

Appendix B

Supplementary fauna assessment

Terrestrial Fauna Surveys & Significance Assessments: Addendum Report

**Proposed Woomargama Bypass, Hume
Highway, Southern N.S.W.**



**An ecological impact assessment report
prepared for Sinclair Knight Merz**

OCTOBER 2009

Report ID_EcIA_0113

Citation

EnviroKey (2009) Terrestrial Fauna Surveys & Significance Assessments: Addendum Report: Proposed Woomargama Bypass: Hume Highway, Southern N.S.W. A report prepared by EnviroKey for Sinclair Knight Merz. Report ID_EclA_0113.

Commercial In Confidence

All intellectual property rights, including copyright, in documents created by **EnviroKey** remain the property of **EnviroKey**. The information contained within this document is confidential. It may only be used by the person to whom it is provided for the stated purpose for which it is provided. The document must not be imparted to any third person without the prior written approval of **EnviroKey**.

Disclaimer

EnviroKey accept no liability or responsibility for or in respect of any use of or reliance upon this report and its supporting material in whole or in part by any third party. Information in this report is not intended to be a substitute for site specific assessment of legal advice in relation to any matter.

Executive Summary

EnviroKey were engaged by Sinclair Knight Merz to undertake target fauna and habitat surveys for the Bush Stone-curlew, Squirrel Glider, Brown Treecreeper, Painted Honeyeater, Swift Parrot, Hooded Robin, Black-chinned Honeyeater, Turquoise Parrot, Barking Owl, Superb Parrot, Grey-crowned Babbler, Speckled Warbler, Diamond Firetail, Masked Owl and Regent Honeyeater along the proposed route of the Woomargama Bypass in southern New South Wales.

Field surveys were undertaken between 26th September 2009 and 1st October 2009 which revealed a total of three threatened fauna species (Squirrel Glider, Brown Treecreeper, Gang-gang Cockatoo), one migratory listed species (Rainbow Bee-eater) and one species listed under a preliminary determination for inclusion under the schedules of the Threatened Species Conservation Act 1995 (Little Eagle). In total, 79 species of fauna were recorded during the field survey which can be summarised as follows:

- 63 species of bird
- 10 species of mammal
- 3 species of frog
- 3 species of reptile.

Habitat surveys identified a number of habitat types (Eucalypt Woodland, Riparian Woodland, Open Farmland, Rock Outcropping) within the boundaries of the Proposal. Of the woodland fauna habitats, 10.8 hectares will be directly affected. Hollow-bearing trees were also identified within the range of fauna habitats with 106 trees identified, 40 of which will be directly impacted by the Proposal.

Significance Assessments completed in the previous assessment were reviewed, taking into consideration the results of this study and known habitat requirements. EnviroKey agree with the conclusions made by Parsons Brinckerhoff Pty. Ltd. in that it is unlikely the Proposal would have a significant impact on threatened and migratory terrestrial fauna species assessed within the previous assessment.

However, an evaluation of entities that are likely to occur in the study area based on the results of this survey identified one additional threatened species, the Gang-gang Cockatoo that was not the subject of a Significance Assessment in the previous assessment. The Significance Assessment completed for Gang-gang Cockatoo by EnviroKey concluded that it is unlikely that they will be significantly impacted by the Proposal.

Additionally, six species currently the subject of 'preliminary determination' under the TSC Act at the time of writing were also identified as either being known to, or are likely to occur in the study area. These were the:

- White-browed Woodswallow
- Varied Sittella
- White-fronted Chat

- Little Eagle
- Scarlet Robin
- Flame Robin

While there is no obligation to do so, Significance Assessments were also completed for these six species which concluded that it is unlikely they will be significantly impacted by the Proposal should they be listed as threatened species.

The previous assessment presents a range of mitigation measures commensurate to the level of knowledge of the study area. However, EnviroKey recommend a number of additional mitigation measures specific to the Woomargama Bypass site based on the results of this study and the ability of these to minimise potential impacts on threatened fauna species in the study area and locality.

It is recommended that crossing zones for Squirrel Glider be created in the central portion of the study area and on the eastern side of the existing Hume Highway alignment, south of Fairbairn Road.

Additional recommendations are provided relevant to nest boxes specifically designed for Squirrel Glider and Brown Treecreeper as well as their placement in the locality. Further, any nest box program should also have consideration for microbats. A significant proportion of boxes that are designed explicitly for microbat roosting should be included and monitored to determine their success.



Steve Sass

Principal Ecologist

B.App.Sci (Env.Sci) (Hons)

Certified Environmental Practitioner, Environment Institute of Australia & New Zealand

Practicing Member, Ecological Consultants Association of New South Wales

Adjunct Associate, Ecology & Biodiversity Group, Institute of Land, Water & Society,
Charles Sturt University

Table of Contents

1	INTRODUCTION	1
2	METHODOLOGY	2
2.1	STUDY AREA	2
2.1.1	Climate	2
2.2	LITERATURE REVIEW.....	2
2.3	FIELD SURVEYS.....	4
2.3.1	Diurnal Birds.....	4
2.3.2	Reptiles	4
2.3.3	Call Playback Surveys	8
2.3.4	Nocturnal Surveys.....	8
2.3.5	Habitat Surveys.....	9
2.3.6	Opportunistic	11
2.4	NOMENCLATURE	11
2.5	LICENSING	11
2.6	LIMITATIONS.....	11
3	RESULTS	12
3.1	TARGET FAUNA	12
3.2	SPECIES RICHNESS.....	16
3.3	FAUNA HABITAT	20
3.3.1	Eucalypt woodland	20
3.3.2	Riparian woodland	21
3.3.3	Open farmland	21
3.3.4	Rock outcropping	21
3.3.5	Hollow-bearing trees	31
4	REVIEW OF SIGNIFICANCE ASSESSMENT	38
4.1	HABITAT TO BE IMPACTED.....	38
4.2	SIGNIFICANCE ASSESSMENTS.....	38
4.2.1	Bush Stone-curlew	39
4.2.2	Squirrel Glider	40
4.2.3	Brown Treecreeper	41
4.2.4	Painted Honeyeater	41
4.2.5	Swift Parrot.....	42

4.2.6	Hooded Robin	42
4.2.7	Black-chinned Honeyeater	43
4.2.8	Regent Honeyeater	43
4.2.9	Turquoise Parrot	43
4.2.10	Superb Parrot.....	44
4.2.11	Barking Owl.....	44
4.2.12	Masked Owl	45
4.2.13	Grey-crowned Babbler	45
4.2.14	Speckled Warbler.....	46
4.2.15	Diamond Firetail	46
4.2.16	Microchiropteran Bats	47
4.2.17	Migratory Species	48
4.3	EVALUATION OF THREATENED AND MIGRATORY FAUNA	48
4.4	ADDITIONAL SIGNIFICANCE ASSESSMENTS	53
4.4.1	Gang-gang Cockatoo	53
4.4.2	Threatened Woodland Birds (White-browed Woodswallow, Varied Sittella).....	55
4.4.3	White-fronted Chat	58
4.4.4	Little Eagle	60
4.4.5	Robins (Scarlet Robin, Flame Robin).....	61
4.5	HOLLOW-BEARING TREES	63
4.6	SIGNIFICANCE ASSESSMENT CONCLUSION	63
5	SPECIFIC MITIGATION MEASURES	64
5.1	SQUIRREL GLIDER	64
5.2	NEST BOXES	65
5.3	MICROCHIROPTERAN BATS.....	66
6	REFERENCES	67

1 INTRODUCTION

EnviroKey were engaged by Sinclair Knight Merz (SKM) to complete target threatened terrestrial fauna and habitat surveys for the proposed Woomargama Bypass ('Proposal') as part of the Hume Highway duplication. An Environmental Assessment for the Woomargama Bypass has been prepared by Parsons Brinckerhoff Pty.Ltd (PB) (2009), however due to access constraints at the time, detailed fauna surveys could not be undertaken. In consultation with the Department of Environment, Climate Change and Water (DECCW), the Roads and Traffic Authority (RTA) committed to undertaking targeted spring surveys (property access dependent) to assist in further refining the mitigation measures as required.

The aims of this study are to:

- To complete target surveys for Bush Stone-curlew, Squirrel Glider, Brown Treecreeper, Painted Honeyeater, Swift Parrot, Hooded Robin, Black-chinned Honeyeater, Turquoise Parrot, Barking Owl, Superb Parrot, Grey-crowned Babbler, Speckled Warbler, Diamond Firetail, Masked Owl and Regent Honeyeater ('target fauna').
- Describe the range of fauna habitats present with a focus on the target species and microbats, including discussion regarding disturbance, the surrounding matrix and any fauna movement corridors if present.
- Provide a list of fauna species recorded during the field survey.
- Undertake a review of the conclusions of the previous Significance Assessments completed by PB (2009) based on the results of this study.
- Provide an evaluation as to whether additional threatened fauna require Significance Assessments based on the results of the field surveys, and if so, provide Significance Assessments for these additional entities.
- Provide recommendations on the refinement of mitigation measures provided in the Woomargama Bypass Environmental Assessment (Parsons Brinckerhoff 2009) where required.

2 METHODOLOGY

2.1 STUDY AREA

The study area is located along the proposed bypass route, west and north of the village of Woomargama in southern NSW (Figure 1) and within the Upper Billabong Creek catchment area which is approximately 80,000 hectares in area (Baker *et al.* 2001). The catchment is located within the South Western Slopes Bioregion (Thackway and Creswell 1995) bordered by the Riverina Bioregion to the west and the South Eastern Highlands Bioregion to the east (NPWS 2003a).

2.1.1 Climate

The study area is likely to be influenced by the complex transitional climate region that exists in the Upper Billabong Creek catchment area between the more mesic highland areas to the east and the xeric plains to the west (Caughley and Gall 1985). The mean annual rainfall is approximately 700 mm, however, this varies widely with up to 900 mm in the far south-east to as low as 550 mm in the west of the catchment (BOM 2009; Caughley and Gall 1985). Rainfall generally occurs primarily in the winter months with up to 60% falling in winter in most years (BOM 2009).

Weather conditions during the survey period were deemed to be conducive to detecting a large number of fauna species.

2.2 LITERATURE REVIEW

The study area has been the subject of numerous environmental assessment and ecological research in recent times. As it is likely that these reports may provide additional information relevant to this study, these are considered where appropriate. These reports are listed as follows:

- Woomargama Bypass Preliminary Ecological Investigation. A report prepared by nghenvironmental for the NSW Roads and Traffic Authority (NGH 2007).
- Hume Highway Upgrade Woomargama Bypass, Environmental Assessment, Technical Paper 1 – Flora and Fauna. A report prepared by Parsons Brinckerhoff Australia Pty Ltd for the NSW Roads and Traffic Authority (PB 2009).
- Technical Paper 1: Hume Highway Duplication Biological Impacts Yarra Yarra to Holbrook and Woomargama to Mullengandra. A report prepared by Parsons Brinckerhoff Australia Pty Ltd for the NSW Roads and Traffic Authority (PB 2007).
- Hume Highway Duplication Sturt Highway to Tarcutta, Kyeamba Hill and Little Billabong: Ecological Impact Assessment. A report by Sinclair Knight Merz for the NSW Roads and Traffic Authority (SKM 2006).
- Bats in fragmented rural landscapes: use of remnant and revegetated habitats. *Honours thesis. Charles Sturt University* (Grabham 2004).

- Of Lizards and Logs: Determinants of reptile diversity in a fragmented landscape. *Honours thesis. Charles Sturt University (Sass 2007).*

While a separate review of each report is not provided, additional information that is relevant to this study is included where appropriate.

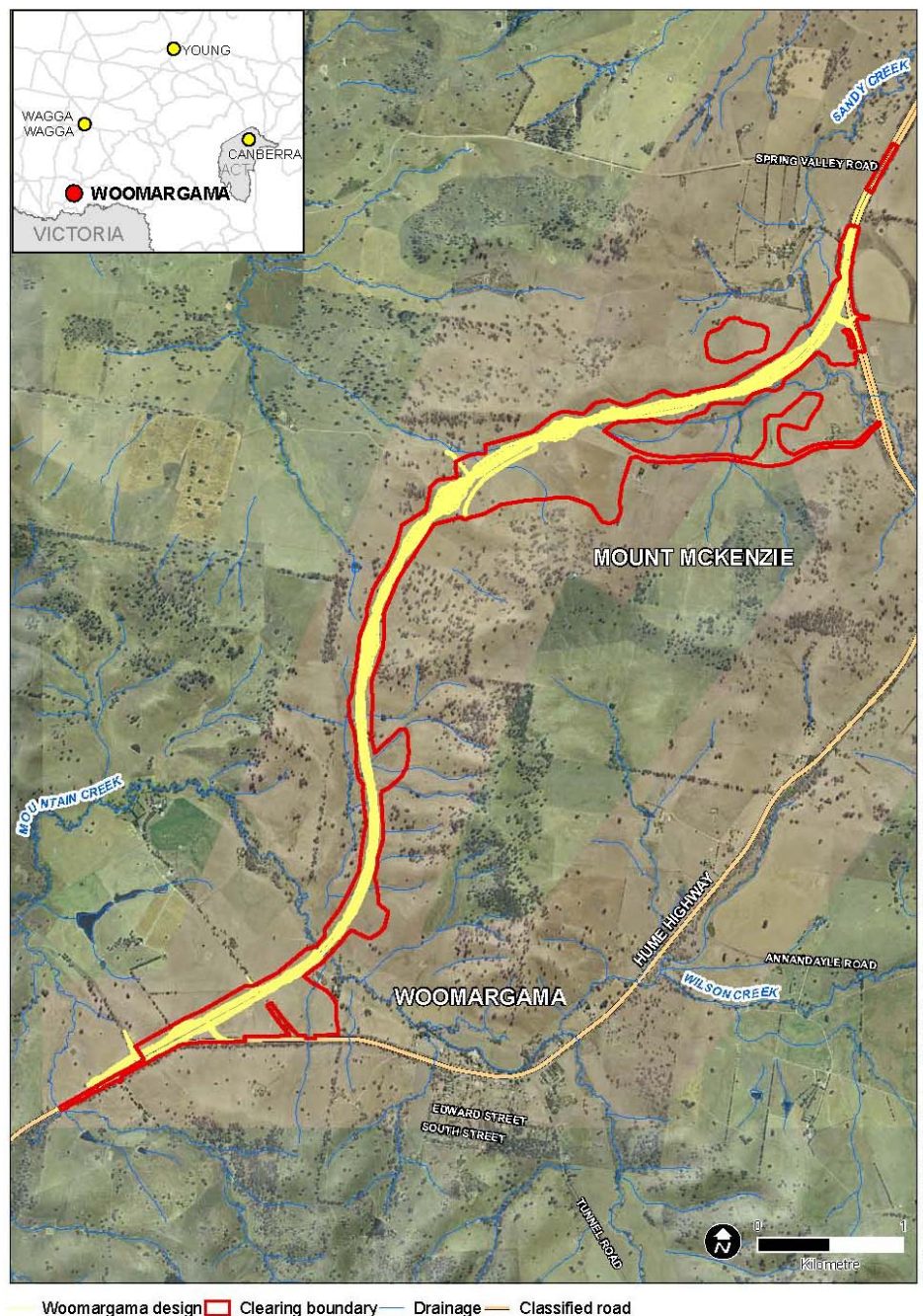


Figure 1: The study area north and west of the village of Woomargama in southern New South Wales (Image courtesy of PB 2009).

2.3 FIELD SURVEYS

Field surveys were undertaken between 26th September 2009 and 1st October 2009 lead by Principal Ecologist Mr Steve Sass (B.App.Sci (Env.Sci) (Hons)) who was assisted by Mr Alex Marks (B.Env.Sci (Land & Water)).

The following sections provide details on the methodology used and level of survey effort applied to the field surveys during this period. The methodology is consistent with the draft guidelines for surveying threatened biodiversity for development activities (DEC 2004). The coordinates of all survey locations were taken with a Garmin handheld Global Positioning System (GPS) in GDA94 and the locations of each are provided (Figure 2.1, 2.2, 2.3).

