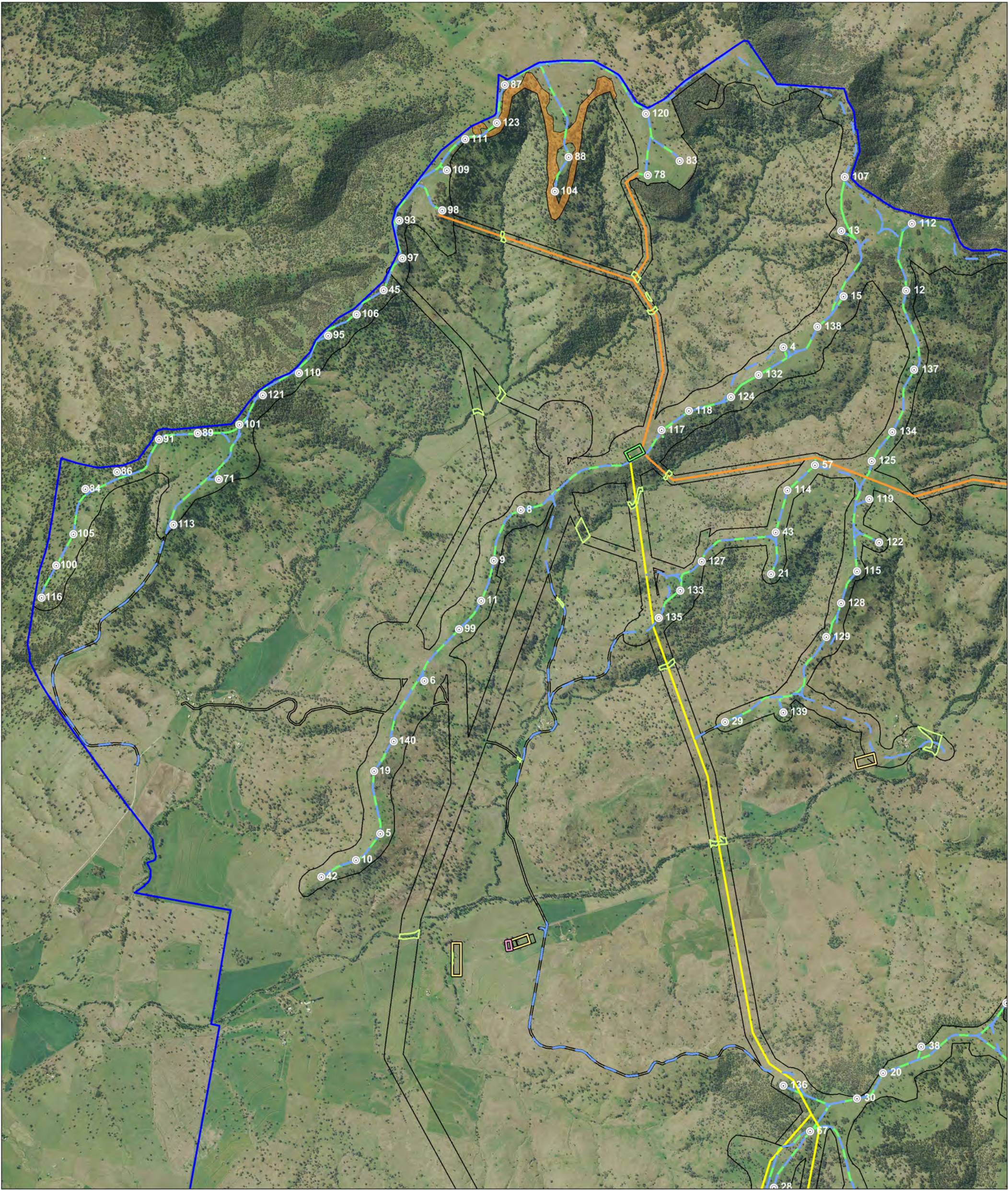


A.8 - Mammal Survey Results Zoom View Map 1



Combined survey area

Site perimeter

Wind Turbine Area

Transmission Area

Infrastructure

Turbine location

Access track

Underground cabling

OH powerline

Transmission line

Proposed substation

Alternative substation

Construction compound

Concrete batch plant

O&M building

Hollow quality

Excellent

Good

Overall habitat quality

Good

Habitat feature

Caves

Listed Microbats

Common bent-wing bat

Corben's long-eared bat

Eastern cave bat

Large-eared pied bat

Yellow-bellied sheath-tail bat

Listed Mammals

Squirrel glider

Additional data

Squirrel glider habitat

EPURON

0 0.5 1 1.5

Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm

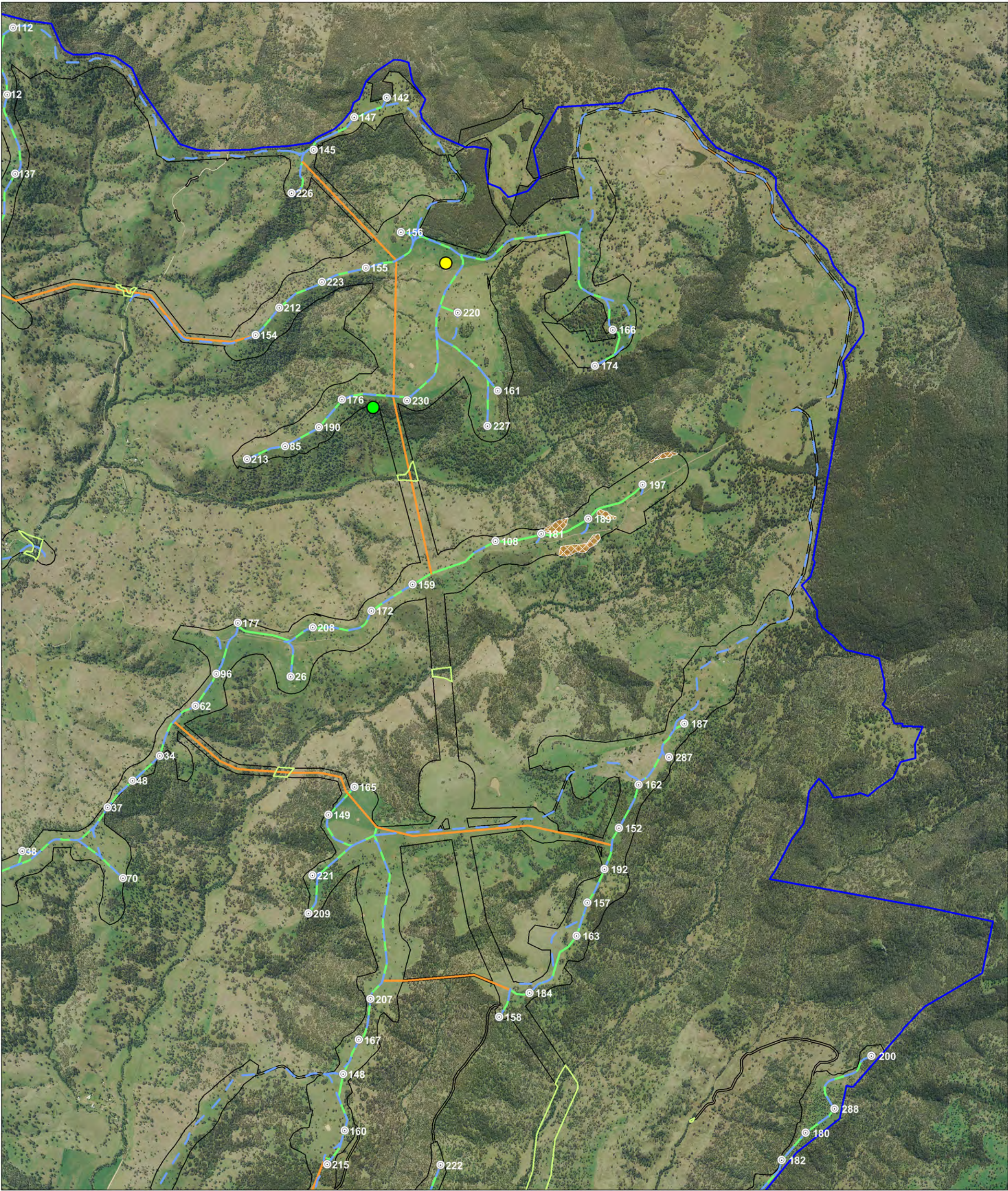
Produced by: Virgil Robinson

Date: 30 March 2017

Projection: GDA94 MGA Zone 55

N

A.8 - Mammal Survey Results Zoom View Map 2



Combined survey area

Site perimeter

Wind Turbine Area

Transmission Area

Infrastructure

Turbine location

Access track

Underground cabling

OH powerline

Transmission line

Proposed substation

Alternative substation

Construction compound

Concrete batch plant

O&M building

Hollow quality

Excellent

Good

Overall habitat quality

Good

Habitat feature

Caves

Listed Microbats

Common bent-wing bat

Corben's long-eared bat

Eastern cave bat

Large-eared pied bat

Yellow-bellied sheath-tail bat

Listed Mammals

Squirrel glider

Additional data

Squirrel glider habitat

EPURON

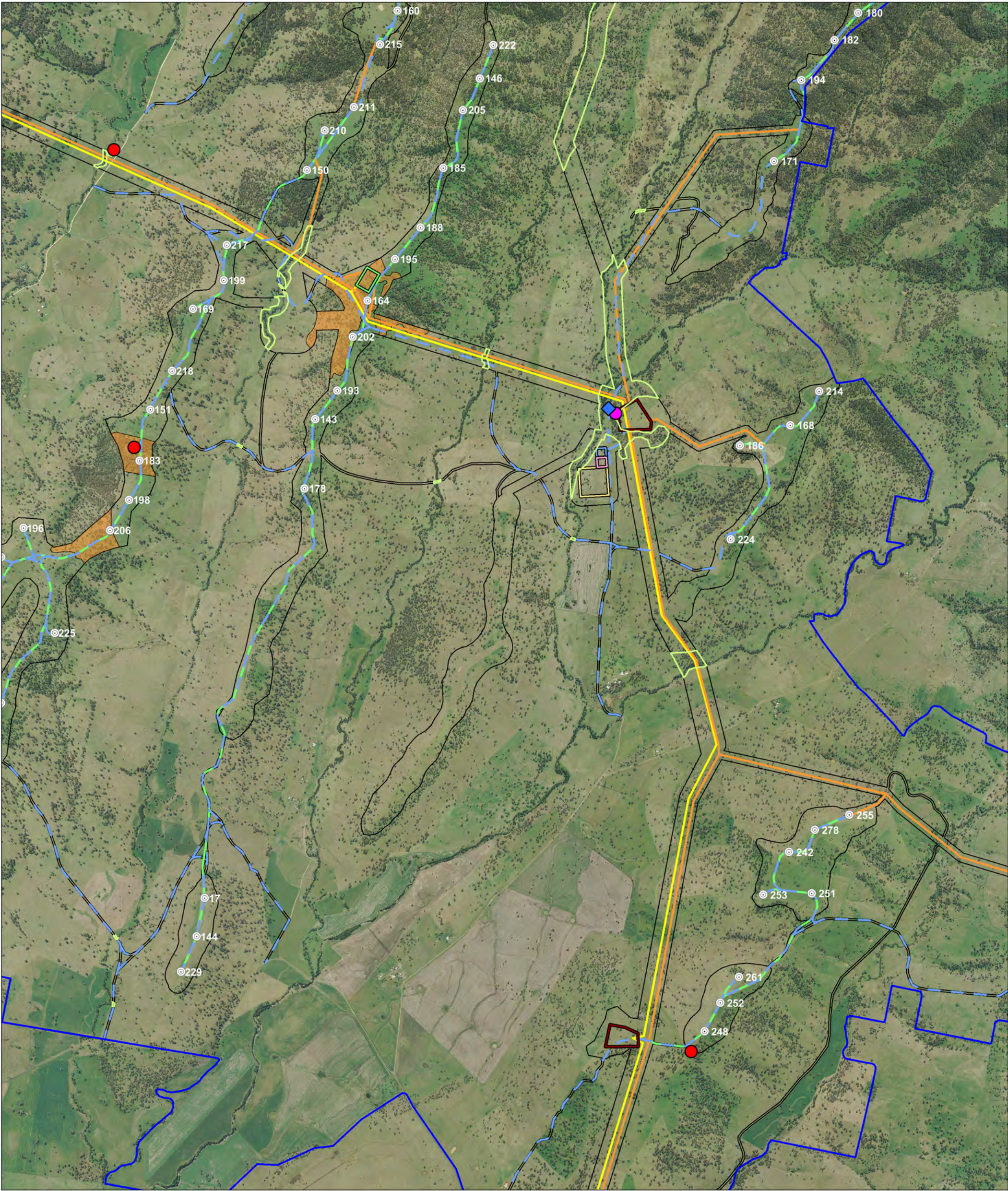
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Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 30 March 2017
Projection: GDA94 MGA Zone 55

N

A.8 - Mammal Survey Results Zoom View Map 3



Combined survey area

Site perimeter

Wind Turbine Area

Transmission Area

Infrastructure

Turbine location

Access track

Underground cabling

OH powerline

Transmission line

Proposed substation

Alternative substation

Construction compound

Concrete batch plant

O&M building

Hollow quality

Excellent

Good

Overall habitat quality

Good

Habitat feature

Caves

Listed Microbats

Common bent-wing bat

Corben's long-eared bat

Eastern cave bat

Large-eared pied bat

Yellow-bellied sheath-tail bat

Listed Mammals

Squirrel glider

Additional data

Squirrel glider habitat

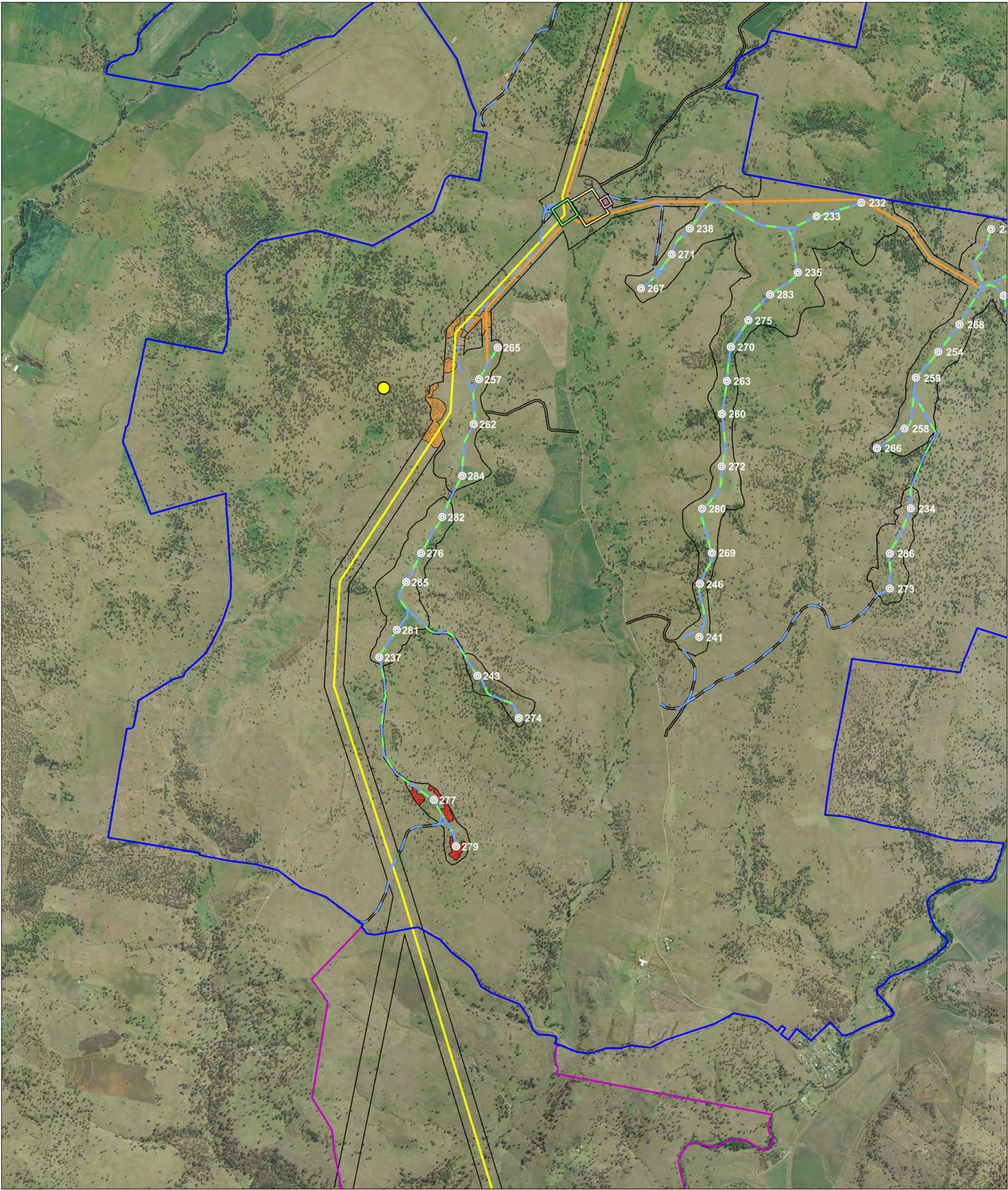
EPURON

0 0.5 1 1.5
Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 30 March 2017
Projection: GDA94 MGA Zone 55

A.8 - Mammal Survey Results Zoom View Map 4



- Combined survey area
- Site perimeter
- Wind Turbine Area
 - Transmission Area
- Infrastructure
- Turbine location
 - Access track
 - Underground cabling

- OH powerline
- Transmission line
- Proposed substation
- Alternative substation
- Construction compound
- Concrete batch plant
- O&M building

- Hollow quality
- Excellent
 - Good
- Overall habitat quality
- Good
- Habitat feature
- Caves

- Listed Microbats
- Common bent-wing bat
 - Corben's long-eared bat
 - Eastern cave bat
 - Large-eared pied bat
 - Yellow-bellied sheath-tail bat
- Listed Mammals
- Squirrel glider

- Additional data
- Squirrel glider habitat

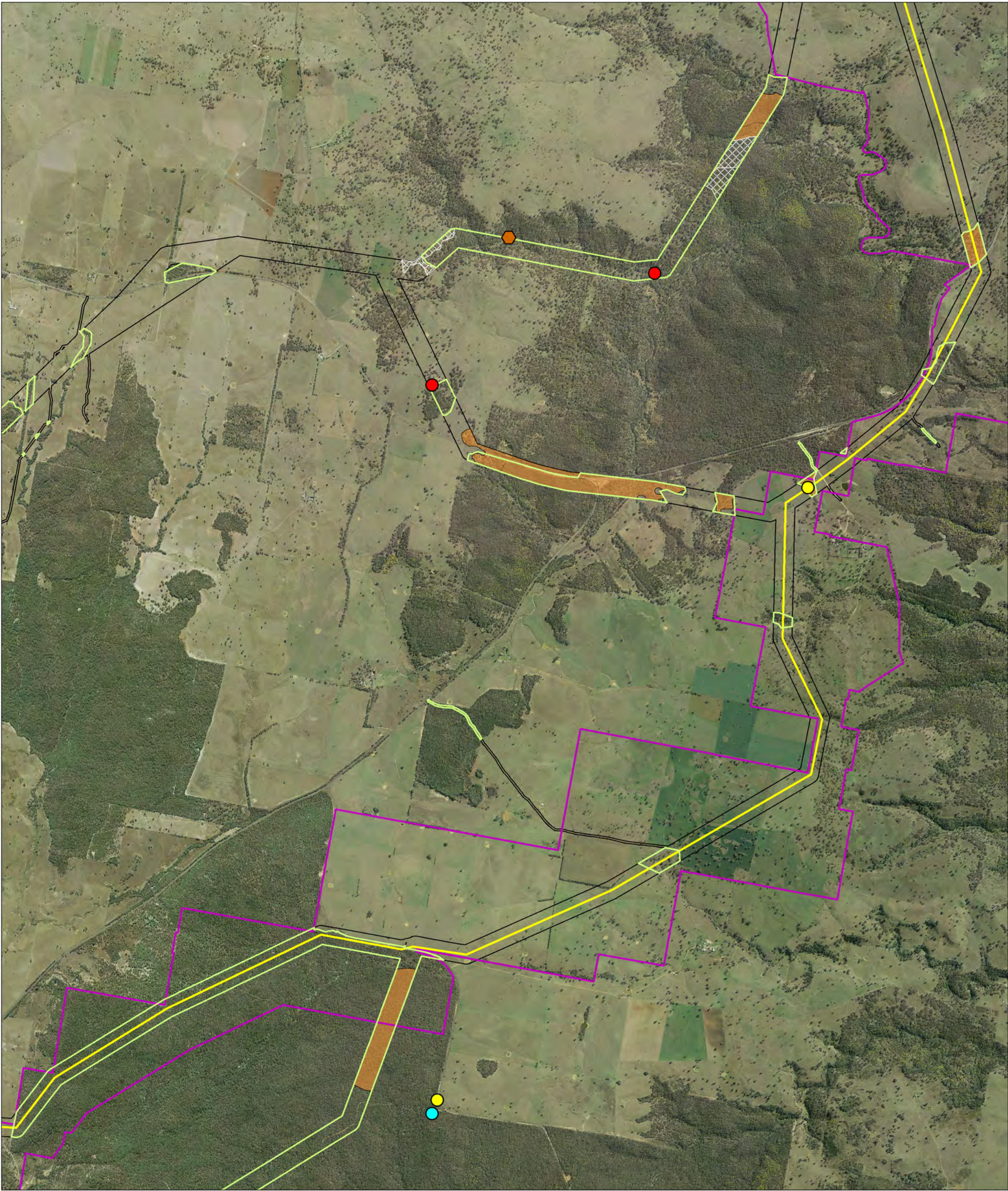
EPURON

0 0.5 1 1.5
Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 30 March 2017
Projection: GDA94 MGA Zone 55

A.8 - Mammal Survey Results Zoom View Map 5



Combined survey area

Site perimeter

Wind Turbine Area

Transmission Area

Infrastructure

Turbine location

Access track

Underground cabling

OH powerline

Transmission line

Proposed substation

Alternative substation

Construction compound

Concrete batch plant

O&M building

Hollow quality

Excellent

Good

Overall habitat quality

Good

Habitat feature

Caves

Listed Microbats

Common bent-wing bat

Corben's long-eared bat

Eastern cave bat

Large-eared pied bat

Yellow-bellied sheath-tail bat

Listed Mammals

Squirrel glider

Additional data

Squirrel glider habitat

EPURON

0 0.5 1 1.5

Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm

Produced by: Virgil Robinson

Date: 30 March 2017

Projection: GDA94 MGA Zone 55

N

A.8 - Mammal Survey Results Zoom View Map 6



- Combined survey area
- Site perimeter
- Wind Turbine Area
 - Transmission Area
- Infrastructure
- Turbine location
 - Access track
 - Underground cabling

- OH powerline
- Transmission line
- Proposed substation
- Alternative substation
- Construction compound
- Concrete batch plant
- O&M building

- Hollow quality
- Excellent
 - Good
- Overall habitat quality
- Good
- Habitat feature
- Caves

- Listed Microbats
- Common bent-wing bat
 - Corben's long-eared bat
 - Eastern cave bat
 - Large-eared pied bat
 - Yellow-bellied sheath-tail bat
- Listed Mammals
- Squirrel glider

- Additional data
- Squirrel glider habitat

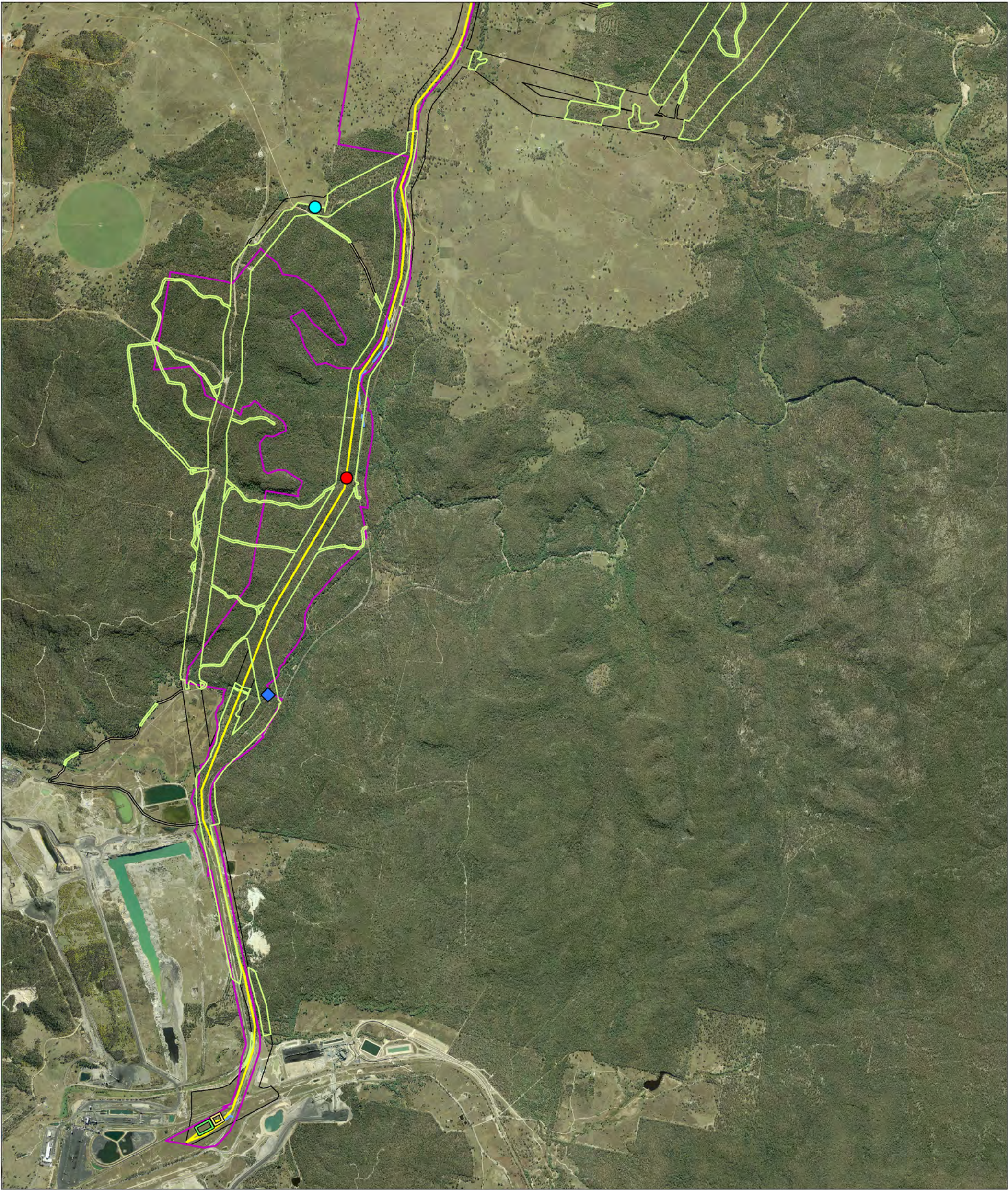
EPURON

0 0.5 1 1.5
Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 30 March 2017
Projection: GDA94 MGA Zone 55

A.8 - Mammal Survey Results Zoom View Map 7



- Combined survey area
- Site perimeter
- Wind Turbine Area
 - Transmission Area
- Infrastructure
- Turbine location
 - Access track
 - Underground cabling

- OH powerline
- Transmission line
- Proposed substation
- Alternative substation
- Construction compound
- Concrete batch plant
- O&M building

- Hollow quality
- Excellent
 - Good
- Overall habitat quality
- Good
- Habitat feature
- Caves

- Listed Microbats
- Common bent-wing bat
 - Corben's long-eared bat
 - Eastern cave bat
 - Large-eared pied bat
 - Yellow-bellied sheath-tail bat
- Listed Mammals
- Squirrel glider

- Additional data
- Squirrel glider habitat

EPURON

0 0.5 1 1.5
Kilometers

A3 @ 1:38,500

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 30 March 2017
Projection: GDA94 MGA Zone 55

APPENDIX B SURVEY EFFORT AND RESULTS

B.1 SURVEY EFFORT COMBINED

Date	Method	Target species	No. Surveys	Time (mins) / survey Effort Time	No. People	Total (hrs)	Area covered (m) Effort Area	Known total (ha)
Flora - Transmission Line Study Area								
8-19 Oct 2012	Random meanders (including targeted searches)	All flora species	41	30	1	20.5	50 x 50	10.3
	Inspection searches	All flora species	30	10	1	5.0	25 x 25	1.9
Subtotal			71			25.5		12.1
1-8 Oct 2013	Random meanders (including targeted searches)	All flora species	90	30	1	45.0	50 x 50	22.5
	Inspection searches	All flora species	59	10	1	9.8	25 x 25	3.7
Subtotal			149			54.8		26.2
20-23 Mar 2015	Random meanders (including targeted searches)	All flora species	9	30	1	4.5	50 x 50	2.3
	Biometric plots	All flora species	2	45	1	1.5	20 x 20	0.1
Subtotal			11			6.0		2.4
4-6 October 2016	Random meander	Vegetation communities	81	15	1	20.3	30000 x 50	150.0
Subtotal			81			20.3		150.0
TOTALS - Flora transmission line study area	Random meanders (including targeted searches)		221			90.3		185.0
	Inspection searches		89			14.8		5.6
	Biometric plots		2			1.5		0.1
	All surveys combined		312			106.6		190.7
Flora - Wind Farm Study Area								
8-19 Oct 2012, 1-8 Oct 2013 (combined)	Random meanders (including targeted searches)	All flora species	79	30	1	39.5	50 x 50	19.8
	Inspection searches	All flora species	77	10	1	12.8	25 x 25	4.8

Date	Method	Target species	No. Surveys	Time (mins) / survey Effort Time	No. People	Total (hrs)	Area covered (m) Effort Area	Known total (ha)
Subtotal			156			52.3		24.6
4-6 October 2016	Random meanders (including targeted searches)	All flora species	16	35	1	9.3	20000 x 50	100.0
Subtotal			16			9.3		100.0
TOTALS - Flora wind farm study area	Random meanders (including targeted searches)		95	65		48.8		119.8
	Inspection searches		77	10		12.8		4.8
	All surveys combined		172	75		61.7		124.6
Flora - Liverpool Plains Wind Farm TLSA and WFSa combined								
	<i>Random meanders (including targeted searches)</i>		316	65		139.1		304.8
	<i>Inspection searches</i>		166	10		27.7		10.4
	<i>Biometric plots</i>		2	0		1.5		0.1
	<i>All surveys combined</i>		484	75		168.3		315.3
Fauna - Transmission Line Study Area								
8-19 Oct 2012	Habitat assessment and hollow-bearing tree survey	All vertebrate fauna	49	20	1	16.3	25 x 25	3.1
8-19 Oct 2012	Bird survey	All birds	49	10	1	8.2	50 x 50	12.3
	Herpetofauna search	All reptiles	49	10	1	8.2	50 x 50	12.3
	Bird utilisation survey	All birds	17	30	1 or 2	8.5	100 x 100	17.0
	Extended herpetofauna search	All reptiles	7	30	1 or 2	3.5	50 x 50	1.8
	Stagwatching /evening listening	All nocturnal fauna with focus on threatened species	10	20	2	6.7	n/a	n/a

Date	Method	Target species	No. Surveys	Time (mins) / survey Effort - Time	No. People	Total (hrs)	Area covered (m) Effort - Area	Known total (ha)
	Spotlighting - on foot	All nocturnal fauna with focus on threatened species	10	60	2	20.0	n/a	n/a
	Spotlighting - vehicle	All nocturnal fauna with focus on threatened species	8	30	2	8.0	n/a	n/a
	Call playback	Squirrel Glider, Powerful Owl, Masked Owl, Barking Owl	8	30	1	4.0	n/a	n/a
	Anabat	Insectivorous bats	12	480		96.0	n/a	n/a
Sub-total			219			179.3		46.3
1-8 Oct 2013	Habitat assessment and hollow-bearing tree survey	All vertebrate fauna	86	20	1	28.7	25 x 25	5.4
	Bird survey	All birds	86	10	1	14.3	50 x 50	21.5
	Herpetofauna search	All reptiles	86	10	1	14.3	50 x 50	21.5
	Bird utilisation survey	All birds	39	30	1 or 2	19.5	100 x 100	39.0
	Extended herpetofauna search	All reptiles	21	30	1 or 2	10.5	50 x 50	5.3
	Stagwatching /evening listening	All nocturnal fauna with focus on threatened species	11	20	2	7.3	n/a	n/a
	Spotlighting - on foot	All nocturnal fauna with focus on threatened species	11	60	2	22.0	n/a	n/a
	Spotlighting - vehicle	All nocturnal fauna with focus on threatened species	9	30	2	9.0	n/a	n/a
	Call playback	Squirrel Glider, Powerful Owl, Masked Owl, Barking Owl	11	30	2	11.0	n/a	n/a
	Anabat	Insectivorous bats	19	480		152.0	n/a	n/a
	IR camera	All nocturnal fauna with focus on threatened species	67	480		536.0	n/a	n/a
Sub-total			446			824.7		92.6

