GREAT WESTERN HIGHWAY UPGRADE, MOUNT VICTORIA TO LITHGOW ALLIANCE

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FORTY BENDS UPGRADE – REVIEW OF ENVIRONMENTAL FACTORS

TECHNICAL PAPER 1

BIODIVERSITY

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NSW GOVERNMENT Transport Roads & Maritime Services

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Definitions and Abbreviations

ASL	Above Sea Level
CMA	Catchment Management Authority
DEC	Department of Environment and Conservation (now OEH)
DECC	Department of Environment and Climate Change (now OEH and/or EPA)
DECCW	Department of Environment Climate Change and Water (now OEH)
EPA	Environment Protection Authority
EPA Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FM Act	Fisheries Management Act 1994
ha	hectare
Local Area	The area within a 10 kilometre radial distance of the study corridor
LGA	Local Government Area
m	metre
mm	millimetre
NP	National Park
NPWS	National Parks and Wildlife Service (now included under OEH)
OEH	NSW Office of Environment and Heritage
RMS	Roads and Maritime Services
RoTAP	Rare or Threatened Australian Plant
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities (Commonwealth)
SEPP	State Environmental Planning Policy
SF	State Forest
TEC	Threatened Ecological Community
TSC Act	Threatened Species Conservation Act 1995

Executive Summary

Background

The NSW Roads and Maritime Services (RMS) is proposing to upgrade the Great Western Highway at Forty Bends, approximately 5.5 kilometres south of Lithgow, NSW. The proposal would include the realignment of about 2.8 kilometres of the Great Western Highway.

This report details the methods and results of the biodiversity field survey and assessment to identify the extent and magnitude of ecological impacts associated with the proposed Forty Bends upgrade. This report addresses the requirements for assessment of significance under the NSW *Environmental Planning and Assessment Act 1979* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The biodiversity assessment for the Mount Victoria to Lithgow Great Western Highway upgrade commenced in the early stages of the project planning phase involving desktop and field investigations designed to inform route selection. Upon selection of the preferred route the assessment progressed to corridor field studies involving a program of detailed ecological surveys during 2011 focused along the length of the proposal study area. The corridor field studies provide a comprehensive inventory of terrestrial and aquatic flora and fauna (biodiversity) including a list of known and potential threatened communities, populations and species.

Existing environment

The study area is located on the lower slope of the escarpment area of Hassans Walls. The geology is dominated by sandstone and shale. The dominant vegetation types comprise dry and wet sclerophyll forests in escarpment areas and on steeper slopes and grassy woodlands in valleys.

Three vegetation communities were identified within the study area, including a Threatened Ecological Community (TEC) comprising:

- Blaxland's Stringybark – Monkey Gum Open Forest.
- Silvertop Ash Open Forest.
- Ribbon Gum Grassy Woodland (TEC).

The Ribbon Gum Grassy Woodland vegetation community is consistent with the final determination of the state-listed TEC Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions (Tablelands Grassy Woodland).

A total of 161 flora species from 57 families was recorded in the study area, of which 28 are exotic species and two are non-indigenous native species and have been introduced (Appendix B). No threatened flora species listed under the *Threatened Species Conservation Act 1995* (TSC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded in the study area.

Fauna habitats present within the study area comprise:

- Dry open forest.
- Aquatic habitats – ephemeral creeks and farm dams.
- Agricultural land.

Hollow trees in the study area occur in moderate abundance, comprising small to medium sized hollows suitable for larger arboreal mammals, as well as a range of bird species, herpetofauna and microbats. Trees supporting larger trunk hollows suitable for large forest owls were not observed in the study area.

Threatened fauna species recorded in the study area comprise Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Purple Copper Butterfly (*Paralucia spinifera*). No threatened bird species were recorded in the study area, however several threatened bird species were recorded in the locality at Hartley and River Lett Hill including Varied Sittella (*Daphoenositta chrysoptera*), Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*) and Gang Gang Cockatoo (*Callocephalon fimbriatum*).

Potential impacts

The construction footprint would be about 22.66 hectares of which 7.4 hectares supports remnant forest vegetation in varying degrees of condition and 15.27 hectares of cleared and highly modified habitats. Impacts to the TEC would be limited to approximately 0.05 hectare of moderate condition vegetation.