2.3.1 *Diurnal Birds*

Target surveys for diurnal birds for completed at 10 locations for a total of 880 person minutes (Table 1). Surveys were completed using an adapted method from the standardized bird survey technique (Watson 2003). The observer actively sought foraging birds while listening for calling birds recording each species as encountered. Surveys are undertaken by two persons in 20 minutes increments (ie, 40 person minutes). Using a stopping rule, surveys ceased once a new species had not been recorded within a 20 minute increment.

Table 1: Diurnal bird survey locations and level of survey effort during this study.

GPD Id	X projection	Y projection	Survey Effort
65	519920.34	6034566.51	120 person minutes
98	524777.24	6039953.46	80 person minutes
105	521752.39	6038058.75	120 person minutes
134	521547.67	6037690.61	40 person minutes
140	521483.89	6036686.56	120 person minutes
144	522822.50	6039034.07	40 person minutes
146	523553.21	6039277.96	40 person minutes
156	521187.31	6035425.31	120 person minutes
184	521483.99	6036128.61	120 person minutes
185	521601.10	6036925.64	80 person minutes

2.3.2 *Reptiles*

Reptile surveys were conducted at two locations that were revealed once a reconnaissance of the proposed route was complete. Two small granite rock outcrops were identified and these were searched for reptile fauna for a total of 90 person minutes (Table 2). Survey effort was deemed completed once all loose and partially imbedded rocks were lifted and all crevices viewed.

Figure 2.1 : Fauna Survey Effort



Hume Highway - Woomargama Bypass



Figure 2.2 : Fauna Survey Effort



Hume Highway - Woomargama Bypass



Figure 2.3 : Fauna Survey Effort



Hume Highway - Woomargama Bypass



Table 2: Reptile survey locations and level of survey effort during this study.

GPS Id	X projection	Y projection	Survey Effort
145	522856.74	603892.74	30 person minutes
146	523553.21	6039277.96	60 person minutes

2.3.3 Call Playback Surveys

Call playback surveys were undertaken using a handheld megaphone to broadcast the calls of Barking Owl, Masked Owl, Squirrel Glider and Bush Stone-curlew to elicit a response from these target species. Calls of each species were played over a 5 minute interval, followed by a 5 minute listening period. Call playback surveys were undertaken at three locations on three separate nights for a total of 120 minutes (Table 3). Spotlighting surveys were then conducted at the completion of call playback surveys where appropriate.

Table 3: Call playback survey locations and level of survey effort during this study.

GPS Id	X projection	Y projection	Survey Effort
95	519865.09	6034858.58	40 minutes on 26/09/2009
105	521752.39	6038058.75	40 minutes on 27/09/2009
156	521187.31	6035425.32	40 minutes on 28/09/2009

2.3.4 Nocturnal Surveys

Nocturnal Surveys consisted of searches with 50w hand-held spotlights targeting Bush Stone-curlew, Squirrel Glider, Barking Owl and Masked Owl. Two persons searched hollow-bearing trees and other vegetation for active and inactive animals by meandering across each survey location for five person hours on three consecutive nights for a total survey effort of 15 person hours (Table 4).

Table 4: Nocturnal Survey locations and level of survey effort during this study.

GPS Id	X projection	Y projection	Survey Effort
66	519986.18	6034614.92	5 person hours on 26/09/2009
105	521752.39	6038058.75	5 person hours on 27/09/2009
156	521187.31	6035425.31	5 person hours on 28/09/2009

2.3.5 *Habitat Surveys*

Habitat surveys were undertaken at eight survey locations within a 20m x 20m quadrat for approximately 20 minutes each after the proposed route was subjected to ground-thruthing at the commencement of this study (Table 5). Each survey collected data relevant to fauna habitat availability, extent and condition on a qualitative and quantitative basis (Table 6).

Table 5: Locations of Habitat surveys undertaken during this study.

GPS Id	X projection	Y projection	Survey Effort
65	519920.33	6034566.51	Approx. 20 minutes
134	521547.67	6037690.61	Approx. 20 minutes
140	521483.89	6036686.56	Approx. 20 minutes
144	522822.49	6039034.07	Approx. 20 minutes
145	522856.74	6038982.74	Approx. 20 minutes
146	523553.21	6039277.96	Approx. 20 minutes
156	521187.31	6035425.32	Approx. 20 minutes
184	521483.99	6036128.61	Approx. 20 minutes

Table 6: Habitat surveys collected a range of data during this study using these variables.

Variable	Measure
Forbs	Percent cover
Grasses	Percent cover
Rocks	Percent cover
Litter	Percent cover
Bare ground	Percent cover
Logs (25mm – 100mm size class)	Number of logs and total length
Logs (101 – 300mm size class)	Number of logs and total length
Logs (> 301mm size class)	Number of logs and total length
Soil type	Sand, Clay, Loam, Gravel or combination
Shrub	Height (mean)
Shrub density	No. of shrubs
General habitat	Qualitative description

Variable	Measure
Matrix composition	Qualitative description
Disturbance	Qualitative description

Each woodland and rocky outcrop was assigned a Habitat Quality Score relative to each other (Good, Moderate, Poor). Habitat quality was determined through several factors such as the availability of microhabitat including fallen timber and mistletoe, amount of exotic vegetation and the number of tree hollows. Also taken into consideration was the known habitat requirements of the threatened species the subject of this report. The following rankings were assigned relative to each other with consideration (but not necessarily all) of the following attributes:

Good

- Patch size large.
- Abundant trees hollows present
- Habitat is well connected to other areas of habitat.
- Good quantities of fallen timber, mistletoe, leaf litter and other microhabitat.
- Contains levels of habitat that are likely to supporting breeding and/or roosting opportunities for threatened fauna species that are known to, or are likely to occur in the study area.
- Threatened species are known to occur there from this survey, previous records or author's knowledge.

Moderate

- Patch size moderately sized and/or tree density remains sparse.
- Abundant trees hollows present.
- Some fallen timber, mistletoe, leaf litter and other microhabitat.
- Habitat has some connectivity to surrounding habitat.
- Contains levels of habitat that may support breeding and/or roosting opportunities for threatened fauna species that are known to, or are likely to occur in the study area.
- Threatened species may occur within this habitat.

Poor

- Patch size small and/or tree density within patch sparse.
- Some trees hollows present.
- Virtually no fallen timber, mistletoe, leaf litter and other microhabitat.
- Habitat has little connectivity to surrounding areas.
- Contains virtually no habitat that would support breeding and/or roosting opportunities for threatened fauna species that are known to, or are likely to occur in the study area.
- Unlikely to support threatened species on a permanent basis.

2.3.6 *Opportunistic*

While travelling between field survey sites, any fauna observed opportunistically were recorded and included in the species list. Including these records provides a greater overview of the faunal assemblage of the study area and often results in species being recorded outside of specific surveys.

2.4 NOMENCLATURE

Nomenclature used within this report follows Morcombe (2004) for birds, Menkhorst & Knight (2004) for mammals (except bats), Churchill (2008) for bats, Tyler & Knight (2009) for frogs and Swan, Shea & Sadlier (2004) for reptiles.

2.5 LICENSING

This study was conducted under a current Scientific Licence issued under Clause 22 of the *National Parks and Wildlife Regulation 2002* and section 132C of the *National Parks and Wildlife Act 1974* by the NSW Department of Environment, Climate Change and Water. Fauna surveys were conducted under an Animal Research Authority approved by and in accordance with the Animal Care and Ethics Committee of the Director-General of the NSW Department of Primary Industries.

2.6 LIMITATIONS

While this study was completed during Spring 2009 when field conditions were conducive to detecting fauna including the target species, a common limitation of many ecological surveys is the short period of time in which they are conducted. When combined with a lack of seasonal sampling this can lead to either low detection rates or false absences being reported. This is also particularly relevant to highly mobile species that can use different habitats across their range at any given time. For these reasons, it should be recognised that it may be impossible to rule out species absence for some species during field surveys. To minimise this, survey of fauna habitats has also been completed to document the resources available to fauna to assist in determining whether they are likely to use the study area.

3 RESULTS

3.1 TARGET FAUNA

Of the 15 target fauna the subject of this study, two species (Brown Treecreeper and Squirrel Glider) were recorded in the study area. Both records of Brown Treecreeper were in the central portion of the study area. The only bird observed was along a north-south ephemeral drainage line just west of the proposed alignment (Figure 3.3), whilst a second bird was heard in a linear remnant also to the west of the alignment (Figure 3.2). A total of five Squirrel Glider were recorded, four of which were where the proposed alignment joins existing carriageway at the southern end (Figure 3.3). Three animals were observed perched together (one adult and two juveniles) while a fourth animal was observed about 30 m north. The last animal was recorded in the central section of the proposed alignment within a sparse section of box-gum woodland.

An additional threatened fauna species (Gang-gang Cockatoo) and another which is being considered as a preliminary determination under the TSC Act (Little Eagle) were also recorded. Four Gang-gang Cockatoo were recorded on a single occasion in the central section of the proposed bypass (Figure 3.2), and were observed flying from west to east calling to one another in-flight. One Little Eagle was recorded adjacent to the existing Hume Highway (Figure 3.1) where it was clearly seen perched in a paddock tree.

One migratory fauna species (Rainbow bee-eater) was recorded. The characteristic call was heard in the north section of the alignment, seemingly from one bird (Figure 3.1).

Of particular ecological interest, but not listed under any threatened species legislation, was the record of a single pair of Zebra finch with one juvenile in tow. Zebra finches are normally regarded as birds of the arid and semi-arid parts of Australia (Morcombe 2004) but their nomadic nature often finds them in moister parts of the country.

The locations of all these records are shown (Figure 3.1, 3.2, 3.3) and further details are provided (Table 7).

Figure 3.1 : Threatened, Migratory and Significant Fauna Species



Hume Highway - Woomargama Bypass



Figure 3.2 : Threatened, Migratory and Significant Fauna Species



Hume Highway - Woomargama Bypass



Figure 3.3 : Threatened, Migratory and Significant Fauna Species



Hume Highway - Woomargama Bypass



Table 7: Records of threatened, migratory and significant fauna species recorded during this study.

Date	Species	Qty.	X projection	Y projection	Detection Method
26/09/2009	Squirrel Glider	3	519986.18	6034614.92	Observed
26/09/2009	Squirrel Glider	1	520054.01	6034671.99	Observed
27/09/2009	Brown Treecreeper	1	521367.79	6037945.74	Heard
28/09/2009	Gang-gang Cockatoo	4	521483.89	6036686.56	Observed
28/09/2009	Squirrel Glider	1	521772.11	6038068.88	Observed
28/09/2009	Zebra Finch	3	522660.43	6038842.22	Observed
30/09/2009	Rainbow Bee-eater	1	522822.50	6039034.07	Heard
01/10/2009	Brown Treecreeper	1	521483.99	6036128.61	Observed
01/10/2009	Little Eagle	1	525095.03	6038932.94	Observed

3.2 SPECIES RICHNESS

A total of 79 species of fauna were recorded during the field surveys (Table 8). These can be summarised as follows:

- 63 species of birds
- 10 species of mammals
- 3 species of frogs
- 3 species of reptiles

Table 8: Fauna species recorded during this study (* denotes introduced species) (Detection Method: O=Observed, H=Heard, S=Scat).

Common name	Scientific name	Detection Method
Birds		
Australian Wood Duck	<i>Chenonetta jubata</i>	O
Australian Shelduck	<i>Tadorna tadornoides</i>	O

Common name	Scientific name	Detection Method
Pacific Black Duck	<i>Anas superciliosa</i>	O
Grey Teal	<i>Anas gracilis</i>	O
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>	O
White-faced Heron	<i>Egretta novaehollandiae</i>	O
Australian White Ibis	<i>Threskiornis molucca</i>	O
Little Eagle	<i>Hieraaetus morphnoides</i>	O
Wedge-tailed Eagle	<i>Aquila audax</i>	O
Australian Hobby	<i>Falco longipennis</i>	O
Nankeen Kestrel	<i>Falco cenchroides</i>	O
Brown Falcon	<i>Falco berigora</i>	O
Masked Lapwing	<i>Vanellus miles</i>	O
Crested Pigeon	<i>Ocyphaps lophotes</i>	O
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	O
Little Corella	<i>Cacatua sanguinea</i>	O
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	O
Galah	<i>Eolophus roseicapilla</i>	O
Crimson Rosella	<i>Platycercus elegans</i>	O
Eastern Rosella	<i>Platycercus eximius</i>	O
Red-rumped Parrot	<i>Psephotus haematonotus</i>	O
Pallid Cuckoo	<i>Cuculus pallidus</i>	O
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	H
Tawny Frogmouth	<i>Podargus strigoides</i>	O
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>	O
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	O
Rainbow Bee-eater	<i>Merops ornatus</i>	H
Brown Treecreeper	<i>Climacteris picumnus</i>	O

Common name	Scientific name	Detection Method
Superb Fairy-wren	<i>Malurus cyaneus</i>	O
Spotted Pardalote	<i>Pardalotus punctatus</i>	O
Striated Pardalote	<i>Pardalotus striatus</i>	O
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	O
Southern Whiteface	<i>Aphelocephala leucopsis</i>	O
Red Wattlebird	<i>Anthochaera carunculata</i>	O
Noisy Friarbird	<i>Philemon corniculatus</i>	O
Little Friarbird	<i>Philemon citreogularis</i>	O
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	O
Noisy Miner	<i>Manorina melanocephala</i>	O
Fuscous Honeyeater	<i>Lichenostomus fuscus</i>	O
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>	O
Jacky Winter	<i>Microeca fascinans</i>	O
Rufous Whistler	<i>Pachycephala rufiventris</i>	O
Golden Whistler	<i>Pachycephala pectoralis</i>	O
Crested Shrike-tit	<i>Falcunculus frontatus</i>	H
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	O
Magpie-lark	<i>Grallina cyanoleuca</i>	O
Restless Flycatcher	<i>Myiagra inquieta</i>	O
Willie Wagtail	<i>Rhipidura leucophrys</i>	O
Grey Fantail	<i>Rhipidura fuliginosa</i>	O
White-winged Triller	<i>Lalage tricolor</i>	O
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	O
Ground Cuckoo-shrike	<i>Coracina maxima</i>	O
Dusky Woodswallow	<i>Artamus cyanopterus</i>	O
Pied Butcherbird	<i>Cracticus nigrogularis</i>	O

Common name	Scientific name	Detection Method
Australian Magpie	<i>Gymnorhina tibicen</i>	O
Australian Raven	<i>Corvus coronoides</i>	O
White-winged Chough	<i>Corcorax melanorhamphos</i>	O
Common Starling*	<i>Sturnus vulgaris</i>	O
Mistletoebird	<i>Dicaeum hirundinaceum</i>	O
Skylark	<i>Alauda arvensis</i>	O
House Sparrow*	<i>Passer domesticus</i>	O
Australian Pipit	<i>Anthus australis</i>	O
Zebra Finch	<i>Taeniopygia guttata</i>	O
Mammals		
Common Wombat	<i>Vombatus ursinus</i>	S
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	O
Squirrel Glider	<i>Petaurus norfolcensis</i>	O
European Hare*	<i>Lepus europeus</i>	O
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	O
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	O
Red Fox*	<i>Vulpes vulpes</i>	S
House Cat*	<i>Felis catus</i>	S
European Rabbit*	<i>Oryctolagus cuniculus</i>	O
White-striped Freetail-bat	<i>Austronomus australis</i>	O, H
Frogs		
Peron's Tree Frog	<i>Litoria peronii</i>	H
Spotted Marsh Frog	<i>Limnodynastes tasmaniensis</i>	H
Common Froglet	<i>Crinia signifera</i>	H
Reptiles		
Tree Skink	<i>Egernia striolata</i>	O

Common name	Scientific name	Detection Method
Wall Skink	<i>Cryptoblepharus pannosus</i>	O
Southern Rainbow Skink	<i>Carlia tetradactyla</i>	O

3.3 FAUNA HABITAT

Habitats along the proposed alignment were identified into four fauna habitat types. These were Eucalypt Woodland, Riparian Woodland, Open Farmland and Rock Outcropping. Within these habitats, Hollow-bearing Trees (HBT) were also identified as an important resource for fauna.

The spatial distribution and relative quality of fauna habitat specifically to threatened fauna species are provided (Figure 4.1, 4.2, 4.3) and the direct impacts to each calculated using the proposed clearing boundary (Table 9).

Table 9: Habitat types and their relative quality within the clearing boundary.