Date	Method	Target species	No. Surveys	Time (mins) / survey Effort Time	No. People	Total (hrs)	Area covered (m) Effort Area	Known total (ha)
20-23 Mar 2015	Habitat assessment and hollow-bearing tree survey	All vertebrate fauna	11	20	1	3.7	20 x 20	0.4
	Bird utilisation survey	All birds	4	20	1	1.3	50 x 50	1.0
	Spotlighting - on foot	All nocturnal fauna with focus on threatened species	3			3.0	n/a	n/a
	Call playback	Squirrel Glider, Powerful Owl, Masked Owl, Barking Owl	2	45	1	1.5	n/a	n/a
	Anabat	Insectivorous bats	8	480		64.0	n/a	n/a
Sub-total			28			73.5		1.4
4 - 6 October 2016	Habitat assessment and hollow-bearing tree survey		n/a				30000 x 50	150.0
Subtotal								
TOTAL - fauna transmission line study area	Habitat assessment and hollow-bearing tree survey		146			48.7		8.9
	Bird survey		135			22.5		33.8
	Herpetofauna search		135			22.5		33.8
	Bird utilisation survey		60			29.3		57.0
	Extended herpetofauna search		28			14.0		7.0
	Stagwatching /evening listening		21			14.0		0.0
	Spotlighting - on foot		24			45.0		0.0
	Spotlighting - vehicle		17			17.0		0.0
	Call playback		21			16.5		0.0
	Anabat		39			312.0		0.0
	IR camera		67			536.0		0.0
	All surveys combined		693			1077.5		140.4

Date	Method	Target species	No. Surveys	Time (mins) / survey Effort Time	No. People	Total (hrs)	Area covered (m) Effort Area	Known total (ha)
Fauna - Wind Farm Study Area								
8-19 Oct 2012, 1-8 Oct 2013 (combined)	Habitat assessment and hollow-bearing tree survey	All vertebrate fauna	84	20	1	28.0	50 x 50	21.0
	Bird survey	All birds	85	10	1	14.2	50 x 50	21.3
	Herpetofauna search	All reptiles	79	10	1	13.2	50 x 50	19.8
	Bird utilisation survey	All birds	24	30	1	12.0	100 x 100	24.0
	Extended herpetofauna search	All reptiles	11	30	1	5.5	50 x 50	2.8
	Stagwatching /evening listening	All nocturnal fauna with focus on threatened species	15	20	2	10.0	n/a	n/a
	Spotlighting - on foot	All nocturnal fauna with focus on threatened species	15	60	2	30.0	n/a	n/a
	Spotlighting - vehicle	All nocturnal fauna with focus on threatened species	13	30	2	13.0	n/a	n/a
	Call playback	Squirrel Glider, Powerful Owl, Masked Owl, Barking Owl	13	30	1	6.5	n/a	n/a
	Anabat	Insectivorous bats	18	480	1	144.0	n/a	n/a
Subtotal			357			276.3		88.8
4 - 6 October 2016	Habitat assessment and hollow-bearing tree survey		n/a				20000*50	100.0
Subtotal								100.0
TOTAL - fauna wind farm study area	Habitat assessment and hollow-bearing tree survey		84			28.0		121.0
	Bird survey		85			14.2		21.3
	Herpetofauna search		79			13.2		19.8
	Bird utilisation survey		24			12.0		24.0
	Extended herpetofauna search		11			5.5		2.8

Date	Method	Target species	No. Surveys	Time (mins) / survey Effort Time	No. People	Total (hrs)	Area covered (m) Effort Area	Known total (ha)
	<i>Stagwatching /evening listening</i>		15			10.0		
	<i>Spotlighting - on foot</i>		15			30.0		
	<i>Spotlighting - vehicle</i>		13			13.0		
	<i>Call playback</i>		13			6.5		
	<i>Anabat</i>		18			144.0		
	<i>All surveys combined</i>		357			276.3		188.8
Fauna - Liverpool Plains Wind Farm TLSA and WFSA combined								
	<i>Habitat assessment and hollow-bearing tree survey</i>		230			76.7		129.9
	<i>Bird survey</i>		220			36.7		55.0
	<i>Herpetofauna search</i>		214			35.7		53.5
	<i>Bird utilisation survey</i>		84			41.3		81.0
	<i>Extended herpetofauna search</i>		39			19.5		9.8
	<i>Stagwatching /evening listening</i>		36			24.0		
	<i>Spotlighting - on foot</i>		39			75.0		
	<i>Spotlighting - vehicle</i>		30			30.0		
	<i>Call playback</i>		34			23.0		
	<i>Anabat</i>		57			456.0		
	<i>IR camera</i>		67			536.0		
	<i>All surveys combined</i>		1050			1353.8		329.1

B.2 SURVEY RESULTS (ADDITIONAL SURVEYS)

B.2.1 2015 Surveys

Flora

Species Name	Common Name	Family Name
Trees		
<i>Acacia floribunda</i>	White Sally Wattle	Fabaceae
<i>Acacia linearifolia</i>		Fabaceae
<i>Brachychiton populneus</i>	Kurrajong	Malvaceae
<i>Callitris endlicheri</i>	Black Cypress Pine	Cupressaceae
<i>E albens x moluccana</i>	White box x Grey Box	Myrtaceae
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	Myrtaceae
<i>Eucalyptus fibrosa</i>	Red Ironbark	Myrtaceae
<i>Eucalyptus macrorhyncha</i>	Red Gum	Myrtaceae
<i>Eucalyptus mannifera</i>	Brittle Gum	Myrtaceae
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum	Myrtaceae
<i>Eucalyptus melliodora</i>	Yellow Box	Myrtaceae
<i>Eucalyptus bridgesiana</i>	Apple Box	Myrtaceae
Shrubs		
<i>Acacia buxifolia</i>		Fabaceae
<i>Acacia implexa</i>	Hickory Wattle	Fabaceae
<i>Acacia linearifolia</i>	Narrow-leaved Wattle	Fabaceae
<i>Acacia sp</i>		Fabaceae
<i>Allocasuarina diminuta</i>		Casuarinaceae
<i>Amyema pendula</i>		Loranthaceae
<i>Cassinia arcuata</i>	Sifton Bush	Asteraceae
<i>Astroloma humifusum</i>	Native Cranberry	Ericaceae
<i>Calytrix tetragona</i>	Common Fringe Myrtle	Myrtaceae
<i>Cassinia aculeata</i>	Dogwood	Asteraceae
<i>Hibbertia obtusifolia</i>	Hoary Guinea-flower	Dilleniaceae
<i>Indigofera australis</i>	Austral Indigo	Fabaceae
<i>Melichrus erubescens</i>	Ruby Urn Heath	Ericaceae
<i>Melichrus urceolatus</i>	Urn Heath	Ericaceae
Forbs		
<i>Ajuga australis</i>	Austral Bugle	Lamiaceae
<i>Bidens pilosa</i>	Cobbler's Pegs	Asteraceae
<i>Chrysocephalum apiculatum</i>	Yellow Buttons	Asteraceae
<i>Calotis cuneifolia</i>	Purple Burr-daisy	Asteraceae
<i>Calotis lappulacea</i>	Yellow Burr Daisy	Asteraceae
<i>Chamaesyce sp</i>		Euphorbiaceae
<i>Chenopodium pumilio</i>	Small Crumbweed	Chenopodiaceae
<i>Commelina cyanea</i>		Commelinaceae
<i>Desmodium varians</i>	Slender Tick-trefoil	Fabaceae
<i>Dichondra repens</i>	Kidney Weed	Convolvulaceae
<i>Dichopogon fimbriatus</i>	Nodding Chocolate Lily	Anthericaceae
<i>Einadia hastata</i>	Berry Saltbush	Chenopodiaceae
<i>Galium sp</i>		Rubiaceae
<i>Geranium solanderi</i>	Native Geranium	Geraniaceae
<i>Glycine tabacina</i>		Fabaceae
<i>Glycine clandestina</i>		Fabaceae
<i>Gonocarpus tetragynus</i>		Haloragaceae

Species Name	Common Name	Family Name
<i>Goodenia hederacea</i>	Forest Goodenia	Goodeniaceae
<i>Hydrocotyle laxiflora</i>	Stinking Pennywort	Apiaceae
<i>Hypericum gramineum</i>	Small St. John's Wort	Clusiaceae
<i>Lagenophora stipitata</i>	Blue Bottle-daisy	Asteraceae
<i>Oxalis sp</i>		Oxalidaceae
<i>Phyllanthus hirtellus</i>	Thyme Spurge	Phyllanthaceae
<i>Plantago varia</i>		Plantaginaceae
<i>Pomax umbellata</i>		Rubiaceae
<i>Santalum sp</i>		Santalaceae
<i>Senecio sp</i>		Asteraceae
<i>Sida corrugata</i>	Corrugated Sida	Malvaceae
<i>Solanum prinophyllum</i>	Forest Nightshade	Solanaceae
<i>Swainsona reticulata</i>	Knead Swainson-pea	Fabaceae
<i>Vittadinia muelleri</i>		Asteraceae
<i>Wahlenbergia gracilis</i>	Sprawling Bluebell	Campanulaceae
<i>Xerochrysum viscosum</i>	Sticky Everlasting	Asteraceae
Grasses		
<i>Aristida ramosa</i>	Purple Wiregrass	Poaceae
<i>Arundinella nepalensis</i>	Reedgrass	Poaceae
<i>Austrostipa verticillata</i>	Slender Bamboo Grass	Poaceae
<i>Chloris truncata</i>	Windmill Grass	Poaceae
<i>Cymbopogon refractus</i>	Barbed Wire Grass	Poaceae
<i>Echinopogon caespitosus</i>	Bushy Hedgehog-grass	Poaceae
<i>Echinopogon ovatus</i>	Forest Hedgehog Grass	Poaceae
<i>Entolasia stricta</i>	Wiry Panic	Poaceae
<i>Eragrostis leptostachya</i>	Paddock Lovegrass	Poaceae
<i>Microlaena stipoides</i>	Weeping grass	Poaceae
<i>Panicum effusum</i>	Hairy Panic	Poaceae
<i>Rytidosperma sp</i>	Wallaby Grass	Poaceae
<i>Sporobolus creber</i>	Western Rat-tail Grass	Poaceae
<i>Themeda triandra</i>	Kangaroo Grass	Poaceae
Graminoids		
<i>Carex sp</i>		Cyperaceae
<i>Gahnia sp</i>	Saw-sedges	Cyperaceae
<i>Juncus sp.</i>		Juncaceae
<i>Lepidosperma laterale</i>		Cyperaceae
<i>Lomandra filiformis</i>	Wattle Mat-rush	Lomandraceae
<i>Macrozamia secunda</i>		Zamiaceae
<i>Lomandra longifolia</i>	spiny-headed mat-rush	Lomandraceae
Ferns		
<i>Cheilanthes sieberi</i>		Pteridaceae
Exotic		
<i>*Hypochoeris radicata</i>	Cat's Ear	Asteraceae
<i>Lepidium sp</i>		Brassicaceae
<i>*Opuntia sp</i>	Prickly Pear	Cactaceae
<i>*Solanum sp.</i>	Nightshade	Solanaceae
<i>Tagetes minuta</i>	Stinking Roger	Asteraceae

Fauna

Scientific Name	Species Name	Status
Amphibians		
<i>Litoria latopalmata</i>	Broad-palmed frog	
<i>Platyplectrum ornatum</i>	Ornate Burrowing Frog	
Aves		
<i>Cracticus tibicen</i>	Australian Magpie	
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	
<i>Corvus coronoides</i>	Australian Raven	
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	
<i>Coturnix ypsilophora</i>	Brown Quail	
<i>Acanthiza pusilla</i>	Brown Thornbill	
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	
<i>Stagonopleura guttata</i>	Diamond Firetail	V TSC
<i>Taeniopygia bichenovii</i>	Double Barred Finch	
<i>Artamus cyanopterus</i>	Dusky Woodswallow	V TSC
<i>Platycercus eximius</i>	Eastern Rosella	
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	
<i>Eopsaltria australis</i>	Eastern Yellow Robin	
<i>Eolophus roseicapillus</i>	Galah	
<i>Rhipidura albiscapa</i>	Grey Fantail	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
<i>Microeca fascians</i>	Jacky Winter	
<i>Alisterus scapularis</i>	King Parrot	
<i>Dicaeum hirundinaceum</i>	Mistletoebird	
<i>Falco cenchroides</i>	Nankeen Kestrel	
<i>Philemon corniculatus</i>	Noisy Friarbird	
<i>Manorina melanocephala</i>	Noisy Miner	
<i>Cracticus nigrogularis</i>	Pied Butcherbird	
<i>Strepera graculina</i>	Pied Currawong	
<i>Neochmia temporalis</i>	Red Browed Finch	
<i>Myiagra inquieta</i>	Restless Flycatcher	
<i>Pachycephala rufiventris</i>	Rufous Whistler	
<i>Todiramphus sanctus</i>	Sacred Kingfisher	
<i>Chthonicola sagittata</i>	Speckled Warbler	V TSC
<i>Pardalotus punctatus</i>	Spotted Pardalote	
<i>Pardalotus striatus</i>	Striated Pardalote	
<i>Acanthiza lineata</i>	Striated Thornbill	
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	
<i>Petrochelidon nigricans</i>	Tree Martin	
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V TSC
<i>Aquila audax</i>	Wedge-tailed Eagle	
<i>Smicrornis brevirostris</i>	Weebill	
<i>Lichenostomus penicillatus</i>	White Plumed Honeyeater	
<i>Gerygone albogularis</i>	White Throated Gerygone	
<i>Cormobates leucophaea</i>	White Throated Treecreeper	
<i>Lichenostomus leucotis</i>	White-eared Honeyeater	
<i>Rhipidura leucophrys</i>	Willie Wagtail	
<i>Acanthiza chrysorrhoa</i>	Yellow Rumped Thornbill	
<i>Acanthiza nana</i>	Yellow Thornbill	
<i>Lichenostomus chrysop</i>	Yellow-faced Honeyeater	
Mammals		
<i>Trichosurus vulpecula</i>	Brushtail Possum	
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	

Scientific Name	Species Name	Status
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	
<i>Oryctolagus cuniculus</i>	European Rabbit	
<i>Vulpes vulpes</i>	Fox	
<i>Sus scrofa</i>	Pig	
<i>Macropus rufogriseus</i>	Red-necked Wallaby	
<i>Petaurus breviceps</i>	Sugar Glider	
<i>Austronomus australis</i>	White-striped Freetail Bat	
<i>Vombatus ursinus</i>	Wombat	
Reptiles		
<i>Amalosia lesueurii</i>	Lesueur's velvet gecko	
<i>Morethia boulengeri</i>	Boulenger's Snake-eyed Skink	
<i>Furina diadema</i>	Red-naped snake	
<i>Underwoodisaurus milii</i>	Thick-tailed Gecko	

B.2.2 2016 Surveys

Flora

North

Species Name	Common Name	Family Name
Trees		
<i>Angophora floribunda</i>	Rough-barked Apple	Myrtaceae
<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>	River Oak	Casuarinaceae
<i>Eucalyptus albens</i>	White Box	Myrtaceae
<i>Eucalyptus laevopinea</i>	Silver-top Stringybark	Myrtaceae
<i>Eucalyptus melliodora</i>	Yellow Box	Myrtaceae
<i>Eucalyptus nortonii</i>	Large-flowered Bundy	Myrtaceae
Shrubs		
<i>Amyema cambagei</i>	Needle-leaf Mistletoe	Loranthaceae
<i>Cassinia laevis</i>	Cough Bush	Asteraceae
<i>Callistemon sieberi</i>	River Bottlebrush	Myrtaceae
<i>Dodonaea viscosa</i> subsp. <i>angustifolia</i>	Sticky Hopbush	Sapindaceae
<i>Korthalsella rubra</i>		Viscaceae
<i>Pimelea curviflora</i>		Thymelaeaceae
Grass		
<i>Aristida ramosa</i>	Purple Wiregrass	Poaceae
<i>Austrostipa aristiglumis</i>	Plains Grass	Poaceae
<i>Austrostipa scabra</i>	Speargrass	Poaceae
<i>Chloris truncata</i>	Winmill Chloris	Poaceae
<i>Chloris ventricosa</i>	Tall Chloris	Poaceae
<i>Poa labillardierei</i> var. <i>labillardierei</i>	Tussock	Poaceae
Forbs		
<i>Acaena ovina</i>	Sheep's Burr	Rosaceae
<i>Arthropodium minus</i>	Small Vanilla Lilly	Anthericaceae
<i>Asperula conferta</i>	Common Woodruff	Rubiaceae
<i>Cymbonotus lawsonianus</i>	Bear's Ear	Asteraceae
<i>Dichopogon fimbriatus</i>	Nodding Chocolate Lily	Anthericaceae
<i>Geranium solanderi</i>	Native Geranium	Geraniaceae
<i>Mentha satuireioides</i>	Native Pennyroyal	Lamiaceae
<i>Oxalis</i> sp.		Oxalidaceae
<i>Rhodanthe anthemoides</i>	Chamomile Sunray	Asteraceae
<i>Rumex brownii</i>	Swamp Dock	Polygonaceae
<i>Senecio quadridentatus</i>	Cotton Fireweed	Asteraceae
<i>Sigesbeckia australiensis</i>		Asteraceae
<i>Swainsona galegifolia</i>	Smooth Darling Pea	Fabaceae (Faboideae)
<i>Triptilodiscus pygmaeus</i>	Common Sunray	Asteraceae
<i>Urtica incisa</i>	Stinging Nettle	Urticaceae
Graminoids		
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>		Lomandraceae
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	Lomandraceae
<i>Melaleuca sieberi</i>		Myrtaceae
Exotic Species		
Forbs		
*?Arenaria sp.		Asteraceae
*Arctotheca calendula	Capeweed	Asteraceae

Species Name	Common Name	Family Name
* <i>Cirsium vulgare</i>	Spear Thistle	Asteraceae
* <i>Echium plantagineum</i>	Patterson's Curse	Boraginaceae
* <i>Erodium cicutarium</i>	Common Crowfoot	Geraniaceae
* <i>Galium aparine</i>	Goosegrass	Rubiaceae
* <i>Hypericum perforatum</i>	St. Johns Wort	Clusiaceae
* <i>Malva parviflora</i>	Small-flowered Mallow	Malvaceae
* <i>Marrubium vulgare</i>	White Horehound	Lamiaceae)
* <i>Medicago minima</i>	Woolly Burr Medic	Fabaceae (Faboideae)
* <i>Medicago sativa</i>	Lucerne	Fabaceae (Faboideae)
* <i>Medicago sp.</i>	A Medic	Fabaceae (Faboideae)
* <i>Plantago lanceolata</i>	Lamb's Tongues	Plantaginaceae
* <i>Rumex spp.</i>	Dock	Polygonaceae
* <i>Salvia verbenaca</i>	Vervain	Lamiaceae
* <i>Silybum marianum</i>	Variegated Thistle	Asteraceae
* <i>Taraxacum officinale</i>	Dandelion	Asteraceae
* <i>Trifolium arvense</i>	Haresfoot Clover	Fabaceae (Faboideae)
* <i>Trifolium repens</i>	White Clover	Fabaceae (Faboideae)
* <i>Trifolium subterraneum</i>	Subterranean Clover	Fabaceae (Faboideae)
Vines and Twiners		
* <i>Vicia sp.</i>	Vetch	Fabaceae (Faboideae)
Grasses		
* <i>Avena spp.</i>	Oats	Poaceae
* <i>Bothriochloa sp.</i>	Redgrass, Bluegrass	Poaceae
* <i>Bromus catharticus</i>	Prairie Grass	Poaceae
* <i>Bromus diandrus</i>	Great Brome	Poaceae
* <i>Bromus molliformis</i>	Soft Brome	Poaceae
* <i>Dactylis glomerata</i>	Cocksfoot	Poaceae
* <i>Hordeum leporinum</i>	A Barley Grass	Poaceae
* <i>Lolium perenne</i>	Perennial Ryegrass	Poaceae
* <i>Phalaris aquatica</i>	Phalaris	Poaceae
Shrubs		
* <i>Rosa rubiginosa</i>	Sweet Briar	Rosaceae
* <i>Rubus fruticosus sp. agg.</i>	Blackberry complex	Rosaceae

South

Species Name	Common Name	Family
Trees		
<i>Acacia implexa</i>	Hickory Wattle	Fabaceae (Mimosoideae)
<i>Acacia linearifolia</i>	Narrow-leaved Wattle	Fabaceae (Mimosoideae)
<i>Allocasuarina luehmannii</i>	Bulloak	Casuarinaceae
<i>Angophora floribunda</i>	Rough-barked Apple	Myrtaceae
<i>Callitris endlicheri</i>	Black Cypress Pine	Cupressaceae
<i>Eucalyptus albens</i>	White Box	Myrtaceae
<i>Eucalyptus albens x moluccana</i>	White Box x Grey Box hybrid	Myrtaceae
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum	Myrtaceae
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	Myrtaceae
<i>Eucalyptus fibrosa</i>	Red Ironbark	Myrtaceae
<i>Eucalyptus macrorhyncha</i>	Red Stringybark	Myrtaceae
<i>Eucalyptus melliodora</i>	Yellow Box	Myrtaceae
<i>Eucalyptus microcarpa</i>	Inland Grey Box	Myrtaceae
<i>Eucalyptus moluccana</i>	Grey Box	Myrtaceae
<i>Eucalyptus moluccana x albens</i>	White Box x Grey Box hybrid	Myrtaceae
<i>Eucalyptus nubila</i>	Blue-leaved Ironbark	Myrtaceae
<i>Eucalyptus punctata</i>	Grey Gum	Myrtaceae
<i>Eucalyptus rossii</i>	Inland Scribbly Gum	Myrtaceae
<i>Eucalyptus sparsifolia</i>	Narrow-leaved Stringybark	Myrtaceae
<i>Eucalyptus tereticornis</i>	Forest Red Gum	Myrtaceae
<i>Santalum lanceolatum</i>	Sandalwood	Santalaceae
Shrubs		
<i>Acacia amoena</i>	Boomerang Wattle	Fabaceae (Mimosoideae)
<i>Acacia buxifolia</i>	Box-leaved Wattle	Fabaceae (Mimosoideae)
<i>Acacia gladiiformis</i>	Sword Wattle	Fabaceae (Mimosoideae)
<i>Acacia paradoxa</i>	Kangaroo Thorn	Fabaceae (Mimosoideae)
<i>Acacia penninervis</i> var. <i>penninervis</i>	Mountain Hickory	Fabaceae (Mimosoideae)
<i>Acacia piligera</i>		Fabaceae (Mimosoideae)
<i>Acrotriche rigida</i>		Ericaceae
<i>Allocasuarina diminuta</i> subsp. <i>diminuta</i>		Casuarinaceae
<i>Allocasuarina gymnanthera</i>		Casuarinaceae
<i>Bossiaea buxifolia</i>		Fabaceae (Faboideae)
<i>Daviesia acicularis</i>		Fabaceae (Faboideae)
<i>Dodonaea viscosa</i>	Sticky Hop-bush	Sapindaceae
<i>Einadia hastata</i>	Berry Saltbush	Chenopodiaceae
<i>Einadia nutans</i> subsp. <i>nutans</i>	Climbing Saltbush	Chenopodiaceae
<i>Exocarpos cupressiformis</i>	Cherry Ballart	Santalaceae
<i>Goodenia pinnatifida</i>	Scrambles Eggs	Goodeniaceae
<i>Grevillea ramosissima</i> subsp. <i>ramosissima</i>		Proteaceae
<i>Grevillea sericea</i>	Pink Spider Flower	Proteaceae
<i>Hakea decurrens</i> subsp. <i>decurrens</i>		Proteaceae
<i>Hibbertia acicularis</i>		Dilleniaceae
<i>Hibbertia obtusifolia</i>	Hoary Guinea-flower	Dilleniaceae
<i>Hibbertia riparia</i>		Dilleniaceae
<i>Hovea rosmarinifolia</i>		Fabaceae (Faboideae)
<i>Hybanthus monopetalus</i>	Slender Violet-bush	Violaceae
<i>Leptospermum polygalifolium</i>		Myrtaceae
<i>Leucopogon muticus</i>	Blunt Beard-heath	Ericaceae
<i>Melichrus erubescens</i>	Ruby Urn Heath	Ericaceae
<i>Melichrus urceolatus</i>	Urn Heath	Ericaceae

<i>Olearia ?tenuifolia</i>	Thin-leaf Daisy-bush	Asteraceae
<i>Podolobium ilicifolium</i>	Prickly Shaggy Pea	Fabaceae (Faboideae)
<i>Pomax umbellata</i>	Pomax	Rubiaceae
<i>Styphelia triflora</i>	Pink Five-Corners	Ericaceae
<i>Cassinia laevis</i>		Asteraceae
<i>Persoonia linearis</i>	Narrow-leaved Geebung	Proteaceae
<i>Phyllanthus hirtellus</i>	Thyme Spurge	Phyllanthaceae
<i>Platysace linearifolia</i>		Apiaceae
<i>Prostanthera scutellarioides</i>		Lamiaceae
<i>Astroloma humifusum</i>	Native Cranberry	Ericaceae
<i>Banksia marginata</i>	Silver Banksia	Proteaceae
<i>Bossiaea obcordata</i>	Spiny Bossiaea	Fabaceae (Faboideae)
<i>Brachyloma daphnoides</i>	Daphne Heath	Ericaceae
<i>Bursaria spinosa</i>	Native Blackthorn	Pittosporaceae
<i>Calytrix tetragona</i>	Common Fringe-myrtle	Myrtaceae
<i>Indigofera adesmiifolia</i>	Tick Indigo	Fabaceae (Faboideae)
<i>Indigofera australis</i>	Australian Indigo	Fabaceae (Faboideae)
<i>Cassinia arcuata</i>	Sifton Bush	Asteraceae
Forbs		
<i>Acaena echinata</i>	Sheep's Burr	Rosaceae
<i>Ajuga australis</i>	Austral Bugle	Lamiaceae
<i>Arthropodium sp.</i>		Anthericaceae
<i>Calotis cuneifolia</i>	Purple Burr-daisy	Asteraceae
<i>Calotis cuneifolia</i>	Purple Burr-daisy	Asteraceae
<i>Calotis lappulacea</i>	Yellow Burr-daisy	Asteraceae
<i>Dampiera lanceolata</i>	Grooved Dampiera	Goodeniaceae
<i>Desmodium brachypodium</i>	Large Tick-trefoil	Fabaceae (Faboideae)
<i>Dianella revoluta</i> var. <i>revoluta</i>	Blueberry Lily	Phormiaceae
<i>Dichondra repens</i>	Kidney Weed	Convolvulaceae
<i>Drosera peltata</i>		Droseraceae
<i>Gahnia aspera</i>	Rough Saw-sedge	Cyperaceae
<i>Geranium solanderi</i>	Native Geranium	Geraniaceae
<i>Gonocarpus elatus</i>	A Raspwort	Haloragaceae
<i>Gonocarpus tetragynus</i>	Poverty Raspwort	Haloragaceae
<i>Goodenia hederacea</i>	Ivy Goodenia	Goodeniaceae
<i>Haloragis heterophylla</i>	Variable Raspwort	Haloragaceae
<i>Laxmannia gracilis</i>	Slender Wire Lily	Anthericaceae
<i>Lepidosperma latens</i>		Cyperaceae
<i>Lomandra filiformis</i> subsp. <i>coriacea</i>		Lomandraceae
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>		Lomandraceae
<i>Lomandra leucocephala</i>	Woolly Mat-rush	Lomandraceae
<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Many-flowered Mat-rush	Lomandraceae
<i>Plantago debilis</i>	Shade Plantain	Plantaginaceae
<i>Poranthera microphylla</i>	Small Poranthera	Phyllanthaceae
<i>Ranunculus sessiliflorus</i>	Small-flowered Buttercup	Ranunculaceae
<i>Scutellaria humilis</i>	Dwarf Skullcap	Lamiaceae
<i>Senecio quadridentatus</i>	Cotton Fireweed	Asteraceae
<i>Sida corrugata</i>	Corrugated Sida	Malvaceae
<i>Stackhousia monogyna</i>	Creamy Candles	Stackhousiaceae
<i>Stackhousia viminea</i>	Slender Stackhousia	Stackhousiaceae
<i>Stellaria pungens</i>	Prickly Starwort	Caryophyllaceae
<i>Stypantra glauca</i>	Nodding Blue Lily	Phormiaceae
<i>Swainsona reticulata</i>	Kneed Swainson-pea	Fabaceae (Faboideae)
<i>Thysanotus patersonii</i>	Twining Fringe Lily	Anthericaceae
<i>Triptilodiscus pygmaeus</i>	Common Sunray	Asteraceae
<i>Vittadinia sp.</i>	Fuzzweed	Asteraceae

<i>Wahlenbergia communis</i>	Bluebell	Campanulaceae
<i>Wahlenbergia gracilentia</i>	Annual Bluebell	Campanulaceae
<i>Wahlenbergia stricta</i>	a Bluebell	Campanulaceae
<i>Wurmbea biglandulosa</i>		Colchicaceae
<i>Chrysocephalum semipapposum</i>		Asteraceae
<i>Galium leptogonium</i>		Rubiaceae
<i>Glossodia major</i>		Orchidaceae
<i>Macrozamia</i> sp.		Zamiaceae
<i>Oncinocalyx betchei</i>		Lamiaceae
<i>Opercularia diphyllo</i>		Rubiaceae
<i>Oxalis radicata</i>		Oxalidaceae
<i>Oxalis</i> sp.		Oxalidaceae
<i>Patersonia sericea</i>		Iridaceae
<i>Rumex brownii</i>	Swamp Dock	Polygonaceae
<i>Stuartina meulleri</i>		Asteraceae
<i>Asperula conferta</i>	Common Woodruff	Rubiaceae
<i>Bulbine bulbosa</i>		Asphodelaceae
<i>Bulbine semibarbata</i>		Asphodelaceae
<i>Cotula australis</i>	Carrot Weed	Asteraceae
<i>Crassula sieberiana</i>	Australian Stonecrop	Crassulaceae
<i>Cymbonotus lawsonianus</i>	Bear's Ear	Asteraceae
<i>Daucus glochidiatus</i>	Native Carrot	Apiaceae
<i>Hydrocotyle laxiflora</i>	Stinking Pennywort	Apiaceae
<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	Slender Rice-flower	Thymelaeaceae
<i>Veronica plebeia</i>	Trailing Speedwell	Plantaginaceae
<i>Xerochrysum bracteatum</i>	Golden Everlasting	Asteraceae
Ferns		
<i>Asplenium flabellifolium</i>	Necklace Fern	Aspleniaceae
<i>Cheilanthes austrotenuifolia</i>	Rock Fern	Adiantaceae
<i>Cheilanthes sieberi</i>	Rock Fern	Adiantaceae
Grasses		
<i>Aristida ramosa</i>	Purple Wiregrass	Poaceae
<i>Aristida vagans</i>	Threeawn Speargrass	Poaceae
<i>Arundinella nepalensis</i>	Reedgrass	Poaceae
<i>Cymbopogon refractus</i>	Barbed Wire Grass	Poaceae
<i>Echinopogon caespitosus</i>	Bushy Hedgehog-grass	Poaceae
<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass	Poaceae
<i>Phragmites australis</i>	Common Reed	Poaceae
<i>Rytidoperma pallidum</i>	Silvertop Wallaby Grass	Poaceae
<i>Rytidoperma</i> sp.		Poaceae
<i>Themeda australis</i>	Kangaroo Grass	Poaceae
Orchids		
<i>Pterostylis concinna</i>	Trim Greenhood	Orchidaceae
<i>Caladenia ?cucullata</i>	Hooded Caladenia	Orchidaceae
<i>Caladenia carnea</i>	Pink Fingers	Orchidaceae
<i>Calochilus robertsonii</i>	Purplish Beard Orchid	Orchidaceae
<i>Diuris goonooensis</i>	Western Donkey Orchid	Orchidaceae
<i>Carex inversa</i>	Knob Sedge	Cyperaceae
Graminoids		
<i>Hardenbergia violacea</i>	False Sarsaparilla	Fabaceae (Faboideae)
<i>Convolvulus erubescens</i>	Pink Bindweed	Convolvulaceae
<i>Eleocharis sphacelata</i>	Tall Spike Rush	Cyperaceae
<i>Schoenus apogon</i>	Common Bog-rush	Cyperaceae
<i>Typha orientalis</i>	Broadleaf Cumbungi	Typhaceae
<i>Xanthorrhoea</i> sp.	Grass tree	Xanthorrhoeaceae
Exotic		

* <i>Acetosella vulgaris</i>	Sheep Sorrel	Polygonaceae
* <i>Anagallis arvensis</i>	Scarlet Pimpernel	Myrsinaceae
* <i>Cirsium vulgare</i>	Spear Thistle	Asteraceae
* <i>Echium plantagineum</i>	Patterson's Curse	Boraginaceae
* <i>Hypericum perforatum</i>	St. Johns Wort	Clusiaceae
* <i>Hypochaeris glabra</i>	Smooth Catsear	Asteraceae
* <i>Hypochaeris radicata</i>	Catsear	Asteraceae
* <i>Petrorhagia</i> spp.		Caryophyllaceae
* <i>Senecio</i> spp.	Groundsel, Fireweed	Asteraceae
* <i>Silybum marianum</i>	Variegated Thistle	Asteraceae
* <i>Solanum</i> spp.		Solanaceae
* <i>Stellaria media</i>	Common Chickweed	Caryophyllaceae
* <i>Trifolium arvense</i>	Haresfoot Clover	Fabaceae (Faboideae)
* <i>Viola betonicifolia</i>	Showy Violet	Violaceae
Shrubs		
* <i>Opuntia stricta</i>	Common Prickly Pear, Smooth Pest Pear	Cactaceae
Grasses		
* <i>Aira</i> sp.	A Hairgrass	Poaceae
* <i>Lolium</i> sp.	A Ryegrass	Poaceae
* <i>Vulpia</i> sp.	Rat's-tail Fescue	Poaceae

Fauna

Scientific Name	Common Name	
Aves		
<i>Acanthiza chrysorrhoa</i>	Yellow Thornbill	
<i>Alisterus scapularis</i>	King Parrot	
<i>Aprosmictus erythropterus</i>	Red-winged parrot	
<i>Aquila audax</i>	Wedge-tailed Eagle	
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	
<i>Calyptrorhynchus funereus</i>	Yellow Tailed black cockatoo	
<i>Ceyx azurus</i>	Azure Kingfisher	
<i>Chalcites basalis</i>	Horsefields Cuckoo	
<i>Chenonetta jubata</i>	Australian Wood Duck	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
<i>Coracina novaehollandiae</i>	Black-faced cuckooshrike	
<i>Corcorax melanorhamphos</i>	White winged Chough	
<i>Cormobates leucophaea</i>	White-throated Treecreeper	
<i>Corvus coronoides</i>	Australian Raven	
<i>Cracticus nigrogularis</i>	Pied Butcherbird	
<i>Cracticus tibicen</i>	Australian Magpie	
<i>Cracticus-tibicen</i>	Magpie	
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	
<i>Dicaeum-hirundinaceum</i>	Mistletoebird	
<i>Egretta novaehollandiae</i>	White faced Heron	
<i>Elanus axillaris</i>	Black Shouldered Kite	
<i>Eolophus roseicapillus</i>	Galah	
<i>Eopsaltria australis</i>	Eastern Yellow Robin	
<i>Glossopsitta concinna</i>	Musk lorikeet	
<i>Grallina cyanoleuca</i>	Magpie- lark	
<i>Hirundo neoxena</i>	Welcome Swallows	
<i>Malurus cyaneus</i>	Fairy Wren	
<i>Malurus cyaneus</i>	Superb Fairy Wren	
<i>Manorina melanocephala</i>	Noisy Minor	

<i>Merops ornatus</i>	Rainbow Bee-eater	
<i>Pachycephala rufiventris</i>	Rufous Whistler	
<i>Philemon corniculatus</i>	Friarbird	
<i>Platycercus elegans</i>	Crimson Rosella	
<i>Platycercus eximius</i>	Eastern Rosella	
<i>Pomatostomus-temporalis</i>	Grey crowned babbler	V TSC
<i>Rhipidura albiscapa</i>	Grey fantail	
<i>Rhipidura-leucophrys</i>	Willie Wagtail	
<i>Strepera-graculina</i>	Pied currawong	
<i>Sturnus vulgaris</i>	Common Starling	
Mammals		
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	
<i>Macropus robustus</i>	Common Wallaroo	
<i>Sus scrofa</i>	Feral Pig	
<i>Oryctolagus cuniculus</i>	European Rabbit	
Reptiles		
<i>Pseudonaja textilis</i>	Eastern Brown Snake	

APPENDIX C ASSESSMENTS OF SIGNIFICANCE

Additional Assessments of Significance (AoS) have been prepared for the following threatened species:

- Regent Honeyeater (Critically Endangered TSC Act, Critically Endangered EPBC Act)
- Dusky Woodswallow (Vulnerable TSC Act)
- Koala (Vulnerable TSC Act, Vulnerable EPBC Act)
- Eastern Pygmy-possum (Vulnerable TSC Act)

The original AoS were revised for the following species:

- Large-eared Pied Bat (Vulnerable TSC Act, Vulnerable EPBC Act)
- Square-tailed Kite (Vulnerable TSC Act)
- Yellow-bellied Sheath-tail Bat (Vulnerable TSC Act)

C.1 TSC ACT ASSESSMENTS

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, listed at the state level under the *Threatened Species Conservation Act 1995* (TSC Act).

