastern falsistrelle give birth to one young in late Spring/Summer (December usually) and young are weaned by late February (Churchill 1998).

This species are known to occur within sclerophyll forests of the Great Dividing Range. However, the general lack of this vegetation type and their quality at Marilba which is dominated by open pasture or grassland is unlikely to provide habitat for the species. This is confirmed by the lack of detection by Echolocation call analysis during two seasonal surveys.

Considering the information relative to the study site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the Eastern falsistrelle and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.3 of this report.

Yellow-bellied sheathtail bat

Listed as vulnerable under the NSW TSC Act, this cryptic species is known to use a variety of habitats (DECC 2009b). Yellow-bellied sheathtailed bats roost solitarily or in small groups in hollows, old buildings or occasionally abandoned nests of other species such as Sugar Gliders (Churchill 1998). The species is sedentary and possibly territorial, though has been found in Southern Australia only between January and June (Churchill 1998) which may suggest some movement for hibernation. In the Murrumbidgee catchment, the species is thought to be associated with dry sclerophyll forests, although there are no records in the catchment (DECC 2009b). A fast flying species with low manoeuvrability, it favours a range of insect species, mainly beetles (Churchill 1998; Richards 2001). One young are born December to mid-March, though peak is likely to be December (Churchill 1998). The relevant threats to this species are loss of hollow-bearing trees and clearing and fragmentation of forest and woodland habitat (DECC 2009b).

Little is known about the migratory and foraging movements of the species. However, it has not been recorded in either the September or January surveys. Richards (2001) claims that the species may favour habitat in large tracts of vegetation with a dense understory. This habitat is not present at Marilba and combined with the non-detection of this species, it is unlikely that the species occurs on site.

Considering the information relative to the study site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the Yellow-belled sheathtail bat and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.3 of this report.

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

No microbats defined as an endangered population as listed under the NSW *Threatened Species Conservation Act 1995* occur in the vicinity of the proposal.

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

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

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

No microbats are listed under the NSW *Threatened Species Conservation Act 1995* as an endangered ecological community.

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

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

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

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

The total development envelope is 2,918ha. At this stage of the proposal, although the design has not yet been finalized, around 6.74 ha of woodland is likely to be removed. Hollow-bearing trees would be removed, however, the exact number is unclear. The biodiversity assessment recommends an absolute minimum.

The study site is already extremely modified by clearing and fragmentation effects from extensive agricultural activities. Minimal fragmentation by the loss of 6.74ha is likely to be less important to highly mobile species such as microbats.

While 12 species of microbat have been recorded across two seasons, low bat activity and the lack of threatened microbats suggests that the Marilba site is of minor importance to regional populations of threatened species.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the study site.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

At the time of writing, no recovery plan was in place for any microbat species considered in this assessment.

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

Several key threatening processes are relevant to the proposed activity in relation to microbats. These include:

- *Clearing of native vegetation*
- *Loss of hollow-bearing trees*
- *Human caused climate change*

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Around 6.74ha of woodland will be removed by this proposal.

An unknown number of hollow-bearing trees will be removed within this area of woodland. The biodiversity assessment recommended the absolute minimum of hollow-bearing tree removal (**ngh**environmental 2009c).

Although the construction activities that would occur as part of site development may seem minor, they contribute to a global, cumulative impact on atmospheric greenhouse gas concentrations and potential for climate change impact. However, the operation of a wind farm is a renewable energy source that will contribute to the minimisation of green-house gas emissions and overall human caused climate change.

Conclusion

While the Marilba study site does provide some habitat to common microbat species, one threatened microbat, the Eastern bentwing bat was detected in the September surveys. The absence of this species during the known occupation of the Church Cave maternity site which is some 34kms south, suggests that Marilba is of lesser importance for foraging during the known breeding season than other areas, such as Carrols Ridge.

Nonetheless, based on the above assessment and the adoption and implementation of the recommendations outlined in section 5.3 of this report, the proposed Marilba Precinct is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW TSC Act.