Habitat Quality in Area (ha)					
Habitat Type	No quality assigned	Poor	Moderate	Good	Total (ha)
Eucalypt Woodland	-	3.98	1.05	4.79	9.82
Open Farmland	218.17	-	-	-	218.17
Riparian Woodland	-	-	0.60	-	0.60
Rocky Outcropping	-	0.39	-	-	0.39
Totals	218.17	4.37	1.65	4.79	228.98

3.3.1 *Eucalypt woodland*

Five areas of eucalypt woodland (EW) habitat were identified during the survey that have the potential to be impacted by the Proposal either directly or indirectly. Three of these being within the 'Mount Raven' property, a fourth within 'Dunraven' and the last within the roadside reserve of the existing Hume Highway near Fairbairn Road. All but one of these areas was inspected in detail, as the fifth (the lineal remnant on 'Mount Raven') was clearly outside of the works area as defined by surveyors pegs, and at the request of the RTA, no entry was permitted to such areas. Each habitat survey area is given the prefix 'EW' followed by the GPS ID detailed in Table 5. Details of each survey site are provided (Table 10-14).

3.3.2 *Riparian woodland*

One area of riparian woodland (RW) habitat were identified along the proposed alignment. These were at Mountain Creek in the southern portion of the study area which has been identified as providing habitat for threatened aquatic fauna (PB 2009). A second riparian area was identified in the northern portion of the 'Spring Valley' property. However, this area has been previously cleared, with little habitat for terrestrial fauna now remaining.

The habitat survey is given the prefix 'RW' followed by the GPS ID detailed in Table 5. Details of the survey site are provided (Table 15).

3.3.3 *Open farmland*

The study area is dominated by areas of open farmland which are clearly visible through aerial photography (PB 2009). A single survey site was given the prefix 'OF' followed by the GPS ID detailed in Table 5; details of which are provided (Table 16).

3.3.4 *Rock outcropping*

Two small areas of rock outcropping were identified during ground-thruthing of the proposed Bypass. Rock outcropping was extremely limited in extent and quality, providing little opportunity for threatened reptile species. Limited data relevant to these areas was collected to provide an indication of these attributes. These sites were given the prefix 'RO' followed by the GPS ID detailed in Table 5; details of which are provided (Table 17-18).

While the Pink-tailed worm-lizard has been recorded near Holbrook (PB 2007), catchment-wide surveys have failed to detect this or other threatened reptiles (Sass 2007; Sass *et al.* 2008) and are not discussed further within this report.

Table 10: Habitat survey results at EW134.

General Habitat	Site Photo
A small woodland patch ~7 trees on 'Mount Raven' property. Moderate levels of fallen timber, but no leaf litter present. Ground cover is dominated by Capeweed and Ryegrass.	
Matrix	Disturbance
The patch is 'loosely' connected to woodland areas of Mt McKenzie to the east. To the west, a linear patch is around 150m away connected only by a paddock tree (~80m away). To the south open farmland is present. To the north, a larger woodland is present connected to Mt Kenzie.	The site has been subjected to cattle grazing recently (scats present). Dominance by exotic flora suggests that 'pasture improvement' may have occurred in the past.
Habitat Variables	Quantity
Forbs (% cover)	60
Grasses (% cover)	40
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	7
Logs 25-100mm diameter (lineal metres)	15
Logs 101-300mm diameter (No.)	8
Logs 101-300mm diameter (lineal metres)	30
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	<5 clumps
Hollows (No. visible - any size)	See HBT section
Loose bark (yes/no)	Yes
Shrub height (mean)	None
Shrub density (no. of shrubs)	n/a
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Clay loam
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 11: Habitat survey results at EW65.

General Habitat	Site Photo
White box woodland ~50m wide semi continuous parallel to Hume Highway near the southern connection with the Proposal (See Figure 4.3). Fallen timber, leaf litter, few acacia emerging Very weedy groundcover with few native species present.	
Matrix	Disturbance
The western side comprises the Hume Highway, while the eastern side is open farmland dominated by agricultural activity.	This patch is degraded by an existing vehicular track, evidence of firewood removal and the site also appears to have some limited fire history.
Habitat Variables	Quantity
Forbs (% cover)	20
Grasses (% cover)	45
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	10
Logs 25-100mm diameter. (No.)	8
Logs 25-100mm diameter (lineal metres)	25
Logs 101-300mm diameter (No.)	1
Logs 101-300mm diameter (lineal metres)	4
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	>20 clumps
Hollows (No. visible - any size)	See HBT section
Loose bark (yes/no)	Yes
Shrub height (mean)	0.9m
Shrub density (no. of shrubs)	12
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Clay
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 12: Habitat survey results at EW184.

General Habitat	Site Photo
While the site appears to be open farmland, the presence of scattered eucalypts as well as the record of a Brown Treecreeper, suggests that a sparse open woodland is present. A minor ephemeral drainage line is present, and the site appears to be just west of Proposal. A farm dam at located at the end of drainage line Two raptor sized nests on yellow box trees- no signs of occupation which appear to small for Little eagle. Brown falcon recorded at this site. Site is on 'Dunraven' property.	
Matrix	Disturbance
Similar open farmland- loose connectivity with isolated paddock trees – large Yellow Box but few hollows	The site is currently grazed by cattle and exotic pasture species dominate.
Habitat Variables	Quantity
Forbs (% cover)	30
Grasses (% cover)	70
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	<6 clumps present
Hollows (No. visible - any size)	See HBT section
Loose bark (yes/no)	Yes
Shrub height (mean)	None
Shrub density (no. of shrubs)	n/a
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Loamy clay
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 13: Habitat survey results at EW140.

General Habitat	Site Photo
While the site appears to comprise paddock trees, the presence of Brown Treecreeper to the south of this site (within the same drainage line) suggests that a woodland environment may be operating. The site is located on the eastern side of a minor ephemeral gully and is located directly to the west of the Proposal. The drainage line hosts small quantities of fallen timber, but none are present on the site. Tussock grasses can be found within a minor depression. A number of stags are present supporting at least two pairs of Striated Pardalote. Site is on 'Dunraven' property.	
Matrix	Disturbance
The site is surrounded by open farmland and is not considered connected to the woodland areas to the east. Loose connectivity to the west and the linear patch to the north may provide some explanation as to the presence of Brown Treecreeper within this gully.	The site is currently being grazed by cattle and there appears to have been some level of 'pasture improvement' in the past. Currently, the site is dominated by exotic flora ground species.
Habitat Variables	Quantity
Forbs (% cover)	30
Grasses (% cover)	70
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No.)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	<6 clumps observed.
Hollows (No. visible - any size)	See HBT section
Loose bark (yes/no)	Yes
Shrub height (mean)	0
Shrub density (no. of shrubs)	0
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Loam
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 14: Habitat survey results at EW105.

General Habitat	Site Photo
This site comprises a small patch of box-gum woodland that has a very open canopy dominated by White Box and Yellow Box. There is a clear absence of an understorey and virtually no fallen timber is insitu (although there are piles that appear to have been 'cleaned up'. There is virtually no leaf litter present. The site is dominated by exotic flora species at ground level and only a handful of mistletoe were observed within the canopy. Site is located on 'Mount Raven' property.	
Matrix	Disturbance
The site is surrounded by open farmland. However, connectivity is loosely available by paddock trees to the linear patch to the west (in photo background). Given that the Proposal is likely to remove this link and Squirrel Glider was recorded at this site, efforts should be made to maintain or improve this connectivity.	The site has experienced cattle grazing recently (scats) and the ground vegetation is dominated by exotic flora. Fallen timber has been placed into piles in what appears to be 'cleaning up' practices.
Habitat Variables	Quantity
Forbs (% cover)	60
Grasses (% cover)	40
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No.)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	0
Hollows (No. visible - any size)	See HBT section
Loose bark (yes/no)	Yes
Shrub height (mean)	0
Shrub density (no. of shrubs)	0
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Clay
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 15: Habitat survey results at RW156.

General Habitat	Site Photo
Riparian woodland along Mountain creek. The site is lined with red gum, with some willows and occasional acacia. Creek bank is widely incised with a channel depth of 2m and a width of 5m. Aquatic emergent vegetation is sparse, with occasional patches of Phragmites. Fringing vegetation is continuous- grasses mostly. Riparian vegetation is largely discontinuous, with canopy spaces in places up to 30m. Site is located on 'Dunraven' property.	
Matrix	Disturbance
Cleared open farmland with scattered eucalypts both sides.	The site is currently grazed by cattle and exotic flora dominates the ground vegetation.
Habitat Variables	Quantity
Forbs (% cover)	0
Grasses (% cover)	100
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No.)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	<10 plants observed
Hollows (No. visible - any size)	See HBT section
Loose bark (yes/no)	No
Shrub height (mean)	Nil
Shrub density (no. of shrubs)	Nil
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Loam
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 16: Habitat survey results at OF144.

General Habitat	Site Photo
The site comprises Open Farmland habitat, with the occasional scattered rock that is deeply embedded and very small (<10m² in area). Some scattered eucalypts are present to the north of the site. Site is located on 'Mount Raven' property.	
Matrix	Disturbance
Continuous with Open Farmland, Oats sown in paddock to the south west	Likely previous woodland considering surrounding hills, so extensively cleared. Currently grazed by sheep and cattle.
Habitat Variables	Quantity
Forbs (% cover)	60
Grasses (% cover)	40
Rocks (% cover)	0
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No.)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	0
Hollows (No. visible - any size)	0
Loose bark (yes/no)	No
Shrub height (mean)	0
Shrub density (no. of shrubs)	0
Soil crevices/cracks (lineal metres visible)	0
Soil type (Sand, clay, loam, gravel)	Granite Clay
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 17: Habitat survey results at RO146.

General Habitat	Site Photo
Rocky Outcrop amongst Open Farmland. The area is small in area and is isolated from other outcrops. Large boulders still deeply embedded- some rock on rock, some loose rock at bottom outcrop side Only ~50 searchable rocks present - all searched. Site is located on 'Mount Raven' property.	
Matrix	Disturbance
Surrounded by Open Farmland – occasional rock outcrop in paddock of <10m ² .	Exotic flora dominates the vegetation. Currently sheep graze the site.
Habitat Variables	Quantity
Forbs (% cover)	35
Grasses (% cover)	10
Rocks (% cover)	50
Litter (% cover)	0
Bare ground (% cover)	5
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No.)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	0
Hollows (No. visible - any size)	0
Loose bark (yes/no)	No
Shrub height (mean)	0
Shrub density (no. of shrubs)	0
Soil crevices/cracks (lineal metres visible)	Cracks in exfoliating granite, but few present.
Soil type (Sand, clay, loam, gravel)	Granite Clay
Prickly flora (ie, spinifex, acacia - % cover)	0

Table 18: Habitat survey results at RO145.

General Habitat	Site Photo
Granite rock outcrop situated within Open Farmland on ridge. The site comprises deeply embedded boulders, with few loose or partially imbedded rocks. Only ~50 rocks were searchable within an approximate area of 400m². Site is located on 'Mount Raven' property.	
Matrix	Disturbance
Surrounded by Open Farmland with the nearest small rocky outcrop at least 70m distant.	Apart from the site being extremely weedy, recent geotechnical activities are likely to have created some minor disturbance.
Habitat Variables	Quantity
Forbs (% cover)	15
Grasses (% cover)	15
Rocks (% cover)	75
Litter (% cover)	0
Bare ground (% cover)	0
Logs 25-100mm diameter. (No.)	0
Logs 25-100mm diameter (lineal metres)	0
Logs 101-300mm diameter (No.)	0
Logs 101-300mm diameter (lineal metres)	0
Logs >300mm diameter (No.)	0
Logs >300mm diameter (lineal metres)	0
Mistletoe (No. of clumps)	0
Hollows (No. visible - any size)	0
Loose bark (yes/no)	No
Shrub height (mean)	0
Shrub density (no. of shrubs)	0
Soil crevices/cracks (lineal metres visible)	Limited crevices provide refuge for <i>Egernia</i> sp.
Soil type (Sand, clay, loam, gravel)	Granite Clay
Prickly flora (ie, spinifex, acacia - % cover)	0

3.3.5 *Hollow-bearing trees*

One hundred and six hollow-bearing trees (HBT) were recorded within or adjacent to the proposed alignment (Table 19). These HBT were characterised by a total of 300 hollows (openings) consisting of 141 small, 107 medium, 39 large and 13 extra large sized hollows with an average diameter at breast height (dbh) of 88cm. The distribution of all HBT across the study area is provided (Figure 4.1, 4.2, 4.3).

After queries were run in GIS comparing the distribution of the HBT and the proposed clearing boundary, SKM confirmed that a total of forty HBT will be directly impacted by the Proposal comprising a total of 114 hollows (59 small, 39 medium, 12 large and 4 extra large). Each individual HBT to be removed is shown in **BOLD** (Table 19).

Table 19: Attributes of the hollow-bearing trees found within or adjacent to the Proposal. GPS ID marked in **BOLD** will be removed by the Proposal.

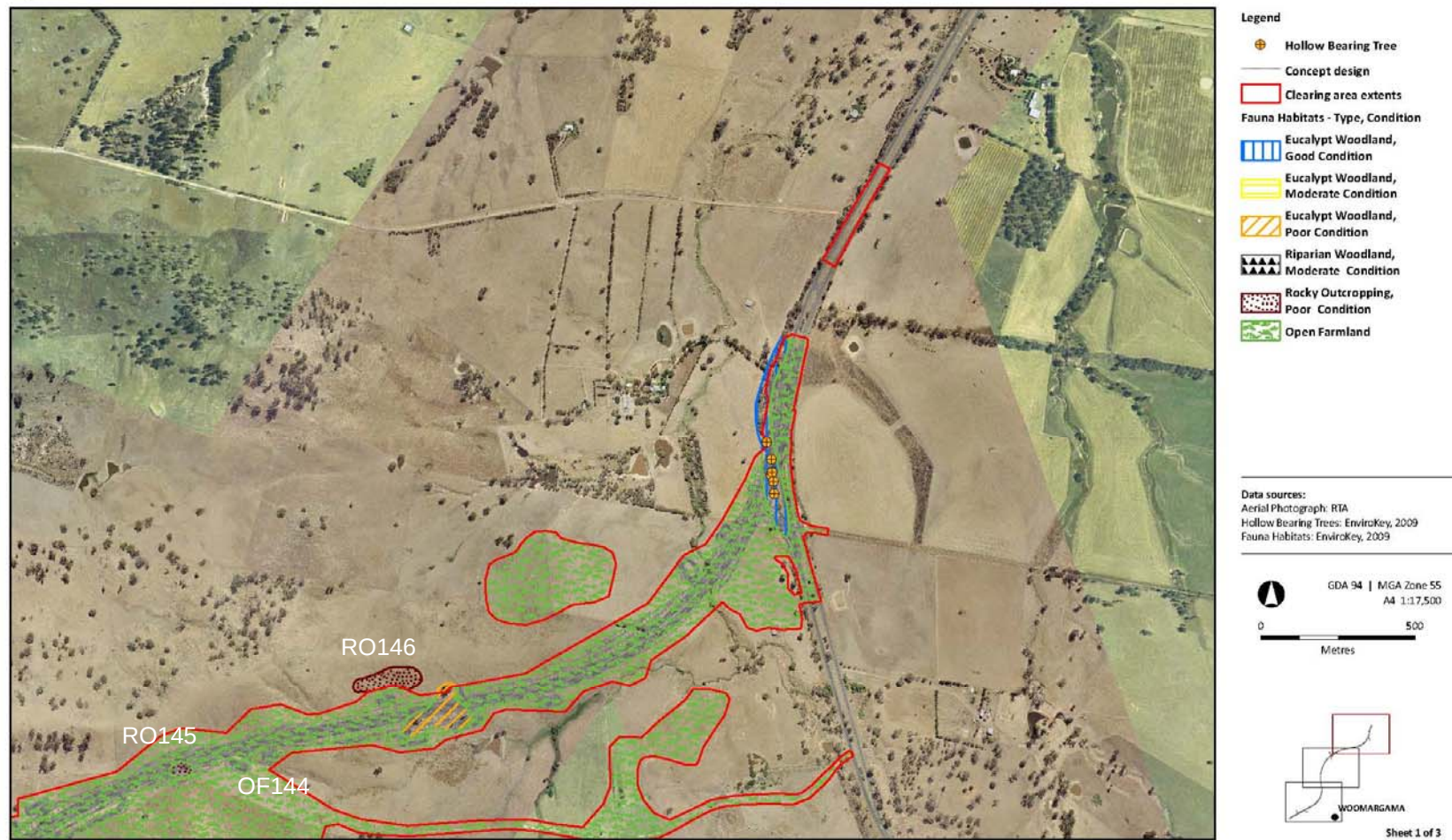
GPS_Id	X_projection	Y_projection	dbh (cm)	Hollow Size			
				Small (<10cm)	Med (10-20cm)	Large (20-30cm)	X-large (>30cm)
68	520060.82	6034676.03	80	0	4	2	0
69	520092.35	6034677.05	90	0	2	2	1
70	520105.92	6034667.99	100	0	1	0	0
71	520104.09	6034687.55	75	0	3	0	0
72	520116.81	6034688.49	62	0	4	1	0
73	520093.97	6034702.13	60	0	1	0	0
75	520250.52	6034752.69	70	0	1	0	0
76	520263.35	6034760.41	110	0	0	1	3
77	520293.21	6034750.93	50	0	0	1	0
78	520315.49	6034773.37	95	2	2	1	0
79	520329.22	6034764.29	85	0	2	0	0
80	520145.25	6034685.95	100	0	1	0	0
81	520030.57	6034646.17	62	1	2	1	0
82	519972.65	6034594.69	80	0	1	0	0
83	519960.19	6034610.67	50	4	2	1	0
84	519957.23	6034612.28	100	2	1	0	0
85	519952.02	6034601.12	60	0	1	1	0
86	519938.58	6034597.10	70	0	1	0	0
87	519922.76	6034579.52	75	2	2	0	0