Regent Honeyeater

Although the Regent Honeyeater is known from the region, including Coolah Tops National Park and Goulburn river National Park (NPWS 2002), most records are from vegetation communities not present in the WFSA such as box-ironbark and from wetter, fertile sites within such communities (Franklin et al. 1999). The Project Area does not support known core or good quality habitat for this species, as indicated by the habitat assessments undertaken on site and the lack of records known for the project area.

The turbines themselves would be located on the tops of ridges, which have been historically cleared (more so than the slopes and gullies). The microhabitat requirements that were considered for Regent Honeyeaters during habitat assessments were:

- Mature trees
- Mistletoe abundance

Information about other microhabitat requirements has become available since the surveys were undertaken. Information that can be gleaned from the original assessment includes:

- Vegetation coverage (using aerial imagery and BioBanking methodology)
- Elevation
- 'Rich-patches'

Vegetation condition assessments utilised BioBanking methodology which focuses on understorey species diversity rather than overstorey diversity; information about patches where tree diversity is high (greater than four species) cannot be obtained from NGH Environmental (2013a, 2013b).

The good quality forests in the southern half of the TLSA are Sandstone Forest and are located on sandstone soils of low fertility.

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.

Foraging

The Regent Honeyeater is a nomadic/migratory species that follows food availability across its range. The Recovery Plan (DoE 2016) lists key feed species including Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*), and Needle-leaf Mistletoe (*Amyema cambagei*). These species occur throughout the Project Area in a number of vegetation communities:

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483)
- River Oak – Rough-barked Apple – red gum – box riparian tall woodland (ID084)
- Rough-barked Apple – Blakely’s Red Gum – Yellow Box woodland on alluvial clay to loam soils on valleys floors in the northern South-west Slopes and BBS Bioregions (ID281)
- Silvertop Stringybark - Yellow Box – Norton’s Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488)
- Yellow Box grassy woodland on lower hillslopes and valley flats in the southern Brigalow Belt South bioregion (ID437).

However, presence of suitable vegetation communities alone is insufficient to predict occurrence of Regent Honeyeaters. Scientific understanding of the habitat requirements and preferences of Regent Honeyeater are increasing. Regent Honeyeater habitat assessments have found that (DoE 2016, Roderick et al. 2014, Roderick & Ingerwsen 2014):

- The species is a “rich patch specialist” > dependent on high-yielding habitats on fertile soils
- The species requires areas with a high level of tree diversity (four or more tree species)
- The probability of presence is driven by vegetation *coverage*, followed by elevation and humidity/soil moisture

Regent Honeyeater was placed into the ‘woodland birds’ suite for the purposes of habitat mapping. This includes areas of moderate or better quality habitat. Mistletoe occurrence is shown at points where habitat assessments were undertaken (was not extrapolated across whole site as for other features). It is clear from the map that areas of moderate to good quality treed habitat, on low lying fertile sites with mistletoe are rare in the LRWP project area, Appendix A Map set A.6. The majority of habitat on site does not meet the specific foraging habitat requirements for the Regent Honeyeater.

Breeding

Regent Honeyeaters generally breed between early spring and mid-summer. Breeding is linked to patterns of flowering in key feed species (Franklin *et al.* 1988, DoE 2016). The species is not monogamous (Bird Life Australia 2016). There are four known key breeding regions for the Regent Honeyeater: north-east Victoria (Chiltern-Albury), Capertee Valley, Bundarra-Barraba region and Hunter Valley (DoE 2016, Roderick *et al.* 2013). Other breeding sites used intermittently include the Australian Capital Territory, Munghorn Gap Nature Reserve and Mudgee-Wollar (DoE 2016, Roderick *et al.* 2013). The Mudgee-Wollar Important Bird and Biodiversity Area (IBA) is located approximately 15 km south of the TLSA and was dedicated in part due to regular use by Regent Honeyeaters. Regent

Honeyeaters are certainly present in the region although there are few records nearby the proposed LRWF project area and they were not recorded in any of the surveys conducted for the project to date. The closest BioNet records to the WFSA are north-east of the wind farm within Coolah Tops National Park. BioNet records also exist south and east of the southern portion of the TLSA near the Goulburn River National Park.

Based on little specific foraging habitat for Regent Honeyeaters and no breeding habitat in the LRWF, the effect of habitat clearing for the proposal is unlikely to place a local population of the species at risk of extinction. (Please note that collision impacts to migrating Regent Honeyeaters is assessed in a Collision Risk Assessment (CRA) in Appendix D).

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

Not applicable

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

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

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

Not applicable

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

- a) **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- b) **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**
- c) **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.**

- a) Habitat for 'woodland birds' would be affected to the extent given in Table 5.8. Of relevance to Regent Honeyeater:

- o 23 ha of moderate or better quality woodland
- o Four known areas of mistletoe

In terms of the pattern of clearing, clearing for the wind farm area is relatively discrete; small patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60 m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation. Regent Honeyeaters move through areas by hopping between rich patches of forest habitat, using vegetation corridors such as drainage lines and watercourses where available (DoE 2016).

The TL proposal crosses a number of riparian corridors at the far southern end just north of the Ulan Colliery. The transmission line in this part runs north-south and needs to enter the Ulan Colliery in order to utilise the existing electrical infrastructure there. The intersecting riparian corridors run mostly east-west and therefore avoiding the riparian areas is not possible (refer to Appendix A Map set A.6) however, no moderate or better quality riparian habitat would not be directly impacted (9.6 ha of poor quality would be cleared). Habitat

surrounding the riparian zones in this area is mostly woodland and open forest, and is not considered of moderate or better quality (i.e. they are not 'rich-patches'). Although some riparian corridors would require disturbance, many more in the locality would not be affected (refer to aerial imagery in Maps). On this basis, and as the habitat is not considered of high importance to the Regent Honeyeater, it is considered that the proposal would not cause fragmentation or isolation of Regent Honeyeater habitat or corridors.

- a) The habitat to be removed is considered to be of moderate importance to Regent Honeyeaters on the basis of the critically endangered status of the species, that there is a secondary breeding area in the region (Mudgee-Wollar IBA is around 15 km from the LRWF area - DoE 2016, Roderick *et al.* 2013), and that the migratory species may move through vegetation in the LRWF project area when accessing suitable foraging and breeding habitat elsewhere in the region. Relatively little is known about their movement patterns.

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

There are no relevant critical habitat declarations for the Regent Honeyeater. The Recovery Plan for the species lists critical habitat as: any breeding or foraging areas where the species is likely to occur, and any newly discovered breeding or foraging locations. Breeding habitat is not likely to occur in the LRWF project area. Dispersal patterns are poorly known (Roderick *et al.* 2013), and key habitat sites change from year to year (DoE 2016). Foraging habitat, albeit marginal, is likely to occur, and the species is likely to pass through the area from time to time. The habitat is therefore considered critical foraging habitat. Areas of clearing, particularly around the transmission line, would be subject to an adverse impact. Conversely, areas of critical foraging habitat would also occur in the offsetting areas. Conserving habitat on private land is an objective of the Recovery Plan, and this LRWF project would help to achieve this in its commitment to offset the clearing impacts of the project in accordance with the FBA.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

The LRWF project would contribute to the objectives and actions of the *National Recovery Plan*, in particular Strategy 1 and Strategy 3. Strategy 1 of the *National Recovery Plan* (DoE 2016) is to improve the extent and quality of habitat for the species, including protection of critical habitat (1c) and rehabilitation of degraded habitat and corridors (1d, 1e). The proposal would assist these objectives of the *Recovery Plan* through the Offset Plan. The LRWF project would also indirectly contribute to Strategy 3 of the *Recovery Plan*; to increase understanding of population trends of the species. The LRWF project includes a commitment to a Bird and Bat Management Plan (BBMP) during the early operation phase of the wind farm. A component of this plan is bird utilisation surveys around the LRWF project area. These surveys, which would be repeated over several years, would contribute to the knowledge of birds in the local area. It would provide an opportunity for regular survey (indirectly) for Regent Honeyeaters on private land nearby to the Mudgee-Wollar IBA. All results would be submitted to the OEH BioNet database and would be available to the Regent Honeyeater Recovery Team.

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

The LRWF project consists of a several components which would reduce the effect of KTPs already acting upon the Regent Honeyeater. These components are the Offset Plan and the wind turbines, and are described below. According to the *National Recovery Plan*, key threats to the Regent Honeyeater include habitat loss and fragmentation, habitat degradation (such as weed invasion and pest animals), competition from noisy miners, and competition from introduced honeybees. Although potential foraging habitat would be removed (refer to Table 5.8 for full figures), similar or habitat would be 'gained' through offset and protected and managed in perpetuity. Existing processes of habitat

degradation would be addressed where relevant, through weed and feral animal management as part of the Offset Plan.

The LRWF project also contributes positively to the reduction of the effects of anthropogenic Climate Change (another KTP). The LRWF project is consistent with the *Priorities for Biodiversity Adaptation to Climate Change* (DECCW 2010), which acknowledges the need for mitigation of climate change impacts through reduction of greenhouse gas emissions. Wind turbines are a source of renewable energy.

Dusky Woodswallow

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.

Foraging

The Dusky Woodswallow is an aerial insectivore, sallying above the tree canopy catching insect prey, as well as perch-pouncing over leaf litter and dead timber (NSW Scientific Committee 2016). Thus, a rich and abundant insect population is important to the species for foraging. This is assumed to come about in floristically diverse forests and woodlands. Structural diversity is also important, with insect populations assumed to be reliant on dead wood and ground litter.

Breeding

Dusky Woodswallow is considered a 'woodland dependent bird', with most breeding records in woodland and dry open forest on the western slopes (NSW Scientific Committee 2016). They build a nest, often in a tree hollow or crevice (NSW Scientific Committee 2016). During breeding they mostly utilise an area of around two hectares around the nest site, although home ranges are larger (NSW Scientific Committee 2016). They are seasonal migrants, and move south in spring to breed (NSW Scientific Committee 2016). Dusky Woodswallow were recorded in LRWF project area in October. It is therefore assumed that the LRWF area provides breeding habitat for the species.

Clearing for the proposal in any one area is minimal, considering the large area over which the linear infrastructure will occur (refer to Section 5.3). Outside of clearing areas, the project would not affect the structural or floristic diversity of existing foraging and breeding habitat areas. The collision risk assessment for this species considers it a high risk species due to its possible likelihood of collision and moderate population consequence should ongoing collisions occur.

Specific recommendations to minimise adverse effects include: buffer high quality woodland areas, retain hollow-bearing paddock trees by micro-siting infrastructure where possible (these provide connectivity and nesting habitat), leave fallen timber in place or relocate to another area to retain habitat, control noxious and invasive weeds. These measures, in combination with the relatively low level of clearing required for the large scale infrastructure project, would ensure that the LRWF project would not place the Dusky Woodswallow at risk of extinction.

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

Not applicable

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

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

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

Not applicable

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

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

- a) Habitat for 'woodland birds' would be affected to the extent given in Table 5.8:
 - a. 75.3 ha of native grassland EEC vegetation
 - b. 23 ha of moderate or better quality woodland habitat
 - c. 62.3 ha of habitat with moderate or better density of hollow-bearing trees
- b) In terms of the pattern of clearing, clearing for the wind farm area is relatively discrete; small patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60 m wide lineal cleared corridor and this aspect of the proposal is likely to contribute to habitat fragmentation.
- c) The habitat to be affected in the LRWF project area is considered to be of moderate importance to the Dusky Woodswallow on the basis of: the western slopes (nearby the LRWF project area) being the core breeding habitat in NSW for the species (NSW Scientific Committee 2016) and that the species is assumed to breed in the LRWF project area. The majority of suitable habitat in the LRWF project area is considered of low to moderate quality, therefore the habitat is considered to be of moderate rather than high importance.

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

Critical habitat has not been officially declared for the Dusky Woodswallow.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

There is no Recovery Plan for the Dusky Woodswallow. Threat Abatement Plans have not been prepared for the specific threats identified for the Dusky Woodswallow (refer below). The Office of Environment and Heritage has identified no priority actions to help recover the Dusky Woodswallow in New South Wales.

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

Clearing of native vegetation, Noisy Miners and removal of dead wood and trees are listed as KTPs threatening the Dusky Woodswallow. Aspects of the LRWF project would have a positive effect on the operation of these KTPs: including offsetting to protect habitat in perpetuity. Although potential habitat would be removed (refer to Tables 5.6, 5.7 and 5.8 for full figures), similar or better quality potential habitat would be 'gained' through offsets and protected and managed in perpetuity.

Koala

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.

Foraging

Habitat for Koala centres around preferred feed tree species. The LRWF is between the Northern Tablelands and the Western Slopes and Plains koala management areas. One primary feed tree species occurs, Forest Red Gum *Eucalyptus tereticornis*. This feed tree is listed under the SEPP 44 and as a primary feed species for the Northern Tablelands koala management area. Several other secondary and supplementary feed tree species occur (refer to Table 5.8) across the range of vegetation communities in the LRWF project area. In addition to preferred feed trees, Koalas also prefer structurally diverse and nutrient rich habitat, and are more likely to be found in lower relief areas than on ridges (DECC 2008).

The primary feed tree, Forest Red Gum, occurs only in some areas of Riparian Forest – Rough-barked Apple, Blakely's Red Gum (ID 481) that were surveyed in 2016. The tree species was not recorded in earlier vegetation surveys elsewhere in the LRWF project area. Thus, there are small pockets of secondary habitat (either class A – Phillips 2000b in DECC 2008, or class B – Callaghan in DECC 2008) capable of supporting medium to low densities of koala habitat. Elsewhere, habitat consists of secondary and supplementary habitat only, capable of supporting low koala densities (DECC 2008).

Breeding and dispersal

Significant breeding areas for Koala have been identified at Wedderburn, Pilliga, in the Brigalow Belt, Port Stephens and Dorrigo (NRMMC 2009). Koalas live in "breeding aggregations" within a large home range ranging from 5 ha to 500 ha depending on habitat quality (DECC 2008). They have a low fecundity (DECC 2008).

The habitat for Koalas at LRWF is low to moderate quality. There are recent records in the locality (within 15 years). The activities associated with the construction and operation of LRWF are unlikely to place the species at risk of extinction as the project would not affect known breeding areas, would cause small areas of clearing of low to moderate importance habitat and would not affect dispersal.

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

Not applicable

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

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

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

Not applicable

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

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

c) 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.
a) Potential habitat for Koala would be affected to the extent given in 5.8: - o 158.6 ha of communities that contain primary or secondary feed species (all condition classes) - o 23 ha of moderate or better quality woodland habitat - o 0 ha of moderate or better quality forest habitat Although not specifically targeted, 1,425 hours of fauna surveys failed to detect this species in this habitat. Clearing areas for Koala habitat seem high, however, this area is distributed over a very large project area. Being linear, impacts in any one area would be low and unlikely to affect Koala dispersal. Further, only poor quality forest habitat would be directly impacted and the majority of woodland communities affected are also in poor condition with only 23 ha woodland (all communities) to be cleared considered in moderate or better quality in terms of fauna habitat. a) Clearing for the wind farm area is relatively minor in any one location; discrete patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a linear cleared corridor (25-60m wide) and this aspect of the proposal is the most likely to cause habitat fragmentation, by unlikely to restrict the dispersal ability of Koala. The latest TL route has been chosen to avoid as much riparian area as possible, and for the footprint to occupy already disturbed areas rather than go through continuous forest. b) The habitat to be affected in the LRWF project area is considered to be of low importance to Koalas on the basis of: few primary feed trees and that most of the secondary habitat is of low quality based on habitat components such as logs and cover. In the northern section of the LRWF (the WFSa), the habitat is already quite fragmented and degraded. Better quality areas occur in Turrill SF and Durridgere SCA, although Koala is not known to occur in these protected areas (DECC 2008).
Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).
Critical habitat has not been officially declared for Koala.
Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.
The LRWF project has potential to contribute toward Objective 2 of the Koala Recovery Plan through the LRWF Offset Plan: rehabilitate and restore Koala habitat (DECC 2008). Otherwise, the LRWF is not inconsistent with Recovery Plan objectives.
Whether the action proposed constitutes or is part of a key threatening process (KTP) or is likely to result in the operation of, or increase the impact of, a key threatening process.
The LRWF project's Offset Plan and other construction environmental management plans have the potential to contribute positively toward reducing the operation of key threatening processes faced by Koalas. Offsets would secure, for perpetuity, similar habitat to that being removed, on private land. Areas under consideration are near to existing conservation reserves and would effectively extend the conserved area. Recommendations for habitat management within Offset Areas and in the LRWF include weed control and goat management, which would assist to reduce existing habitat degradation. Further, climatic extremes threaten Koalas (DECC 2008). The LRWF project contributes positively to the reduction of the effects of anthropogenic Climate Change (another KTP). The LRWF project is consistent with the <i>Priorities for Biodiversity Adaptation to Climate Change</i> (DECCW 2010), which

acknowledges the need for mitigation of climate change impacts through reduction of greenhouse gas emissions. Wind turbines are a source of renewable energy.

Eastern Pygmy-possum

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.

According to BioNet, the nearest known Eastern Pygmy-possum record is about 36 kilometres to the north-west of the LRWF project. There are a few scattered records further to the south-west, in ironbark-cypress pine vegetation communities, and known populations about 45 kilometres to the south-east, near Wollemi National Park. Although none were recorded during the LRWF surveys, the species is notoriously difficult to encounter in fauna surveys (NSW Scientific Committee 2001). For this reason, OEH requested that an AoS be undertaken for this species.

Foraging and shelter

A study by Tulloch & Dickman (2006) found little evidence that the species responded to any structural components of habitat, but did find strong associations with particular genera in the Proteaceae family, including *Banksia*, *Eucalyptus* and *Xanthorrhoea*. This association has been noted previously, with Turner (1984) describing the protein benefits to the species by consumption of *Banksia* pollen. The species is thought to depend on flowering resources (nectar and pollen), supplemented with invertebrates (Huang *et al.* 1987). Habitat requirements at the western limits of the species range in NSW are poorly documented, but appear (based on data provided in historical records) to be primarily in areas with an overstorey dominated by Ironbarks and a shrubby understorey containing Tea-trees (*Leptospermum* spp.) or Guinea-flowers (*Hibbertia* spp.).

There is also some evidence to suggest that Eastern Pygmy-possums utilise open areas for foraging but use trees to avoid predation (Gresser 1996), and possibly use *Xanthorrhoea* species for shelter (Tulloch & Dickman 2006). Due to the widespread availability of these associated species, and the lack of other structural or floristic requirements of the species, they have been recorded in a variety of vegetation types, including coastal heath and scrub, moorland, low woodland, open forest, tall forest, rocky alpine vegetation, wet sclerophyll forests, and rainforest (Harris *et al.* 2008). Hollows used by the species range from 0-15 m above the ground, with entrance diameters of about 3.5 cm, with one study showing that between 6 and 9 den sites were used by an individual (Goldingay 2011).

Vegetation types in the LRWF project area that were observed to, or are known to, contain high abundances of *Xanthorrhoea* species include the Mountain Gum - Silvertop - Stringybark (ID 490) (known from near Coolah Tops National Park), and the sandstone forest communities in the southern half of the TLSA, which contained occasional patches of relatively dense *Xanthorrhoea* (thought to be *X. johnsonii*). The lack of any communities that contained high abundances of *Banksia* is notable, with just one species (*B. marginata*) recorded during the vegetation surveys in the TLSA, and not at all in the WFS.

As the populations of Eastern Pygmy-possums in the western side of its distribution often contain Ironbarks in the overstorey and Tea-trees in the understorey, habitat comparisons for these species were also made with the study area. Some of the vegetation survey locations, mainly in the vicinity of Durridgere SCA, were found to contain communities that are similar to those containing known populations of Eastern Pygmy-possums, including Sandstone Forest – Black Cypress dominant (ID 480; 10.3 ha in all condition classes), Narrow-leaved Ironbark dominant (ID 468, 479; 42.6 ha in all condition classes). These communities were surveyed in 2012 and 2013 with spotlighting and some camera trapping (aimed at *Xanthorrhoea* flower spikes), with no Eastern Pygmy-possums recorded. Further, a survey of Durridgere commissioned by OEH in 2013 (OEH 2013) also failed to find any Eastern Pygmy-

possums. More spotlighting was conducted by NGH Environmental in March 2015 over three nights at both Turill SF and Durridgere and did not detect the Eastern Pygmy-possum.

The area to be cleared of the communities listed above are very small in any one location (refer to Table 5.1 and Appendix A Map set A.4), especially considering the wide distribution of the LRWF project. The habitat generally contains a low abundance of tree hollows, although small hollows can be hard to detect from the ground accurately. The construction and operation of LRWF is unlikely to affect foraging availability, dispersal or breeding opportunities for Eastern Pygmy-possum such that a local population could be placed at risk of extinction.

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

Not applicable

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

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

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

Not applicable

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

- a) **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- b) **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**
- c) **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.**

- a) Habitat for Eastern Pygmy-possum would be affected to the extent given in Table 5.7 and 5.8:
 - o 50.8 ha total of vegetation communities containing known important species
 - o 101.1 ha of all forest, woodland and riparian habitat likely to contain moderate to excellent hollow abundance

Note: this modelling does not suggest that all areas contain all micro features important to this species, such as flora requirements for foraging.

- b) Clearing for the wind farm area is relatively minor; small patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25--65m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation, limiting dispersal ability of the Eastern Pygmy-possum. The latest TL route has been chosen to occupy already disturbed areas rather than go through continuous forest wherever possible.
- c) Due to the low abundance of associated flora species, in combination with a lack of records from the locality, it is considered that the habitat in LRWF project area is of low importance to Eastern Pygmy-possum.

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

Critical habitat has not been officially declared for Eastern Pygmy-possum.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

A Recovery Plan has not been prepared for the Eastern Pygmy-possum. No relevant Threat Abatement Plans are known.

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

Threats listed on the species' profile (OEH 2017) include habitat loss and fragmentation and overgrazing by stock. Loss of hollow-bearing trees would also be a KTP relevant to the Eastern Pygmy-possum. The LRWF project's Offset Plan and other construction environmental management plans have potential to contribute positively toward reducing the operation of key threatening processes faced by the Eastern Pygmy-possum. Offsets would secure, for perpetuity, potential habitat for Eastern Pygmy-possum on private land. Areas under consideration are near to existing conservation reserves and would effectively extend the conserved area. This is consistent with actions listed in the 'action toolbox' under the Species Action Statement for Eastern Pygmy-possum (OEH 2017b). Recommendations for habitat management within Offset Areas and in the LRWF include weed control and goat management, which would assist to reduce existing habitat degradation.

Large-eared Pied Bat

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.

In southern parts of the Large-eared Pied Bat's range, it appears to be dependent upon the presence of large tracts of sclerophyll forest nearby to roost sites (Churchill 2008, Richards unpubl. in Richards 2005). Most records have been found around fertile woodlands or forests within kilometres of cliffs or rocky terrain that provide roosts (SPRAT 2016). Large-eared Pied Bats inhabit similar roost sites to the Eastern Cave Bat, and they are sometimes found roosting in caves together (van Dyck & Strahan 2008). Suitable roosts may be found in volcanic, karst or sandstone geology or in disused mines (DERM 2011). BioNet shows seven records of this species, all from within Goulburn River NP. In the WFSa, Large-eared Pied Bats were identified from two calls (one tentative), both in woodland environments. The species was also identified from 13 calls in the TLSA, in four broad vegetation types. The Large-eared Pied Bat has also been detected by Anabat and in harp traps at cliff line sites at Ulan Mine (to the south of the TLSA) (Eco Logical 2012). Diurnal roosts are not known to occur in the LRWF project area, but have the potential to occur. For example, caves were found during surveys (refer to Appendix Map set A.8). This cave is no longer in the subject site and will not be impacted by the proposal.

Very little is known of the movement patterns of this species, although one colony was found to disperse during the autumn months, with individuals found in a state of deep torpor in winter (van Dyck & Strahan 2008). Individuals disperse from maternity roosts, but movements are thought to be less than 100 km (SPRAT 2016). Distribution is limited by the availability of suitable nursery roosts; only two are known in NSW (SPRAT 2016). One nursery cave is in Barraba NSW (approximately 200 km north-east of WFSa) and another near Coonabarabran (DERM 2011). Other maternity roosts could occur in the Pilliga and at the Ulan Mines, near Ulan (SPRAT 2016, DERM 2011). Ulan Mine is within 50 km of the WFSa and adjoins the southern end of the TLSA.

Their combination of short, broad wings and a low weight per unit area of wing suggests that Large-eared Pied Bats forage below the forest canopy on small flying insects (van Dyck & Strahan 2008). They tend to be recorded within canopied habitats including narrow riparian corridors, and appear to be sensitive to clearing (SPRAT 2016). They appear to forage within several kilometres of roosts (DERM 2011).

During the construction phase, the LRWF project could affect foraging habitat for the Large-eared Pied Bat, potentially foraging habitat near to a maternity cave (Ulan). Habitat would be modified and cleared, as well as protected under an Offset Plan. The extent of habitat to be affected is not expected to affect the lifecycle, i.e. ability to forage, disperse and breed, nor place Long-eared Pied Bat at risk of extinction. The LRWF is not expected to affect Large-eared Pied Bat during the operational phase. A Collision Risk Assessment (CRA Appendix D) found it has a rare likelihood of collision.
In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.
Not applicable
In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: 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 is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
Not applicable
In relation to the habitat of a threatened species, population or ecological community: a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and b) 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 c) 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.
a) Habitat for Long-eared Pied Bat would be affected to the extent given in Table 5.8: o 23 ha of moderate of better quality woodland Note: this modelling does not suggest that all areas contain all micro features important to this species, particularly proximity to caves. b) Clearing for the wind farm area is relatively minor in any one location; discrete patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation. The revised TL route has been chosen to avoid as much riparian area as possible, and for the footprint to occupy already disturbed areas rather than go through continuous forest wherever possible. c) As there is a potential nursery site just south of the LRWF project area and there is a concentration of records in the region, this habitat in the LRWF is considered of high importance to Large-eared Pied Bats (although roost sites were not identified in LRWF project area).
Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).
Critical habitat has not been officially declared for the Large-eared Pied Bat.
Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

A National Recovery Plan has been prepared for the Large-eared Pied Bat (DERM 2011). The LRWF project has the potential to assist in the recovery of this species, particularly: Action 2.1 “protection of known roosts and associated foraging habitats.”. The LRWF Offset Plan would provide protection for associated foraging habitats and includes recommendations to control goats, rabbits, pigs and foxes to reduce habitat degradation in offset areas.

The LRWF project has committed to a Bird and Bat Management Plan (BBMP), which would include regular surveys for microbats. This may also contribute indirectly to the data required for objectives 4 and 5 of the Recovery Plan.

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

Roost disturbance is a key threat to Large-eared Pied Bats. Although roosts are not known in the LRWF project area, they have the potential to occur and are likely to occur in the locality (based on records of the species). The Offset Plan includes recommendations for habitat management within Offset Areas and in the LRWF include weed control and goat management, which would assist to reduce the threat of roost disturbance existing habitat degradation.

Key threatening processes which are relevant to this project and Large-eared Pied Bat include clearing of native vegetation, anthropogenic climate change and removal of dead wood and dead trees. The clearing caused by the construction of LRWF would be offset and this represents a gain to conservation efforts of Large-eared Pied Bat. The LRWF, as a renewable energy generator, contributes to the solution for anthropogenic climate change.

Square-tailed Kite

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.

Square-tailed Kite was recorded nesting near the Ulan Mine site toward the southern end of the TLSA in 2013. A buffer on activities near the nest is now a recommendation of the report, with the aim of minimising any impacts on breeding. The species breeds between July and December (Debus 1998). Collision risk was considered in Appendix D to be high; although collision likelihood is unlikely, the consequence could be high given the low fecundity, low breeding density and low recruitment rate of the species (Debus 1998, NSW Scientific Committee 2009).

The Square-tailed Kite hunts over treed habitats (Schodde & Tidemann 2007). The nest is currently located near large blocks of vegetation nearby Durridgere SCA and Turrill SF. The transmission line would involve linear clearing through some of these large blocks of vegetation. Square-tailed Kites appear to continue utilising habitat around transmission lines where they occur through suitable habitat (B.Heinze *pers.obs*). Therefore, the clearing would not be likely to constitute a large impact in terms of loss of habitat for the species.

With protection and buffering of the nest site during the breeding period, the LRWF is not expected to place the local population at risk of extinction.

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

Not applicable

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

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

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

Not applicable

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

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

- a) Habitat for the Square-tailed Kite would be affected to the extent given in Table 5.8:
 - o 23 ha of moderate or better quality woodland

Table 5.7 shows that no forest habitat in moderate or better habitat quality would now be affected. It is however likely that lesser quality habitat is used by this species: 66.2 ha of poor quality forest and 164 ha of woodland (comprised of 23 ha moderate or better quality and 141 ha of poor quality) would be cleared.

- b) Clearing for the wind farm area is relatively minor in any one location; discrete patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation. The revised TL route has been chosen to avoid as much riparian area as possible, and for the footprint to occupy already disturbed areas rather than go through continuous forest wherever possible.
- c) The habitat in the TLSA is considered of high importance, given the presence of a nest (active in 2013). The habitat in the WFSa is considered of moderate importance as it may not be part of the nest territory and has less suitable habitat.

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

Critical habitat has not been officially declared for the Square-tailed Kite.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

A Recovery Plan has not been prepared, and there are no relevant Threat Abatement Plans.

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

Key threatening processes which are relevant to this project and Square-tailed Kite include clearing of native vegetation, anthropogenic climate change and removal of dead wood and dead trees. The clearing caused by the construction of LRWF would be offset and this represents a gain to conservation of Square-tailed Kite foraging habitat. The LRWF, as a renewable energy generator, contributes to the solution for anthropogenic climate change.

The Offset Plan includes recommendations for habitat management within Offset Areas and in the LRWF include weed control and goat management, which would assist to reduce the existing threat of habitat degradation.

Yellow-bellied Sheath-tail Bat

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 Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) is a widespread species, with records throughout most of NSW. Despite this, there are very few historical records from within the study area, possibly due to a lack of surveys being undertaken in the region. There are, however, two records of the species from Turill State Conservation Area, in the TLSA. No recordings of this species were made in the WFSA during the 2012 Anabat surveys. One probable recording was identified from sandstone forest vegetation in the TLSA during the 2012 surveys, but no calls were identified in this area after the more comprehensive 2013 surveys nor during the 2015 surveys. It is assumed that this species is more widespread in the study area than is currently known, or that the species may be more common in the region towards the end of summer or in autumn. Surveys in the Ulan Mine site (similar habitat to the TLSA) have detected the presence of the Yellow-bellied Sheathtail Bat with Anabat devices, however it has only been recorded occasionally and would not be considered common in the area (Glenn Hoyer, pers. comm. 11/03/2015).