Appendix D **QUALIFICATIONS AND EXPERIENCE OF PERSONNEL**

NAME	ROLE	SPECIALIST SKILLS AND ABILITIES
Nicholas Graham-Higgs	**Director and senior review**	Nicholas has worked as an environmental planning and resource consultant since 1992, specialising in natural resource management. A wide range of assignments covering diverse natural and modified environments, have enabled Nick to develop a broad knowledge base in the area of natural resource planning and management. Nick is accredited as a Certified Environmental Practitioner by the Environment Institute of Australia and New Zealand.
Brooke Marshall	**Project Manager** **Peer review**	Brooke graduated as a first class honours Natural Resources graduate of the University of New England (UNE). She specialised in wildlife management, ecosystem rehabilitation and natural resource management in developing countries and was awarded a University Medal in recognition of high academic achievement. Brooke completed her honours project in association with CRC Pest Animal Control at CSIRO Sustainable Ecosystems Canberra, investigating conditioned aversion (CA) as a means to reduce the impact of fox predation upon colonies of threatened ground-nesting birds. This project used novel statistical analyses to investigate the responses of captive foxes to treated prey items. The paper summarising the findings of this study is currently being peer reviewed and will hopefully be published in the near future. Since joining **ngh**environmental, Brooke has prepared impact assessment reports relating to a variety of infrastructure development (including roads, wind farms, telecommunications, water supply management and residential development) as well as river modification and prescribed burning works. These reports have included threatened floral and faunal species assessments, research, fieldwork and GIS components. Her major projects have included impact assessments for numerous wind farm developments, a Species Impact Statement involving 33 subject species, a natural values desktop study to be used for strategic planning in the Snowy River Shire and Biocertification investigations in the Bega Valley Shire.

NAME	ROLE	SPECIALIST SKILLS AND ABILITIES
Steven Sass B. App. Sci. (Env.Sci) (Hons) CSU	**Senior Ecologist** **Senior Author/ Anabat Analysis**	Steven joined **ngh**environmental in August 2006 with expertise in environmental consulting and biodiversity assessment. In the four years prior, he played a key role at Charles Sturt University, undertaking flora and fauna impact assessment for the Johnstone Centre (Environmental Consulting) and as a senior research officer within the biodiversity research and education team with much of his work in western NSW. Steven is an experienced ecologist having undertaken more than 500 aquatic and terrestrial threatened flora and fauna surveys and habitat assessments. As a Certified Environmental Practitioner by the Environment Institute of Australia and New Zealand and as Senior Ecologist, Steven provides technical advice and peer-review to the **ngh**environmental ecology team.
Bianca Heinze B.App.Sci (ERM/Coastal Mngt) SCU	**Ecologist** **Field surveys/Data control**	Bianca completed her Bachelor of Applied Science (Environmental Resource/Coastal Management) at Southern Cross University, Lismore in 2006. Since joining **ngh**environmental Bianca has been mentored in the preparation of Assessments of Significance for threatened biota (7-part tests), Biodiversity Assessments and Review of Environmental Factors for clients including Epuron and Country Energy. Bianca also has field experience in biodiversity assessments including terrestrial fauna surveys and habitat evaluation across a variety of ecosystems.
Ally Madden B.Sc (App.Geo) (Hons) UNSW	**Spatial Analyst** **GIS Mapping**	Ally graduated as a first class Honours student at the University of NSW in 2006. Since the completion of her studies she has specialised in Geographic Information Systems (GIS) working with ArcMap version 9.2. Prior to joining **ngh**environmental, Ally worked for the National Parks and Wildlife Service managing the design and development of interactive park maps for the NPWS website. Ally was also involved in mapping fire management strategies, Aboriginal Cultural Heritage sites and worked on the mapping and data analysis for the SE Koala Discovery Surveys. Ally is now involved in managing GIS data and the preparation and presentation of maps for biodiversity, heritage and environmental assessment projects, including wind farm projects and other major infrastructure projects across NSW.