GPS_Id	X_projection	Y_projection	dbh (cm)	Hollow Size			
				Small (<10cm)	Med (10- 20cm)	Large (20- 30cm)	X-large (>30cm)
88	519889.81	6034549.39	70	1	4	2	0
89	519870.69	6034573.86	75	1	0	0	0
90	519731.92	6034489.79	50	0	1	0	0
91	519691.92	6034447.95	75	4	0	0	0
92	519657.83	6034431.31	70	0	5	2	0
93	519616.64	6034396.56	60	4	0	0	0
94	519601.67	6034395.07	73	1	2	1	0
96	524761.29	6040035.06	120	5	1	0	3
97	524776.92	6039979.03	75	0	4	0	0
99	524774.06	6039930.26	70	5	0	0	0
100	524778.02	6039935.66	75	0	0	0	1
101	524782.76	6039908.05	100	0	3	0	0
102	524785.61	6039866.57	80	0	4	0	3
106	521689.31	6038078.44	75	1	0	0	0
107	521634.63	6038081.24	45	2	0	0	0
108	521648.77	6038069.68	70	1	0	0	0
109	521612.00	6038057.41	75	1	0	0	0
110	521600.37	6038091.37	100	2	0	0	0
111	521584.46	6038080.37	122	2	0	1	0
112	521565.19	6038078.66	120	0	1	0	0
113	521586.43	6037994.36	173	1	0	0	0
114	521637.91	6038027.47	50	1	0	0	0
115	521731.32	6038027.22	100	1	0	0	0
116	521733.66	6037990.99	120	1	0	0	0
117	521713.19	6037975.33	80	1	0	0	0
118	521721.17	6037959.76	75	2	2	0	0
119	521735.59	6037960.97	80	0	1	0	0
120	521776.75	6037880.81	90	5	1	0	0
121	521793.92	6037926.36	60	0	0	1	0
122	521811.56	6037928.78	50	0	0	0	0

GPS_Id	X_projection	Y_projection	dbh (cm)	Hollow Size			
				Small (<10cm)	Med (10-20cm)	Large (20-30cm)	X-large (>30cm)
123	521825.90	6037939.42	80	0	1	0	0
124	521798.32	6037997.06	53	1	0	0	0
125	521812.29	6038052.14	50	0	1	0	0
126	521859.14	6038048.18	65	0	1	0	0
127	521811.74	6038068.58	40	1	0	0	0
128	521804.95	6038058.73	60	1	0	0	0
129	521789.39	6038073.27	75	1	0	0	0
130	521738.68	6038084.87	50	3	0	1	0
131	521763.12	6038063.72	60	3	0	0	0
132	521745.61	6038072.18	40	2	0	0	0
133	521732.22	6038083.05	70	2	2	0	0
135	521601.06	6037741.89	85	1	0	1	0
136	521639.23	6037720.52	120	4	2	0	0
137	521625.95	6037687.62	80	4	0	0	0
138	521582.23	6037677.86	60	0	1	0	0
139	521582.19	6037655.46	70	3	0	0	0
141	521475.32	6036661.46	50	1	0	0	0
142	521503.51	6036639.04	135	2	0	0	0
143	521520.07	6036671.64	130	2	0	0	0
147	521524.46	6037891.86	110	2	1	2	0
148	521599.29	6037883.43	115	1	1	0	0
149	521472.74	6037715.18	90	1	1	0	0
150	521480.33	6037765.49	100	1	0	0	0
151	521507.24	6037757.90	110	3	1	0	0
152	521399.89	6037770.80	110	3	1	0	0
153	521621.03	6037593.05	110	3	1	0	0
154	522136.35	6038504.58	105	2	1	0	0
155	522151.82	6038517.55	100	7	0	0	0
157	521232.79	6035390.01	90	0	1	0	0
158	521254.61	6035370.48	80	1	1	0	0

GPS_Id	X_projection	Y_projection	dbh (cm)	Hollow Size			
				Small (<10cm)	Med (10- 20cm)	Large (20- 30cm)	X-large (>30cm)
159	521288.62	6035344.87	50	2	1	0	0
160	521165.52	6035448.04	100	0	0	0	1
161	521164.92	6035457.30	120	1	0	2	0
161	521164.92	6035457.30	120	0	0	0	1
162	521164.71	6035473.49	150	1	1	0	0
163	521169.52	6035489.90	110	1	3	0	0
164	521148.97	6035496.58	110	1	3	0	0
165	521135.13	6035500.47	120	0	0	3	0
166	521119.84	6035508.08	120	0	4	0	0
167	521118.21	6035557.55	90	2	1	0	0
168	521227.66	6035440.75	130	1	2	1	0
169	521285.64	6035440.55	130	1	1	3	0
170	521114.37	6035459.21	150	1	3	1	0
171	521110.20	6035432.43	130	1	1	0	0
172	521158.87	6035437.48	150	0	1	2	0
173	521092.19	6035326.18	120	5	1	1	0
174	521112.21	6035338.27	80	0	3	0	0
175	520712.96	6035209.93	80	2	1	0	0
176	520722.19	6035194.42	110	3	0	1	0
177	520740.47	6035179.23	80	0	0	2	0
178	520745.93	6035172.40	120	0	3	1	0
179	521460.85	6037275.99	140	1	1	0	0
180	521598.46	6036595.66	70	2	0	0	0
181	521502.88	6036349.13	80	2	0	0	0
182	521429.96	6036056.91	80	2	0	0	0
183	521422.59	6035991.93	60	3	0	0	0
185	521601.09	6036925.64	100	1	0	0	0
			totals	141	107	39	13

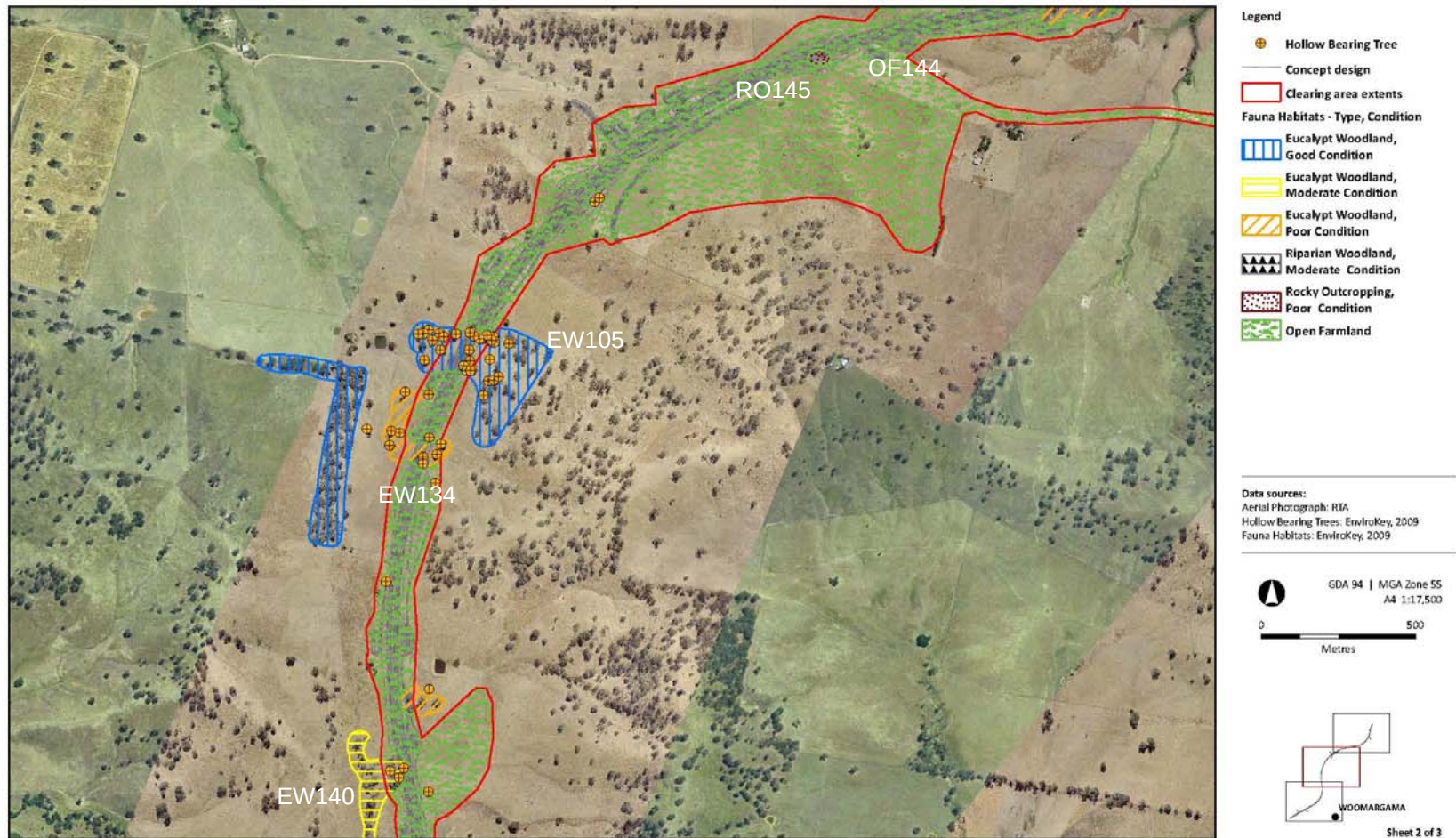
Figure 4.1 : Fauna Habitats



Hume Highway - Woomargama Bypass



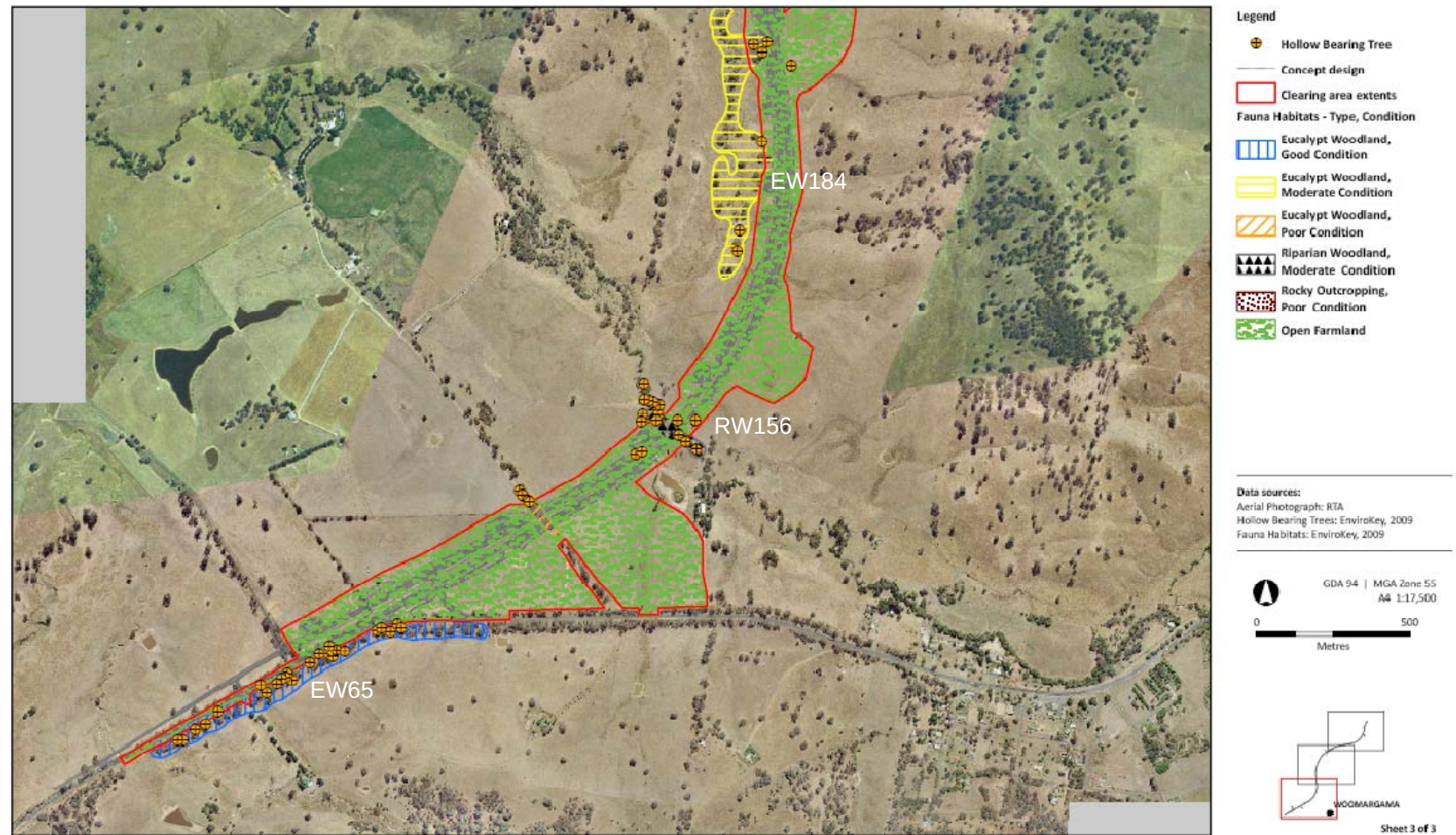
Figure 4.2 : Fauna Habitats



Hume Highway - Woomargama Bypass



Figure 4.3 : Fauna Habitats



Hume Highway - Woomargama Bypass



4 REVIEW OF SIGNIFICANCE ASSESSMENT

4.1 FAUNA HABITAT TO BE IMPACTED

PB (2009) identified fauna habitat that were likely to be removed by the Proposal (Table 5-1, pg 55) based on a broad understanding of the study area from preliminary investigations. Considering all habitat types (with the exception of open farmland), eight hectares were identified for removal.

Spatial queries completed by SKM and performed against habitat mapping undertaken during this study revealed that the total area of fauna habitat to be directly impacted by the Proposal was 228.98 hectares (including 218.17 hectares of open farmland). Removing open farmland, a total of 10.81 hectares of fauna habitat will be directly impacted by the Proposal. The on-ground evaluation has resulted in an additional 2.81 hectares of woodland fauna habitat being identified (Table 20).

Table 20: Comparison between fauna habitats identified within PB (2009) and this study.

Habitat Type	Area in ha (PB 2009)	Area in ha (This study)
Box-gum woodland	6	-
Eucalypt woodland	-	9.82
Other tree cover	1	-
Riparian vegetation	1	-
Riparian woodland	-	0.60
Rock outcropping	-	0.39
Open farmland	-	218.17

One hundred and six hollow-bearing trees (HBT) were recorded within or adjacent to the proposed alignment (Table 19). Forty HBT will be removed by the Proposal comprising 114 hollows (59 small, 39 medium, 12 large and 4 extra large). The results of Habitat Surveys will now form the basis of our review of the Significance Assessments.