Yellow-bellied Sheathtail-bats are found across most of northern and eastern Australia (Churchill 1998), but its seasonal movements are largely unknown. It is thought that the species migrates to the southern-most parts of its range in late summer or autumn as all records in the far south are between January and July (ALA 2016, Churchill 2008, OEH 2017). They appear to defend an aerial territory (OEH 2017, Churchill 2008), although this may be the case in the non-migratory parts of their range such as the far north. A CRA has been undertaken for this species in Appendix D and assesses collision risk for this species as moderate; low likelihood of collision and moderate consequence.

The species has one or two periods of birthing during December to Mid-march, with mating and gestation occurring from early spring through summer (Chimimba & Kitchener 1987). Yellow-bellied Sheathtail-bats are a tree roosting species, and are generally thought to roost solitarily or in small mixed-sex groups (less than 10) (OEH 2017, Churchill 2008). Larger colonies have been recorded from 30 to 100 (Rhoes & Hall 1997, ALA 2016). One large group was found roosting in a hollow eucalypt stag. Roost trees have been found in isolated trees and small stands in cleared areas (Law *et al.* 2000, Rhodes & Hall 1997). The distribution of Yellow-bellied Sheathtail Bat may be partly influenced by availability of suitable trees for roosts (Kitchener 1989).

Studies in the Cadia Valley (Orange, NSW) indicate that presence of this species may be dictated by the microhabitat elements of extensive high quality habitat with a shrub understorey, in tracts of several hundred hectares (Richards, unpubl. in Richards 2005b). Such micro-habitat is rare in the Project Area; shrubs are generally absent in all the vegetation communities in the WFSA, except for a small area of Sifton Bush shrubland and Bottlebrush Riparian Shrubland Wetland (NGH Environmental 2013a). The latter community is outside of the current LRWF project area and found in only one location.

Although potentially occurring in low densities at the LRWF, the Yellow-bellied Sheathtail Bat has the potential to be affected by loss of foraging, roosting and breeding habitat (in the form of hollow-bearing trees). In general, the quality of the habitat to be cleared is low to moderate, with low densities of hollow-bearing trees. Given the relatively small extent of clearing relative to the large site and the lower quality of habitat, any extant population at LRWF project area is unlikely to be placed at risk of extinction as a result of the proposal.

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

Not applicable

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

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

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

Not applicable

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

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

- a) Habitat for Yellow-bellied Sheathtail Bats would be affected to the extent given in Table 5.8:

- a. 23 ha of moderate or better quality woodland
 - b. 101 ha of habitat likely to contain moderate to excellent hollow abundance

Note: this modelling does not suggest that all areas contain all micro features important to this species, such as flora requirements for foraging.

- b) Clearing for the wind farm area is relatively minor in any one location; discrete patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation. However, the Yellow-bellied Sheathtail Bat is highly mobile and utilises open habitats and edges (OEH 2017). The TL may actually increase foraging areas along forest edges.
- c) Given few records of the species but potential foraging, roosting and breeding habitat in the vast LRWF project area, the importance of the habitat on site is considered moderate.

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

Critical habitat has not been officially declared for Yellow-bellied Sheathtail Bat.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

There is no Recovery Plan or relevant Threat Abatement Plan for the Yellow-bellied Sheathtail Bat. 'Activities to assist this species' are listed under its' OEH online profile (OEH 2017). Of note include: reduce the use of pesticides and poison-spraying in the environment. Weed management is recommended for the LRWF project area and offset sites. A recommendation is included to ensure that pesticides are used in a way that minimises the chance of spill, over-application and run-off. Weed spraying should be undertaken in accordance with best practice standards including training of users. Other activities include protecting native vegetation and hollow-bearing trees. This action is met by the LRWF through the Offset Plan, which offsets the loss of such habitat resources within the LRWF wind farm and transmission line sites.

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

Key threatening processes which are relevant to this project and Yellow-bellied Sheathtail Bat include clearing of native vegetation, anthropogenic climate change and removal of dead wood and dead trees. No known important sites (e.g. a roost site) would be affected by the proposal. The clearing of habitat

caused by the construction of LRWF would be offset and this represents a gain to conservation efforts of Yellow-bellied Sheathtail Bat. The LRWF, as a renewable energy generator, contributes to the solution for anthropogenic climate change.

C.2 EPBC ACT ASSESSMENTS

The *Environment Protection and Biodiversity Conservation Act 1999* specifies factors to be taken into account in deciding whether a development is likely to significantly affect Endangered Ecological Communities, threatened species and migratory species, listed at the Commonwealth level. The following assessment assesses the significance of the likely impacts associated with the proposed works on:

- Regent Honeyeater (Critically Endangered)
- Koala (Vulnerable)
- Large-eared Pied Bat (Vulnerable)

Regent Honeyeater

Will the action lead to a long-term decrease in the size of a population of a species?
As set out in C.2 for this species, the LRWF project is not expected to lead to a long-term decrease in a population of the Regent Honeyeater, with the implementation of specific mitigation measures. The habitat on site is considered sub-optimal potential foraging habitat as the majority does not meet the specific foraging habitat requirements of Regent Honeyeaters as detailed in DoE (2016), Roderick et al. (2013) and Roderick & Ingerwsen (2014). However, any potential foraging habitat is classed as critical habitat under the National Recovery Plan (DoE 2016). A known intermittent breeding site, the Mudgee-Wollar IBA, is located approximately 15 km south of the LRWF project area. The southern portion is where the transmission lines are proposed; these meet up with the existing Ulan colliery, immediately south of the LRWF (i.e. the colliery is between the Mudgee-Wollar IBA and LRWF area). A Collision Risk Assessment (CRA, Appendix D), found that turbine collision would be a rare/unlikely event for Regent Honeyeaters however, it is recognised that the high consequence of ongoing collisions make this a high risk species. A risk based adaptive bird and bat monitoring plan is already included for the project and would manage risks to this species. An offset plan will secure and manage for improvement habitat similar to that being removed in perpetuity.
Will the action reduce the area of occupancy of the species?
The Regent Honeyeater is a nomadic / migratory honeyeater species, and thus has a very large area of occupancy. At present, key areas for the species in NSW include Hunter Valley, Central Coast, Capertee Valley and the Bundarra-Barraba region north of Tamworth (Bird Life Australia 2016, Roderick 2010 in Roderick et al. 2013, OEH BioNet). The LRWF project does not affect any of these areas and onsite habitat is generally considered suboptimal for this species. As clearing for the wind farm area is relatively minor in any one location; discrete patches would be cleared, it is unlikely to affect the occupancy of this species.
Will the action fragment an existing population into two or more populations?
The LRWF proposal would not fragment the Regent Honeyeater population. The transmission lines necessitate clearing 25-60m in width. Vegetated riparian corridors are generally considered important for the Regent Honeyeater to move through the landscape (DoE 2016). The scale of clearing is not considered extensive enough to fragment the habitat and isolate portions of the population from each other.
Will the action adversely affect habitat critical to the survival of a species?
No breeding habitat is known to occur in the LRWF project area. As already discussed, all potential foraging habitat is considered critical habitat (DoE 2016). The turbines themselves would be located on

the tops of ridges, which have been historically cleared (more so than the slopes and gullies). Relevant aspects of clearing works for woodland birds has been modelled at (refer to Table 5.8:

- 23 ha of moderate or better quality woodland
- 0 ha of moderate or better quality forest and riparian areas

Conversely, areas of critical foraging habitat would also occur in the offsetting areas. Conserving habitat on private land is an objective of the Recovery Plan, and this LRWF project would help to achieve this by offsetting in accordance with the FBA.

Will the action disrupt the breeding cycle of a population?

The LRWF project is not expected to disrupt the breeding cycle of the Regent Honeyeater. The key breeding areas are not nearby: north-east Victoria (Chiltern-Albury), Capertee Valley, Bundarra-Barraba region and Hunter Valley (DoE 2016, Roderick et al. 2013)

An intermittent breeding area, Mudgee-Wollar IBA, occurs 15 km south of the LRWF. Access to this breeding area is not anticipated to be negatively affected by the LRWF.

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

Habitat for 'woodland birds' would be affected to the extent given in Table 5.8. Of this, habitat suitable for Regent Honeyeater represents only a small portion (woodland/forest but not grassland).

Clearing for the wind farm area is relatively minor in any one location; discrete patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation. Regent Honeyeaters move through areas by hopping between rich patches of forest habitat, using vegetation corridors such as drainage lines and watercourses where available (DoE 2016).

The TL proposal crosses a number of riparian corridors at the far southern end just north of the Ulan Colliery. The transmission line in this part runs north-south and needs to enter the Ulan Colliery in order to utilise the existing electrical infrastructure there. It is clear from the map that areas of moderate to good quality treed habitat, on low lying fertile sites with mistletoe are rare in the LRWF project area, Appendix A Map set A.6. The majority of habitat on site does not meet the specific foraging habitat requirements for the Regent Honeyeater. Although some riparian corridors would require disturbance, clearing would be relatively minor in any one location and none of this habitat has been classed as moderate or better in terms of habitat quality. On this basis, and as the habitat is not considered of high importance to the Regent Honeyeater, it is considered that the proposal would not cause fragmentation or isolation of Regent Honeyeater habitat or corridors. These affects are unlikely to cause the Regent Honeyeater to decline.

Will the action result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species habitat?

The *National Recovery Plan* lists both the native Noisy Miner and the introduced honey bee (potentially) as species that threaten the Regent Honeyeater. Both compete for nectar and the bee also competes for tree hollows in breeding areas. The Noisy Miner has already been recorded in the LRWF, and the project would therefore not contribute to its colonisation of the locality. Noisy Miner numbers may increase with clearing, as the project would see an increase of their preferred habitat including forest/woodland edges and forest/woodland with an open mid- and under-storey (NSW Scientific Committee 2013). Noisy Miners were recorded in approximately half of the bird surveys undertaken at LRWF project area. This suggests that there is some potential for their spread if the project was to increase their preferred habitat.

Will the action introduce disease that may cause the species to decline?

The *National Recovery Plan* does not list any specific diseases to which the Regent Honeyeater is susceptible. The plan does, however, note that disease management is particularly important for the captive breed and release program for the species (DoE 2016). The LRWF project has no bearing on this aspect of the recovery plan. The proposal is not anticipated to introduce any disease that may cause the Regent Honeyeater to decline.

Will the action interfere with the recovery of the species?

The LRWF project would contribute positively to the objectives and actions of the *National Recovery Plan*, in particular Strategy 1 and Strategy 3. Strategy 1 of the *National Recovery Plan* (DoE 2016) is to improve the extent and quality of habitat for the species, including protection of critical habitat (1c) and rehabilitation of degraded habitat and corridors (1d, 1e). The proposal would assist these objectives of the *Recovery Plan* through the Offset Plan. The LRWF project would also indirectly contribute to Strategy 3 of the *Recovery Plan*; to increase understanding of population trends of the species. The LRWF project includes a commitment to a Bird and Bat Management Plan (BBMP) during the early operation phase of the wind farm. A component of this plan is bird utilisation surveys around the LRWF project area. These surveys, which would be repeated over several years, would contribute to the knowledge of birds in the local area. It would provide an opportunity for regular survey (indirectly) for Regent Honeyeater on private land nearby to the Mudgee-Wollar IBA. All results would be submitted to the OEH BioNet database and would be available to the Regent Honeyeater Recovery Team.

Koala

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

The proposal site has the potential to support an important population of the species. The primary feed tree occurs only in some areas of Riparian Forest – Rough-barked Apple, Blakely's Red Gum (ID 481) that were surveyed in 2016. The tree species was not recorded in earlier vegetation surveys elsewhere in the LRWF project area. Thus, there are small pockets of secondary habitat (either class A – Phillips 2000b in DECC 2008, or class B – Callaghan in DECC 2008) capable of supporting medium to low densities of koala habitat. Elsewhere, habitat consists of secondary and supplementary habitat only, capable of supporting low koala densities (DECC 2008). The proposal is not considered likely to lead to a long term decrease in the size of the population in the locality, as the clearing may seem high but is spread over a large area and large patches of remnant vegetation will remain.

Will the action reduce the area of occupancy of an important population?

Potential habitat for Koala would be affected to the extent given in Table 5.8:

- o 158.6 ha of communities that contain primary or secondary feed species
- o 23 ha of moderate or better quality woodland habitat
- o 0 ha of moderate or better quality forest habitat

Although not specifically targeted, 1,425 hours of fauna surveys failed to detect this species in this habitat.

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

As discussed above the proposal area is likely to support only low to moderate density populations due to the low to moderate quality of the habitat. Clearing requirements are relatively discrete and unlikely to fragment populations.

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

The proposal will have impacts mainly on habitat that contains secondary tree species that support low to moderate densities of koalas, it will not adversely affect habitat critical to the survival of the koala species.

Will the action disrupt the breeding cycle of an important population?

Significant breeding areas for Koala have been identified at Wedderburn, Pilliga, in the Brigalow Belt, Port Stephens and Dorrigo (NRMCC 2009). Koalas live in "breeding aggregations" within a large home range

ranging from 5 ha to 500 ha depending on habitat quality (DECC 2008). They have a low fecundity (DECC 2008).

The habitat available for Koalas at LRWF is low to moderate quality. There are recent records in the locality (within 15 years). The activities associated with the construction and operation of LRWF are unlikely to place the species at risk of extinction as the project would not affect known breeding areas, would clear small areas of low to moderate habitat and would not affect dispersal.

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?

Habitat for the Koala would be affected to the extent given in Table 5.8, and stated above. Clearing for the wind farm area is relatively minor; small patches for turbine footings and relatively narrow lineal sections for access tracks. Clearing for the transmission line area involves a 25-60m wide lineal cleared corridor and this aspect of the proposal is the most likely to cause habitat fragmentation, limiting dispersal ability of the Koala. The latest TL route has been chosen to avoid better habitat, within input from OEH, to occupy already disturbed areas rather than go through continuous forest wherever possible. The habitat to be affected in the LRWF project area is considered to be of low importance to the Koala on the basis of: few primary feed trees and low quality secondary habitat based on habitat components such as logs and cover. In the northern section of the LRWF (the WFS), the habitat is already quite fragmented and degraded. Better quality areas occur in Turrill SF and Durridgere SCA, although the Koala is not known to occur in these protected areas (DECC 2008).

Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The proposal is considered unlikely to result in invasive species becoming established within the koala's habitat. One threat to Koalas is dog attacks, however these occur more commonly in urban and rural-residential areas (recovery plan). It is suggested there is a low rate of mortality by other invasive species such as foxes. The LRWF Offset Plan would provide protection for associated foraging habitats and includes recommendations to control goats, rabbits, pigs and foxes to reduce habitat degradation in offset areas.

Will the action introduce disease that may cause the species to decline?

The main disease that is known to cause decline within the species is Chlamydia while *Phytophthora cinnamomi* impacts on the habitat itself. The proposal is not considered likely to introduce Chlamydia. The potential for construction activities to introduce phytophthora to the site is considered to be low, if measures are adhered to; a measure to manage the spread of *Phytophthora cinnamomi* is a recommendation of this report.

Will the action interfere substantially with the recovery of the species?

The LRWF project has potential to contribute towards Objective 2 of Koala Recovery Plan through the LRWF Offset Plan: rehabilitate and restore Koala habitat (DECC 2008). Otherwise, the LRWF is not inconsistent with Recovery Plan objectives.

Large-eared Pied Bat

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

Although the proposal will remove 23 ha of moderate of better quality woodland, the LRWF Offset Plan would provide protection for associated foraging habitats and includes recommendations to control goats, rabbits, pigs and foxes to reduce habitat degradation in offset areas. A Collision Risk Assessment (Appendix D) found it has a rare likelihood of collision and is a moderate collision risk. The proposal is unlikely to lead a long-term decrease in the size of an important population, given mitigation measures to monitor collision impacts and offset habitat removal.

Will the action reduce the area of occupancy of an important population?

During the construction phase, the LRWF project would affect foraging habitat for the Large-eared Pied Bat, potentially foraging habitat near to a maternity cave (Ulan). The impact areas are relatively discrete over a broad area and unlikely to affect the occupancy of an important population. Habitat to be cleared would be offset.

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

Clearing for the transmission line area involves a 25-60m wide lineal cleared corridor and this aspect of the proposal is the most likely to cause habitat fragmentation. The revised TL route has been chosen to avoid as much of the riparian areas as possible, and for the footprint to occupy already disturbed areas rather than go through continuous forest wherever possible.

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

In southern parts of the Large-eared Pied Bat's range, it appears to be dependent upon the presence of large tracts of sclerophyll forest nearby to roost sites (Churchill 2008, Richards unpubl. in Richards 2005). Most records have been found around fertile woodlands or forests within kilometres of cliffs or rocky terrain that provide roosts (SPRAT 2016). The roosting site is outside the development area, therefore will not be disturbed (see below).

Will the action disrupt the breeding cycle of an important population?

Large-eared Pied Bats inhabit similar roost sites to the Eastern Cave Bat, and they are sometimes found roosting in caves together (van Dyck & Strahan 2008). Suitable roosts may be found in volcanic, karst or sandstone geology or in disused mines (DERM 2011).

BioNet shows seven records of this species, all from within Goulburn River NP. In the WFSa, Large-eared Pied Bats were identified from two calls (one tentative), both in woodland environments. The species was also identified from 13 calls in the TLSA, in four broad vegetation types. The Large-eared Pied Bat has also been detected by Anabat and in harp traps at cliff line sites at Ulan Mine (to the south of the TLSA) (Eco Logical 2012). Diurnal roosts are not known to occur in LRWF project area, but have potential to occur. For example, caves were found during surveys (refer to Map Set A.8). The cave identified is no longer in the subject site (i.e. will not be impacted by the proposal). The extent of habitat to be affected is not expected to affect the lifecycle, i.e. ability to forage, disperse and breed, nor place Long-eared Pied Bat at risk of extinction.

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?

Habitat for Long-eared Pied Bat would be affected to the extent given in Table 5.8. Clearing for the wind farm area is relatively discrete. Clearing for the transmission line area involves a 20-65m wide lineal cleared corridor and this is the most likely aspect of the proposal to cause habitat fragmentation. The revised TL route has been chosen to avoid as much riparian area as possible, and for the footprint to occupy already disturbed areas rather than go through continuous forest wherever possible.

As there is a potential nursery site just south of the LRWF project area and there is a concentration of records in the region, this habitat in the LRWF is considered of high importance to the Large-eared Pied Bat (but would not be affected).

Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Predation by introduced predators such as cats, foxes and rats can be exacerbated by creating clearings/movement corridors such as for the TL easement. Increased predators in the TL line are unlikely to impact this species, where foraging not congregation or breeding occurs.

As discussed above the LRWF Offset Plan would provide protection for associated foraging habitats and includes recommendations to control invasive species to reduce habitat degradation in offset areas.

Will the action introduce disease that may cause the species to decline?

No diseases are listed in the recovery plan as affecting this bat species. The proposal is unlikely to introduce disease that may cause this species to decline.

Will the action interfere substantially with the recovery of the species?

A National Recovery Plan has been prepared for the Large-eared Pied Bat (DERM 2011). The LRWF project has the potential to assist in the recovery of this species, particularly: Action 2.1 “protection of known roosts and associated foraging habitats.” The LRWF Offset Plan would provide protection for associated foraging habitats and includes recommendations to control goats, rabbits, pigs and foxes to reduce habitat degradation in offset areas.

The LRWF project has committed to a Bird and Bat Management Plan (BBMP), which would include regular surveys for microbats. This may also contribute indirectly to the data required for objectives 4 and 5 of the Recovery Plan.

APPENDIX D COLLISION RISK ASSESSMENTS

A Collision Risk Assessment (CRA) has been used to evaluate the risk that the operational wind farm may pose to birds and bats. It focusses on potential for fatal collision. It does not consider barrier effects or behavioural displacement (these effects are discussed in Section 7.2 of the addendum as well as the original biodiversity assessments and are not repeated in this assessment; NGH Environmental 2013a and b).

A CRA has been undertaken for 13 birds and bats, in accordance with the evaluation in Section 5.3:

- Eastern Cave Bat
- Corben's Long-eared Bat
- Barking Owl
- Powerful Owl
- Masked Owl
- Spotted Harrier
- Regent Honeyeater
- Swift Parrot
- Large-eared Pied Bat
- Dusky Woodswallow
- Square-tailed Kite
- Eastern Bentwing Bat
- Yellow-bellied Sheath-tail Bat

Methodology

The qualitative risk assessment matrix (Table D-I) and descriptors below have been used to assess the overall risk of the windfarm to the species in terms of potential mortalities to individuals from collision, based on the discussions that follow. As can be seen from Table D-II, this risk assessment incorporates population considerations.

Table D-I Risk matrix with three risk levels: Low, Moderate and High, assigned based on the likelihood

Likelihood	Consequence			
	Insignificant	Minor	Moderate	Significant
Rare	Low	Low	Moderate	High
Unlikely	Low	Low	Moderate	High
Possible	Low	Moderate	High	High
Probable	Moderate	High	High	High

Table D-II Descriptions of likelihood and consequence ratings.

Likelihood	Description	Consequence	Description
Rare	An impact may occur only in unusual circumstances	Insignificant	Impact on species not detectable in the short term
Unlikely	An impact might occur at some time	Minor	Impact may cause non-significant changes to local abundance of species
Possible	An impact could occur during most circumstances	Moderate	Impacts may cause significant changes to local abundance of species
Probable	An impact is expected to occur in most circumstances	Significant	Impacts may be significant at a population scale

Eastern Cave Bat

The Eastern Cave Bat was recorded in the LRWF project area in open forest with grassy understorey, sandstone forest and woodland in both the TLSA and the WFSa. Little information is available about the population and ecology of the Eastern Cave Bat.

The Eastern Cave Bat roosts in colonies of 50 – 240 in sandstone overhang caves with specific characteristics, with occasional roost sites in buildings, culverts and disused mines (Churchill 2008; Law *et al.* 2005; van Dyck & Strahan 2008). Small groups (of 2-3 individuals) are also recorded roosting in Fairy Martin (*Hirundo ariel*) nests beneath bridges and culverts (Shultz 1998, Churchill 2008). They have low roost fidelity (Churchill 2008), except for maternity roosts. Females congregate in maternity colonies of up to 500 individuals during November (Van Dyck & Strahan 2008).

They are not known to be migratory. Roost sites tend to be an average of 1.5 km apart, although some are further, with one female moving 3.75 km (Law *et al.* 2005). Roosts at LRWF are far more likely to be located on the sandstone geology of the lower slopes and transmission line areas, rather than the basalt-dominated hills of the upper slopes of the Liverpool Range.

Observations indicate that the species forages over small areas flying low within the vegetation canopy (Churchill 2008), and crossing up to 500m of open paddock between stands of trees (Law *et al.* 2005).

The likelihood of turbine interaction is judged as rare (an impact may occur only in unusual circumstances) based on:

- Observations suggest this is a mostly low flying species.
- A non-migratory species with nightly movements between roosts and foraging habitat within a relatively small area.
- Roost habitat is likely to be concentrated in discreet locations rather than abundant throughout the Project Area and is unlikely to coincide with the WFSa.

The consequence of any interactions is considered moderate (impacts may cause significant changes to local abundance of the species), due to:

- Very little information being available about populations (precautionary principle).

Therefore, the Eastern Cave Bat is at moderate risk from turbine interactions at LRWF.

Corben's Long-eared Bat

Corben's Long-eared Bat was recorded in WFSa and TLSa. There are also a number of historical records in the well-vegetated areas of the TLSa. This species has been commonly recorded at the Ulan Mine site (near the southern end of the TLSa) (Glenn Hoyer, pers. comm. 11/03/2015).

Whilst little is known about Corben's Long-eared Bats, it is thought that they roost solitarily under exfoliated bark and in crevices on trees, with females forming small maternity colonies in larger tree cavities during the warmer months (van Dyck & Strahan 2008). As for other *Nyctophilus* spp., Corben's Long-eared Bats probably reproduce between autumn (when copulation occurs) to summer (lactation and weaning) (van Dyck & Strahan 2008).

Despite a lack of studies confirming speculative data, it is thought that Corben's Long-eared Bats forage within a few kilometres of their roosting area (van Dyck & Strahan 2008), with larger, intact remnants of suitably forested habitat needed to sustain viable population densities.

Foraging is concentrated around and within patches of trees (SPRAT 2016, Churchill 2008), with the highly manoeuvrable species weaving through the canopy (Churchill 2008). Corben's Long-eared Bats have undulating flight patterns, whereby insects are taken both in flight and by gleaning from vegetation or the ground (van Dyck & Strahan 2008). The bats are known to travel an average of 2 km and up to 7 km between roosts and foraging areas, with low roost fidelity (SPRAT 2016)

The likelihood of turbine interactions for this species is considered rare (an impact may occur only in usual circumstances) and the consequence is minor (may cause non-significant changes to local abundance of species), given a risk of low. This is based on:

- Mostly low level flight.
- Highly manoeuvrable flight.
- Non-migratory.
- Relatively short distance travelled between roosts and foraging areas.
- While rare, the species appears to be locally common in the region.

Barking Owl

The Barking Owl was not recorded in LRWF but could occur on site as suitable habitat is present and it is known from the area (refer to NGH Environmental 2013a, b) for more information. It was originally considered at high collision risk. However, this has been reviewed. Although the Barking Owl uses open habitat and forest edge – farmland mosaic habitat, it is a sedentary species with foraging behaviour that makes it unlikely to encounter turbine blades. In a comprehensive study of Barking Owls in the Pilliga Forests, Stanton (2011) documented the following hunting techniques:

- Sally-strike or hawking: Barking Owl perches (in vegetation) and when observes flying prey, pursues and captures prey (e.g. beetle, microbat) within 20 metres of perch
- Low quartering in short bursts around forest edge at dusk to locate prey (birds) coming in to roost, which are then swooped upon and captured
- Flush-strike: Noisily making short movements between perches within canopy, with short stays with the aim of flushing prey (birds, insects) from roosts, with the prey taken on the wing.
- Ambush / pounce on arboreal and ground mammals using perch-pounce method.

Of these hunting behaviours, the flush-strike is the most likely behaviour that would see the Barking Owl fly above the tree canopy, however, it is considered that flying within the rotor-swept area would be rare, and a collision rarer still. The effect upon the population of a Barking Owl collision is likely to be minor, giving the Barking Owl a low risk of collision.

Powerful Owl

Powerful Owl was recorded on site. The Powerful Owl swoops upon prey (mostly arboreal mammals) within the canopy and sub-canopy of woodland and forest. It is unlikely to encounter the rotor-swept area during foraging. While dispersing, it is likely that the dispersing owls fly between patches of similar habitat along vegetated corridors. Thus, the likelihood of collision for Powerful Owl is rare.

Given that the Powerful Owl was recorded on site, on two occasions and there are gully systems in the project area that provide potential roosting (and perhaps breeding) sites (refer to AoS in NGH Environmental 2013b for more information), the consequence of any collision is considered moderate. This gives the Powerful Owl a collision risk rating of moderate.

Masked Owl

Masked Owl was not recorded on site and the wet forest habitat preferred by the species is considered marginal or absent in the LRWF project area. Originally the collision risk for Masked Owl was assessed as moderate, based on the presence of suitable habitat near turbines. Masked Owl hunts by low quartering through forest or clearings or by perch-pounce from vegetation or the ground (Schodde & Tidemann 2007). The species is unlikely to encounter the rotor-swept area while foraging. Although little information is available about dispersal methods, it is likely that the dispersing owls fly between patches of similar habitat along vegetated corridors. Thus, the likelihood of collision for Masked Owl is rare.

In the event of a collision, the consequence is considered minor (may cause non-significant changes to the local abundance of species), as the species is not known to occur on site and breeding is not known to occur in the project area. This gives the Masked a low risk for collision at LRWF.

Spotted Harrier

The Spotted Harrier was not recorded in the LRWF project area, but records do occur in the locality and suitable habitat is present on site. The Spotted Harrier is nomadic and hunts by hedge-hopping, low soaring and low quartering over open vegetation, often within five metres of the ground (BirdLife 2017, Schodde & Tidemann 2007). They breed in response to prey availability and build a new nest. Display flights involve high soaring, spiralling and plummeting (Schodde & Tidemann 2007). The likelihood of collision is considered rare given that they may only encounter the rotor-swept area during breeding display flights. The consequence of collision is minor, considering that the semi-arid and arid parts of Australia are considered the species' stronghold and key breeding areas (BirdLife Australia 2017). This gives a risk rating of low for the Spotted Harrier.

Regent Honeyeater

The critically endangered Regent Honeyeater is strongly associated with the inland/eastern slopes of the Great Dividing Range, as well as several coastal regions, particularly the Hunter Valley and Central Coast of NSW (Bird Life Australia 2016). At present the Lower Hunter Valley represents one of the most important areas of habitat for the species throughout its entire range (Roderick 2010 in Roderick *et al.* 2013).

BioNet records for the Regent Honeyeater in NSW show that:

- Most records are from three main regions, including the Capertee Valley and surrounds, coastal forests, and the Bundarra-Barraba region north of Tamworth
- Most records outside of these areas are near major roads or well-forested reserves/forests
- Records outside of the three main areas appear haphazardly scattered throughout the range of the species.

Regent Honeyeaters were not observed during surveys in the Project Area in October 2012 and 2013, although survey timing was suitable for detecting the species (Bird Life Australia 2016). The species can be difficult to detect due to (Roderick *et al* 2013):

- Relatively cryptic plumage
- Low population numbers
- Dispersal patterns and key habitat sites are poorly known.

Figure D-I shows a snapshot of the likely current distribution of the species and known breeding areas, as well as the approximate location of the Proposal Area.

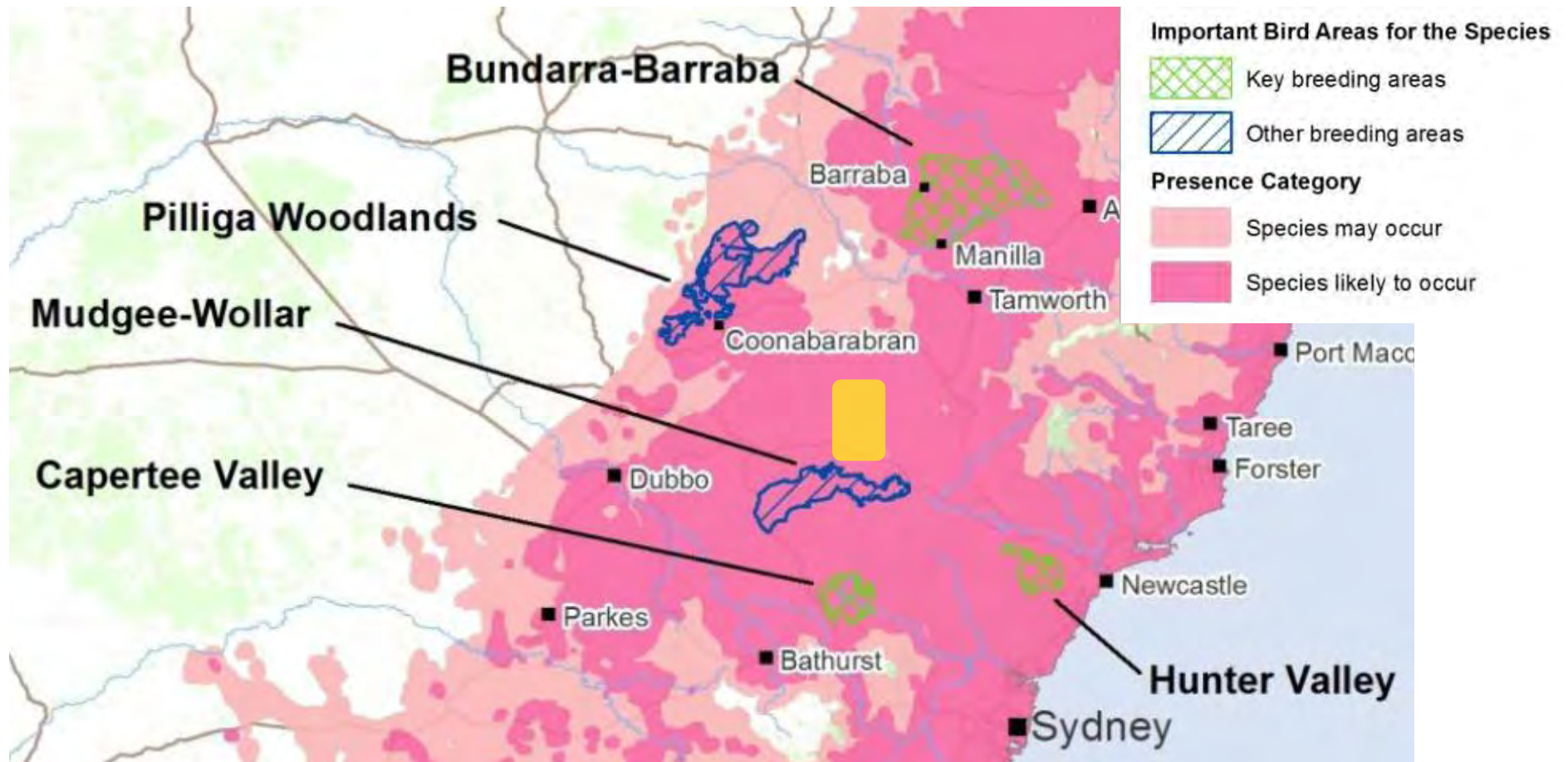


Figure D-I Presence and important areas for Regent Honeyeater (DoE 2016 p.12; only the relevant portion of map shown), with approximate location of Project Area (yellow rectangle) overlaid

The Regent Honeyeater is certainly present in the region. The Mudgee-Wollar Important Bird and Biodiversity Area (IBA) is located approximately 15 km south of the TLSA and was dedicated in part due to regular use by Regent Honeyeaters. Records nearby the proposed LRWF project are few. The closest BioNet records to the WFSA are north-east of the wind farm within Coolah Tops National Park. BioNet records also exist south and east of the southern portion of the TLSA near the Goulburn River National Park.