4.2 SIGNIFICANCE ASSESSMENTS

PB (2009) completed Significance Assessments on terrestrial threatened fauna that had the potential to be affected by the Proposal based on the likelihood of species occurrence given the extent and quality of habitats present (Table 21).

Table 21: Summary of Significance Assessments for terrestrial threatened fauna completed by PB (2009) (Table 7-1, PB 2009).

Threatened Fauna	TSC Act ¹	EPBC Act ²	Likely significant impact
Threatened woodland birds assessed as a group (Brown Treecreeper, Hooded Robin, Black-chinned Honeyeater, Painted Honeyeater, Grey-crowned Babbler, Speckled Warbler and Diamond Firetail)	V		No
Barking and Masked Owl	V		No
Bush Stone-curlew	E		No
Regent Honeyeater	E	EM	No
Superb Parrot	V	V	No
Swift Parrot	E	E	No
Turquoise Parrot	V		No
Squirrel Glider	V		No
Microbats (Eastern False Pipistrelle, Greater Long-eared Bat, Large-footed Myotis, Yellow-bellied Sheath-tail Bat)	V	V#	No

Notes: 1- TSC Act, V = Vulnerable, E = Endangered. 2- EPBC Act, V = Vulnerable, E=Endangered, M=Migratory. #Only the Greater Long-eared Bat.

PB (2009) found that the Proposal was not likely to have a significant impact on the threatened fauna species the subject of Significance Assessments (PB 2009, Appendix E).

This section will now consider each of the target fauna species as well as microchiropteran bats taking into account their known habitat requirements, the results of this study and the previously completed Significance Assessment by PB (2009).

4.2.1 *Bush Stone-curlew*

The Bush Stone-curlew is known to inhabit open forests and woodlands that have a grassy ground layer, fallen timber and leaf litter (DEC 2006; Garnett and Crowley 2000; Morcombe 2004) and is listed as Endangered under the TSC Act (DECCW 2009). This study failed to detect any individual Bush Stone-curlew or any likely habitat that conforms to the known microhabitat requirements of the species.

Key threats to this species such as foxes, possible trampling by domestic stock and the modification or removal of microhabitat such as firewood removal or 'cleaning up' practices,

heavy grazing and the spread of introduced pasture grasses (DECCW 2009), would appear to be in heavy operation within all parts of the Proposal. Previous studies have failed to detect this species in the study area and the wider locality (NGH 2007; PB 2007).

As the Proposal would remove woodland patches that are small in area and do not provide suitable microhabitat features, it is unlikely these would support Bush Stone-curlew. Given the extent and quality of the potential habitats of the study area, EnviroKey agree with the conclusion made by PB (2009, page E-34), that it is unlikely that the Proposal would have a significant impact on the Bush Stone-curlew.

4.2.2 Squirrel Glider

The Squirrel Glider can be found across box-gum and ironbark woodlands and river red gum forests to the blackbutt-bloodwood forests on the coast across eastern Australia from northern Queensland to western Victoria (DECCW 2009; Kavanagh 2004; Menkhorst and Knight 2001). Relevant to the study area, the Squirrel Glider is listed as Vulnerable under the TSC Act (DECCW 2009).

During this study, a total of five Squirrel Glider were recorded during spotlighting surveys. It is well known that the woodlands within the study area and along the route of the Hume Highway Duplication project, support seemingly robust populations of Squirrel Glider (NGH 2007; PB 2007; SKM 2006) with a long-term monitoring program now in progress (Van der Ree 2008). Prior to this study commencing, several individuals were located during clearing operations near Fairbairn Road (Karen Webb, pers.com., 27/10/2009); very likely to be spatially connected to the four individuals observed in the eastern road reserve along the existing Hume Highway corridor. Interestingly, three individuals were recorded perched within a single white-box tree, two of which appeared to be juveniles in comparison to the third animal, while a fourth individual was located less than 30 metres away, providing limited evidence of breeding within this linear woodland. However, it is likely that the long-term viability of any local population within any linear woodland could be at significant risk given the fragmentation and isolation processes presently operating as well as the potential degradation of these remaining habitats (Van der Ree 2002). A large canopy gap exists between the Fairbairn Rd intersection and Blue Metal Travelling Stock Reserve (TSR), and could be acting as a barrier to dispersal activity. Defining this area as a crossing zone for Squirrel Glider may benefit the local population with the TSR and within the road reserve of the existing highway.

A single animal was recorded within an open woodland patch within the central portion of the study area (Figure 3.2). Given the number of hollow-bearing trees in the direct vicinity of this record, and that a number of isolated paddock trees provide potential east-west connectivity to the linear patch located within an old road reserve to the west of the Proposal, this record is not surprising given previous studies in fragmented landscapes (van der Ree *et al.* 2003).

The recommendation that a crossing zone for the Squirrel glider be created near Mountain creek, linking the riparian woodland across the Proposal (PB 2009) should be extended to also include a similar crossing zone in the central portion of the study area as the Proposal is likely to create a substantial barrier to their movement.

Given the extent and quality of the habitats of the study area, and combined with additional mitigation measures proposed within Section 5 of this report, EnviroKey agree with the conclusion made by PB (2009, page E-58), that it is unlikely that the Proposal would have a significant impact on the Squirrel Glider.

4.2.3 Brown Treecreeper

The Brown Treecreeper is most commonly found within the eucalypt forests and woodlands of the slopes of the Great Dividing Range and western inland plains (DECCW 2009; Garnett and Crowley 2000; Morcombe 2004). The species has declined across much of its range, and particularly where isolation or fragmentation has occurred for more than 50 years (Reid 1999). The species is generally sedentary, protecting a territory between one and ten hectares in area where it can breed as a single pair or in a cooperative breeding group of up to five birds (DECCW 2009).

Two records of Brown Treecreeper were collected during this study (Figure 3.2, 3.3). Additional records in the study area (DECC 2009; NGH 2007; PB 2007; 2009), confirm that the Woomargama and Holbrook areas support populations of this species in remaining woodland patches. The observation of a single bird within an open woodland patch along a minor ephemeral gully suggests that fragmentation and isolation effects are likely to be already operating within the study area given that a brief survey of the Blue Metal TSR (several kilometres south of the study area) at the conclusion of this study revealed more than 6 Brown Treecreeper in less than 15 minutes. The north-south linear patch to the west of the Proposal (west of EW105) provides mature white-box habitat with numerous hollows that could support this species. While no survey of this patch was undertaken during this study, Brown Treecreeper calls were heard from this area (Figure 3.2). No individuals were recorded within EW105, despite NGH (2007) recording the species previously. Lack of records in this study, may be the result of a general decline in the species after the past drought given that many of the key threats to this species appear to be operating within the study area.

Given the extent and quality of the habitats of the study area, and combined with additional mitigation measures proposed within Section 5 of this report, EnviroKey agree with the conclusion made by PB (2009, page E-27), that it is unlikely that the Proposal would have a significant impact on the Brown Treecreeper.

4.2.4 Painted Honeyeater

The Painted Honeyeater is a nomadic species which can be found in a range of habitats including box-gum woodlands where it mainly relies on the fruits of mistletoes as well as limited invertebrates and nectar (DECCW 2009; Morcombe 2004; Oliver *et al.* 2003). The species is listed as Vulnerable under the TSC Act (DECCW 2009).

Despite the absence of this species during the field surveys, Painted Honeyeater has been recorded within the wider locality (DECC 2009) and by local ecologist Matt Herring (NGH 2007). However, considering their nomadic nature, the wider extent of both paddock trees

and small woodland patches hosting mistletoe across the wider locality, the vegetation to be impacted by the Proposal is unlikely to be of high importance to this species.

Given the extent and quality of the habitats of the study area, EnviroKey agree with the conclusion made by PB (2009, page E-27), that it is unlikely that the Proposal would have a significant impact on the Painted Honeyeater.

4.2.5 Swift Parrot

The Swift Parrot is a migratory species that breeds in Tasmania during spring and summer, moving to south-eastern Australia in the autumn and winter months, returning to Tasmania to breed the following season (DECCW 2009; Morcombe 2004). Relevant to the study area, it is recorded within the box-gum and ironbark woodlands of the South-west slopes (DECC 2009) which are also considered favoured feed species (DECCW 2009). It is listed as Endangered under both the TSC Act and the EPBC Act.

No Swift Parrot were recorded during this study, however, the timing of the survey (October) was unlikely to reveal any individuals should they use the study area from time to time. The extent and condition of box-gum woodland to be removed by the Proposal suggests that these areas are unlikely to be utilised by Swift Parrot. As such, EnviroKey agree with the conclusion made by PB (2009, page E-51), that it is unlikely that the Proposal would have a significant impact on the Swift Parrot.

4.2.6 Hooded Robin

The Hooded Robin is known from lightly wooded habitats such as eucalypt woodlands and mallee shrublands (DECCW 2009; Morcombe 2004). First recognised as a declining woodland bird (Reid 1999), Hooded Robin is now listed as Vulnerable under the TSC Act. No Hooded Robin were recorded during this study.

It is generally considered that the Hooded Robin requires a structurally diverse habitat including microhabitat such as native grasses, shrubs and fallen timber across a territory a breeding territory of around 10 hectares (DECCW 2009). Despite not being recorded in this study, previous surveys have detected Hooded Robin in the study area (NGH 2007). The previous survey was completed within a heavy drought year (2006) which is thought to influence movements of Hooded Robin (DECCW 2009) and may have resulted in localised records. However, Watson *et al.* 2001 believe that the species generally exhibits demanding requirements for both habitat complexity and area (>100ha) (Watson *et al.* 2001), therefore, previous records of Hooded Robin within the linear habitat adjacent to the existing Hume Highway may be explained by the drought year. Nonetheless, the record of a pair on the northern slopes between the Telco towers and the existing Hume Highway alignment occurs within a large area of woodland habitat that is structurally diverse and is likely to support a resident pair.

However, the extent and quality of the woodland to be directly impacted by the Proposal suggests that these areas are unlikely to contain habitat for the Hooded Robin. As such, EnviroKey agree with the conclusion made by PB (2009, page E-27), that it is unlikely the Proposal would have a significant impact on the Hooded Robin.

4.2.7 *Black-chinned Honeyeater*

The Black-chinned Honeyeater is known from across the tablelands and western slopes of the Great Dividing Range and the Riverina plains (DECC 2009) where it is known from drier open forests and woodlands (DECCW 2009). Black-chinned Honeyeater is listed as Vulnerable under the TSC Act (DECCW 2009). No Black-chinned Honeyeater were recorded during this study.

The presence of Noisy Miner across all woodland patches during this study, may suggest that they unlikely to provide important habitat to the Black-chinned Honeyeater (DECCW 2009). Given this, and that other studies have found that the species is more inclined to occur in larger woodland patches in fragmented landscapes (DECCW 2009), Black-chinned Honeyeater are unlikely to occur within the boundaries of the Proposal such that these patches would at best be considered only marginal habitat. As such, EnviroKey agree with the conclusion made by PB (2009, page E-27), that it is unlikely the Proposal would have a significant impact on the Black-chinned Honeyeater.

4.2.8 *Regent Honeyeater*

The Regent Honeyeater is known to occur in woodlands and open forests of south-east Australia (Garnett and Crowley 2000; Morcombe 2004). Past clearing for agricultural activities has resulted in the loss of large areas of habitat and the species is now listed as Endangered under the TSC Act and EPBC Act. The Regent Honeyeater was not recorded during this study.

The species now generally occurs within woodlands that support a high abundance and species richness of avifauna, but is likely to suffer from competition with larger honeyeaters such as Noisy Miners, Noisy Friarbirds and Red Wattlebirds (DECCW 2009). The study area provides very few opportunities for Regent Honeyeater, despite the presence of several small woodland patches. These sites are dominated by these aggressive honeyeater species, and combined with the suppression of regeneration, so common in many woodland patches as a result of overgrazing, these factors are likely to be contributing to long-term landscape degradation for this species. It is considered that the vegetation that would be directly impacted by the Proposal is at best, marginal habitat if at all for the Regent Honeyeater. As such, EnviroKey agree with the conclusion made by PB (2009, page E-39), that it is unlikely the Proposal would have a significant impact on the Regent Honeyeater.

4.2.9 *Turquoise Parrot*

The Turquoise Parrot occurs from southern Queensland through to northern Victoria where it is known from woodland and riparian habitats particularly those with a grassy or shrubby understorey (DECCW 2009; Morcombe 2004). The species is often seen at the ecotone between woodland and open farmland, along timbered ridges and watercourses and had been previously recorded near Little Billabong in early 2006 by ecologists at Charles Sturt University (SKM 2006). The Turquoise Parrot is listed as Vulnerable under the TSC Act. The Turquoise Parrot was not recorded during this study.

Many of the known threats to the Turquoise Parrot are already operating within the study area. The landscape has been extensively cleared over the past century and any remaining woodland patches are often small and degraded through grazing, firewood collection and the establishment of exotic pasture species. Potential nesting habitat may occur along Mountain creek, however, no signs of breeding of this species were recorded despite surveys being undertaken within their known breeding period. The quality of the riparian woodland along Mountain creek has been degraded over time with willow infestation and exotic pasture grasses dominating the ground layer. The presence of breeding habitat along a fairly continuous stretch of riparian woodland could provide resources for this species from time to time. For the remainder of the study area, the extent and quality of the woodland patches suggests that it is unlikely that the species would occur there on a permanent basis.

However, given the nature of the Proposal in that only a small area of potential, but marginal habitat is to be removed, EnviroKey agree with the conclusion made by PB (2009, page E-54) in that it is unlikely the Proposal would have a significant impact on the Turquoise Parrot.

4.2.10 Superb Parrot

The Superb Parrot is known from the box-gum woodlands, box-pine woodlands and river red gum forests of NSW and Victoria (DECCW 2009; Morcombe 2004) and is listed as Vulnerable under the TSC Act and EPBC Act. Despite extensive surveys during this study and the landscape scale effort of previous surveys in the locality, no Superb Parrot have been recorded in the study area (NGH 2007; PB 2007; 2009).

Superb Parrots are known to nest in box-gum woodland, riparian woodland and isolated paddock trees, where they may travel as far as 10 km to suitable foraging habitat (DECCW 2009). In the south-west slopes, their core breeding habitat has been identified as roughly bordered by the towns of Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west (DECCW 2009). Other known breeding sites are located within the corridors of the Murrumbidgee, Murray and Edward Rivers.

While the study area presents resources that could be used by this species (hollow-bearing trees and small woodland patches), their absence from the locality across numerous surveys suggests that, at best, the study area is likely to only provide marginal habitat for the Superb Parrot.

As such, EnviroKey agree with the conclusion made by PB (2009, page E-44, 45) in that it is unlikely the Proposal would have a significant impact on the Superb Parrot.

4.2.11 Barking Owl

The Barking Owl is a moderately large owl known from open forests and woodlands of Australia except for the central arid regions and Tasmania (DECCW 2009; Morcombe 2004; NPWS 2003b). They are most often encountered along timbered watercourses, especially in dense vegetation where they will roost. Widespread decline in southern Australia lead to their listing as Vulnerable under the TSC Act (DECCW 2009). No Barking Owl were recorded in this study, although they have been recorded in the eastern parts of the

catchment (DECC 2009), and more recently along Billabong creek at Holbrook (Amy Currey, nghenvironmental, pers.com., January 2009).

The timing of the survey is considered late to detect breeding activity of this species, however, they are known to be present all year round within their territories (DECCW 2009). Detailed assessment of 106 HBT failed to reveal any evidence to suggest Barking Owl have been breeding in the study area. Riparian woodland along Mountain creek is likely to provide the only suitable resources for the species, should it occur there. Larger hollows could provide breeding opportunities for Barking Owl while willows are likely to provide roosting opportunities. Our surveys, using both spotlighting and call playback, failed to detect their presence, suggesting that the study area provides only marginal habitat, if at all, for this species.

Given this, EnviroKey agree with the conclusion made by PB (2009, page E-32) in that it is unlikely the Proposal would have a significant impact on the Barking Owl.

4.2.12 *Masked Owl*

The Masked Owl is known to occur over much of NSW, with the exception of the extreme north-western corner where it is known from dry eucalypt forests and woodlands, often foraging along the interface between woodlands and open farmlands and along roads on terrestrial and arboreal mammals (DECC 2006; Kavanagh 1996; Kavanagh and Bamkin 1995; Kavanagh and Murray 1996). The species is currently listed as Vulnerable under the TSC Act (DECCW 2009). No Masked Owl were recorded during this study.

The timing of the survey is considered late to detect breeding activity of this species. Assessment of 106 HBT failed to reveal any evidence to suggest that Masked Owl have been breeding in the study area. Riparian woodland along Mountain creek is likely to provide the only suitable resources for the species, should it occur there. Larger hollows could provide breeding potential breeding opportunities, however, the generally low abundance of mammals across the study area suggests that that it is unlikely to form important breeding habitat. Our surveys, using both spotlighting and call playback, failed to detect their presence, providing further evidence that the study area is unlikely to provide habitat for the Masked Owl should it occur in the locality.

Given this, EnviroKey agree with the conclusion made by PB (2009, page E-32) in that it is unlikely the Proposal would have a significant impact on the Masked Owl.

4.2.13 *Grey-crowned Babbler*

The Grey-crowned Babbler is found on the western slopes of the Great Dividing Range as well as some locations in the Hunter Valley where it inhabits woodlands in family groups of up to fifteen individuals (DECCW 2009; Reid 1999). These family groups maintain territories that can range from one to fifty hectares which are defended all year round, where disputes with neighbouring groups are frequent (DECCW 2009). The species is listed as Vulnerable under the TSC Act. No Grey-crowned Babbler were recorded during this study.

Known habitat requirements for the Grey-crowned Babbler include an understorey of young trees and shrubs and a relatively sparse ground layer dominated by litter, none of which were recorded within the study area. Previous surveys have failed to detect this species, although the White-browed Babbler was recorded east of the Telco towers on Mt McKenzie (NGH 2007). Given the lack of suitable habitat present, it is unlikely that the Grey-crowned Babbler would occur within the area to be directly impacted by the Proposal.

Therefore, EnviroKey agree with the conclusion made by PB (2009, page E-27), that it is unlikely the Proposal would have a significant impact on the Grey-crowned Babbler.

4.2.14 *Speckled Warbler*

The Speckled Warbler is known from a patchy distribution throughout the eastern half of NSW where it occurs within a wide range of eucalypt dominated communities, often on rocky ridges or gullies that host a grassy understorey (DECCW 2009; Reid 1999). It is generally considered that the Speckled Warbler requires relatively large areas of habitat to survive long-term in fragmented landscapes (DECCW 2009; Reid 1999). The species is now listed as Vulnerable under the TSC Act. No Speckled Warbler were recorded during this study, or have been recorded by previous surveys (NGH 2007; PB 2009) despite some records within nature reserves and national parks in the wider locality (DECC 2009). This is likely due to many larger woodland remaining not seemingly being impacted by fragmentation and isolation effects and processes supporting more structurally diverse microhabitats than smaller patches (Lindenmayer and Fischer 2006) which would favour the Speckled Warbler. However, habitat where the Hooded Robin was recorded (between the Telco towers and the existing Hume Highway) could support Speckled Warbler.

Given the extent and condition of remaining woodland patches the subject of this report, it is unlikely that Speckled Warbler would occur within the clearing boundary. As such, EnviroKey agree with the conclusion made by PB (2009, page E-27), in that it is unlikely the Proposal would have a significant impact on the Speckled Warbler.

4.2.15 *Diamond Firetail*

The Diamond Firetail is widely distributed across NSW, with an apparent concentration of records across the western slopes of the Great Dividing Range (DECC 2009; DECCW 2009; Morcombe 2004). They are known to occur in a range of vegetation communities including box-gum woodland and often in lightly wooded farmland (DECCW 2009). The species is listed as Vulnerable under the TSC Act.

Despite not being recorded during this study, the Diamond Firetail has been previously recorded in the Upper Billabong catchment by numerous workers (Cooney and Watson 2005; DECC 2009; Herring 2003). Recent surveys in the Holbrook area also detected this species in riparian woodland (Amy Currey, nghenvironmental, pers.com., January 2009) and on numerous occasions during an ecological research project by the writer between 2005-2007.

The study area provides some habitat for the Diamond Firetail considering the presence of eucalypt woodland and riparian woodland habitats, and to a lesser extent, open farmland.

However, these have been degraded by exotic pasture species invasions significantly reducing native grasses which provide an important foraging resource for the species (DECCW 2009). The presence of Mistletoe as a nesting resource may lessen the impact of the non-existence of a shrubby understorey to their breeding success (Cooney and Watson 2005; Cooney *et al.* 2006). However, it is unlikely to offset the impacts of landscape scale removal of woodland habitats which have occurred in the study area over the past century (Woodward 1998). Combined with the quality and extent of the remaining patches, the study area is unlikely to provide habitat resources of importance to the Diamond Firetail.

Given this, EnviroKey agree with the conclusion made by PB (2009, page E-27), in that it is unlikely the Proposal would have a significant impact on the Diamond Firetail.

4.2.16 *Microchiropteran Bats*

This study did not specifically undertake a survey for threatened microbats; however, given the extent of HBT across the study area, discussion is warranted.

A baseline resource that examines the microbats of the study area comes from the two-year study conducted by Grabham (2004). Eleven species of microbat were recorded within the Woomargama area including three threatened species: Yellow-bellied Sheath-tail Bat, Eastern False Pipistrelle and Eastern Long-eared Bat (now known as the South-eastern long-eared bat *Nyctophilus* species 2 (Churchill 2008)). This study found that levels of microbat activity were significantly greater in larger areas of remnant vegetation compared with smaller remnants and isolated paddock trees such as those found within the study area.

All three species are known to use HBT as both roosting sites and maternity sites (Churchill 2008; Menkhorst and Knight 2001), and this study identified forty HBT that would be removed by the Proposal containing 114 hollows (openings) comprising 59 small, 39 medium, 12 large and 4 extra large sized hollows. While nocturnal surveys failed to reveal any microbats exiting on dusk from any hollows, the sheer number of trees (106 HBT) and hollows in the study area meant that the majority of hollows could not be surveyed during this study. Given that the previous study recorded eleven species of microbat, it is likely that some of these could occur within the boundaries of the Proposal.

While the quality of these HBT has been compromised by their position within an agricultural landscape, their importance as a limiting resource should not be underestimated (Gibbons and Boak 2002; Gibbons and Lindenmayer 2002). However, surveys across the locality (if undertaken) would probably reveal similar number of hollows and HBT across this agricultural landscape and that numerous HBT were also located within the road reserve of the existing Hume Highway, suggesting that this resource may not be limited. Local knowledge of the author also confirms that HBT are distributed across many parts of the Upper Billabong Creek catchment area.

Given the extent and quality of the habitats of the study area, and combined with additional mitigation measures proposed within Section 5 this report, EnviroKey agree with the conclusion made by PB (2009, page E-64), that it is unlikely the Proposal would have a significant impact on Microchiropteran Bats.

4.2.17 *Migratory Species*

One species of bird, Rainbow Bee-eater, recorded during this and previous surveys are currently recognised as 'Migratory' under the EPBC Act. Protected under several international agreements to which Australia is a signatory, Migratory species are considered Matters of National Environmental Significance. Under the EPBC Act, an action is likely to have a significant impact on a migratory species if it substantially modifies, destroys or isolated an area of important habitat for the species (DEH 2006).

PB (2009) considers a number of migratory species (as identified in Table 22) that are known to, or have the potential to occur in the study area and suggests that the study area is unlikely to be considered important habitat for any of the migratory species as it does not contain:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecological significant proportion of the population of the species.
- Habitat that is of critical importance to the species at particular life-cycle stages.
- Habitat used by a migratory species that is at the limit of the species' range.
- Habitat within an area where the species is declining (DEH 2006).

Rainbow Bee-eater is a regular summer visitor to the southern Australia (Morcombe 2004), where it breeds within riparian environments, often burrowing into incised banks and other suitable substrates (pers.obs). One individual was heard calling during the field surveys, while other sources across the locality have also recorded the species (DECC 2009; Herring 2003; NGH 2007).

While no breeding activity was observed where the Proposal crosses Mountain creek, or any other part of the study area, it is likely that the species does breed in the locality, and quite possibly within the boundaries of the Proposal. However, given that breeding of this species occurs across a wide geographic distribution in southern Australia, the resources present within the study area are not regarded as important habitat. Further, similar resources (creeklines, incised banks) are found across virtually all parts of the locality, the Upper Billabong catchment and the south-west slopes bioregion.

Our study does not present any additional information that would alter the conclusion made by PB (2009) in that the study area does not contained areas of important habitat. As such, EnviroKey agree with PB in that the impacts of the Proposal on migratory species are not likely to be regarded as significant.

4.3 EVALUATION OF THREATENED AND MIGRATORY FAUNA

Significance Assessments were completed by PB (2009) using a prediction model whereby species were selected based on a moderate or high likelihood of their potential for occurrence in the study area (Table 2-4, p17, PB 2009).

Based on the results of this study, EnviroKey have undertaken an additional evaluation to review whether further Significance Assessments are required using the following factors in this consideration:

- the presence of potential habitat
- condition of and approximate extent of potential habitat
- species occurrence within the study area and locality

The following criteria were applied to the same species list used in the previous assessment (PB 2009, Appendix D) to evaluate the likelihood of their occurrence in the study area:

- No (no suitable habitat based on known habitat requirements within the study area)
- Unlikely (no suitable habitat is present, but there are records in the locality and the species is highly-mobile)
- Likely (recorded in the locality, suitable habitat within the study area)
- Yes (recorded during the field survey).

Given that one species (Little Eagle) was recorded during the field survey that is currently the subject of 'preliminary determination' under the TSC Act at the time of writing, other species also under 'preliminary determination' that were identified in the preliminary ecological investigation as having previous records in the Woomargama region (Appendix 1, NGH 2007) were included within this evaluation even though there is no obligation to do so. The species included are:

- White-fronted Chat (Vulnerable species listing on public exhibition between 21 August – 16 October 2009)
- Flame Robin (Vulnerable species listing on public exhibition between 8 May – 10 July 2009)
- Little Eagle (recorded during the field survey) (Vulnerable species listing on public exhibition between 8 May – 10 July 2009)
- Scarlet Robin (Vulnerable species listing on public exhibition between 8 May – 10 July 2009)
- Varied Sittella (recorded by NGH 2007) (Vulnerable species listing on public exhibition between 8 May – 10 July 2009)
- White-browed Woodswallow (recorded by NGH 2007) (Vulnerable species listing on public exhibition between 8 May – 10 July 2009)

The results of this evaluation are provided (Table 22).

Table 22: Evaluation of the likelihood of threatened and migratory species occurrence within the study area.

Threatened or Migratory Fauna	Recorded during survey	Recorded previously in locality	Potential habitat in study area	Likelihood of species occurring within study area
FROGS				
Sloane's Toadlet <i>Crinia sloanei</i>	NO	YES	NO	NO
Booroolong Frog <i>Litoria booroolongensis</i>	NO	NO	NO	NO
Southern Bell Frog <i>Litoria raniformis</i>	NO	YES	NO	NO
BIRDS				
Great Egret <i>Ardea alba</i>	NO	YES	YES	LIKELY
Cattle Egret <i>Ardea ibis</i>	NO	NO	YES	LIKELY
White-browed Woodswallow <i>Artamus leucorhynchus</i>	NO	YES	YES	LIKELY
Bush Stone-curlew <i>Burhinus grallarius</i>	NO	YES	NO	UNLIKELY
Gang-gang Cockatoo <i>Callocephalon fimbriatum</i>	YES	YES	YES	YES
Glossy Black-cockatoo <i>Calyptorhynchus lathami</i>	NO	NO	NO	NO
Brown Treecreeper (eastern subspecies) <i>Climacteris picumnus victoriae</i>	YES	YES	YES	YES
Varied Sittella <i>Daphoenositta chrysotera</i>	NO	YES	YES	LIKELY
White-fronted Chat <i>Epthianura albifrons</i>	NO	YES	YES	LIKELY
Grey Falcon <i>Falco hypoleucos</i>	NO	YES	NO	NO
Latham's Snipe <i>Gallinago hardwickii</i>	NO	YES	NO	NO
Painted Honeyeater <i>Grantiella picta</i>	NO	YES	YES	LIKELY

Threatened or Migratory Fauna	Recorded during survey	Recorded previously in locality	Potential habitat in study area	Likelihood of species occurring within study area
Brolga <i>Grus rubicunda</i>	NO	YES	NO	UNLIKELY
White-bellied Sea-eagle <i>Haliaeetus leucogaster</i>	NO	YES	NO	UNLIKELY
Little Eagle <i>Hieraaetus morphnoides</i>	YES	YES	YES	YES
White-throated Needletail <i>Hirundapus caudacutus</i>	NO	NO	YES	UNLIKELY
Swift Parrot <i>Lathamus discolor</i>	NO	YES	YES	LIKELY
Square-tailed Kite <i>Lophoictinia isura</i>	NO	NO	NO	NO
Hooded Robin (southeastern form) <i>Melanodryas cucullata cucullata</i>	NO	YES	NO	UNLIKELY
Black-chinned Honeyeater (eastern subspecies) <i>Melithreptus gularis gularis</i>	NO	YES	YES	LIKELY
Rainbow Bee-eater <i>Merops ornatus</i>	YES	YES	YES	YES
Satin Flycatcher <i>Myiagra cyanoleuca</i>	NO	YES	NO	UNLIKELY
Turquoise Parrot <i>Neophema pulchella</i>	NO	YES	YES	LIKELY
Barking Owl <i>Ninox connivens</i>	NO	YES	YES	LIKELY
Powerful Owl <i>Ninox strenua</i>	NO	YES	NO	NO
Blue-billed Duck <i>Oxyura australis</i>	NO	NO	NO	NO
Olive Whistler <i>Pachycephala olivacea</i>	NO	NO	NO	NO
Scarlet Robin <i>Petroica multicolor</i>	NO	YES	YES	LIKELY
Flame Robin <i>Petroica phoenicea</i>	NO	YES	YES	LIKELY
Pink Robin <i>Petroica rodinogaster</i>	NO	NO	NO	NO

Threatened or Migratory Fauna	Recorded during survey	Recorded previously in locality	Potential habitat in study area	Likelihood of species occurring within study area
Superb Parrot <i>Polytelis swainsonii</i>	NO	YES	YES	LIKELY
Grey-crowned Babbler <i>Pomatostomus temporalis</i>	NO	YES	NO	UNLIKELY
Speckled Warbler <i>Pyrholaemus sagittatus</i>	NO	YES	NO	UNLIKELY
Rufous Fantail <i>Rhipidura rufifrons</i>	NO	NO	NO	NO
Painted Snipe <i>Rostratula benghalensis</i>	NO	YES	NO	NO
Diamond Firetail <i>Stagonopleura guttata</i>	NO	YES	YES	LIKELY
Freckled Duck <i>Stictonetta naevosa</i>	NO	YES	NO	NO
Masked Owl <i>Tyto novaehollandiae</i>	NO	NO	YES	LIKELY
Regent Honeyeater <i>Xanthomyza phrygia</i>	NO	YES	YES	LIKELY
MAMMALS				
Eastern Pygmy-possum <i>Cercartetus nanus</i>	NO	NO	NO	NO
Spotted-tailed Quoll <i>Dasyurus maculatus</i>	NO	YES	NO	NO
Eastern False Pipistrelle <i>Falsistrellus tasmaniensis</i>	NO	YES	YES	LIKELY
Large-footed Myotis <i>Myotis adversus</i>	NO	NO	NO	NO
Eastern Long-eared Bat <i>Nyctophilus bifax</i>	NO	YES	YES	LIKELY
Squirrel Glider <i>Petaurus norfolcensis</i>	YES	YES	YES	YES
Brush-tailed Phascogale <i>Phascogale tapoatafa</i>	NO	NO	NO	NO
Koala <i>Phascolarctos cinereus</i>	NO	YES	NO	NO
Yellow-bellied Sheath-tail Bat <i>Saccolaimus flaviventris</i>	NO	YES	YES	LIKELY

Threatened or Migratory Fauna	Recorded during survey	Recorded previously in locality	Potential habitat in study area	Likelihood of species occurring within study area
REPTILES				
Pink-tailed Worm-lizard <i>Aprasia parapulchella</i>	NO	YES	NO	NO
Striped Legless Lizard <i>Delma impar</i>	NO	NO	NO	NO
Heath Monitor <i>Varanus rosenbergi</i>	NO	NO	NO	NO

Based on the above evaluation and the Significance Assessments completed to date by PB (2009), one threatened species, the Gang-gang Cockatoo requires additional assessment. Additionally, six species currently the subject of 'preliminary determination' under the TSC Act at the time of writing are also known to, or are likely to occur in the study area (Table 22). These being the White-browed Woodswallow, Varied Sittella, White-fronted Chat, Little Eagle, Scarlet Robin and Flame Robin.