Regent Honeyeater habitat assessments have found (DoE 2016, Roderick *et al.* 2013, Roderick & Ingerwsen 2014):

- The species is a “rich patch specialist” > dependent on high-yielding habitats on fertile soils
- The species requires areas with high levels of tree diversity (four or more tree species)
- The probability of presence is driven by vegetation *coverage*, followed by elevation and humidity/soil moisture
- Habitat assessments in the Hunter Valley found that 39.4% of Regent Honeyeater records were from lower slopes compared to 1.4% on ridges.

To be suitable for use, remnants need to be of high quality. There are four known key breeding regions for the Regent Honeyeater: north-east Victoria (Chiltern-Albury), Capertee Valley, Bundarra-Barraba region and Hunter Valley (DoE 2016, Roderick *et al.* 2013). Other breeding sites used intermittently include the Australian Capital Territory, Munghorn Gap Nature Reserve and Mudgee-Wollar (DoE 2016, Roderick *et al.* 2013).

Regent Honeyeaters are a highly mobile species that may visit the Proposal Area from time to time, depending on the availability of food resources both at the site and in other areas. A Regent Honeyeater fatality has not been recorded in available wind farm monitoring data. Two potential risk periods could occur for the species: foraging while in the region, or during migration / nomadic movements through the region.

Figure D I shows that the Proposal would be located in between several Regent Honeyeater breeding areas, including being close to the Mudgee-Wollar IBA. At a glance this suggests that the risk of turbine interactions for the species would be high, as Regent Honeyeaters are likely to travel through (or stop to forage in) the region. However, the location of the proposed turbines is inconsistent with the known habitat requirements and the supposed migration style of the species:

- Turbines are proposed on ridges while the Regent Honeyeater forages in low relief areas
- Turbines are proposed on ridges while the Regent Honeyeater is thought to follow paths through forest in lower elevations and linking riparian corridors during migration
- Turbines are proposed in fragmented and degraded habitat while the Regent Honeyeater depends upon ‘rich patches’ for foraging, and vegetated corridors for movement paths.

Thus, the number of individuals and flights over the turbine ridges is likely to be low. This suggests that likelihood of potential collisions would be rare. As to the consequence of any fatalities:

- The species is now critically endangered (population may be as low as 350-400 individuals; DoE 2016)
- Low reproductive output (DoE 2016)
- Breeding occurs in the region from time to time (Mudgee-Wollar)

The consequence of any individual's fatality would be significant. Using the risk assessment matrix, this places the Regent Honeyeater at high risk from turbine interactions. But it must be stressed that the high risk is an outcome of consequence due to the low population size NOT likelihood of collision.

Swift Parrot

Swift Parrots were not considered in detail in the WFSA of the BA due to the paucity of records from the region, particularly within the development envelope. As for Regent Honeyeater, Swift Parrots are "rich patch specialist" species that depend upon high-yielding habitats on fertile soils (Roderick *et al.* 2013). The species preferentially utilises richer and more fertile sites (Saunders & Tzaros 2011) that are:

- Lower in the landscape
- Along gullies
- On lower slopes.

Within the winter non-breeding habitat, Swift Parrots move nomadically through the landscape, using a diversity of foraging habitats (Threatened Species Scientific Committee 2016). The latest population estimates are of around 2000 mature individuals, including 940 breeding pairs, and that the species occurs as a single, migratory population (Roderick *et al.* 2013, Saunders & Tzaros 2011).

Swift Parrots (*Lathamus discolor*) are small, nectivorous parrots that occur in the eucalypt forests of south-eastern Australia. Analysis of BioNet Swift Parrot records in NSW shows the majority of records are located in coastal forests and the Capertee Valley regions. The records from outside of these zones are relatively haphazard and show no clear patterns or regularity of visitation. The closest Important Bird Area (IBA) identified for the Swift Parrot is the Capertee Valley, which is well south of the Project Area. There is a clear absence of records from the region surrounding the proposed LRWF project. It is likely that if Swift Parrots regularly utilised the area within the Wind Farm and around Coolah there would be records present from the region. The absence of records is most likely linked to the lack of larger patches of good quality Box-Ironbark woodland (preferred habitat) in the vicinity of the turbine layout. The degraded woodlands recorded on-site provide limited foraging resources for this species

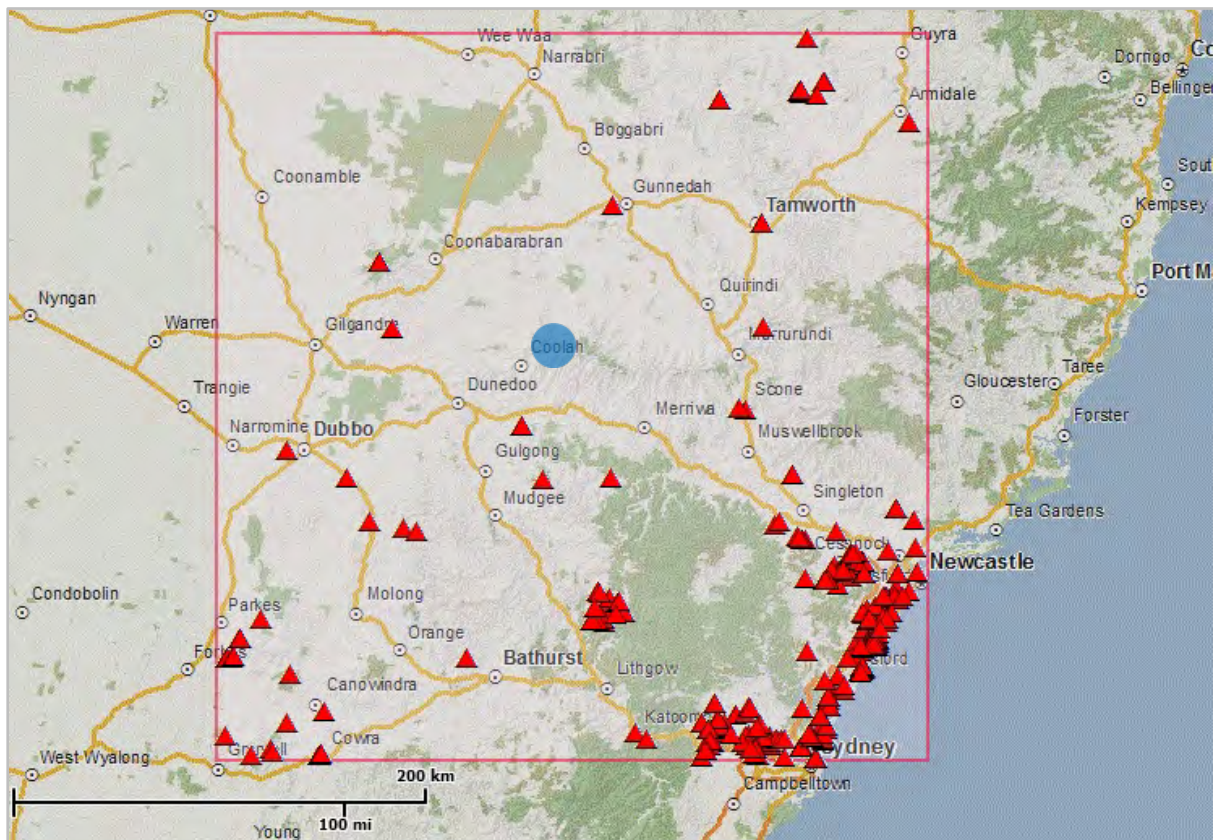


Figure D-II Location of the proposed wind farm (blue dot) within a NSW context, showing all records of Swift Parrots within about 150 km (Bionet Atlas Search Results, Office of Environment and Heritage, accessed 08/2014, <http://www.environment.nsw.gov.au/mapviewerapp/>)

Swift Parrots are a highly mobile species that may visit the Proposal Area from time to time, depending on the availability of food resources both at the site and in other areas. Two habitat types, the eucalypt forests of the coastal plains and the box-ironbark woodlands of the inland slopes, are considered to be the core non-breeding habitats for Swift Parrots (Kennedy & Overs 2001; Kennedy & Tzaros 2005; Department of the Environment 2014).

Within the winter non-breeding habitat, Swift Parrots move nomadically through the landscape, using a diversity of foraging habitats. The species forage in flocks in areas with high abundances of lerp, nectar and non-aggressive competitors (Threatened Species Scientific Committee 2016; Saunders & Heinsohn 2008). They typically forage in foliage at the top of the canopy (Schodde & Tiedemann 2007). Wintering flocks may remain in a district for weeks, returning as a flock to the same tree each night for roosting. The latest population estimates are of around 2000 mature individuals, including 940 breeding pairs, and that the species occurs as a single, migratory population (Roderick *et al.* 2013, Saunders & Tzaros 2011).

A Swift Parrot fatality has not been recorded in available wind farm monitoring data. However, collision mortality for the species is listed as a threat to the species in the Recovery Plan (Saunders & Tzaros 2011) as the species is prone to colliding with fences, windows and cars. Presumably this is due to their very fast and direct flight behaviour (Schodde & Tiedemann 2007). The likelihood of collision is thought to be influenced by the proximity of a structure to a concentrated foraging area (Smales 2005). The Recovery Plan goes on to comment that poorly sited wind turbines may have implications for the migratory Swift Parrot (Saunders & Tzaros 2011). A poorly sited wind farm on the mainland, in respect of the Swift Parrot,

would be one placed within, near or between (close) important winter foraging sites, particularly if turbines were placed at lower elevations in the landscape.

An assessment that modelled the potential collision rate of Swift Parrot at 39 (operating and proposed) wind farms within the species' distribution found that total predicted deaths equated to slightly more or less than one parrot killed due to wind turbine collision every ten years (Smales 2005). Thus the potential for an individual to be killed on the LRWF project is even lower, as it would represent just one of the total number of wind farms in operation.

The likelihood of collision for Swift Parrot at LRWF project is judged as rare based on the following points:

- No known important foraging sites nearby
- Generally degraded condition of vegetation communities in the Project Area
- Turbines would be located along ridges while Swift Parrots would forage mostly at lower elevations; dispersal between foraging sites is also likely to be in vegetated corridors at low relief including riparian corridors.

The consequence of collision for Swift Parrot is judged as moderate, based on the following points:

- The Project Area is not near a breeding area for the species
- The species is now critically endangered.

Thus, potential collisions at LRWF project present a moderate risk to the Swift Parrot population. The attribution of moderate risk is based mostly on the consequence of a collision rather than the likelihood.

Large-Eared Pied Bat

In NSW, the patchy occurrence of Large-eared Pied Bat includes concentrations around the sandstone escarpments of the Sydney Basin and the north-west slopes including Coolah Tops, Mount Kaputar National Park to the north and Pilliga Nature Reserve (north-west from Project Area) (SPRAT 2016). There is little potential for turbine interaction in this species, as it probably forages below canopy level. The species may be present in vegetated areas near to the turbine array, but the likelihood of collision is rare (occur in unusual circumstances). The consequence of any collisions of Large-eared Pied Bat may be moderate (may cause significant changes to local abundance) on the basis of:

- Potential nursery site at the southern end of the Project Area.
- There is a concentration of Large-eared Pied Bat records in the region.

This makes the Large-eared Pied Bat a moderate risk species for turbine interactions.

Dusky Woodswallow

Dusky Woodswallow is a flocking seasonal migrant to the area (Schodde & Tidemann 2007, BirdLife 2017). They are aerial insectivores and pursue prey on the wing high in the air or sally just above the tree canopy (Schodde & Tidemann 2007, Lloyd undated). Anecdotal records indicate that flocks, which may be large, also circle high above the ground when preparing to migrate northward in autumn (Lloyd undated, COG undated). One Dusky Woodswallow has been recorded during mortality surveys at an operating wind farm in Australia, based on publicly available information (Smales 2015).

The likelihood of a Dusky Woodswallow collision is possible, given that they occur in the LRWF project area and that they have been previously recorded amongst mortality data. The consequence of a collision is moderate given that:

- The species occurs in flocks therefore multiple fatalities may occur in a single event.

- The western slopes, near the LRWF project area, are the core breeding habitat in NSW (NSW Scientific Committee 2016)

This gives the Dusky Woodswallow a high risk rating for collision.

Square-tailed Kite

The Square-tailed Kite was recorded nesting in riparian vegetation along the Goulburn river in the southern part of the TLSA. Construction activity restrictions within 500 m of the Square-tailed Kite nest are a recommendation of this assessment.

The NSW Scientific Committee (2009) considers that “windfarms may cause occasional collision mortalities of Square-tailed Kites, although this species is a very manoeuvrable, slow flyer and is probably capable of generally avoiding collisions with turbines blades.” They also note that collisions may occur with transmission lines. When hunting, the kite quarters and circles over tree canopies and occasionally soars (Schodde & Tiedemann 2007). As already discussed, the pair of Square-tailed Kites in the LRWF project area are likely to be sedentary in a large established territory rather than being nomadic. In established territories, the same nest sites are used in subsequent years. During breeding, the male kite is often mobbed by birds as he leaves the nest, although there is a zone of mutual tolerance for about a 200 m radius around the nest (Schodde & Tiedemann 2007). As discussed in NGH Environmental (2013a), where raptor nests are near wind farms, the fledgling birds are considered at greatest risk when learning to fly.

Although they have large hunting territories of more than 100 km², the wind farm area is around 30 km north of the nest site. This may be beyond the territory of the pair, assuming the territory radiates regularly around the nest. (This is in fact often not the case, but is highly site dependent - Olsen & Fuentes 2005). The wind turbine section of LRWF may be within the home range of the Square-tailed Kite though, which is generally a larger area than a raptor’s defended territory. The species is rare, has a low fecundity (0.7 young per pair per year – NSW Scientific Committee 2009), low breeding density and low recruitment rate (Debus 1998).

The likelihood of a Square-tailed Kite collision with a turbine is considered unlikely (an impact might occur at some time) based on:

- WFSA assumed to be outside of the territory of the resident pair (at the southern end of the transmission line), therefore regular encounters with turbines is unlikely
- Dispersing newly fledged individuals may encounter the wind farm
- The species is highly manoeuvrable

The consequence of a Square-tailed Kite collision with a turbine is considered potentially significant on the following basis:

- Established nesting territory nearby; potential for a population sink
- Low fecundity, low breeding density and low recruitment
- Sparsely distributed species across its range.

Therefore, the Square-tailed Kite is potentially at high risk of collisions with turbines.

Eastern Bentwing Bat

Eastern Bentwing Bat was recorded in the LRWF project area in moderate numbers. This is a species for which there is a great deal of information about population and ecology. Populations are centred on a maternity cave, and then the population disperses to other caves for winter within a territorial range

(Churchill 2008). Movement between territories is uncommon (Churchill 2008). Territorial range sizes are unknown but could be extrapolated to be around 31,400 km² (1.3 million ha) or a circle with a diameter of 200 km, based on a study that found over-winter caves occur within 100 km of a maternity site (Wilson 2008)¹. However, with little documented about migration, this assessment assumes that over-winter caves may be greater than 100 km from a maternity cave.

The closest known roost sites are listed below and shown approximately on Figure 7-1:

- Wellington Caves: used as intermittent roost, south of Dubbo and about 150km south-west of wind farm (approximate lat/long location -32.6209885, 148.9364489)
- Main Cave at Timor Caves Reserve: an important winter roost site, approximately 120 km south of Tamworth and approximately 200 km east of wind farm (approximate lat/long location -31.6848819, 151.1099652)
- Tunnel Cave in Borenore Karst Conservation Reserve: winter roost site, approximately 17 km west of Orange and 220 km south-south-west of wind farm (approximate lat/long location -33.2409309, 148.9252942)
- Kanangra-Boyd Karst in the Kanangra-Boyd National Park: maternity cave approximately 180 km south-west of Sydney and 300 km south of the wind farm (approximate lat/long location -34.0333288, 150.0478059)
- Willi Willi Caves in Macleay Karst Arc: maternity cave, approximately 450 km north-east of the wind farm (approximate lat/long location -30.9553612, 152.4389947)
- Church Cave at Wee Jasper: maternity cave, approximately 35 km north-west of Canberra and 480 km south of the wind farm (approximate lat/long location -35.1250344, 148.3993452).

In southern parts of its range (in the temperate zone) species disperses for winter and females congregate for breeding in summer (Churchill 2008). The Willi Willi maternity cave, the closest maternity cave to LRWF, is approximately 450 km north-east of the proposed wind farm.

Dwyer (1969) documents a study of banded Eastern Bentwing Bats undertaken in the 1960s. This study found bats that utilised Willi Willi Cave migrated both north and south. A bat marked at Willi Willi in August was re-trapped in August the following year at Murwillumbah (~300 km north of Willi Willi). A bat marked at Willi Willi in September was recaptured at Wombeyan in May two years later (~400 km south-west). Two bats marked at North Sydney in August and June were re-captured at Willi Willi in January and November (~350 km south of Willi Willi). The proposed LRWF may be within reachable distance from Willi Willi caves, if a suitable roosting site were located nearby.

Dwyer (1969) suggests that populations are separated by major physiographical features such as drainage basins and dividing mountain ranges. The Great Dividing Range has potential to act both as a barrier and funnel for migration movements. Therefore it is assumed that the bats utilising Wee Jasper on the southern tablelands are more likely to winter at Borenore, on the western slopes, while bats utilising Kanagra-Boyd are more likely to winter at Timor, both being on the eastern side of GDR (DECCW 2010). However, BioNet Eastern Bentwing-bat records suggest a migration route between Timor Caves and Kanagra-Boyd on both sides of the range ().

¹ Assuming a maternity cave in the centre of a territory, then the area of the territory could be worked out using πr^2 , with $r = 100$ km.

Either way, the proposed Liverpool wind farm does not sit along a migration pathway between known winter and maternity caves. This is supported by Anabat records obtained at LRWF. Although conditions were cold (refer to Section 3.2.1), these surveys were undertaken during the southern migration period for Eastern Bentwing-bat, and yet the species was detected in relatively low numbers. Further, while surveys in the Ulan Mine site (similar habitat to the TLSA) detected the Eastern Bentwing-bat, it has only been recorded occasionally and would not be considered common in the area (Glenn Hoye, pers. comm. 11/03/2015).

The Eastern Bentwing-bat forages above canopy height in treed areas and they fly close to the ground in open habitats such as grasslands (Churchill 2008). Lower flying height around turbines has been confirmed at an operating wind farm on the Southern Tablelands, where Anabat detectors were placed at nacelle height (80 m) and ground height at four wind turbines over several weeks (Richards, G. & NGH Environmental, unpubl.). Eastern Bentwing-bats were recorded at ground height but not at nacelle height. Other species of bat, including White-striped Freetail Bat, were recorded at nacelle height.

Eastern Bentwing-bats are migratory, and are a fast-flying species that forage above canopy height. These factors suggest that the species would be at high risk of turbine interactions. Given the existing risk factors it is unlikely (an impact might occur at some time) that an Eastern Bentwing-bat would suffer a turbine collision at LRWF, based on the following points:

- Prey pursuit foraging around and/or within the canopy.
- There are no known caves sites or karst areas around the wind farm study area.
- The Proposal Area does not sit along a migration pathway between known winter and maternity caves; high numbers are not expected to pass through the WFSA.
- The proposed turbine sites are mostly located on cleared ridgelines, and here the species would be expected to be flying lower.
- Occurrence on the site is likely to be irregular; short-term (e.g. males on a foraging trip away from a main roost cave over several days) and; of course, seasonal. Therefore frequency of impact would be relatively inconsistent and minor.

Based on the discussion above, the consequence of collision is considered minor. This results in a low risk of collision for the Eastern Bentwing Bat at LRWF.

Yellow-bellied Sheathtail-Bat

The Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) is a widespread species, with records throughout most of NSW. Despite this, there are very few historical records from within the study area. There are, however, two records of the species from Turill State Conservation Area, in the TLSA. No records of this species were made in the WFSA during the 2012 Anabat surveys. One probable recording was identified from sandstone forest vegetation in the TLSA during the 2012 surveys, but no calls were identified in this area after the more comprehensive 2013 surveys.

One potential record of Yellow-bellied Sheathtail-bat was recorded in the TLSA but is unconfirmed (NGH Environmental 2013b). The species is assumed to be seasonally present between January and July (Churchill 2008, ALA 2016). The collated carcass search data for eight operational wind farms in south-eastern Australia does not list Yellow-bellied Sheathtail-bat as an impacted species (Smales 2015). Yellow-bellied Sheathtail-bat has not been found in mortality searches over 12 months at two wind farms on the southern tablelands (NGH Environmental unpubl. data). However, the Yellow-bellied Sheathtail Bat has been compared to White-striped Freetail Bat in wind morphology and flight behaviour and foraging style

(Rhodes & Hall 1997). The White-striped Freetail Bat is susceptible to turbine collision (refer to discussion in NGH Environmental 2013a).

Yellow-bellied Sheathtail-bats occur in a range of habitats including rainforest, woodland and grassland (Churchill 2008). Yellow-bellied Sheathtail-bats are fast, agile predators that intercept insects in flight. They utilise open and semi-open microhabitat just above the canopy of a range of vegetation communities (McKenzie *et al.* 2002, Richards 2005a). They may occur more than five metres from the tree canopy (McKenzie *et al.* 2002). They fly fast and straight most often 15-25 m above the ground even in open habitat, although they may also fly close to the ground (Churchill 2008, Rhodes & Hall 1997, Kitchener 1987). Rhodes & Hall (1997) state that the morphological characteristics of the Yellow-bellied Sheathtail Bat and flight observations in Queensland suggest low manoeuvrability. Other observations suggest high manoeuvrability, with the species able to make tight turns with steep bank angles (McKenzie *et al.* 2002). The differences in observed flight behaviour may be related to geographical variation in morphology (Rhodes & Hall 1997).

The likelihood of turbine interaction for Yellow-bellied Sheathtail-bat at LRWF project is considered to be unlikely (an impact might occur at some time), based on the following points:

- Unknown but assumed occurrence in the area.
- Yellow-bellied Sheathtail Bat flies high and fast over the forest canopy, but lower in more open country.
- Has similar morphological characteristics and habitat use as White-striped Freetail Bat but occurs in lower densities in the landscape.
- Not known to have been recorded in carcass searches at operating Australian wind farms.

The consequence of turbine interaction for Yellow-bellied Sheathtail-bat is considered to be moderate (may cause significant changes to local abundance of species) based on:

- Apparent low density in landscape.
- Paucity of information about the species (err on the side of caution).

This makes Yellow-bellied Sheathtail-bat at moderate risk from the wind farm (turbine interaction).

APPENDIX E AGENCY SUBMISSIONS

E.1 SUBMISSIONS

E.2 APPROACH TO ADDRESSING SUBMISSIONS

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
OEH				
Survey Effort (Wind Farm)	The survey effort for bats is inadequate to fully determine the potential for impact on the wind farm study area. - Number and duration of Anabat surveys is different in Section 4.3.3 and Section 4.3. - No discussion in BA of how Anabat devices were set up to maximise bat call detection. - Clusters F4, G4, F5, G5, and the north-western section of the wind farm were not surveyed for bats. - Surveys were probably undertaken at a time of year when weather conditions reduced bat activity. - No discussion as to why activity levels of threatened bat species were “quite low”.	That the proponent either: - Undertake additional bat surveys of the WF study area, or - Assume that threatened bats listed under the TSC Act and EPBC Act that are predicted to occur within the locality are present.	- Clarify number of Anabat survey nights and overall duration of Anabat recording. - Clarify methodology of Anabat surveys. - Assume that relevant listed threatened species are present within the identified areas and produce/update AoSs as required. - Update and clarify bat results from the BA regarding activity levels and temperatures during surveys (summarised in OEH review). - Assume that the lack of harp trapping on the transmission line route resulted in non-detection or under-detection of any potentially-occurring threatened low-flying bat species.	- See Section 3.3 for total survey effort including Anabat survey nights, and Section 7.1.3 for a further break-down of Anabat effort. - See Section 3.1.1 for Anabat methodology for new surveys (2015) and 7.1 for clarifications on previous surveys and limitations including survey timing and activity levels of bats. - Presence assumed and CRA prepared for (Appendix D): Eastern Cave Bat, Corben’s Long-eared Bat, Large-eared Pied Bat, Eastern Bentwing Bat, Yellow-bellied Sheathtail Bat - Presence assumed for: Little Pied Bat, Yellow-bellied Sheathtail Bat

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
Survey Effort (Transmission Line)	- No information provided on size class of hollows. - No detailed information provided on hollow use by threatened species. - Use of Anabat detection alone along TL probably resulted in non-detection or under-detection of some bat species.	That the proponent either: - Undertake additional bat and arboreal mammal surveys of the TL study area, or - Assume that threatened bats and mammals (e.g. squirrel glider and eastern pygmy possum) listed under the TSC Act and EPBC Act that are predicted to occur within the locality of the project are present.	- Clarify size categories of hollows - Provide information on size of hollows used by relevant threatened species, and quantify as best as possible the extent of habitat for each species in all areas of potential habitat. - Assume threatened arboreal mammals occur on site and use existing data to assess impact.	- See Section 3.1.1 and 7.1.4 for clarification of hollow size categories in new (2015) and previous surveys, respectively. - Refer to Section 4.2.2 for microhabitat suites and 5.3.2 for quantification of impact. - Refer to Section 7.1.4 for hollow use by threatened species. - Presence assumed and additional AoS has prepared for Eastern Pygmy-possum (Appendix C). - Squirrel Glider was assessed in the original BAs (NGH Environmental 2013 a and b).
Assessment of direct impacts	The proponent has not provided sufficient detail to support the assessment of impacts on native fauna. The BA has not adequately justified conclusions related to the risk of bird and bat collision and the significance of this impact. - No specific information as to what impacts may be expected. - Conclusions reached regarding blade strike in Assessments of Significance are generally unsubstantiated.	That the proponent conduct further assessment of the potential for bird and bat strike and barotrauma within the wind farm study area. This should be undertaken prior to approval and be incorporated into the Bird and Bat Management Plan with recommendations as to what mitigating measures, such as buffer areas or reconfiguration of the turbine layout, will be implemented to minimise bird and bat strike and barotrauma.	- Re unsubstantiated: Information on non-threatened species is used to inform impacts on less-studied threatened species. This is considered relevant - some species may be good indicators of habitat health and presence of threatened species. - Provide supporting data for conclusions in the Assessments of Significance. Update AoS's - Provide information regarding blade strike and barotrauma including Australian migratory birds, non-threatened species and bats.	- General assumptions stated in Section 5.1. - Specific information as to the impacts that can be expected, including migratory and non-threatened species, is in Section 7.2. - A species-by-species collision risk assessment has been provided in Section 5.5 for Regent Honeyeater, Swift Parrot, Eastern Bentwing-bat, Yellow-bellied Sheath-tail-bat, Eastern Cave Bat, Corben's Long-eared Bat and Large-eared Pied Bat. Migration events for relevant species is also discussed in Section 7.3. - Refer to Section 8 for updated impact avoidance actions and recommendations.

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
	- Surveys were outside the autumn migration period for honeyeater species and key periods when migratory, high-flying species such as swifts are present. - The BA tends to ignore potential threat to species not listed as threatened. - No AoS undertaken for Regent Honeyeater. - Little discussion on the potential impact of blade strike or barotrauma on microbats. - Need clarification of assumptions relating to impacts. - It is unclear how the constraints mapping reflects the placement of turbines		- Include AoS for Regent Honeyeater. - Very little data is available in Australia on the impact of wind farms on microbats. - Assumptions are given in Section 10.1 of the WF report. However, they can be clarified further. - There are inherent uncertainties in the impact assessment that cannot be clarified prior to construction. It is impossible to provide an accurate quantitative assessment of impacts such as blade strike due to the lack of published Australian data. A collision risk assessment approach has been used to review assessment of collision. - Constraints maps: confirm that areas considered high value for birds and bats are located at least 100 m (preferably 200 m (pers. comm. Glenn Hoyer)) from turbines.	
Assessment of indirect impacts	The proponent has not provided sufficient detail to support the assessment of indirect impacts on native fauna relating to the disturbance to birds and bats	That the proponent investigates the potential for the current wind farm configuration to:	Barrier effect was discussed in NGH Environmental (2013a, section 9.2.3). Long term or permanent behaviour displacement leading to barrier	Literature review on barrier effect and behavioural displacement in Section 7.2.3. Cumulative impacts in Section 7.4.

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
	resulting in avoidance of habitats in or near wind farms. - Limited discussion of behavioural displacement of fauna. - Lack of discussion around barrier effect of multiple barriers created by turbine arrays on adjacent ridges.	(a) Disrupt the migratory route of birds and bats, including species not listed in either the TSC Act and EPBC Act; and (b) Reduce the area of habitat available to fauna, in particular seasonal migratory species In order to determine whether reconfiguration of turbines or additional offsets may be required.	effect has been clearly demonstrated at overseas and offshore wind farms, but has yet to be demonstrated at Australian terrestrial wind farms.	
Cumulative impacts	The BA does not address cumulative impacts. Migrating species may pass through multiple wind farms when moving north-south or east-west and this is likely to compound impacts.	That the proponent gives genuine consideration of cumulative impacts to migratory fauna in both a state-wide and regional context and give due consideration to reconfiguring the wind farm should impacts be unacceptable.	Discuss potential cumulative impacts as a result of other wind farms in the region, including the Kyoto, Bodandra, Uungula, and Crudine Ridge WFs.	- Cumulative impacts Section 7.4 - Migratory species Section 7.3.
Impact avoidance (wind farm study area)	OEH considers that there is insufficient information to determine whether further avoidance measures of native vegetation is possible or required. - Serious consideration has not been given to the impact of turbine placement in the wind farm. - OEH is concerned that the value of communities not dominated by Norton's Box or Mountain		- Fauna habitat areas analysed and mapped separate from vegetation communities. - Clarify significant impact guidelines.	- Fauna habitat methods Section 3.1.1 and discussion Section 4.2. - Quantification of fauna habitat types in Section 5.3.2. - The definition of a significant impact is given in DECC (2007).

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
	Gum/Stringybark are under-valued as habitat for fauna. There is no indication of what constitutes a significant impact.			
Impact avoidance (transmission line study area)	- The BA has failed to demonstrate that avoidance of riparian areas along the alternate route is not possible. - It is uncertain to what extent modifications to the route presented might influence the total area being cleared. - No discussion of why further potential routes with less impact to woodland and forest are not presented.	That the proponent be required to: - Ensure that all avoidance measures implemented in finalising the location and design of the facility are fully described - Undertake a more thorough investigation of the transmission line routes, to identify where modifications can be made to maximise avoidance of high conservation value vegetation such as riparian areas. - Sufficiently justify the level of avoidance implemented.	- Provide more detail of avoidance and mitigation measures where possible. - Route selection will reduce impact figures and clarify assessment. - As the TX line is linear in nature and covers a large area, it is not possible to completely avoid crossing riparian areas. Impacts have been minimised where possible. - Proponent to justify chosen route.	- Additional mitigation measures included in Section 8. - One TX line route has been chosen and assessed. - Clearing areas for riparian communities in Section 5.3.1 - Route justification in Section 2.
Monitoring and mitigation	The BA does not provide detail of any monitoring to assess the impacts of rotor strike nor does it adequately consider mitigation measures in response to bird and bat strike. Mitigation measures are general in nature.	- That the proponent develop a FFMP in consultation with OEH before approval. - That the proponent develop a BBMP in consultation with OEH prior to approval. - That the proponent adequately consider the range of mitigation measures for implementation at the site to mitigate any predicted or observed bird and bat impacts.	- Flora and Fauna Management Plan and Bird and Bat Adaptive Management Plan will be developed in consultation with OEH if the project is approved. - Provide more detail of avoidance and mitigation measures where possible.	- It is understood that OEH will be releasing guidelines shortly. - Additional mitigation measures in Section 8.

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
		That should the project be approved, the DPE include a condition of consent requiring a monitoring program capable of detecting any changes in the population of birds and/or bats that can reasonably be attributed to the operation of the project.		
Durridgere SCA	OEH do not support the proposed preferred route through Durridgere SCA	OEH recommends that further investigations be undertaken regarding the alternate routes with specific attention being made to avoidance measures.	Determine new preferred route that does not pass through Durridgere SCA.	New route has been developed in consultation with OEH.
Offsets	The BA does not include a detailed offset proposal. Offset commitments should be available for scrutiny prior to the approval of the impact.	That the proponent provide a detailed offset strategy prior to approval.	Produce a detailed offset strategy, prior to approval, which contains proposed viable offset areas and options to secure these areas in perpetuity.	Offset Strategy summarised in Section 6 and provided in Appendix F.
Offset ratios	OEH considers the proposed system of offset ratios <i>lacking in a scientific rationale</i> and that a 'maintain or improve' outcome has not been achieved.	That the proponent demonstrate the adequacy of the proposed ratios by either running a BioBanking scenario, using representative data if actual data not be available, or providing OEH with sufficient data to run such a scenario itself.	Develop offset ratios by running a BioBanking scenario, using representative values	BioBanking scenario and Offset Strategy summarised in Section 6 and provided in Appendix F.
DPE				
Discrepancies in estimated disturbance areas for assessing	Table 9-2 BA totals are incorrect.	Provide updated tables with correct figures. Ensure consistent impact area assumptions.	- State all impact area assumptions, in consultation with Epuron. - Impact area calculations updated	- Assumptions given in Section 2 - Clearing area figures in Section 5.3

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
impacts on biodiversity				
Access Tracks	- As indicated above, it is unclear whether existing farm tracks are included in the defined survey area and to be included in the proposed 200m "project corridor". - Inconsistency between width for access tracks leading to 10m TLSA vs. 20m for WFSA.	Should be consistent in assumptions.	- State all impact area assumptions, in consultation with Epuron. - Single assessment for both projects	- Assumptions in Section 2 - Combined impact areas by vegetation type provided in Section 5
Public Road Access – Biodiversity Impacts	No biodiversity assessment has been completed on potential impacts on biodiversity as a result of upgrades to public roads.	These areas are either outside the project boundary or development envelope and would not form part of the project determination if these impacts are not assessed. Eg. would need to be assessed by appropriate roads authority under REF separate to this development consent.	Epuron to provide all impact areas in mapping and impact area estimations	Section 2 and Section 5.1-5.3
Vegetation Type areas not assessed	- States that 131.2 ha was not assessed – it is not clear where these areas are. - Also as per comment above the maps do not include vegetation mapping around clearing (20 or 10m disturbance) associated with access tracks.	Clarify where this missing mapping is within the development envelope.	All areas of development enveloped have now been mapped, including tracks.	Refer to Section 5 for calculations and Appendix A for maps.