All seven species will be considered further in Section 4.4.

4.4 ADDITIONAL SIGNIFICANCE ASSESSMENTS

As outlined by PB (2009), projects assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* do not require assessments of significance under Section 5A of the Act (the seven part test).

Table 22 identified one threatened species, the Gang-gang Cockatoo which has not been considered in previous assessment (PB 2009). Six additional species currently the subject of 'preliminary determination' under the TSC Act at the time of writing are known to, or are likely to occur in the study area: White-browed Woodswallow, Varied Sittella, White-fronted Chat, Little Eagle, Scarlet Robin and Flame Robin.

This section provides additional Significance Assessments for all seven species, even though there is no obligation to consider the species currently the subject of 'preliminary determination'.

4.4.1 *Gang-gang Cockatoo*

The Gang-gang Cockatoo is listed as Vulnerable under the TSC Act. It can be found from the Hunter Valley region through to the south-west slopes within NSW and the ACT where it generally occurs in tall mountain forests and woodlands often visiting lower altitude areas in winter including urban areas (DECCW 2009; Morcombe 2004).

Known threats to the species include:

- Clearing of vegetation and degradation of habitat may reduce the abundance of optimal foraging and roosting habitat.
- Individual pairs show high fidelity to selected nesting trees (choosing nesting hollows of particular shape, position and structure), with clearing and frequent fire posing a threat to continued successful breeding.
- Climate change may alter the extent and nature of its preferred habitat (cool temperate vegetation).
- Susceptible to Psittacine cirovirus disease (PCD) which is spread through contaminated nest chambers. PCD is known to have increased near Bowral in the southern highlands of New South Wales over the past decade and constitutes a further threat to the species (DECCW 2009).

Four individuals as part of one flock were recorded flying from west to east in the central portion of the study area. While previous surveys in the Woomargama area have failed to detect the species (NGH 2007), there are numerous records in nearby Woomargama National Park (DECC 2009) and individuals are often seen foraging in gardens within the Woomargama village during the winter months and in foothill forest habitat to the east of the village (pers.obs).

Assessment – *Environmental Planning and Assessment Act 1979*

How is the Proposal likely to affect the lifecycle of a threatened species and/or population?

The lifecycle of the Gang-gang Cockatoo within the study area is unlikely to be affected by the Proposal. Gang-gang Cockatoos are generally known to favour mature cool temperate vegetation (DECCW 2009) for nesting and roosting habitat, so their presence in the study area is likely to be associated with foraging activity only. While foraging habitat will be affected as a result of vegetation clearing (~10.8 hectares), similar small woodland patches and paddock trees can be found across the locality.

The flock observed consisted of two adults and two juvenile birds from last season, and therefore, it is likely that breeding activity is occurring in the locality. Assessment of 106 HBT (40 to be removed and 66 indirectly impacted by disturbance) found no evidence of breeding activity of the Gang-gang Cockatoo, despite suitably sized hollows being present suggesting the cool temperate and dry foothill forest vegetation located to the east of Woomargama normally favoured by this species, provides better quality habitat. Therefore, the Proposal is unlikely to affect the lifecycle of the Gang-gang Cockatoo.

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

The Proposal would remove approximately 10.8 hectares of marginally suitable foraging habitat for this species. The locality contains similar small woodland patches and paddock trees of a similar quality in an already fragmented landscape. As such, the Proposal is

unlikely to affect the availability of habitat for this species which can forage over long distances.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

The Gang-gang Cockatoo is found across the coastal plains and Great Dividing Range and its foothills in NSW generally occurring in tall mountain forests and woodlands often visiting lower altitude areas in winter including urban areas (DECCW 2009; Morcombe 2004). A review of records of this species using BioNET reveals that while the study area is close to its distributional limit, records of Gang-gang Cockatoo extend to some 50km west of the study area (BioNet 2009).

How is the Proposal likely to affect current disturbance regimes?

The study area has been extensively modified for agriculture for more than 100 years with only small, degraded woodland patches remaining. The Proposal is unlikely to affect microhabitat features any more than currently occurring. Conversely, the Proposal would involve the loss of 10.8 hectares of vegetation and the removal of hollow-bearing trees and dead wood, all recognised as key threatening processes.

How is the Proposal likely to affect habitat connectivity?

The study area is already highly fragmented with remaining woodland patches occurring as small isolates or linear remnants and scattered paddock trees. While the Proposal will result in a linear feature through the study area, this is unlikely to affect habitat connectivity for a species that can forage over long distances.

How is the Proposal likely to affect critical habitat?

There is no critical habitat listed for the Gang-gang Cockatoo and given the extent and quality of the remaining woodland patches, the study area is unlikely to be critical to the long-term survival of the species in the locality.

Conclusion

The Gang-gang Cockatoo is unlikely to be significantly affected by the Proposal.

4.4.2 Threatened Woodland Birds (*White-browed Woodswallow, Varied Sittella*)

Seven Threatened woodland bird species were assessed by PB (2009) in a single Significance Assessment as they generally share similar habitat requirements, threats that affect their recovery, and potential impacts as a result of the Proposal. The White-browed Woodswallow and Varied Sittella are also part of this group of woodland birds considered to be declining (Reid 1999) and while not listed as a threatened species, these two species are the subject of a 'preliminary determination' under the TSC Act at the time of writing.

Threats to woodland birds that have been identified include the clearing of woodland resulting in loss and fragmentation of habitat, modification and destruction of ground habitat structure through heavy grazing by stock, removal of fallen timber and litter and the introduction of exotic pasture grasses (Reid 1999; Smith *et al.* 1994; Watson *et al.* 2001).

Descriptions of each species are presented below.

White-browed Woodswallow *Artamus leucorhynchus*

The White-browed Woodswallow occurs in eastern, northern and central Australia (Morcombe 2004). In NSW it typically breeds in open forests and woodlands from the inland slopes to the far western plains but during dry years its distribution extends east to open habitats of the tablelands and coast (Higgins *et al.* 2006).

In agricultural landscapes it generally prefers healthy woodland patches with low disturbance and little grazing (Higgins *et al.* 2006). The species builds a cup-shaped nest of twigs and plant fibres in a fork, crevice or foliage in a tree or shrub (live or dead), vine, creeper, stump or artificial structure.

The species was not recorded during this study, but was recorded in previous surveys of the Woomargama area in woodlands between Mt Kenzie and the existing Hume Highway alignment (NGH 2007).

Varied Sittella *Daphoenositta chrysoptera*

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west (Barrett *et al.* 2007; Morcombe 2004). It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticated bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.

The species was not recorded during this study, but was recorded in previous surveys of the Woomargama area in the woodland of the road reserve of the existing Hume Highway near Annandale Road (NGH 2007).

Assessment – Environmental Planning and Assessment Act 1979

How is the Proposal likely to affect the lifecycle of a threatened species and/or population?

Both species were recorded in higher quality habitat areas in previous surveys of the locality within the woodland of the road reserve of the existing Hume Highway near Annandale Road and between the Mt McKenzie Telco towers and the existing Hume Highway alignment.

The Eucalypt and Riparian Woodland habitat to be removed by the Proposal exists as small, fragmented patches with little microhabitat structure dominated by exotic pasture species. Given that most woodland bird species require habitat patches that are structurally diverse and larger than 100 hectares (Reid 1999; Watson *et al.* 2001), the study area is not considered to contain core habitat for these species.

The habitat to be affected does play some role, albeit a small one, in maintaining connectivity between larger areas and habitat variegation across an already highly modified and fragmented landscape. However, important resources necessary for the lifecycle of these species are unlikely to be present in the study area, and therefore, these species are unlikely to be significantly impacted by the Proposal.

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

The Proposal will result in the removal of approximately 10.8 hectares of vegetation that comprises small, woodland patches that are moderately to highly modified by current and past land use practices. In their current form, they are unlikely to provide quality foraging or breeding resources for either species. Both species have not been recorded within the boundaries of the Proposal, but rather in, higher quality habitat areas to the east.

Given the mobility of these species and that the habitat patches to be removed offer little in terms of habitat, it is unlikely that the Proposal would significantly reduce the availability of habitat for these species in the locality.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

Both species have a wide distribution across much of Australia (Morcombe 2004) and are not considered to be at the limit of their known distribution.

How is the Proposal likely to affect current disturbance regimes?

The study area has been extensively modified for agriculture for more than 100 years with only small, degraded woodland patches remaining. The Proposal is unlikely to affect microhabitat features any more than currently occurring such as grazing and firewood removal.

Conversely, the Proposal would involve the loss of 10.8 hectares of vegetation and the removal of hollow-bearing trees and dead wood; all recognised as key threatening processes.

How is the Proposal likely to affect habitat connectivity?

The habitat to be affected is likely to play some role, albeit a small one, in maintaining connectivity between larger areas and habitat variegation across an already highly modified and fragmented landscape where woodland patches occur as small isolates or linear remnants and scattered paddock trees.

While the Proposal will result in a linear road through the study area, this is unlikely to affect habitat connectivity to these species anymore than currently occurs within the study area and locality.

How is the Proposal likely to affect critical habitat?

There has been no critical habitat identified for these species and given the extent and quality of the remaining woodland patches, the study area is unlikely to be critical to the long-term survival of either species in the locality.

Conclusion

Although both species have been recorded in the locality in previous surveys, these records have been within higher quality habitat than what is present within the study area. Additionally, the Proposal would contribute to a reduction in the extent of vegetation cover across an already fragmented landscape; however, potential foraging and breeding resources will remain in the locality. Given this, and the mitigation measures proposed by PB (2009), the impacts to both species are unlikely to be significant should they be listed as threatened species.

4.4.3 White-fronted Chat

White-fronted Chat can be found across the southern half of Australia mostly within temperate and arid climates (Morcombe 2004). In New South Wales they are mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins *et al.* 2006). While not currently listed as a threatened species under the TSC Act or the EPBC Act, the White-fronted Chat is currently the subject of a 'preliminary determination' under the TSC Act at the time of writing.

Assessment – Environmental Planning and Assessment Act 1979

How is the Proposal likely to affect the lifecycle of a threatened species and/or population?

The White-fronted Chat has not been recorded in the study area by this, or previous studies however, they have been recorded in the wider locality from time to time (DECC 2009)(pers.obs). Potential habitat for this species within the study area can be found within open farmland particularly where this habitat coincides with damp, moist areas such as gullies, soaks or adjacent to riparian areas. While the study area does provide some areas of potential habitat, so does the locality, the Upper Billabong Creek catchment area and much of the South-west Slopes if open farmland habitats as described above, are considered potential habitat.

Given that the species has been not recorded within the study area and that similar resources important to the lifecycle of the White-fronted Chat can be found directly adjacent to the Proposal and across the locality, it is unlikely that the lifecycle of this species will be significant impacted by the Proposal.

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

The Proposal will result in the removal of approximately 218 hectares of open farmland that is dissected by a range of minor ephemeral drainage lines, soaks and farm dams that could provide potential habitat to the White-fronted Chat should it occur within the study area. However, similar habitat can also be found across the locality, the Upper Billabong Creek catchment area and much of the South-west Slopes .

White-fronted Chats are regarded as nomadic from time to time (Higgins *et al.* 2001). However, there is no evidence to suggest the species is migratory other than reports that flocks have been recorded gathering in response to increases in food resources (Higgins *et al.* 2001). Further evidence to support this is provided by a mark-recapture study reporting 189 captures of White-fronted Chat all within 5km of the initial banding site (Higgins *et al.* 2001). With no individuals recorded during this study or previous surveys, it is unlikely that the study area would be considered quality habitat for the White-fronted Chat. As the species is considered mobile to some degree and that only marginal habitat at best is present, it is unlikely that the Proposal would significantly reduce the availability of habitat for this species in the locality.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

White-fronted Chat have a wide distribution across the southern half of Australia (Morcombe 2004) and are not considered to be at the limit of their known distribution.

How is the Proposal likely to affect current disturbance regimes?

It is assumed that the open farmlands of the locality will continue to be farmed, as they have for more than 100 years resulting in current disturbance regimes remaining unaltered.

How is the Proposal likely to affect habitat connectivity?

Open farmland is considered reasonably continuous across the study area and the wider locality with the Proposal dissecting this habitat type with linear road infrastructure. However, given the mobility of the species and the amount of potential habitat in the locality, the Proposal is unlikely to impact on habitat connectivity for the White-fronted Chat.

How is the Proposal likely to affect critical habitat?

There has been no critical habitat identified for the White-fronted Chat and given the extent of open farmland not only in the study area and wider locality, but also across the Upper Billabong Creek catchment area, the study area is unlikely to be critical to the long-term survival of the species.

Conclusion

Based on the above Significance Assessment, White-fronted Chat is unlikely to be significantly impacted by the Proposal should it be listed as a threatened species.

4.4.4 Little Eagle

The Little Eagle can be found across the Australian mainland usually within open woodland, riparian woodlands and open forests (Morcombe 2004). While not currently listed as a threatened species under the TSC Act or the EPBC Act, the Little Eagle is currently the subject of a 'preliminary determination' under the TSC Act at the time of writing.

It is thought that the main threats to the species are clearing and degradation of its foraging and breeding habitat. One Little Eagle was observed adjacent to the existing Hume Highway alignment during the field surveys.

Assessment – Environmental Planning and Assessment Act 1979

How is the Proposal likely to affect the lifecycle of a threatened species and/or population?

Given that one individual was observed during the recent field surveys, the Woomargama area does provide potential foraging and perhaps breeding habitat for a pair of Little Eagle. There is also the likelihood that an individual could range across the areas to be directly impacted by the Proposal as part of a larger home range. However, no evidence of an active or inactive nesting site of Little Eagle was recorded in the vegetation to be directly impacted by the Proposal. Given that the majority of the Proposal area comprises open farmland, it is more likely that the woodlands to the east, and closer to the sighting location, would be of greater importance to the Little Eagle than the study area. Therefore, it is unlikely that the Proposal would affect the lifecycle of the Little Eagle.

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

The Proposal will result in the loss of 10.8 hectares of woodland habitat which may form part of a wider foraging range for a pair of this species. The area of this habitat is not considered to be significant relative to the amount of similar habitat that would remain unaffected by the Proposal. While the Proposal may temporarily affect the spatial use of habitats, it is not likely to result in a long-term reduction in habitat availability in the locality.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

The Little Eagle is distributed across the Australian mainland (Morcombe 2004) and are not considered to be at the limit of their known distribution.

How is the Proposal likely to affect current disturbance regimes?

The study area has been extensively modified for agriculture for more than 100 years with only small, degraded woodland patches remaining. The Proposal is unlikely to affect microhabitat features any more than currently occurring such as grazing and firewood removal. Conversely, the Proposal would involve the loss of 10.8 hectares of native vegetation, all small, degraded woodland patches in a fragmented landscape. It is assumed

that the adjacent areas of habitat will continue to be grazed and farmed with current disturbance regimes remaining unaltered.

How is the Proposal likely to affect habitat connectivity?

The study area is already highly fragmented with remaining woodland patches occurring as small isolates or linear remnants and scattered paddock trees. While the Proposal will result in a linear feature through the study area, this is unlikely to affect habitat connectivity for a species that can forage over large distances.

How is the Proposal likely to affect critical habitat?

There has been no critical habitat identified for the Little Eagle and given the extent and quality of the remaining woodland patches, the study area is unlikely to be critical to the long-term survival of the species in the locality.

Conclusion

Based on the above Significance Assessment, Little Eagle is unlikely to be significantly impacted by the Proposal should it be listed as a threatened species.

4.4.5 Robins (*Scarlet Robin*, *Flame Robin*)

In NSW, the Flame Robin breeds in upland, moist eucalypt forests and woodlands spending winter in more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Similarly, the Scarlet Robin occurs in open forests and woodlands from the coast to the inland slopes and in winter, dispersing birds are known to appear in the east of the inland plains. While not currently listed as threatened species' under the TSC Act or the EPBC Act, the Flame Robin and Scarlet Robin are currently the subject of a 'preliminary determination' under the TSC Act at the time of writing.

The Flame Robin is threatened by the clearing and degradation of breeding habitat, and relevant to the study area, the degradation of wintering habitats such as overgrazing and simplification of the microhabitat structure of woodlands. The Scarlet Robin is considered sensitive to habitat fragmentation (Barrett *et al.* 2007; Watson *et al.* 2001).

For both species, the South-west Slopes Bioregion is regarded as core wintering habitat, and with as much as 84% of bioregion already cleared, habitat fragmentation and degradation is likely to be the long-term threat.

Both species have not been recorded within the study area in the current or past surveys, however, there are scattered records across the locality (DECC 2009) and from surveys east of Holbrook (Klomp *et al.* 1995).

Assessment – *Environmental Planning and Assessment Act 1979*

How is the Proposal likely to affect the lifecycle of a threatened species and/or population?

The woodland habitats to be removed by the Proposal exist as small, fragmented patches with little microhabitat structure dominated by exotic pasture species. Given the already fragmented nature of the study area, both the extent and quality of those patches to be removed by the Proposal, and that the Flame Robin breeds in upland environments, the study area is unlikely to contain core habitat for these species.

The habitat to be affected does play some role, albeit a very small one, in maintaining connectivity between larger areas of habitat and habitat variegation across an already highly modified and fragmented landscape.

It is considered unlikely that the Proposal will affect the lifecycle of either species.

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

The Proposal will result in the removal of approximately 10.8 hectares of vegetation that comprises small, woodland patches that are moderately to highly modified by current and past land use practices. In their current form, they are unlikely to provide quality foraging or breeding resources for either species. Both species have not been recorded within the boundaries of the Proposal.

Given the mobility of these species and that the habitat patches to be removed offer little in terms of habitat, it is unlikely that the Proposal would significantly reduce the availability of habitat for these species in the locality.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

Both species have a wide distribution (Morcombe 2004) and are not considered to be at the limit of their known distribution.

How is the Proposal likely to affect current disturbance regimes?

The study area has been extensively modified for agriculture for more than 100 years with only small, degraded woodland patches remaining. The Proposal is unlikely to affect microhabitat features any more than currently occurring such as grazing and firewood removal.

Conversely, the Proposal would involve the loss of 10.8 hectares of vegetation and the removal of hollow-bearing trees and dead wood; all recognised as key threatening processes.

How is the Proposal likely to affect habitat connectivity?

The study area is already highly fragmented with remaining woodland patches occurring as small isolates or linear remnants and scattered paddock trees.

While the Proposal will result in a linear road through the study area, this is unlikely to affect habitat connectivity to these species anymore than currently occurs within the study area and locality.

How is the Proposal likely to affect critical habitat?

There has been no critical habitat identified for these species and given the extent and quality of the remaining woodland patches, the study area is unlikely to be critical to the long-term survival of either species in the locality.

Conclusion

While the Proposal would contribute to a reduction in the extent of vegetation cover across an already fragmented landscape, the extent and quality of the woodland to be removed is unlikely to be core habitat for these species. Additionally, potential foraging and breeding resources will remain in the locality. Given this, and the mitigation measures proposed by PB (2009) for woodland species, the impacts to both species are unlikely to be significant should they be listed as threatened species.

4.5 HOLLOW-BEARING TREES

This study recorded a total of 106 HBT containing 300 hollows (openings) consisting of 141 small, 107 medium, 39 large and 13 extra large sized hollows that are likely to be directly or indirectly affected by the Proposal. GIS Analysis reveals that 40 HBT will be removed by the Proposal (Table 19). A number of hollow-dependant fauna were recorded during field surveys, including threatened species such as the Squirrel Glider and Brown Treecreeper that rely on these resources for breeding and refuge and this habitat may also provide maternity and roosting opportunities for a number of threatened microbat species.

HBT should be regarded as important fauna habitat within the fragmented landscape that is present. Efforts should be made to ensure replacement hollows (ie, boxes) are provided and connectivity is maintained or created between HBT. This is particularly relevant in the central portion of the study area where Squirrel Glider and Brown Treecreeper were recorded. Despite the fact that HBT are likely to occur across the wider landscape, these have not been investigated and those of the study area are known to support threatened species.

4.6 SIGNIFICANCE ASSESSMENT CONCLUSION

EnviroKey agree with the conclusions made by PB (2009) in that it is unlikely the Proposal would have a significant impact on the threatened and migratory fauna species the subject of Significance Assessments undertaken by PB (2009) as reviewed by EnviroKey (Section 4.2).

An evaluation of entities that are likely to occur in the study area based on the results of this survey, identified seven species (including six currently the subject of preliminary determinations under the TSC Act) that are known to, or have the potential to occur in the Study Area that have not been the subject of Significance Assessments to date (Section 4.3).

Significance Assessments undertaken for these seven species conclude that it is unlikely that they will be significantly impacted by the Proposal (Section 4.4).

5 SPECIFIC MITIGATION MEASURES

Section 6 of PB (2009) present a range of mitigation measures commensurate to the level of knowledge of the study area at the time of reporting and the other sections of the Hume Highway Duplication project. However, EnviroKey recommend a number of additional mitigation measures specific to the Woomargama Bypass site based on the results of this study and the ability of these to minimise potential impacts on threatened fauna species in the study area and locality.

5.1 SQUIRREL GLIDER

The recommendation that a crossing zone for the Squirrel Glider be created near Mountain creek, linking the riparian woodland across the Proposal (PB 2009) should be extended to also include a similar crossing zone in the central portion of the study area as the Proposal is likely to create a substantial barrier to their movement (Figure 5).



Figure 5: Location of recommended additional crossing zone for Squirrel Glider (yellow dot represents Squirrel Glider recorded during this study).

Further, a large canopy gap has been identified between the Fairbairn Rd intersection and Blue Metal Travelling Stock Reserve (TSR), and there is an opportunity to better connect these areas as they could be acting as a barrier to dispersal, or forcing animals to the ground where they are more susceptible to predation. Creating glider crossings within a

crossing zone for Squirrel Glider in this location is likely to benefit the local population (Figure 6).



Figure 6: Location of recommended additional crossing zone (white circle) for Squirrel Glider (yellow dot represents Squirrel Gliders recorded during this study; in total 4 in this area).

5.2 NEST BOXES

Given that 106 HBT will be affected both directly and indirectly (40 HBT will be removed) by the Proposal containing 300 hollows of various sizes, a nest-box replacement and monitoring program should be implemented. The Biodiversity Management Plan recommended by PB (2009) should also include specifics on nest box design and location specifically with the ecology of the Brown Treecreeper and Squirrel Glider and their distribution in the Woomargama area in mind.

Further, it is recommended that the current practice of placing nest-boxes placed in high densities adjacent to roads should be avoided as this has the potential to increase road mortality. As an alternative, the nest box installation should be in areas of habitat away from the proposed alignment. For instance, the area of woodland to the west and east of the Proposal in the central portion of the study area (as identified in Figure 5) should be explored for this purpose as well as the Riparian Woodland areas along Mountain Creek.

5.3 MICROCHIROPTERAN BATS

A previous study has identified that the Woomargama area supports 11 species of microbat including three threatened species: Yellow-bellied Sheath-tail Bat, Eastern False Pipistrelle and Eastern Long-eared Bat (now known as the South-eastern Long-eared Bat *Nyctophilus* species 2 (Churchill 2008))(Grabham 2004). Any nest box replacement program within a Biodiversity Management Plan should have consideration for microbats. A significant proportion of boxes that are designed explicitly for microbat roosting should be included and monitored to determine their success.

6 REFERENCES

- Baker P., Please P., Coram J., Dawes W., Bond W., Stauffacher M., Gilfedder M., Probert M., Huth N., Gaydon D., Keating B., Moore A., Simpson R., Salmon L. & Stefanski A. (2001) Assessment of Salinity Management Options for Upper Billabong Creek catchment, NSW: Groundwater and Farming Systems Water Balance Modelling. *National Land and Resources Audit, Bureau of Rural Sciences*, Canberra.
- Barrett G. W., Silcocks A. F., Cunningham A., Oliver D. L., Weston M. A. & Baker J. (2007) Comparison of Atlas data to determine the conservation status of bird species in New South Wales with an emphasis on woodland-dependent species. *Australian Zoologist* **34**, 37-77.
- BioNet. (2009) Fauna Database. www.bionet.nsw.gov.au.
- BOM. (2009) Bureau of Meteorology. www.bom.gov.au
- Caughley J. & Gall B. (1985) Relevance of zoogeographical transition to conservation of fauna : amphibians and reptiles in the south-western slopes of New South Wales. *Australian Zoologist* **21**, 513-29.
- Churchill S. (2008) Australian Bats. *Reed New Holland, Frenchs Forest, Australia*.
- Cooney S. J. N. & Watson D. M. (2005) Diamond Firetails (*Stagonopleura guttata*) preferentially nest in mistletoe. *Emu* **105**, 317-22.
- Cooney S. J. N., Watson D. M. & Young J. (2006) Mistletoe nesting in Australian birds: a review. *Emu* **106**, 1-12.
- DEC. (2004) Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft). *NSW Department of Environment & Conservation, Hurstville, NSW*.
- DEC. (2006) NSW Recovery Plan for the Bush Stone-Curlew *Burhinus grallarius*. *Department of Environment and Conservation, Hurstville*.
- DECC. (2006) Recovery Plan for the Large Forest owls: Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*). *Department of ENvironment & Climate Change, Hurstville, N.S.W.*
- DECC. (2009) NSW Atlas of Wildlife Database.
- DECCW. (2009) Threatened species, populations and ecological communities of NSW. *Department of Environment, Climate Change & Water, Hurstville, N.S.W.*
www.threatenedspecies.environment.nsw.gov.au.
- DEH. (2006) EPBC Act Policy Statement 1.1 Significant Impact Guidelines, Matters of National Environmental Significance. *Department of the Environment and Heritage*.
- Garnett S. T. & Crowley G. M. (2000) *The Action Plan for Australian Birds 2000*. Environment Australia.
- Gibbons P. & Boak M. (2002) The value of paddock trees for regional conservation in an agricultural landscape. *Ecological Management & Restoration* **3**, 205-10.
- Gibbons P. & Lindenmayer D. B. (2002) *Tree Hollows and Wildlife Conservation in Australia*. CSIRO Publishing.

- Grabham C. (2004) Bats in fragmented rural landscapes: use of remnant and revegetated habitats. *Honours thesis, Charles Sturt University.*
- Herring M. (2003) Eastern Billabong wildlife : a snapshot in time. *CSIRO and Murray Darling Basin Commission.*
- Higgins P., Peter J. & Steele W. (2001) *Handbook of Australian, New Zealand and Antarctic Birds. Volume 5: Tyrant-flycatchers to Chats.* Oxford University Press, Melbourne.
- Higgins P. J., Peter J. & Cowling S. (2006) *Handbook of Australian, New Zealand and Antarctic Birds (vol 7).* Oxford University Press, Melbourne.
- Kavanagh R. P. (1996) The Breeding Biology and Diet of the Masked Owl *Tyto novaehollandiae* Near Eden, New South Wales. *Emu* **96**.
- Kavanagh R. P. (2004) Distribution and conservation status of possums and gliders in New South Wales. In: *The Biology of Australian Possums and Gliders* (eds R. Goldingay and S. M. Jackson). Surrey, Beaty & Sons, Chipping Norton.
- Kavanagh R. P. & Bamkin K. L. (1995) Distribution of nocturnal forest birds and mammals in relation to the logging mosaic in south-eastern New South Wales, Australia. *Biological Conservation* **71**, 41-53.
- Kavanagh R. P. & Murray M. (1996) Home Range, Habitat and Behaviour of the Masked Owl *Tyto novaehollandiae* near Newcastle, New South Wales. *Emu* **96**, 250-7.
- Klomp N. I., Bester A. J. & Marshall R. D. (1995) Fauna study of the Four Mile Creek and surrounding catchment area near Woomargama, NSW. *Charles Sturt University, Johnstone Centre Report.*
- Lindenmayer D. B. & Fischer J. (2006) *Habitat fragmentation and Landscape change: An ecological and conservation synthesis.* CSIRO, Melbourne.
- Menkhorst P. & Knight F. (2001) A field guide to the mammals of Australia. *Oxford University Press.*
- Morcombe M. (2004) *Field guide to Australian Birds.* Steve Parish Publishing, Archerfield, Queensland.
- NGH. (2007) Preliminary Ecological Investigations : Proposed Woomargama By-pass Hume Highway. *Report prepared by ngenvironmental to NSW to Roads and Traffic Authority.*
- NPWS. (2003a) The Bioregions of New South Wales: their biodiversity, conservation and history. *NSW National Parks and Wildlife Service, Hurstville.*
- NPWS. (2003b) Draft Recovery Plan for the Barking Owl. *NSW National Parks and Wildlife Service, Hurstville.*
- Oliver D. L., Chambers M. A. & Parker D. G. (2003) Habitat and resource selection of the Painted honeyeater (*Grantiella picta*) on the northern floodplains region of New South Wales. *Emu* **103**, 171-6.
- PB. (2007) Technical Paper 1: Hume Highway Duplication Biological Impacts Yarra Yarra to Holbrook and Woomargama to Mullengandra. *A report prepared for the NSW Roads and Traffic Authority.*
- PB. (2009) Hume Highway Upgrade Woomargama Bypass, Environmental Assessment, Technical Paper 1 - Flora and Fauna. . *A report prepared by Parsons Brinckerhoff Australia Pty Ltd for the NSW Roads and Traffic Authority.*

- Reid J. R. W. (1999) Threatened and declining birds in the New South Wales sheep-wheat belt: Diagnosis, Characteristics and Management. *A consultancy report prepared for the NSW National Parks and Wildlife Service*.
- Sass S. (2007) Of Lizards and Logs: Determinants of reptile diversity in a fragmented landscape. *Charles Sturt University, Honours Thesis*.
- Sass S., Watson D. M. & Wilson A. (2008) The Reptile Fauna of the Upper Billabong Creek Catchment Area, Southern New South Wales. *Herpetofauna* **38**, 41-9.
- SKM. (2006) Hume Highway Duplication Sturt Highway to Tarcutta, Kyeamba Hill and Little Billabong: Ecological Impact Assessment. *A report prepared by Sinclair Knight Merz for the NSW Roads and Traffic Authority*.
- Smith P. J., Pressey R. L. & Smith J. E. (1994) Birds of particular conservation concern in the western division of New South Wales. *Biological Conservation* **69**, 315-38.
- Thackway R. & Creswell I. D. (1995) An interim biogeographic regionalisation for Australia: a framework for establishing the national system of reserves. Version 4.0. *Australian Nature Conservation Agency, Canberra*.
- Van der Ree R. (2002) The population ecology of the squirrel glider (*Petaurus norfolcensis*) within a network of remnant linear habitats. *Wildlife Research* **29**, 329-40.
- Van der Ree R. (2008) Hume Highway Duplication Threatened Species (Squirrel Glider) Monitoring Draft Report Autumn 2008. *Australian Research Centre for Urban Ecology, Melbourne*.
- van der Ree R., Bennett A. F. & Gilmore D. C. (2003) Gap-crossing by gliding marsupials: thresholds for use of isolated woodland patches in an agricultural landscape. *Biological Conservation* **115**, 241-9.
- Watson D. M. (2003) The 'standardized search' : An improved way to conduct bird surveys. *Austral Ecology* **28**, 515:25.
- Watson J., Freudenberger D. & Paul D. (2001) An assessment of the focal-species approach for conserving birds in variegated landscapes in south-eastern Australia. *Conservation Biology* **15**, 1364-73.
- Woodward C. (1998) Upper Billabong Catchment Landuse - Vegetation, Pastures and Cropping study.