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
Flora Surveys and low condition derived native grassland/exotic pasture	Based on survey effort maps in BA Appendix C – a number of the ridge lines have had no flora plots or inspections undertaken to allow assessment for vegetation community or condition class. How has the mapping been undertaken?		- More than 160 hours were spent in actual flora survey time and over 300 ha were physically inspected and searched. The study area is so vast, that it is necessary to extrapolate the remaining area from these survey sites. Due to the requirements of assessment both vegetation/habitat type and condition need to be extrapolated. - Clarify how extrapolation is undertaken.	Extrapolation methods in Section 7.1.2.
Fauna Surveys and potential high quality bat/bird habitat within the project boundary/proximity to turbines.	- in some cases there appears to be potential good quality fauna habitat (woodland) immediately adjoining areas classified as low condition. - BA Section 9.3.5 also notes that a greater distance of 600m between turbines within areas of intact woodland is better to minimise barrier effects and to avoid placing turbines between core areas of habitat. - While a habitat assessment was undertaken (s4.3.3	- Maps showing habitat/ habitat condition / connectivity between core habitat patches results would be useful, particularly focusing on fauna species at risk through blade strike, barotrauma and barrier effects. - Additional mapping across the windfarm project area will also assist in confirming potential offset areas as discussed below. - Mapping of specific fauna type habitats would also be useful here ie. Squirrel Glider habitat, Powerful Owl habitat.	- Provide maps showing habitat/ habitat condition - Provide maps showing specific fauna type habitats. - Provide more detail of avoidance and mitigation measures where possible.	- Habitat type and condition maps in Appendix A.5-A.9. - Habitat discussion in Section 4.2 - Discussion of collision and barrier effect in Section 5.5 and 7.2. - Discussion of mitigation measures including nest sites in Section 8.

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
	methodology) and incorporated into constraints mapping, no separate habitat quality mapping is provided of good quality habitat in close proximity to the development - envelope or connectivity between good quality woodland patches across turbines. - A high number of Wedge-tailed Eagle sightings were recorded during the surveys. The BA recommends a buffer to Wedge-tailed eagle nests, noting distances of between 500-1,000 m have been used elsewhere.	- Mapping of the 100m bird and bat buffer as described at p.69 of the BA should be included. - Spring fauna surveys did not comprehensively search for Wedge-tailed Eagle nests. The RTS should outline proposed management measures for protecting and buffering nest sites detected in pre-construction surveys.		
Biodiversity Offsets	It is noted that the Proponent commits to undertaking Biometric (BBAM) plots in the proposed offset areas.	- Utilisation of the Framework for Biodiversity Assessment (FBA) to calculate the offset requirements for the project - Demonstrate the adequacy of the proposed offsets in consultation with OEH. - Identify whether a staged offsetting approach is proposed (refer to general comments below about staging of the project).	Prepare biodiversity offset strategy, in accordance with previous advice and similar to prepared for Yass wind farm, showing feasibility of offset candidates.	Offset strategy summarised in Section 6 and provided in Appendix F. Note, not all offset locations have not yet been confirmed.

TOPIC	AGENCY ADEQUACY COMMENT	AGENCY RECOMMENDATION	NGH SOLUTION TO ADDRESS INADEQUACY	LOCATION IN THIS ADDENDUM
		- Offset locations within the project boundary be defined – including current condition and - proposed management actions/ security and incorporated into the project approval conditions. - Any offsets within the project boundary would need to be a reasonable distance from turbine areas to avoid any indirect impacts from the turbines – OEH submission indicated potential indirect impacts “zone of disturbance” of 600m for fauna.		

APPENDIX F REVISED OFFSET STRATEGY

EPURON

Biodiversity Offset Strategy

LIVERPOOL WIND FARM PROJECT

MAY 2017



Document Verification



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1 INTRODUCTION

1.1 PURPOSE OF THIS STRATEGY

The objective of this Offset Strategy is to demonstrate that suitable and adequate offsets will be achievable for the Liverpool Range Wind Farm Project, with reference to the Framework for Biodiversity Assessment (FBA, 2016) for Major Projects. This strategy includes:

Section 2 Preliminary development site credit calculations

- A preliminary assessment of the offset requirement for the proposal, sourcing VIS benchmark plot data, in advance of obtaining project specific plot data and using the Major Projects option of the NSW Office of Environment and Heritage (OEH) BioBanking Credit Calculator (BCC) and the rules under the FBA.
- An estimate of the areas that would be required to meet the offset requirement.

Section 3 Preliminary offset candidate evaluation

- Identification of candidate offset sites within the vicinity of the project, their availability and general adequacy to meet the offset requirements.

Section 4 Implementation

- Options being considered to secure and manage the offset sites.
- Time lines for implementation of a detailed offset plan.

1.2 DATA SOURCES

Data for this assessment was sourced as follows:

- | | |
|--|--|
| <ul style="list-style-type: none">• Vegetation type and condition of the development site: | Biodiversity Assessment Addendum of the Liverpool Wind Farm (NGH Environmental 2017). The addendum provides the most complete dataset, including areas surveyed in the 2013 Biodiversity Assessments for the project as well as additional areas surveyed in 2015 and 2016. |
| <ul style="list-style-type: none">• Impact area calculations: | Biodiversity Assessment Addendum of the Liverpool Wind Farm (NGH Environmental 2017 v1), using 'worst case' or 'upper limit values' where multiple route options / layouts are proposed. Areas were calculated using a GIS by Epuron, using the project infrastructure layout, buffered by required widths for road, transmission lines, turbine footings and hardstands etc. ¹ |

¹ The impact area figures in the final Biodiversity Assessment Addendum of the Liverpool Wind Farm (NGH Environmental 2017 **v2**) have changed slightly from those used in this assessment ; an addition of 7.8 ha.

- Plot data (vegetation survey data required to be entered into the online BCC):

OEH vegetation database benchmark data is used to derive plot data. Using benchmark data assumes all vegetation to be impacted is of high quality; scores for native species diversity, native overstorey regeneration, fallen timber, hollow-bearing trees, weediness and other parameters reflect a vegetation community in good condition.

Median parameter values are entered in this preliminary assessment, within the benchmark range. No Biometric surveys have been undertaken for the project at this stage.
- Threatened species:
 - o Threatened species likely or unlikely to be impacted
 - o Threatened species habitat impact areas

Biodiversity Addendum of the Liverpool Wind Farm (NGH Environmental 2017). As above, the addendum provides the most complete dataset including an assessment of threatened species impacts for the project.
- BioBanking calculations:

OEH BioBanking online calculator, commencing December 2016; selecting Major Project and Linear Assessment. ID 0035/2016/4151MP and 0035/2017/4183MP; two assessments are required as the project spans two Catchment Management Area boundaries.
- Offset area estimate:

OEH credit converter tool, accessed January 2017.

2 PRELIMINARY CREDIT CALCULATIONS: DEVELOPMENT SITE

2.1 OVERVIEW

Key aspects of this credit assessment methodology are detailed below. The assessment is considered preliminary, to ensure suitable and adequate offsets will be achievable for the Liverpool Wind Farm Project, in advance of plot data collection and some remaining pre-clearance surveys to be undertaken prior to construction.

The impact area figures have changed slightly (an addition of 7.8 ha) since the preparation of this Offset Strategy. However, the offset calculations have not been re-done as the process used in preparation of the offset requirement was precautionary and the additional 7.8 ha would not have a material impact to the preliminary offset calculations. A commitment to undertake the final Biobanking calculations based on the approved construction footprint and field data remains and would address any discrepancies. The impact areas used in the current calculations are shown below.

Table 2-1 Impact areas used in this assessment by vegetation type (EECs in blue shading).

Vegetation type	Impact area (ha)
River Oak Woodland (ID 084)	6.5
Blakely's Red Gum – Grey Box-White Box – riparian woodland (ID 278) EEC	3.6
Riparian forest - Rough-barked Apple, Blakely's Red Gum and Yellow Box (ID 281) EEC	18.9
Native Pasture (ID 395) (some parts are EEC)	86.6
Yellow Box Woodland (ID 437) EEC	1.5
Sandstone Forest - Blue-leaved Ironbark dominant (ID 467)	3.3
Sandstone Forest - Inland Scribbly Gum dominant (ID 477)	31.5
Sandstone Forest - Red Ironbark dominant (ID 478)	1.2
Sandstone Forest - Black Cypress dominant (ID 480)	10.3
Riparian forest - Rough-barked Apple and Blakely's Red Gum (ID 481)	30.0
White Box - Grey Box Grassy Woodland (ID 483) EEC	101.1
Norton's Box Woodland (ID 488)	59.8
Mountain Gum - Silvertop - Stringybark Forest (ID 490)	1.1
Brittle Gum - Stringybark Woodland (ID 495)	3.1
White Box - White Cypress Pine shrubby open forest (ID 588)	0.4
Sandstone Forest - Narrow-leaved Ironbark dominant (ID 468 and 479)	42.6
Exotic	343.4

Vegetation type	Impact area (ha)
Unknown ²	0
Disturbed	0.05
Total	745.0

The final offset requirement is proposed to be calculated using field collected plot data, and would be based on the final impact areas derived from civil construction drawings (not yet available). This will provide a further incentive throughout the detailed design to minimise the clearing impacts of the works and thereby reduce the offset requirement.

Two assessments were run as the development spans two CMAs:

- The northern section: Central West CMA, Section 2.2 (map provided in Appendix A.1)
- The southern section: Hunter / Central Rivers CMA, Section 2.3 (map provided in Appendix A.5)

2.2 BIOBANKING ASSESSMENT CENTRAL WEST CMA

2.2.1 Landscape assessment

Native vegetation extent, before and after the project

In accordance with Appendix 5 of the FBA, using a GIS generated 550 m buffer from the centreline of infrastructure components:

- The total area of the project buffer is 23,522.48 ha.
- The total area of native vegetation mapped within the buffer (using canopy connected by less than 100m as a surrogate for native vegetation, as woody vegetation would have originally covered the site) is 15,193.14 ha.

The current native vegetation cover score is therefore 65%.

- The total area of native vegetation within the buffer that would be impacted by the project is 154.35 ha.

The future native vegetation cover score is therefore 64%. The extent of native vegetation within the buffer is mapped in Appendix A.1

Rivers and streams

The proposal traverses several waterways. The largest include:

- In the north, the proposed infrastructure crosses several waterways with their headwaters in Coolah Tops National Park. The largest is **Trabragar River**, a second order river where the project transmission line crosses it. It would not be impacted directly.

² Unknown areas mapped in the original assessment have now either been avoided or classified based on field assessment results.

- Near Cassilis, the transmission line crosses **Four Mile Creek**, a second order river in this location. It would not be impacted directly.

Native vegetation in the area is generally 1,000-5,000ha with connecting widths 100-500m; as such a 'large biodiversity link' has been entered in the BCC.

Patch size

For a development that is linear shaped or a multiple fragmentation development, the assessor must assess the patch size for each **Mitchell landscape** in which the development occurs, averaging the scores. For this project, several landscapes are impacted:

- Liverpool Range Valleys and Footslopes 80% cleared – most of the wind farm site
- Coolah Tops 61% cleared – small area at the very northern extent of wind farm site
- Liverpool Tops 20% cleared – small area at the north east extent of wind farm site

Refer to map of Mitchell Landscapes, Appendix A.2. The average patch size score is 12.5.

Area to perimeter ratio

One representative patch within the GIS produced buffer would be affected by the project (ID: A). The patch is made up of one polygon. The area and perimeter ratio before development is shown below.

Table 2-2 Area to perimeter ratio

Patch	Area (m ²)	Perimeter (m)
A	5,026,890	26,435.54
Area m² / Perimeter m	190.16	

Patch A is shown in Appendix A.3.

The effect of the development (the future score) is to increase the number of polygons. Taking into account the development, the future area and perimeter ratio of Patch A after development is shown below.

Table 2-3 Future patch size and perimeter

Patch A	Area (m ²)	Perimeter (m)
a	3,313,070	14,647.75
b	1,650,160	20,287.60
Totals:	4,963,230	34,935.35
Area m² / Perimeter m	142.07	

As the current ratio is greater than the future ratio, the calculator returns a proportional change % and score of Zero (0).

The landscape assessment score resulting from these inputs is 25.5.

Location of the site

IBRA SUBREGIONS

The proposed infrastructure crosses three IBRA subregions:

- Brigalow Belt South - Liverpool Range – northern area and the majority of site, including most wind turbines
- Brigalow Belt South - Pilliga – central area, south of Cassilis
- Sydney Basin – Kerrabee – southern area

Refer to map of IBRA regions, Appendix A.4. The Liverpool Range - Central West was entered into the BCC.

LOCAL GOVERNMENT AREAS (LGA)

The proposed infrastructure crosses three LGAs:

- Warrumbungle Shire
- Upper Hunter Shire
- Mid-Western Regional

Upper Hunter is the central LGA and has been entered in the calculator.

CATCHMENT MANAGEMENT AREAS

- The majority of the wind farm infrastructure proposed would be located in the Central West CMA.
- The majority of the transmission line is in the Hunter Rivers CMA.

This assessment considers infrastructure proposed in the Central West CMA only.

The resulting landscape score is 20.5.

2.2.2 Vegetation zones

The native vegetation zones that would be impacted by the northern section of the project (within the Central West CMA) as entered into the BCC (including their condition class, number of biometric plots required for them, as determined by the BCC), are provided below.

For one community, not plot data were available on the VIS database (Derived Speargrass – wallaby grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region ID 395). In the northern section of the project, this community often occurs adjacent to Silvertop Stringybark - Yellow Box – Norton’s Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range ID 488. This community and benchmark data were utilised in the BCC, deleting the overstorey cover to zero and reducing the species richness by two (to account for overstorey species). This vegetation type is of the same formation (Grassy Woodlands) in accordance with OEH advice (S. Cox, 19 Jan 2017).³

³ Vegetation communities of the same class were also considered but had poor species assemblage overlap.

2.2.3 Plot data used in the assessment

Use of benchmark data

As plot field data has not been collected for the project, the proposed approach of this preliminary assessment, as discussed in the OEH submission, is to use OEH benchmark plot data. This approach has also been used recently for the Rye Park Wind Farm; OEH held benchmark data specific to the vegetation communities to be impacted are used and are considered representative of the values that would be obtained in vegetation onsite in good condition. It may therefore be considered a conservative approach, over estimating areas that are actually of lesser quality. It is considered reasonable as this is a preliminary assessment used to determine whether offsets are feasible for the project. Having determined the likely scope of offsets, a commitment is made by the project to secure offsets in accordance with the FBA BCC methodology, using field collected plot data and based on the final construction footprint.

Modifications to benchmark data

The following plot data have been derived from benchmark data on the OEH vegetation data base. The number of plots required, as shown in Table 2-4, have been duplicated for each zone. In the cases where no benchmark is provided for a parameter, a precautionary treatment has been applied as follows:

- Exotic cover is scored as zero, assuming the vegetation is weed free.
- Regeneration is scored as 1, assuming all occurring trees are regenerating.
- Where hollow-bearing tree bench marks are listed as a decimal (ie 0.8), 1 is entered in the plot data.

Note, as the data were not collected in the field, no Easting and Northing locations apply; '111111, 1111111' has been entered for each plot.

The management scores *with development* have been entered as zero for each parameter – that is, total removal of habitat would result from the development. Future site value scores would all be zero.

Table 2-4 Impacts in vegetation zones within the project's Central West CMA, northern section (Endangered Ecological Communities (EECs) shown in bold)

Reported as:	Formation	Biometric name	Impact area	Plot number
River Oak – Rough-barked Apple – red gum – box riparian tall woodland (ID084)	Forested wetlands	River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion	6.47	3
Rough-barked Apple - Blakely's Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley floors in the northern south-west slopes and BBS Bioregions (ID281)	Grassy woodlands	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South bioregion	7.79	3
Derived Speargrass – wallaby grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region (395) ⁴	Grassy woodland	Changed in the BCC to: Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488) This could not be entered in the BCC as an EEC.	9.34	3
Yellow Box Gum Woodland (ID 437)	Grassy woodland	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion	1.51	1
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483)	Grassy Woodlands	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion	64.94	5
Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488)	Grassy Woodlands	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	59.77	5
Silvertop Stringybark – Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range (ID490)	Grassy Woodlands	Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion	1.05	1

⁴ This vegetation type is described and mapped in the biodiversity addendum report. As no benchmark data is available and this community occurs adjacent to Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range ID488 onsite, an additional ID 488 zone was created and ID 488 modified plot data were used in the assessment (overstorey reduced to zero, species richness reduced by two).

Reported as:	Formation	Biometric name	Impact area	Plot number
Brittle Gum - Silvertop Stringybark grassy open forest of the Liverpool Range (ID495)	Dry Sclerophyll Forests (Shrub/grass sub-formation)	White Box - Red Stringybark shrubby woodlands on basalt slopes of the Nandewar Bioregion and Brigalow Belt South Bioregion	3.12	2
White Box - White Cypress Pine shrubby open forest (ID588)	Dry Sclerophyll Forests (Shrub/grass sub-formation)	White Box - White Cypress Pine shrubby hills open forest mainly in the Nandewar Bioregion	0.36	1

Table 2-5 Plot data, derived from OEH database benchmarks

River Oak – Rough-barked Apple – red gum – box riparian tall woodland (ID084)

084	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	21	29	10	16	3	10	0	1	1	50	111111	1111111	1

Rough-barked Apple - Blakely's Red Gum – Yellow Box Woodland on Alluvial Clay to Loam Soils on Valley Floors in the Northern South-West Slopes and BBS Bioregions (ID281)

281	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	19	18	10	30	4	10	0	0.8	1	66	111111	1111111	1

Derived Speargrass – Wallaby Grass – Wire Grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region (395); plot data entered into BCC was derived from Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488) and not VIS plot data for 395 is available.

488 modified ⁵	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	30	0	8	40	12	10	0	2	1	15	111111	1111111	1

Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion (ID437)

437	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	25	20	12	30	4	12	0	1	1	50 ⁶	111111	1111111	1

Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483)

483	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	23	30	30	30	8	20	0	2	1	50	111111	1111111	1

Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488)

488	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	32	40	8	40	12	10	0	2	1	15	111111	1111111	1

⁵ ID 488 plot modified as follows: overstorey scored as zero, overstorey richness reduced by two to account for said overstorey species.

⁶ There is a suspected error in the benchmark data that lists this score as 0.5m. 50m has been used instead, which more closely resembles the score for similar vegetation types.

Silvertop Stringybark – Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range (ID490)

490	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	32	40	8	40	12	10	0	2	1	15	111111	1111111	1

Brittle Gum - Silvertop Stringybark grassy open forest of the Liverpool Range (ID495)

495	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	33	30	12	19	8	4	0	2	1	20	111111	1111111	1

White Box - White Cypress Pine shrubby open forest (ID588)

588	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	26	18	18	25	6	4	0	1	1	15	111111	1111111	1

2.2.4 Geographic features

The following features returned in the BCC would/would not be impacted:

Table 2-6 Geographic features

• Impacted	Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber
• Impacted	Grey Falcon	<i>Falco hypoleucos</i>	land containing within 100 m of riparian woodland on inland rivers containing mature living eucalypts or isolated paddock trees overhanging water or dry watercourses
• Not impacted ⁷	Large-eared Bat	Pied <i>Chalinolobus dwyeri</i>	land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels

2.2.5 Ecosystem credit species

The following species are all species predicted by the BCC to occur, based on the data entered for the landscape assessment and the geographic and habitat features in the assessment. These constitute all species which will generate ecosystem credits in the credit calculations.

Table 2-7 Species predicted to occur.

• Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis subsp. gularis</i>
• Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus subsp. victoriae</i>
• Bush Stone-curlew	<i>Burhinus grallarius</i>
• Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>
• Diamond Firetail	<i>Stagonopleura guttata</i>
• Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>
• Flame Robin	<i>Petroica phoenicea</i>
• Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>
• Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis subsp. temporalis</i>
• Hooded Robin (south-eastern form)	<i>Melanodryas cucullata subsp. cucullata</i>
• Little Eagle	<i>Hieraetus morphnoides</i>

⁷ In response to the OEH submission, this species is assumed to occur in the southern assessment (Hunter/Central Rivers). However, no caves now occur in the project footprint and so no impact on this geographic feature has been entered.

• Little Lorikeet	<i>Glossopsitta pusilla</i>
• Masked Owl	<i>Tyto novaehollandiae</i>
• Painted Honeyeater	<i>Grantiella picta</i>
• Powerful Owl	<i>Ninox strenua</i>
• Scarlet Robin	<i>Petroica boodang</i>
• Speckled Warbler	<i>Chthonicola sagittata</i>
• Spotted Harrier	<i>Circus assimilis</i>
• Spotted-tailed Quoll	<i>Dasyurus maculatus</i>
• Swift Parrot	<i>Lathamus discolor</i>
• Turquoise Parrot	<i>Neophema pulchella</i>
• Varied Sittella	<i>Daphoenositta chrysoptera</i>
• Yellow-bellied Glider	<i>Petaurus australis</i>
• Yellow-bellied Sheathtail-bat	<i>Saccolaimus flaviventris</i>

2.2.6 Threatened species credit species

The following species were returned by the BCC as requiring survey. The table below states whether each species was detected during surveys and furthermore, if impacts are likely.

Table 2-8 Species that generate species credits if impacted.

• Australasian Bittern	<i>Botaurus poiciloptilus</i>	Not identified	No impact
• Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	Not identified	No impact
• Eastern Pygmy-possum	<i>Cercartetus nanus</i>	Not identified	No impact
• Grey Falcon	<i>Falco hypoleucos</i>	Not identified	No impact
• Koala	<i>Phascolarctos cinereus</i>	Not identified	No impact
• Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Identified	Impact
• Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	Not identified	No impact
• Regent Honeyeater	<i>Anthochaera phrygia</i>	Not identified	No impact
• Squirrel Glider	<i>Petaurus norfolcensis</i>	Identified in WFSA	Impact

The Large-eared Bat and Squirrel Glider were returned by the BCC. Based on habitat modelling an estimated 19 ha of potential moderate or better woodland habitat would be impacted for each species. This has been entered as a loss.

Additionally, the following species are known to occur and have been entered into the BCC as being impacted as follows:

- Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*

If species are identified in consultation with OEH or in subsequent surveys, this information would inform the final offset package to be developed for the project.

2.2.7 Credit statement

The following credit statement was returned from the BCC.

Table 2-9 Credit statement for the Central West northern section of the proposal

PC type code	Plant community type name	Management zone area (ha)	TS with highest credit req	Ecosystem credits required
CW180	River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion	6.47	Masked Owl	518
CW111	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	7.79	Powerful Owl	562
CW304	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	9.34	Powerful Owl	581
CW322	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion	64.94	Powerful Owl	4078
CW304	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	59.77	Powerful Owl	4789
CW303	Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion	1.05	-	32

PC type code	Plant community type name	Management zone area (ha)	TS with highest credit req	Ecosystem credits required
CW210	White Box - Red Stringybark shrubby woodlands on basalt slopes of the Nandewar Bioregion and Brigalow Belt South Bioregion	3.12	Masked Owl	210
CW225	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion	1.51	Masked Owl	118
CW214	White Box - White Cypress Pine shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion	0.36	Masked Owl	22
Scientific name		Common name	TS offset multiplier	Species credits required
<i>Petaurus norfolcensis</i>		Squirrel Glider	2.2	418
Chalinolobus dwyeri		Large-eared Pied Bat	1.3	247
Miniopterus schreibersii subsp. oceanensis		Eastern Bentwing-bat	1.3	247

2.3 BIOBANKING ASSESSMENT HUNTER / CENTRAL RIVERS CMA

2.3.1 Landscape assessment

Native vegetation extent, before and after the project

In accordance with Appendix 5 of the FBA, using a GIS generated 550 m buffer from the centreline of infrastructure components:

- The total area of the project buffer is 9,789.16 ha.
- The total area of native vegetation mapped within the buffer (using canopy connected by less than 100m as a surrogate for native vegetation) is 3,076.93 ha.

The current native vegetation cover score is therefore 31%.

- The total area of native vegetation within the buffer that would be impacted by the project is 247.13 ha.

The future native vegetation cover score is therefore 29%. The extent of native vegetation within the buffer is mapped in Appendix A.5.

Rivers and streams

The proposal traverses several waterways. The largest include:

- Near Turil, the transmission line crosses **Curryall Creek**, a third order river in this location. It would not be impacted directly.
- In the south, the transmission line crosses **Goulburn River**, a fourth order river in this location. It would not be impacted directly.

As the easements may require additional clearing within these riparian corridors, impact on a 'riparian buffer of a 4th or 5th order stream has been selected.

Patch size

For a development that is linear shaped or a multiple fragmentation development, the assessor must assess the patch size for each **Mitchell landscape** in which the development occurs, averaging the scores. For this project, several landscapes are impacted:

- Cassillis Slopes 65% cleared - most of the transmission line easement
- Talbragar – Upper Macquarie Terrace Sand 93% cleared – small areas of transmission line and access
- Goulburn River Channels and Floodplains 71% cleared – very small area of transmission line at south of project site

Refer to map of Mitchell Landscapes, Appendix A.2. The average patch size score is 12.5.

Area to perimeter ratio

One representative patch within the GIS produced buffer would be affected by the project (ID: A). The patch is made up of one polygon. The area and perimeter ratio before development is shown below.

Table 2-10 Area to perimeter ratio

Patch	Area (m ²)	Perimeter (m)
A	33,130,700	14,647.75
B	16,501,600	20,287.60
Area m² / Perimeter m	142	

Patch A is shown below in Appendix A.6.

The effect of the development (the future score) is to increase the number of polygons. Taking into account the development, the future area and perimeter ratio of Patch A after development is shown below.

Table 2-11 Future patch size and perimeter

Patch A	Area (m ²)	Perimeter (m)
a	1,481,580	11,229.79
b	949,369	6,455.49
c	4,943	412.47
d	6,518	328.40
e	1,031	268.25
Totals:	2,443,441	18,694.39
Area m2 / Perimeter m	131	

As the current ratio is greater than the future ratio, the calculator returns a proportional change % and score of Zero (0).

The landscape assessment score resulting from these inputs is 23.45.

Location of the site

IBRA SUBREGIONS

The proposed infrastructure crosses three IBRA subregions:

- Brigalow Belt South - Liverpool Range – northern area
- Brigalow Belt South - Pilliga – central area, south of Cassilis
- Sydney Basin – Kerrabee – southern area

Refer to map of regions, Appendix A.4. The Kerrabee – Hunter central rivers was entered into the BCC.

LOCAL GOVERNMENT AREAS (LGA)

The proposed infrastructure crosses three LGAs:

- Warrumbungle Shire
- Upper Hunter Shire
- Mid-Western Regional

Upper Hunter is the central LGA and has been entered in the calculator.

CATCHMENT MANAGEMENT AREAS

- The majority of the wind farm infrastructure proposed would be located in the Central West CMA.
- The majority of the transmission line is in the Hunter / Central Rivers CMA.

This assessment considers infrastructure proposed in the Hunter / Central Rivers CMA only.

The resulting landscape score is 24.75.

2.3.2 Vegetation zones

The native vegetation zones that would be impacted by the southern section of the project (within the Hunter Rivers / Central CMA) as entered into the BCC (including their condition class, number of biometric plots required for them, as determined by the BCC), are provided below.

For one community, not plot data were available on the VIS database (Derived Speargrass – wallaby grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region ID 395). In the southern section of the project, this community occurs most often adjacent to Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region ID 483, this community and benchmark data were utilised in the BCC, deleting the overstorey cover to zero and reducing the species richness by two (to account for overstorey species). This vegetation type is of the same formation (Grassy Woodlands) in accordance with OEH advice (S. Cox, 19 Jan 2017).⁸

2.3.3 Plot data used in the assessment

As stated in Section 2.2.3, the following plot data have been derived from benchmark data on the OEH vegetation data base. The number of plots required, as shown in Table 2-4, have been duplicated for each zone. In the cases where no benchmark is provided for a parameter, a precautionary treatment has been applied as follows:

- Exotic cover is scored as zero, assuming the vegetation is weed free.
- Regeneration is scored as 1, assuming all occurring trees are regenerating.
- Where hollow-bearing tree bench marks are listed as 0.8, 1 is entered in the plot data.

Note, as the data were not collected in the field, no Easting and Northing locations apply; '111111, 1111111' has been entered for each plot.

The management scores *with development* have been entered as zero for each parameter – that is, total removal of habitat would result from the development. Current site value scores are shown in Table 2-4. Future site value scores would all be zero.

⁸ Vegetation communities of the same class were also considered but had poor species assemblage overlap.

Table 2-12 Vegetation zones within the project (EECs shown in bold)

Reported as:	Formation	Biometric name	Impact area	Plot number
Riparian Blakely's Red Gum - box - sedge - grass tall open forest of the central NSW South Western Slopes Bioregion (ID 278).⁹	Grassy Woodlands	Entered in BCC as: Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion HU681, 278 plot data used.	3.55	2
Rough-barked Apple - Blakely's Red Gum – Yellow Box Woodland on Alluvial Clay to Loam Soils on Valley Floors in the Northern South-West Slopes and BBS Bioregions (ID281)	Grassy woodlands	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South bioregion HU714	11.15	3
Derived Speargrass – wallaby grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region (395)¹⁰	Grassy woodland	Entered in the BCC as Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483). 483 plot data used. Could not be selected as an EEC in the BCC.	77.26	5
Blue-Leaved Ironbark – Black Cypress Pine Shrubby Sandstone Open Forest in the Southern BBS Bioregion (Benson ID 467)	Dry Sclerophyll Forests (Shrubby sub-formation)	Blue-leaved Ironbark - Black Cypress Pine shrubby sandstone open forest in the southern Brigalow Belt South Bioregion (including Goonoo) HU 682	3.30	2

⁹ Not available to be selected in the BCC.

¹⁰ This vegetation type is described and mapped in the biodiversity addendum report. As no benchmark data is available and this community occurs adjacent to Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region ID483 onsite, an additional ID 483 zone was created and ID 483 modified plot data were used in the assessment (overstorey reduced to zero, species richness reduced by two).

Reported as:	Formation	Biometric name	Impact area	Plot number
Inland Scribbly Gum – Red Stringybark – Black Cypress Pine – Red Ironbark Open Forest on Sandstone Hills in the Southern Brigalow Belt South Bioregion and Northern NSW South Western Slopes Bioregion (ID 477) ¹¹	Dry Sclerophyll Forests (Shrubby sub-formation)	Entered into BCC as Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion HU 707	31.51	4
Narrow-leaved Stringybark – Narrow-leaved Wattle Forest (478)	Dry Sclerophyll Forests (Shrubby sub-formation)	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion HU 707	1.20	1
Black Cypress Pine – Ironbark – Wattle Low Open Forest Mainly on Narrabeen Sandstone (ID 480)	Dry Sclerophyll Forests (Shrubby sub-formation)	Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion HU 678	10.32	3
Rough-barked Apple / Blakely's Red Gum / Narrow-leaved Stringybark +/- Grey Gum Sandstone Riparian Grass Fern Open Forest in the Southern BBS and Upper Hunter Regions (ID481)	Dry Sclerophyll Forests (Shrubby sub-formation)	Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest on in the southern Brigalow Belt South Bioregion and Upper Hunter region HU713	30.04	4

¹¹ Not available to be selected in the BCC.

Reported as:	Formation	Biometric name	Impact area	Plot number
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483)	Grassy Woodlands	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley HU690	36.16	4
Narrow-leaved Ironbark – Blakeley's Red Gum shrubby open forest on sandstone low hills (ID468) and Narrow-Leaved Ironbark – Black Cypress Pine – Stringybark – Wattle Shrubby Open Forest on Sandstone (ID 479) ¹²	Dry Sclerophyll Forests (Shrubby sub-formation)	Entered as one zone in the BCC as ID 479 in the BCC. Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney Basin Bioregion HU 702 479 plot data used.	42.65	4

Table 2-13 Plot data, derived from OEH database benchmarks

Riparian Blakely's Red Gum - box - sedge - grass tall open forest of the central NSW South Western Slopes Bioregion (ID 278); entered in BCC as Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion HU681

278 – 2 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	25	22	10	50	4	10	0	0.8	1	66	111111	1111111	1

Rough-barked Apple - Blakely's Red Gum – Yellow Box Woodland on Alluvial Clay to Loam Soils on Valley Floors in the Northern South-West Slopes and BBS Bioregions (ID281)

281 – 3 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	19	18	10	30	4	10	0	0.8	1	66	111111	1111111	1

¹² As per the Biodiversity Addendum, these vegetation types are combined as one zone. The 479 plot data are entered into the BCC as Narrow-Leaved Ironbark – Black Cypress Pine – Stringybark – Wattle Shrubby Open Forest on Sandstone Hills ID 479, given the benchmark data are slightly higher values and this may be a conservative approach.

Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483)

483 – 5 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	23	30	30	30	8	20	0	2	1	50	111111	1111111	1

Blue-Leaved Ironbark – Black Cypress Pine Shrubby Sandstone Open Forest in the Southern BBS Bioregion (Benson ID 467)

467 – 2 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	30	22	20	20	20	20	0	2	1	46	111111	1111111	1

Inland Scribbly Gum – Red Stringybark – Black Cypress Pine – Red Ironbark Open Forest on Sandstone Hills in the Southern Brigalow Belt South Bioregion and Northern NSW South Western Slopes Bioregion (Benson Id477)

477 – 4 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	30	22	22	15	15	15	0	2	1	46	111111	1111111	1

Narrow-leaved Stringybark – Narrow-leaved Wattle Forest (478)

478 – 1 plot	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	30	22	20	20	20	18	0	2	1	20	111111	1111111	1

Black Cypress Pine – Ironbark – Wattle Low Open Forest Mainly on Narrabeen Sandstone (Benson Id480)

480 – 3 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	30	30	20	20	20	18	0	2	1	20	111111	1111111	1

Rough-barked Apple / Blakely's Red Gum / Narrow-leaved Stringybark +/- Grey Gum Sandstone Riparian Grass Fern Open Forest in the Southern BBS and Upper Hunter Regions (ID481)

481 – 4 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	31	30	30	30	30	20	0	1.5	1	10	111111	1111111	1

Narrow-Leaved Ironbark – Black Cypress Pine – Stringybark – Wattle Shrubby Open Forest on Sandstone Hills (Benson Id479)

479 – 4 plots	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	30	22	20	20	20	18	0	2	1	66	111111	1111111	1

2.3.4 Geographic features

No features were returned by the BCC.

2.3.5 Ecosystem credit species

The following species are all species predicted by the BCC to occur, based on the data entered for the landscape assessment and the geographic and habitat features in the assessment. These constitute all species which will generate ecosystem credits in the credit calculations.

Table 2-14 Species predicted to occur.

• Barking Owl	<i>Ninox connivens</i>
• Little Lorikeet	<i>Glossopsitta pusilla</i>
• Painted Honeyeater	<i>Grantiella picta</i>
• Square-tailed Kite	<i>Lophoictinia isura</i>
• Turquoise Parrot	<i>Neophema pulchella</i>
• Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>

2.3.6 Threatened species credit species

The following species were returned by the BCC as requiring survey. The table below states whether each species was detected during surveys and furthermore, if impacts are likely.

Table 2-15 Species that generate species credits if impacted.

• <i>Commersonia procumbens</i>	<i>Commersonia procumbens</i>	Not identified	No impact
• Large leafed Monotaxis	<i>Monotaxis macrophylla</i>	Not identified	No impact
• Regent Honeyeater	<i>Anthochaera phrygia</i>	Not identified	No impact
• Scant Pomaderris	<i>Pomaderris queenslandica</i>	Not identified	No impact

Silky Swainson-pea was recorded in the TLSA in native pasture / White Box-Grey Box Grassy Woodland; one individual. It is not listed above as either predicted to occur or requiring survey. It was entered as being impacted into the BCC.

Additionally, the following species are known to occur and have been entered as being impacted as follows:

- Squirrel Glider *Petaurus norfolcensis* – 19 ha of moderate or better woodland habitat.¹³
- Large-eared Pied Bat *Chalinolobus dwyeri* - 19 ha of moderate or better woodland habitat.¹⁴

¹³ All habitat impacts have been added to the norther section assessment and not split between the southern section impacts.

- Diamond Firetail *Stagonopleura guttata* — 19 ha of moderate or better woodland habitat.
- Black-chinned Honeyeater *Melithreptus gularis gularis* - 19 ha of moderate or better woodland habitat.
- Grey-crowned Babbler *Pomatostomus temporalis*- 19 ha of moderate or better woodland habitat.
- Speckled Warbler *Pyrrholaemus sagittatus* - 19 ha of moderate or better woodland habitat.¹⁵
- Eastern Cave Bat *Vespadelus troughtoni* - 19 ha of moderate or better woodland habitat.
- Corben's Long-eared Bat *Nyctophilus corbeni* (form. *timorensis*) - 19 ha of moderate or better woodland habitat.
- Masked Owl *Tyto novaehollandiae* - 19 ha of moderate or better woodland habitat.
- Glossy Black Cockatoo *Calyptorhynchus lathami* - 19 ha of moderate or better woodland habitat.
- Powerful Owl *Ninox strenu* - 19 ha of moderate or better woodland habitat.
- Dusky Woodswallow *Artamus cyanopterus* - 19 ha of moderate or better woodland habitat.¹⁶

If species are identified in consultation with OEH or in subsequent surveys, this information would inform the final offset package to be developed for the project.

2.3.7 Credit statement

The following credit statement was returned from the BCC.

¹⁴ All habitat impacts have been added to the northern section assessment and not split between the southern section impacts.

¹⁵ Not available in the BCC to add to the species list.

¹⁶ Not available in the BCC to add to the species list.

Table 2-16 Credit statement for the Hunter / Central Rivers southern section of the proposal

PC type code	Plant community type name	Management zone area (ha)	TS with highest credit req	Ecosystem credits required
HU681	Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion	3.55	Barking Owl	266
HU714	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	11.15	Barking Owl	836
HU690	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	77.26	Barking Owl	6273
HU682	Blue-leaved Ironbark - Black Cypress Pine shrubby sandstone open forest in the southern Brigalow Belt South Bioregion (including Goonoo)	3.3	Barking Owl	242
HU707	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion	31.51	Barking Owl	2511
HU707	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion	1.2	Barking Owl	85
HU678	Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	10.32	Barking Owl	838
HU713	Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest on in the southern Brigalow Belt South Bioregion and Upper Hunter region	30.04	Barking Owl	2439
HU690	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	36.16	Barking Owl	2936
HU702	Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney	42.65	Barking Owl	3196

PC type code	Plant community type name	Management zone area (ha)	TS with highest credit req	Ecosystem credits required
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Basin Bio

Scientific name	Common name	TS offset multiplier	Species credits required
<i>Melithreptus gularis subsp. gularis</i>	Black-chinned Honeyeater (eastern subspecies)	1.3	247
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	2.1	399
<i>Stagonopleura guttata</i>	Diamond Firetail	1.3	247
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	1.3	247
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	1.8	342
<i>Pomatostomus temporalis subsp. Temporalis</i>	Grey-crowned Babbler (eastern subspecies)	1.3	247
<i>Tyto novaehollandiae</i>	Masked Owl	3	570
<i>Ninox strenua</i>	Powerful Owl	3	570
<i>Swainsona sericea</i>	Silky Swainson-pea	1.8	18

2.4 CREDIT CONVERSION

The OEH 'credit converter' tool has been used to convert the credit requirements of the development into an estimate of the areas of each vegetation type needed to satisfy those credit requirements.

Table 2-17 Credit conversion: area estimated to achieve offset requirement

Entity requiring offsets		Credit requirement	Area of land required, as determined by the credit calculator (ha)
Northern section: Central West Catchment Management Area			
CW180	River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion	518	55.7
CW111	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	562	60.4

Entity requiring offsets		Credit requirement	Area of land required, as determined by the credit calculator (ha)
CW304	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	581	62.5
CW322	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion	4078	438.5
CW304	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	4789	514.9
CW303	Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion	32	3.4
CW210	White Box - Red Stringybark shrubby woodlands on basalt slopes of the Nandewar Bioregion and Brigalow Belt South Bioregion	210	22.6
CW225	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion	118	12.7
CW214	White Box - White Cypress Pine shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion	22	2.4
Subtotal		10,910	1,173.10
<i>Petaurus norfolcensis</i>	Squirrel Glider	418	70
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	247	41
<i>Miniopterus schreibersii subsp. Oceanensis</i>	Eastern Bentwing-bat	247	41
Subtotal		912	152.00
Southern section: Hunter Rivers Catchment Management Area			
HU681	Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion	266	28.6
HU714	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	836	89.9
HU690	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	6273	674.5
HU682	Blue-leaved Ironbark - Black Cypress Pine shrubby sandstone open forest in the southern Brigalow Belt South Bioregion (including Goonoo)	242	26

Entity requiring offsets		Credit requirement	Area of land required, as determined by the credit calculator (ha)
HU707	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion	2511	270
HU707	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion	85	9.1
HU678	Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	838	90.1
HU713	Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest on in the southern Brigalow Belt South Bioregion and Upper Hunter region	2439	315.7
HU690	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	2936	315.7
HU702	Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney Basin Bio	3196	343.7
Subtotal		19,622	2,163.30
<i>Swainsona sericea</i>	Silky Swainson-pea	18	2
<i>Calyptrorhynchus lathami</i>	Glossy Black-Cockatoo	342	52
<i>Melithreptus gularis</i> subsp. <i>gularis</i>	Black-chinned Honeyeater (eastern subspecies)	247	41
<i>Ninox strenua</i>	Powerful Owl	570	90
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	399	70
<i>Pomatostomus temporalis</i> subsp. <i>Temporalis</i>	Grey-crowned Babbler (eastern subspecies)	247	41
<i>Stagonopleura guttata</i>	Diamond Firetail	247	41
<i>Tyto novaehollandiae</i>	Masked Owl	570	90
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	247	41
Subtotal		2,887	468.00

Table 2-18 Project credit and area summary

Entity requiring offsets	Credit requirement	Area of land required, as determined by the credit calculator (ha)
Ecosystem credits		
Northern section ecosystem credit subtotal	10,910	1,173.10
Southern section ecosystem credit subtotal	19,622	2,163.30
Total	30,532	3,336.40
Species credits		
Northern section species credit subtotal	912	152.00
Southern section species credit subtotal	2,887	468.00
Total	3,799	620.00

Combined for the project, approximately 3,336.40 ha would be required to satisfy ecosystem credits. Subject to this area being able to also satisfy species credits, up to an additional 620 ha may be required for species credits.

Note:

The requirements are not cumulative. If species credit requirements are required, an area may concurrently satisfy the vegetation community and one or more threatened species requirements, subject to confirmation that the site provides habitat for the species.

3 PRELIMINARY OFFSET EVALUATION

3.1 CANDIDATE OFFSET SITES

Given the extensive offsets required, a suite of sites is likely to be required if physical offsets are secured for the project, rather than the purchase of credits or payment into and offset fund (refer to Section 4.1 for discussion on options available to satisfy the offset requirement). The intention of this evaluation is to demonstrate that physical offsets are feasible and achievable for the project.

The proponent has indicated a preference to secure offset areas within the project boundary. Involved landowners within the project boundary are able to be involved in the offset package, rather than involving a third party or external site. As they already own the site, no purchase of a BioBanking site is required. Mapping and surveys undertaken to date suggest that there is vegetation within the site boundary that is similar to that being cleared and therefore is highly likely to offer a like for like offset. It is noted that some additional sites outside the project boundary have also been identified as they offer strategic benefits for connectivity to existing reserves.

Based on the preliminary assessment of likely credit requirements in Section 2, ten candidate offset sites have been so far been identified, totalling 3,025 ha. These landowners have been approached and are amenable to further investigation and to having suitable areas managed for conservation in perpetuity. As such, all of the candidate sites so far considered are feasible to include within the offset package for the project, subject to further investigation to verify their suitability.

An overview of the suitability of these sites is presented overleaf, with reference to what is known either from rapid field assessment conducted during the 2015 and 2016 additional surveys, or because of surveys adjacent to these areas Table 3-1. The location of each site is mapped in Appendix A.7 and A.8.

Note on impacts to Ulan Mine offset areas:

All areas impacted by the wind farm and ancillary infrastructure would be offset, as demonstrated by this strategy. However, it is noted that a section of the proposed main powerline passes through the Bobadeen East Vegetation Offset Area (BEVOA) which is a proposed offset area for the Ulan Mine. An amendment to the boundary of the BEVOA has been made such that the wind farm's impact area is now outside the BEVOA. The amendment now ensures no impact on the BEVOA. All native vegetation impacts would be offset in accordance with the FBA offset requirements.

3.2 FINAL SELECTION OF SITES

Use of actual rather than benchmark plot data in this final offset calculations is likely to reduce the credit requirement somewhat as not all parameters of the vegetation to be impacted are expected to be within benchmark. Determining and securing offsets in accordance with the FBA for Major Projects, and in consultation with OEH, is a commitment of this project.

In delineating the final offset site boundaries, a minimum distance from infrastructure would be implemented to ensure the sites are not affected in the long term by indirect impacts. For example:

- 300m from wind turbines (300m from centres);
- 50m from tracks, powerlines and other linear infrastructure (50m from centrelines); and
- 50m from the outer edge of all other infrastructure.

3.3 COMMONWEALTH OFFSET REQUIREMENTS

Commonwealth offsets are not considered specifically in this assessment. It is noted that all vegetation communities and threatened species that could be impacted significantly and therefore required to be offset under the Commonwealth requirements are already included in the NSW assessment. It is further noted that the NSW offset requirements are usually more onerous than the Commonwealth requirements and therefore, as a preliminary assessment, Commonwealth offset requirements (if needed) are similarly expected to be able to be offset.

Table 3-1 Offset site overview

Site and size	Vegetation	Threatened species	Landscape position / connectivity
1 262.29 ha	Vegetation in this area is in good condition and includes: - Narrow-leaved Ironbark – Blakeley’s Red Gum shrubby open forest on sandstone low hills (ID468) - Narrow-Leaved Ironbark – Black Cypress Pine – Stringybark – Wattle Shrubby Open Forest on Sandstone (ID 479) - Rough-barked Apple / Blakely’s Red Gum / Narrow-leaved Stringybark +/- Grey Gum Sandstone Riparian Grass Fern Open Forest in the Southern BBS and Upper Hunter Regions (ID481) - Derived Speargrass – wallaby grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region (395)	Threatened species recorded from the proposed transmission line that dissects the site include: - Glossy Black Cockatoo - Corbens long eared bat - Speckled warbler	The site is to the immediate west of Curryall State Forest. It provides an important east-west link in an area where woodland habitat narrows and a landscape scale. It is understood OEH have intended to purchase this area and manage it for biodiversity conservation. Occurring adjacent the proposed transmission line, it is expected to be very suitable to offset the vegetation and habitat required to be cleared for the transmission line. If secured, edge effects of these impacts could be best managed and the link’s function maintained.
2 219.65 ha	Vegetation in this area is in moderate to good condition and includes: - Narrow-leaved Ironbark – Blakeley’s Red Gum shrubby open forest on sandstone low hills (ID468) - Narrow-Leaved Ironbark – Black Cypress Pine – Stringybark – Wattle Shrubby Open Forest on Sandstone (ID 479) - Rough-barked Apple / Blakely’s Red Gum / Narrow-leaved Stringybark +/- Grey Gum Sandstone Riparian Grass Fern Open Forest in the Southern BBS and Upper Hunter Regions (ID481) - Blue-Leaved Ironbark – Black Cypress Pine Shrubby Sandstone Open Forest in the Southern BBS Bioregion (Benson ID 467)	Threatened species recorded from the proposed transmission line that dissects the site include: - Powerful Owl - Black Cockatoo Fauna habitat includes: - Open forest - Woodland and, - Riparian areas	Occurring adjacent the proposed transmission line, it is expected to be very suitable to offset the vegetation and habitat required to be cleared for the transmission line. If secured, edge effects of the transmission line could be specifically managed.

Site and size	Vegetation	Threatened species	Landscape position / connectivity
3 17.74 ha	The vegetation in this area unknown, but based on adjacent vegetation is likely to include: - Narrow-leaved Ironbark – Blakeley’s Red Gum shrubby open forest on sandstone low hills (ID468) - Narrow-Leaved Ironbark – Black Cypress Pine – Stringybark – Wattle Shrubby Open Forest on Sandstone (ID 479)	Threatened species recorded from the proposed transmission line nearby include: - Black Cockatoo Fauna habitat includes: - Pasture with scattered trees and, - Woodland	Occurring adjacent the proposed transmission line, it is expected to be very suitable to offset the vegetation and habitat required to be cleared for the transmission line. If secured, edge effects of the transmission line could be specifically managed.
4 399.42 ha	Unknown	Unknown	Located along the northern edge of more extensive woodland, management of this large land parcel may reduce edge effects in adjacent habitats to the south and thereby contribute to landscape connectivity.
5 78.22 ha	Vegetation in this area is in moderate to good condition. It may contain vegetation including: - Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley HU690, - Blue-leaved Ironbark - Black Cypress Pine shrubby sandstone open forest in the southern Brigalow Belt South Bioregion (including Goonoo) HU682, - Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion HU678 and - Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney Basin Bioregion HU702.	Fauna habitat features mapped in this area include - two rocky outcrops and - one hollow bearing tree.	This area is surrounded by Goulburn River National Park. Converting this area to conservation management objectives would consolidate the existing reserve and remove threats that may affect adjacent areas in the park, such as weed or feral animal spread resulting from agriculture. While located within an extensive vegetated area, this location provides a diversity of habitat, from more open woodland to gullies. Ecotonal areas can have higher diversity of flora and fauna.

Site and size	Vegetation	Threatened species	Landscape position / connectivity
6 186 ha	Occur adjacent to: poor condition Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483), however, the tree cover on the offset candidate site is likely to mean this vegetation is of higher quality than the mapped vegetation. Note: infrastructure buffers would be applied to minimise impacts of infrastructure, if this site is included in the offset package.	Fauna habitat includes: Woodland	Includes the lower slope and northern bank of a riparian corridor and may therefore enhance local movement corridors if managed for biodiversity conservation.
7 192 ha	Occurs adjacent to: poor – moderate condition Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483), however, the tree cover on the offset candidate site is likely to mean this vegetation is of higher quality than the mapped vegetation. Note: infrastructure buffers would be applied to minimise impacts of infrastructure, if this site is included in the offset package.	Fauna habitat includes: - Pasture with scattered trees and, - Woodland	Relatively isolated but includes steep slopes and gullies that could provide good habitat if managed for biodiversity conservation.
8 535 ha	Includes: - moderate condition River Oak – Rough-barked Apple – red gum – box riparian tall woodland (ID084) as well as - poor condition Rough-barked Apple - Blakely's Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley floors in the northern south-west slopes and BBS Bioregions (ID281) and - poor condition Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488), based on surveys conducted through this area for a transmission line that has since been rerouted. Note: infrastructure buffers would be applied to minimise impacts of infrastructure, if this site is included in the offset package.	Fauna habitat includes: - Pasture with scattered trees and, - Woodland	Through candidates 9 and 10, this candidate would contribute to a large connected area contiguous with Coolah Tops National Park. Includes steep slopes and gullies that could provide good habitat if managed for biodiversity conservation.

Site and size	Vegetation	Threatened species	Landscape position / connectivity
9 121 ha	Occurs adjacent to: poor – moderate condition Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483), however, the tree cover on the offset candidate site is likely to mean this vegetation is of higher quality than the mapped vegetation. Note: infrastructure buffers would be applied to minimise impacts of infrastructure, if this site is included in the offset package.	Nearby records include: - Varied Sittella, - Wedge-tailed Eagle, - Nankeen Kestrel and - Brown Falcon. Fauna habitat includes: - Pasture with scattered trees and, - Woodland	Through candidate 10, this candidate would contribute to a large connected area contiguous with Coolah Tops National Park. Includes steep slopes and gullies that could provide good habitat if managed for biodiversity conservation.
10 1021 ha	Occurs adjacent to: - moderate condition Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488) and - poor condition Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483). Note: infrastructure buffers would be applied to minimise impacts of infrastructure, if this site is included in the offset package.	Nearby records include: - Wedge-tailed Eagle, - Nankeen Kestrel and - Brown Falcon. Fauna habitat includes: - Pasture with scattered trees and, - Woodland	This candidate would contribute to a large connected area contiguous with Coolah Tops National Park. Includes steep slopes and gullies that could provide good habitat if managed for biodiversity conservation.
3,025 ha	Total		

4 IMPLEMENTATION

4.1 OPTIONS TO SATISFY THE PROJECT'S CREDIT REQUIREMENT

The proponent commits to securing a formal vehicle to secure and manage the project's offset sites in perpetuity. It is understood that a number of options may be available including:

- Purchase of existing credits from the BioBanking Public Register
- Establishment of BioBanking sites
- Payment into an Offset Fund.

The proponent commits to working with the DPE and OEH to find a suitable security mechanism for the project.

4.2 TIMING OF IMPLEMENTATION

Assuming that not all of the credits can be found on the BioBanking Public Register and that an Offset Fund is not available for the project, this implementation section focusses on identifying and securing physical offset sites from among the project's involved landowners.

It is proposed that the project's offsets requirement should accurately reflect the project's final impact on biodiversity values as much as possible and not be based on concept drawings, as are currently available. This is particularly important for wind farm projects where the detailed design phase can require adjustments to access tracks and turbine locations. Additionally, this will provide a further incentive throughout the detailed design to minimise the clearing impacts of the works and thereby reduce the offset requirement.

The following stages of implementing the final Offset Package for the project are proposed. The aim of this timeline is to provide a clear path to identifying, securing and managing suitable offset lands prior to any construction impact.

Post approval, documented within the project's detailed Offset Plan

1. Determine final credit requirement using the FBA in consultation with OEH, based on:
 - a. Detailed construction drawings, (which will be submitted to Department of Planning and Environment (DPE) and deemed by the proponent to be final)
 - b. Plot data collected for the project footprint, in accordance with the FBA.
2. Select the final suite of offset sites including accurate calculation of credits able to be retired at each offset site based on plot data collected for the offset sites, in accordance with the FBA.
3. Develop detailed management actions in consultation with the landowners who will be responsible for implementing the actions, referencing the templates provided by OEH for BioBank site management. An example of typical management measures expected to be carried out is provided overleaf, Table 4-1.

After construction

4. Verify that the actual post construction impact area does not exceed that used to calculate the offset requirement in Step 1.
5. Formally secure the offset sites as BioBanking sites, including detailed management plans for each offset site and delineation of the final offset site boundaries. All costs of site assessment and credit purchase will be borne by the proponent.
6. Landowners become responsible for Biobank site management actions in accordance with the site specific management plans, with funding provided by the Biobanking fund, to ensure ongoing biodiversity improvement at the offset sites for the life of the project.

Table 4-1 Example offset site management measures

Management measure	Objective	Justification	Action	Timing
Exclusion of stock	To prevent overgrazing and encourage regeneration of native vegetation and maintenance of tussocks in grasslands.	Grazing would be likely to degrade habitat.	Install stock proof fencing around the perimeter of the Offset Site.	- At establishment of the Offset Site. - Ongoing repairs as required.
Weed control	To minimise the occurrence of weeds within the Offset Site particularly Weeds of National Significance (WoNS) and listed noxious weeds.	Weeds compete with native species and degrade habitats.	- Survey to identify target locations for weed control. - Weed control using appropriate methodologies considering target species and landscape context.	- At establishment of the Offset Site. - Ongoing as required.
Planting trees in pasture	To enhance connectivity in secondary grasslands.	Planting would provide greater connectivity and potential for hollows in the long term. In turn, it would also increase tree numbers through natural recruitment.	- Plant tube stock trees, appropriate to the vegetation type, in native pasture and derived grasslands - Placement to consider strategic connectivity.	At establishment of the Offset Site.
Feral animal control	To minimise the risk of the Offset Site becoming a refuge for feral animals.	Feral animals can reduce native vegetation quality, compete with native fauna for resources and/or prey on native fauna.	- Monitor for presence of feral animals. - Conduct control appropriate to the feral animal species	Consideration given to action on the basis of monitoring results.

Management measure	Objective	Justification	Action	Timing
			detected during monitoring. Where possible, coordinate control efforts with adjacent landowners to maximise effects	

5 CONCLUSION

This strategy demonstrates means to secure suitable and adequate offsets, prior to any construction impacts, with reference to the Framework for Biodiversity Assessment (FBA, 2016) for Major Projects.

Combined for the project, approximately 3,336.40 ha would be required to satisfy ecosystem credits. Subject to this area being able to also satisfy species credits, up to an additional 620 ha may be required for species credits.

It is understood that several options may be considered for transitional major project offsets:

- Purchase of existing credits from the BioBanking Public Register
- Establishment of BioBanking sites
- Payment into an Offset Fund.

Several candidate offset sites have currently been investigated to varying degrees. The offset candidates in total equal 3,025 ha and include vegetation and habitat types required to be offset.

The proponent commits to working with the DPE and OEH to find a suitable in perpetuity security mechanism for the project. Implementation notes are included in this strategy to ensure the final offsets account for the final clearing impacts.

APPENDIX A OFFSET STRATEGY MAP SET

A.1 Extent of native vegetation: northern section, central west CMA

A.2 Mitchell landscapes for the project area

A.3 Representative patch used in landscape assessment: northern section, central west CMA

A.4 IBRA subregions for the project area

A.5 Extent of native vegetation: southern section, hunter / central rivers CMA

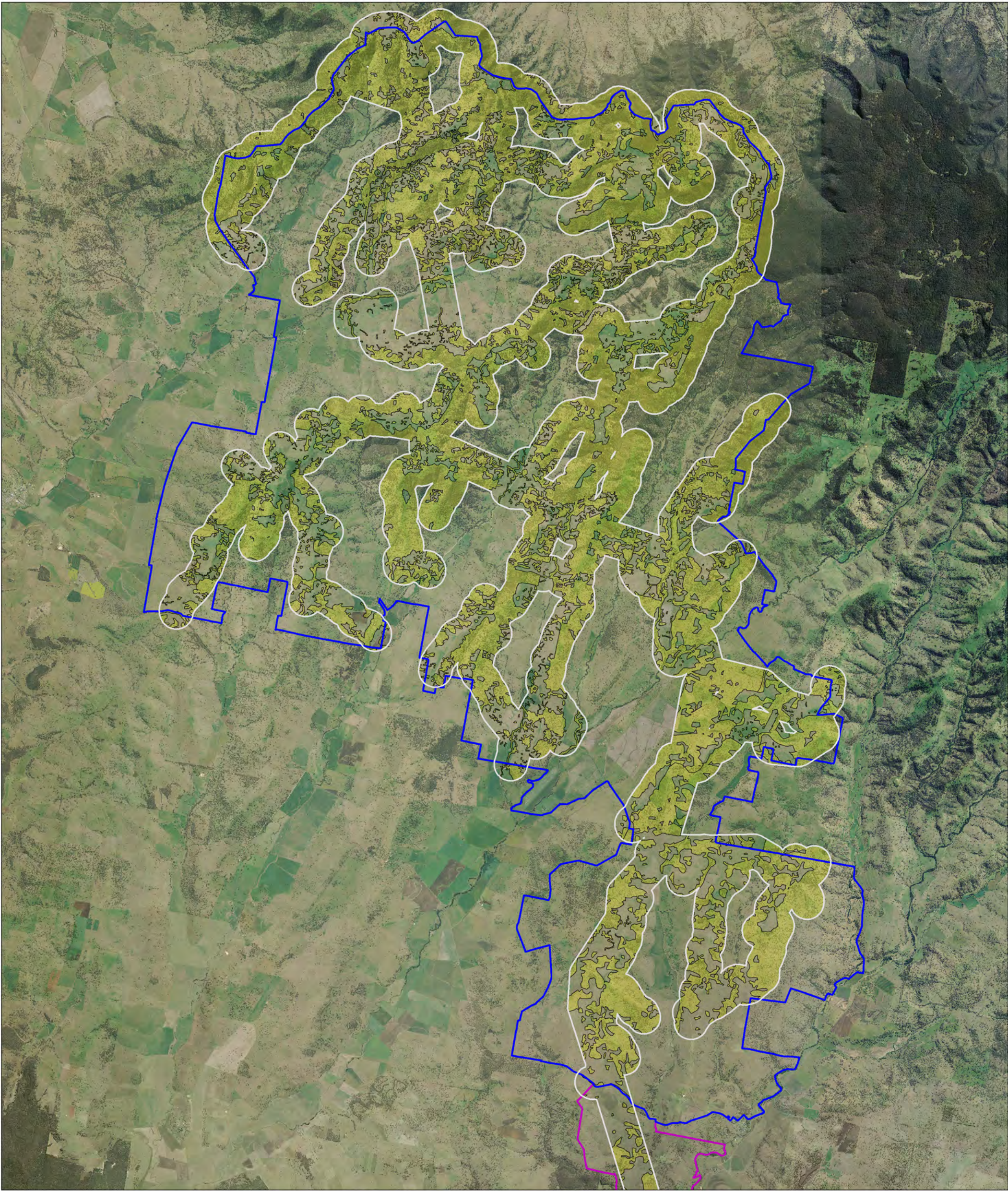
A.6 Representative patch used in landscape assessment: southern section, hunter / central rivers CMA

A.7 Offset candidates north

A.8 Offset candidates south

A.1 EXTENT OF NATIVE VEGETATION: NORTHERN SECTION, CENTRAL WEST CMA

A.1 - Extent of Native Vegetation Northern Overview Map



- 550m infrastructure buffer
- Site perimeter
- Wind Turbine Area
- Transmission Area
- Additional data
- Native vegetation

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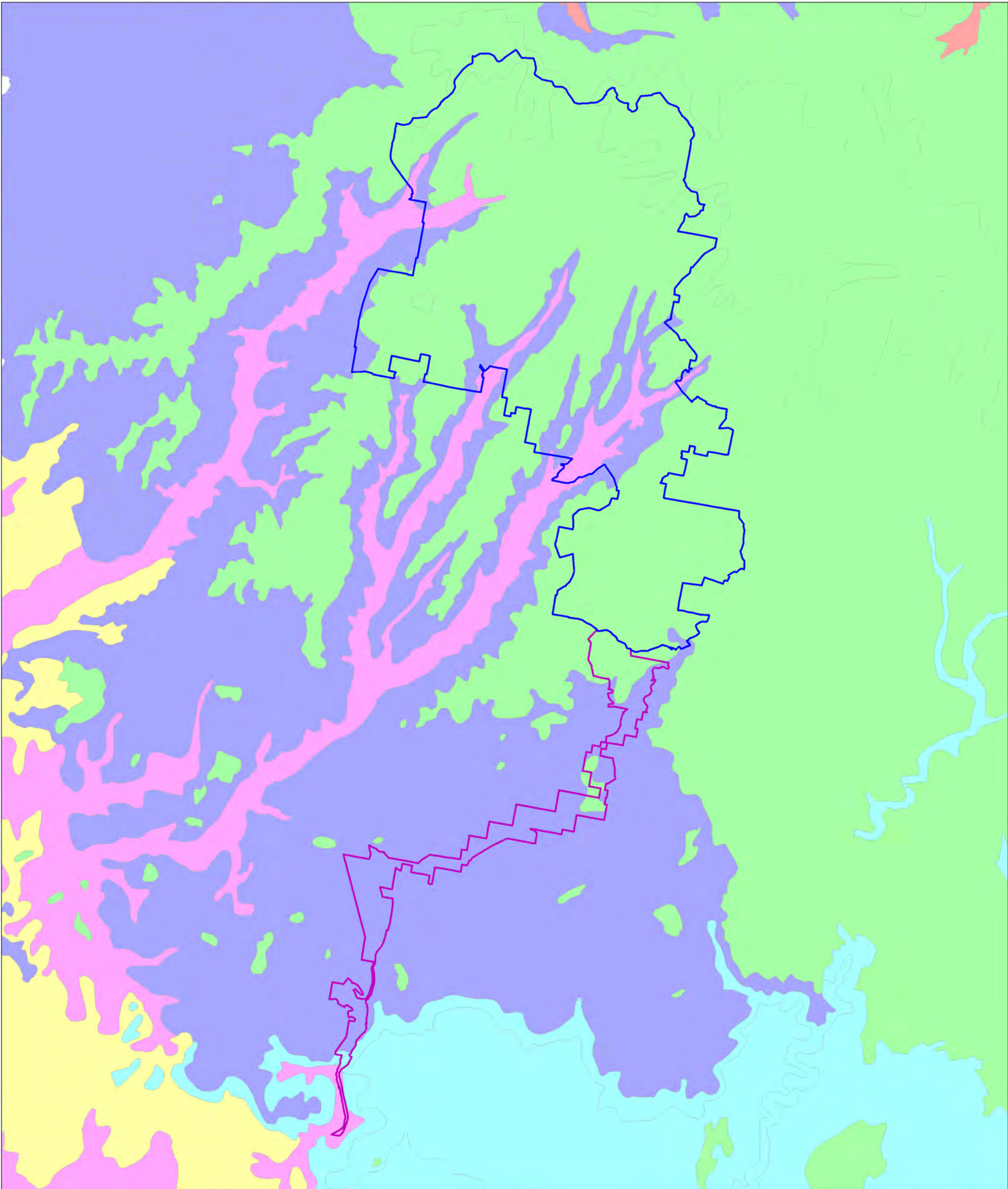
A3 @ 1:120,000

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 April 2017
Projection: GDA94 MGA Zone 55



A.2 MITCHELL LANDSCAPES FOR THE PROJECT AREA

A.2 - Mitchell Landscapes Site Overview Map



Site perimeter
Wind Turbine Area
Transmission Area

Mitchell Landscapes
BBS Liverpool Plains
BBS Liverpool Range
BBS Pilliga
NSS Upper Slopes
NSS Upper Slopes Granites
SB Kerrabee

EPURON

0 3 6 9
Kilometers

A3 @ 1:220,000

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 April 2017
Projection: GDA94 MGA Zone 55



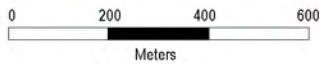
A.3 REPRESENTATIVE PATCH USED IN LANDSCAPE ASSESSMENT: NORTHERN SECTION, CENTRAL WEST CMA

A.3 - Representative Patch used in Landscape Assessment: Northern Section, Central West CMA



Northern Patch
Segment a
Segment b

EPURON



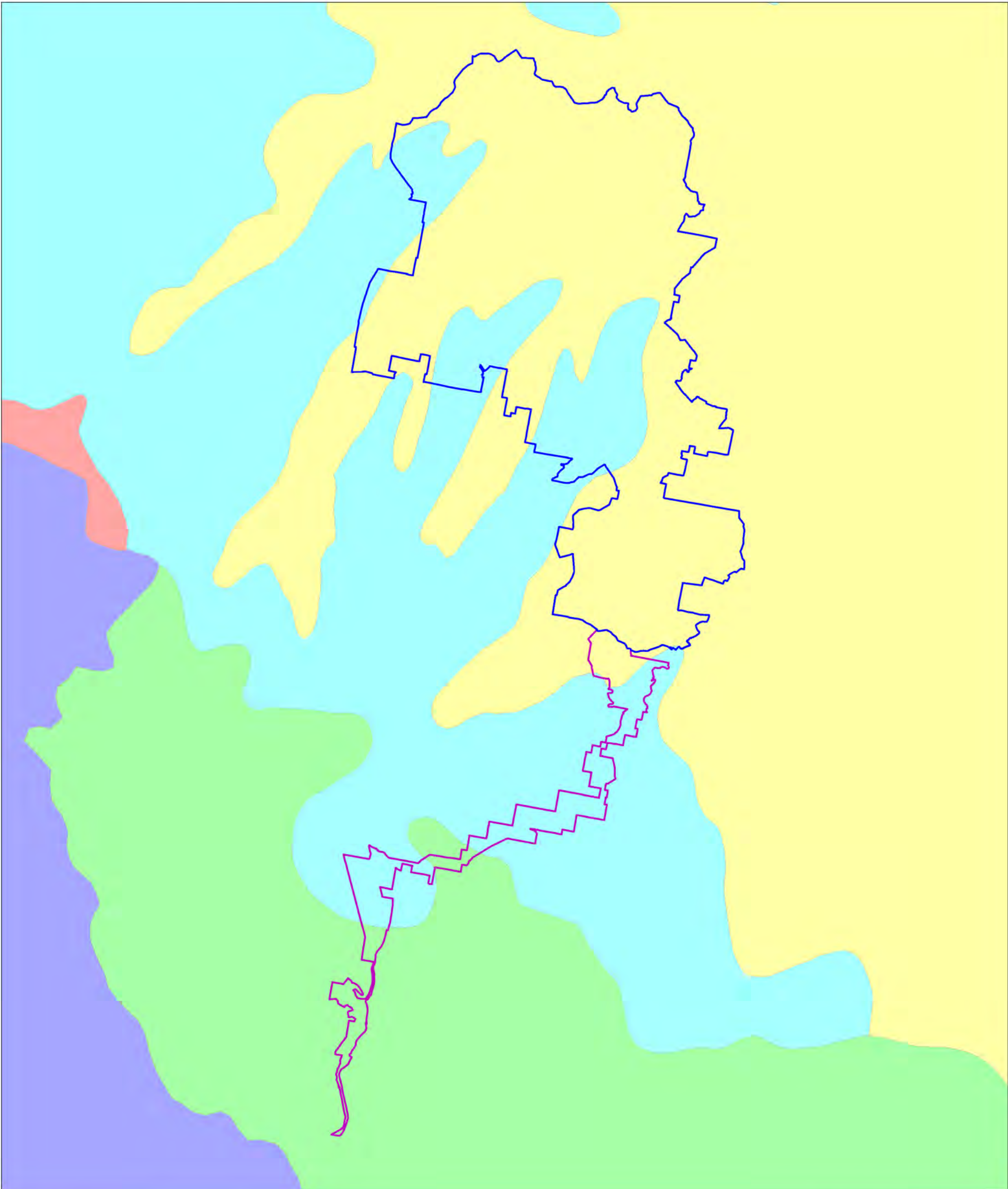
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Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 February 2017
Projection: GDA94 MGA Zone 55



A.4 IBRA SUBREGIONS FOR THE PROJECT AREA

A.4 - NSW Subregions Site Overview Map



Site perimeter
Transmission Area
Wind Turbine Area

NSW Subregions
Inland Slopes
Kerrabee
Liverpool Range
Pilliga
Talbragar Valley

EPURON



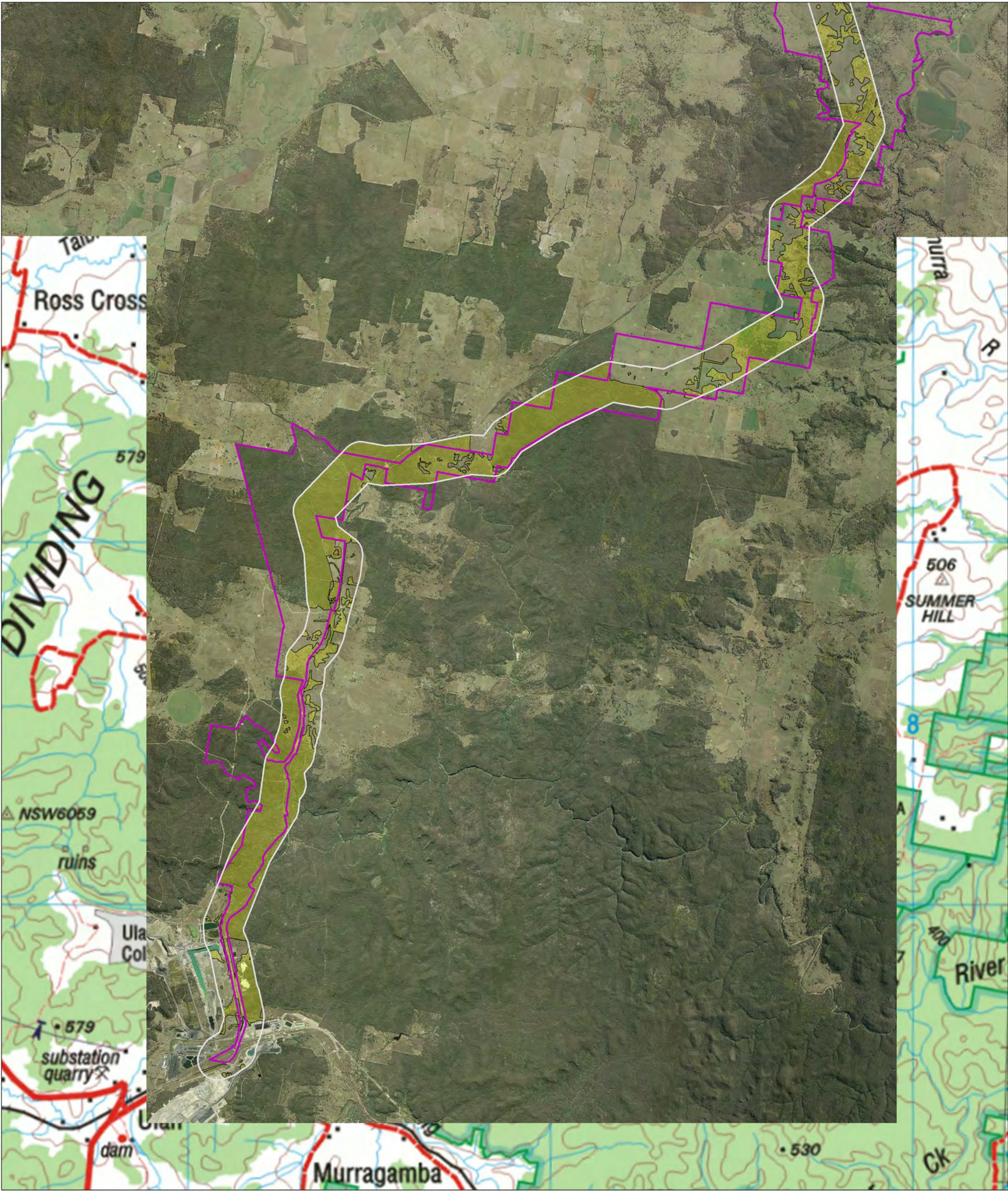
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Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 April 2017
Projection: GDA94 MGA Zone 55



A.5 EXTENT OF NATIVE VEGETATION: SOUTHERN SECTION, HUNTER / CENTRAL RIVERS CMA

A.5 - Extent of Native Vegetation Southern Overview Map



- 550m infrastructure buffer
- Site perimeter
- Wind Turbine Area
- Transmission Area
- Additional data
- Native vegetation

EPURON

0 1.5 3 4.5
Kilometers

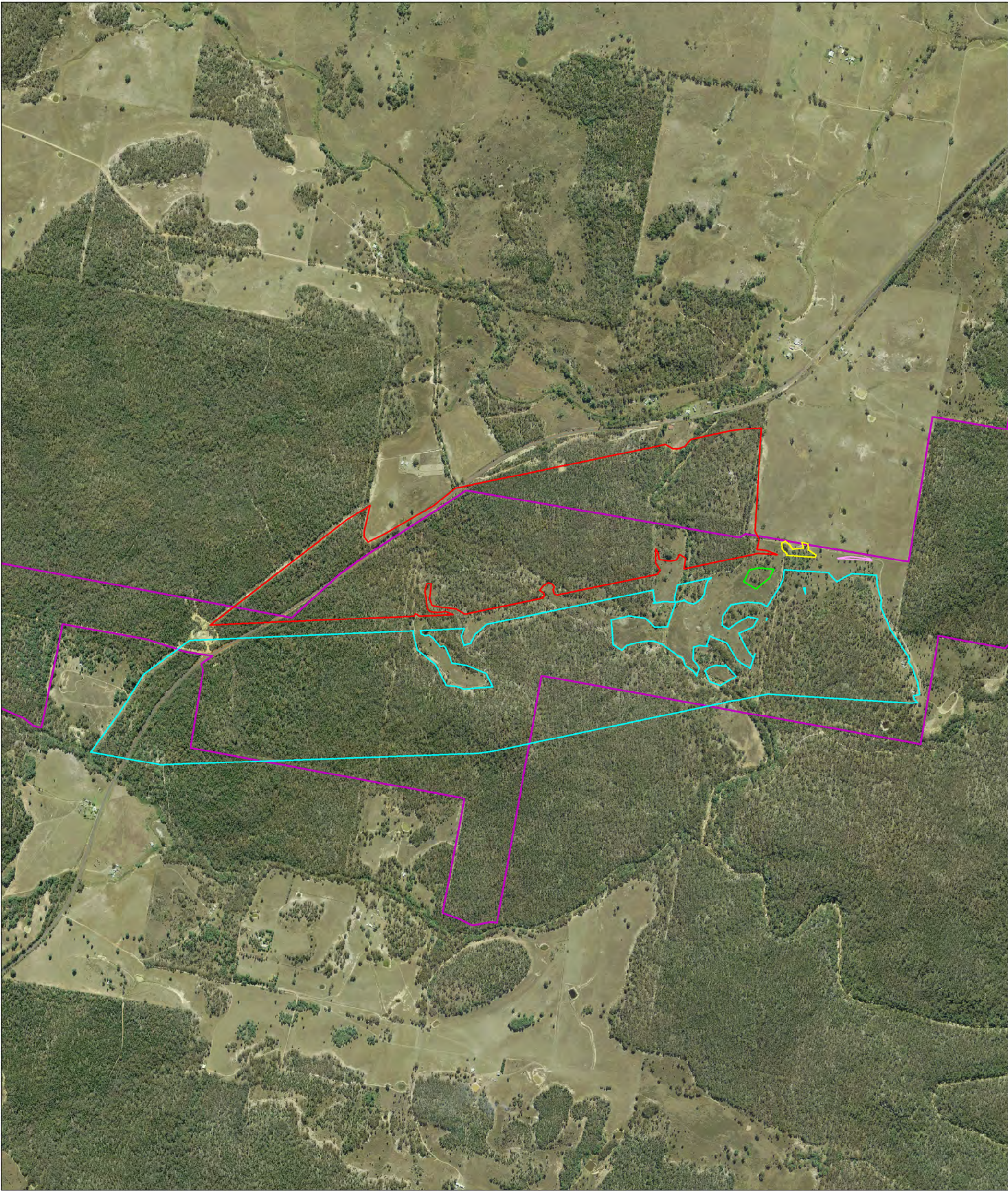
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Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 April 2017
Projection: GDA94 MGA Zone 55



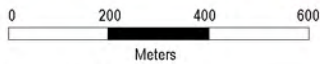
A.6 REPRESENTATIVE PATCH USED IN LANDSCAPE ASSESSMENT: SOUTHERN SECTION, HUNTER / CENTRAL RIVERS CMA

A.6 - Representative Patch used in Landscape Assessment: Southern Section, Central West CMA



- Site perimeter
- Transmission Area
- Southern Patch
- Segment a
 - Segment b
 - Segment c
 - Segment d
 - Segment e

EPURON



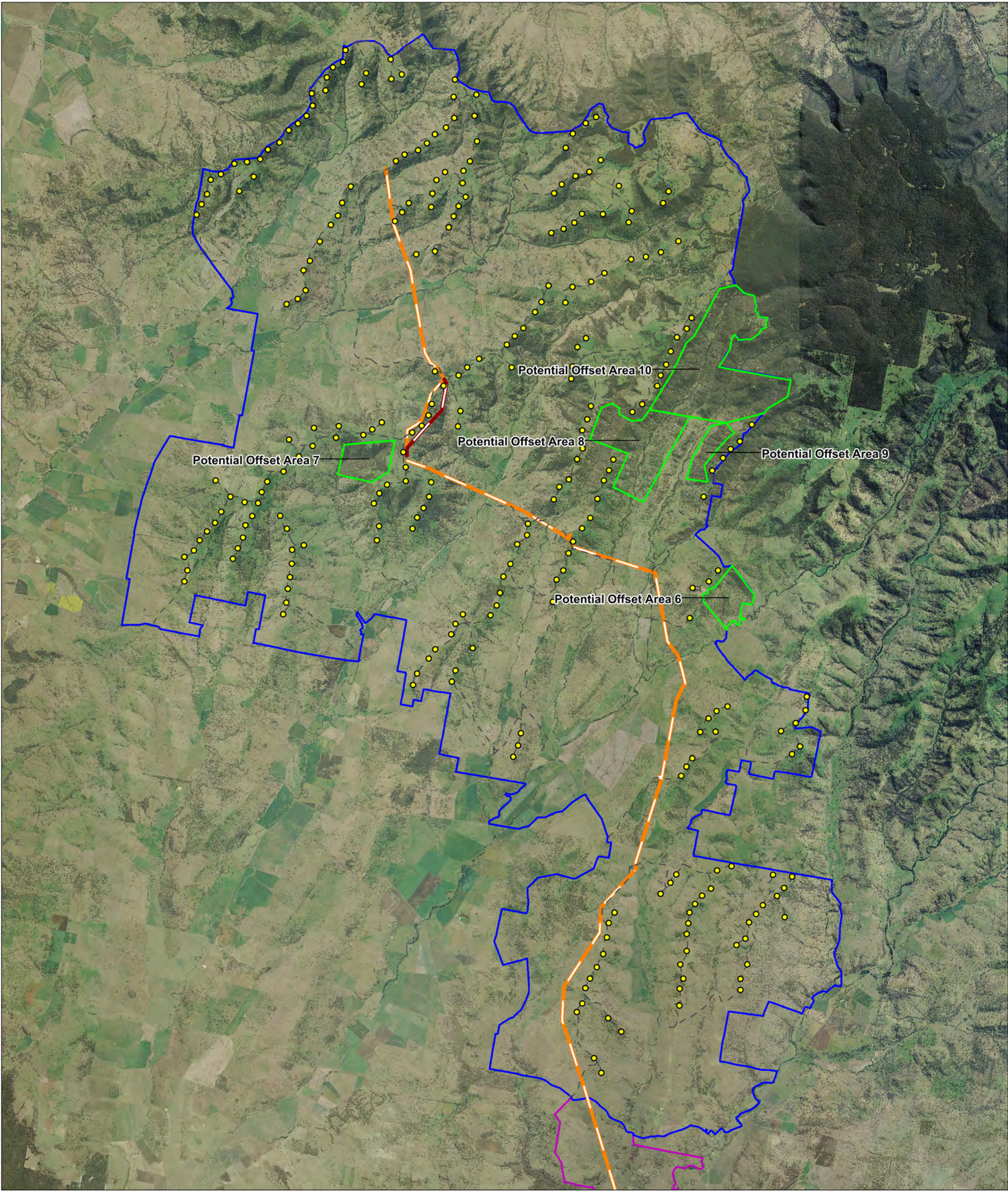
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Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 February 2017
Projection: GDA94 MGA Zone 55



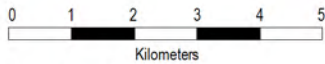
A.7 OFFSET CANDIDATES NORTH

A.7 - Potential Offset Areas Northern Overview Map



- Site perimeter
- Wind Turbine Area
 - Transmission Area
- Additional data
- Potential Offset Area

EPURON



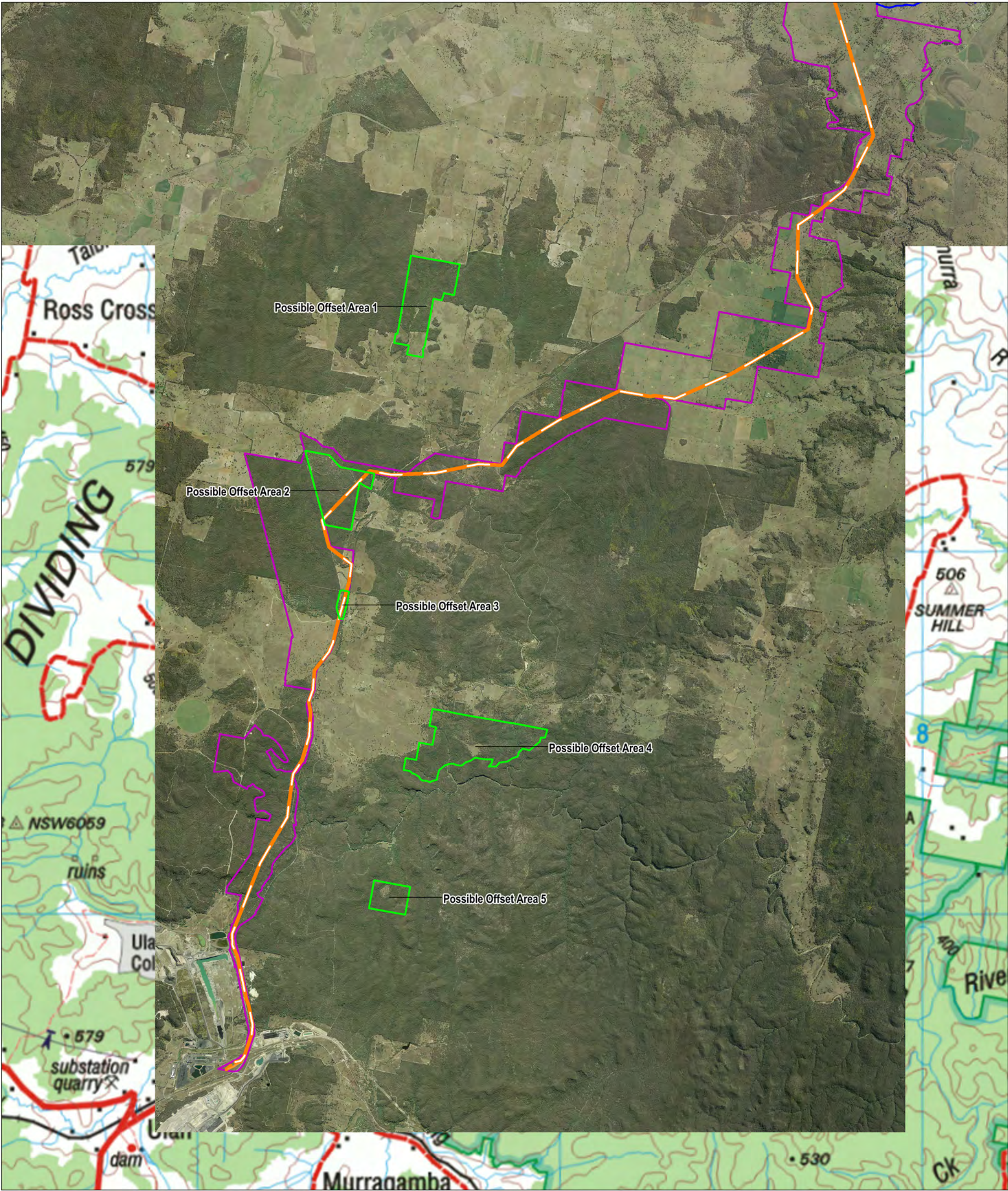
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Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 April 2017
Projection: GDA94 MGA Zone 55



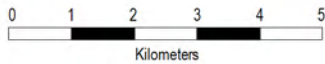
A.8 OFFSET CANDIDATES SOUTH

A.8 - Potential Offset Areas Northern Overview Map



- Site perimeter
- Wind Turbine Area
 - Transmission Area
- Additional data
- Potential Offset Area

EPURON



A3 @ 1:100,000

Project: Liverpool Range Wind Farm
Produced by: Virgil Robinson
Date: 3 April 2017
Projection: GDA94 MGA Zone 55



APPENDIX B BIODIVERSITY CREDIT REPORTS

BioBanking Credit Calculator

Ecosystem credits

Proposal ID : 0035/2016/4151MP

Proposal name : Liverpool wind farm north

Assessor name : Brooke Marshall

Assessor accreditation number : 0035

Tool version : v4.0

Report created : 30/01/2017 12:38

Assessment circle name	Landsc ape score	Vegetation zone name	Vegetation type name	Condition	Red flag status	Management zone name	Manage ment zone area	Current site value	Future site value	Loss in site value	Credit required for bio diversity	Credit required for TS	TS with highest credit requirement	Average species loss	Species TG Value	Final credit requirement for management zone
liverpool wind farm	20.50	CW180_Moderate/Good	River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion	Moderate/Good	Yes	1	6.47	100.00	0.00	100.00	0	518	Masked Owl	100.00	3.00	518
liverpool wind farm	20.50	CW111_Moderate/Good	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Moderate/Good	Yes	1	7.79	89.33	0.00	89.33	562	562	Powerful Owl	100.00	3.00	562
liverpool wind farm	20.50	CW304_Moderate/Good_Other	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	Moderate/Good_Other	Yes	1	9.34	76.04	0.00	76.04	0	581	Powerful Owl	83.33	3.00	581
liverpool wind farm	20.50	CW322_Moderate/Good	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion	Moderate/Good	Yes	1	64.94	76.89	0.00	76.89	4,078	4,078	Powerful Owl	80.00	3.00	4,078
liverpool wind farm	20.50	CW304_Moderate/Good	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	Moderate/Good	Yes	1	59.77	100.00	0.00	100.00	0	4,789	Powerful Owl	100.00	3.00	4,789
liverpool wind farm	20.50	CW303_Moderate/Good	Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion	Moderate/Good	Yes	1	1.05	100.00	0.00	100.00	0	0		0.00	0.00	32
liverpool wind farm	20.50	CW210_Moderate/Good	White Box - Red Stringybark shrubby woodlands on basalt slopes of the Nandewar Bioregion and Brigalow Belt South Bioregion	Moderate/Good	Yes	1	3.12	82.81	0.00	82.81	0	210	Masked Owl	94.44	3.00	210
liverpool wind farm	20.50	CW225_Moderate/Good	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion	Moderate/Good	Yes	1	1.51	97.33	0.00	97.33	118	118	Masked Owl	94.44	3.00	118

Assessment circle name	Landsc ape score	Vegetation zone name	Vegetation type name	Condition	Red flag status	Management zone name	Manage ment zone area	Current site value	Future site value	Loss in site value	Credit required for bio diversity	Credit required for TS	TS with highest credit requirement	Average species loss	Species TG Value	Final credit requirement for management zone
liverpool wind farm	20.50	CW214_Mo derate/Goo d	White Box - White Cypress Pine shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion	Moderate/Goo d	Yes	1	0.36	73.96	0.00	73.96	0	22	Masked Owl	88.89	3.00	22

BioBanking Credit Calculator

Species credits

Proposal ID : 0035/2016/4151MP
Proposal name : Liverpool wind farm north
Assessor name : Brooke Marshall
Assessor accreditation number : 0035
Tool version : v4.0
Report created : 30/01/2017 12:38

Scientific name	Common name	Species TG value	Identified population?	Can Id. popn. be offset?	Area / number of loss	Negligible loss	Red flag status	Number of credits
Chalinolobus dwyeri	Large-eared Pied Bat	1.30	No		19.00	0.00	No	247
Miniopterus schreibersii subsp. oceanensis	Eastern Bentwing-bat	1.30	No		19.00	0.00	No	247
Petaurus norfolcensis	Squirrel Glider	2.20	No		19.00	0.00	No	418

BioBanking Credit Calculator

Ecosystem credits

Proposal ID : 0035/2017/4183MP

Proposal name : Liverpool wind farm south

Assessor name : Brooke Marshall

Assessor accreditation number : 0035

Tool version : v4.0

Report created : 30/01/2017 12:56

Assessment circle name	Landsc ape score	Vegetation zone name	Vegetation type name	Condition	Red flag status	Management zone name	Management zone area	Current site value	Future site value	Loss in site value	Credit required for bio diversity	Credit required for TS	TS with highest credit requirement	Average species loss	Species TG Value	Final credit requirement for management zone
hunter	24.75	HU681_Moderate/Good	Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion	Moderate/Good	Yes	1	3.55	91.67	0.00	91.67	266	266	Barking Owl	100.00	3.00	266
hunter	24.75	HU714_Moderate/Good	Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Moderate/Good	Yes	1	11.15	91.67	0.00	91.67	836	836	Barking Owl	100.00	3.00	836
hunter	24.75	HU690_Moderate/Good_Other	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Moderate/Good_Other	Yes	1	77.26	100.00	0.00	100.00	6,273	6,273	Barking Owl	100.00	3.00	6,273
hunter	24.75	HU682_Moderate/Good	Blue-leaved Ironbark - Black Cypress Pine shrubby sandstone open forest in the southern Brigalow Belt South Bioregion (including Goonoo)	Moderate/Good	Yes	1	3.30	89.33	0.00	89.33	0	242	Barking Owl	61.90	3.00	242
hunter	24.75	HU707_Moderate/Good	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion	Moderate/Good	Yes	1	31.51	98.00	0.00	98.00	0	2,511	Barking Owl	100.00	3.00	2,511
hunter	24.75	HU707_Moderate/Good_Other	Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion	Moderate/Good_Other	Yes	1	1.20	86.67	0.00	86.67	0	85	Barking Owl	100.00	3.00	85
hunter	24.75	HU678_Moderate/Good	Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	Moderate/Good	Yes	1	10.32	100.00	0.00	100.00	0	838	Barking Owl	100.00	3.00	838

Assessment circle name	Landsc ape score	Vegetation zone name	Vegetation type name	Condition	Red flag status	Management zone name	Management zone area	Current site value	Future site value	Loss in site value	Credit required for bio diversity	Credit required for TS	TS with highest credit requirement	Average species loss	Species TG Value	Final credit requirement for management zone
hunter	24.75	HU713_Moderate/Good	Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest on in the southern Brigalow Belt South Bioregion and Upper Hunter region	Moderate/Good	Yes	1	30.04	100.00	0.00	100.00	0	2,439	Barking Owl	100.00	3.00	2,439
hunter	24.75	HU690_Moderate/Good	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Moderate/Good	Yes	1	36.16	100.00	0.00	100.00	2,936	2,936	Barking Owl	100.00	3.00	2,936
hunter	24.75	HU702_Moderate/Good	Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney Basin Bio	Moderate/Good	Yes	1	42.65	91.67	0.00	91.67	0	3,196	Barking Owl	100.00	3.00	3,196

BioBanking Credit Calculator

Species credits

Proposal ID : 0035/2017/4183MP
Proposal name : Liverpool wind farm south
Assessor name : Brooke Marshall
Assessor accreditation number : 0035
Tool version : v4.0
Report created : 30/01/2017 12:56

Scientific name	Common name	Species TG value	Identified population?	Can Id. popn. be offset?	Area / number of loss	Negligible loss	Red flag status	Number of credits
Swainsona sericea	Silky Swainson-pea	1.80	No		1.00	0.00	Yes	18
Calyptorhynchus lathami	Glossy Black-Cockatoo	1.80	No		19.00	0.00	No	342
Melithreptus gularis subsp. gularis	Black-chinned Honeyeater (eastern subspecies)	1.30	No		19.00	0.00	No	247
Ninox strenua	Powerful Owl	3.00	No		19.00	0.00	No	570
Nyctophilus corbeni	Corben's Long-eared Bat	2.10	No		19.00	0.00	No	399
Pomatostomus temporalis subsp. temporalis	Grey-crowned Babbler (eastern subspecies)	1.30	No		19.00	0.00	No	247
Stagonopleura guttata	Diamond Firetail	1.30	No		19.00	0.00	No	247
Tyto novaehollandiae	Masked Owl	3.00	No		19.00	0.00	No	570
Vespadelus troughtoni	Eastern Cave Bat	1.30	No		19.00	0.00	Yes	247

APPENDIX G AUTHOR QUALIFICATIONS

Brooke Marshall
Project Manager

Brooke has an honours degree in Natural Resources from the University of New England (UNE, 2004) where she specialised in wildlife management and ecosystem rehabilitation. Since joining nghenvironmental, Brooke has undertaken environmental impact assessment, biodiversity survey and assessment, environmental management documentation and community consultation.

Brooke has worked on large scale infrastructure projects and project managed the input of specialists, as required. She is a specialist in wind and solar farm environmental assessment and has prepared construction and operational environmental management documentation to over ten renewable energy projects. Brooke is an accredited Biobanking Assessor and Certified Environmental Practitioner.

Freya Gordon – lead author 2015 (work halted)
Senior Ecologist

Freya Gordon is a senior ecologist with extensive field experience. She holds a Bachelor of Science with Honours from Monash University, Melbourne. Projects she has managed and implemented include a microbat monitoring program for the Holbrook Bypass (RMS); a Squirrel Glider monitoring program for the Albury Bypass (Conneq); and multiple ecological assessments and constraints analyses for Stockland, RMS, Lake Coal, Epuron, and local councils. Freya has completed an Environmental Assessment for a Solar Farm in western NSW including a detailed investigation of the status of the Grey-crowned Babbler on the site and surrounding study area. Her work requires experience in Commonwealth and State environmental legislation, policies and standards. Prior to joining NGH Environmental she worked for the Institute of Wildlife Research, The University of Sydney, designing, managing and implementing survey programs for a range of species. She has managed large scale field programs in the Simpson Desert for the University of Sydney Desert Ecology Research Group.

Brenton von Takach Dukai - 2015 surveys
Ecologist

Brenton is a botanist and ecologist with NGH Environmental's biodiversity team, and performs flora and fauna assessments for a wide variety of projects. Brenton has been involved with developments ranging from large-scale wind farms and dam upgrades to minor road upgrades. He is familiar with a broad array of monitoring and survey techniques for both flora and fauna, and has conducted surveys in a number of biogeographic regions of NSW. As a result, he is familiar with many of the vegetation types and communities found throughout the state. Brenton's work requires knowledge of and experience in the management of threatened species and communities as well as a solid understanding of legislative requirements at both State and Commonwealth levels. Prior to joining nghenvironmental he worked for the *Australian Wetlands and Rivers Centre* at the University of NSW, conducting survey trips across Australia to undertake vegetation assessments and fauna trapping programs. He has been involved in fauna monitoring programs with OEH and radio tracking fauna for the Australian Wildlife Conservancy. Brenton is a very capable field ecologist with excellent reporting skills.

George Madani - 2015 surveys

Ecologist

George Madani is a freelance wildlife ecologist and has an extensive background in wildlife ecology with ten years of field survey skills and practical research and applied management experience. He has conducted fauna surveys and field studies across various regions and habitats in Australia. His work has taken him into remote areas as the Kimberley, Cape York, Simpson and Strzelecki Deserts as well across a range of temperate sclerophyll woodlands and rainforests along the East Coast and inland into the WA Goldfields, Victorian Mallee Country and rangelands of Western NSW. He has comprehensive knowledge of and experience with the identification, distribution, habitat and ecology of terrestrial vertebrate fauna, especially reptiles, amphibians and avifauna. George has a Masters in Wildlife Health and Population Management from the University of Sydney. He has worked with various State and Federal Government departments, universities, environmental consultancies and NGO's on projects ranging from wildlife monitoring, baseline inventory surveys to impact based assessments.

Bianca Heinze – lead author 2016

Ecologist

Bianca completed her Bachelor of Applied Science (Environmental Resource/Coastal Management) at Southern Cross University, Lismore in 2006. Bianca has been involved with around 15 wind farm projects in New South Wales, South Australia and Western Australia. Her experience includes undertaking preliminary desktop investigations, coordinating and undertaking field work, preparing Biodiversity Assessments and environmental management plans as well as planning and undertaking monitoring surveys at operational wind farms.

Bianca has almost 10 years experience in conducting and participating in fauna surveys and monitoring. Her particular area of interest is woodland birds. Bianca's skills in targeted threatened bird surveys include surveys for woodland diurnal birds and for owls. Her experience includes locating roost and nest sites of the vulnerable Powerful Owl *Ninox strenua* in inland and coastal environments, and utilising a range of bird survey techniques including area search and point counts to target birds such as Speckled Warbler *Chthonicola sagittatus*.

Ryan Sims – 2016 surveys

Lead Ecologist

Ryan Sims is a consultant botanist and vegetation ecologist based in the Hunter who has 10 years botanical experience in Queensland and New South Wales. He has undertaken countless flora surveys, vegetation mapping and classification and threatened species searches for major projects in NSW. Ryan has a thorough understanding of NSW flora and demonstrated botanical field experience in the Hunter, Sydney Basin, Central West, Blue Mountains, and North Coast regions. Ryan has experience in both private consulting and local government. As a consultant, he has liaised with local, state and commonwealth government on development assessments. In local government, Ryan provided specialised botanical expertise for development and planning assessments and biodiversity conservation projects. Recently, Ryan completed a Masters at UNSW with David Keith. The study focused on grassy woodland restoration after livestock fencing. As such, Ryan has a very good understanding of grassy woodland dynamics. He is experienced in statistical analysis of floristic data, survey design, field survey techniques (including government standard methods i.e. Biometric and Biobanking), data analysis, and has a thorough understanding of environmental legislation. Ryan is also experienced in GIS mapping.

Calia Jones – 2016 surveys
Ecology technical assistant

Calia has a Bachelor degree in Wildlife and Conservation Biology from La Trobe University (LTU). Since starting with nghenvironmental in 2015, Calia has been a project officer on a wide range of projects including biodiversity assessments and assisting in solar and windfarm projects. She has had experience in the field assisting senior ecologists and undertaking simple assessments by herself. She also assists in writing documentation for a wide range of projects.