The proposal would have some potential impacts to wildlife connectivity. The proposal would increase the width of the Great Western Highway in the study area, and therefore increase the distance for any wildlife crossing the road. There would also be several large cuttings and retaining walls which would create a barrier to terrestrial fauna movements.

There is also potential for indirect impacts such as altered hydrology, weed, pest and pathogen invasion, altered noise, vibration and light levels, and injury to native wildlife.

The proposal would involve the enaction of several key threatening processes associated with habitat degradation, feral species, pathogens, weeds and climate change.

Avoidance and mitigation

The proposed mitigation measures specified are consistent with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).

Avoidance of impacts has been a major part of the mitigation strategy to limit the potential impacts to native vegetation with particular emphasis on avoiding the TEC, known locations of Purple Copper Butterfly and habitat for other threatened fauna. Where impacts cannot be avoided mitigation measures are required and consist of wildlife crossing structures and management measures which would be detailed in a Contractor Environmental Management Plan (CEMP). This would include pre-clearing field surveys to confirm the appropriate management measures to minimise impacts to biodiversity, such as salvage and reuse of bushrock, hollow trees and woody debris. Other mitigation measures include the establishment of exclusion zones, staged habitat removal, weed management, pest and disease management and a wildlife connectivity strategy.

The proposed upgrade would incorporate a combination of wildlife crossing structures, including two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass.

The existing highway crossing over Whites Creek would be excavated and the creek line rehabilitated. These measures would improve wildlife connectivity allowing a greater diversity of fauna species to pass beneath the highway and overpasses (canopy bridges and glider poles) would provide additional connectivity, avoiding injuries and mortalities.

A biodiversity offset strategy would be developed to compensate for the proposed impacts from the upgrade. One potential offset location has been identified at South Bowenfels currently owned by RMS which supports a population of Purple Copper Butterfly. Further assessment and negotiation would be required to establish an appropriate biodiversity offset.

Significance assessments

Significance assessments were undertaken for a total of 24 threatened species and one TEC. The threatened species comprise 11 mammal species, 11 bird species, one reptile and one invertebrate species. The results of the significance assessments confirmed that there would be no significant impacts to any threatened species, populations or ecological communities and therefore there is no requirement for a Species Impact Statement.

Conclusion

Under the EPBC Act a referral is required to the Australian Government for proposed 'actions that have the potential to significantly impact on matters of national environmental significance or Commonwealth land'. Significance assessments undertaken for matters of national environmental significance indicate that a significant impact is unlikely. As a precautionary measure the RMS will submitted a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action in relation to potential impacts on a number of threatened fauna species including the Purple Copper Butterfly, Koala, Spotted Tail Quoll, Grey Headed Flying Fox, Regent Honey Eater and the Swift Parrot.

If the proposal is determined to be a controlled action, the approval of the Australian Government Minister for the Environment would be required.

1. Introduction

1.1. Background

The Mount Victoria to Lithgow Great Western Highway upgrade is part of the NSW and Australian Governments' commitment to improve road safety and accessibility to communities in the Blue Mountains and central west region of NSW. Investigations for the upgrade started in May 2008 to determine the preferred route corridor for the proposal. The preferred route alignment was announced in May 2010, followed by corridor investigations to inform the concept design and detailed ecological surveys in Spring/Summer 2011 to inform the detailed design for Forty Bends and assess the potential ecological impacts. This report assesses the potential ecological impacts of the proposed Forty Bends upgrade.

1.2. Proposal description

RMS is proposing to upgrade the Great Western Highway at Forty Bends, approximately 5.5 kilometres south of Lithgow. The proposal would include the realignment of about 2.8 kilometres of the Great Western Highway from a point about 470 metres east of the eastern end of Forty Bends Road to a point about 250 metres west of McKanes Falls Road (the proposal).

- The proposal has been developed based on the concept design that has been prepared using the available information and current design standards and criteria for the Great Western Highway upgrade program. Some elements of the design may be further refined during detailed design. The key elements of the Construction of a new road alignment consisting of generally three lanes with two lanes eastbound to the east of Whites Creek and two lanes westbound to the west of Whites Creek. Lane widths would be 3.5 metres with shoulder widths typically varying between 1.0 metres and 2.5 metres. The upgrade alignment would diverge up to 40 metres south of the existing Great Western Highway in the vicinity of Whites Creek.
- The design speed for the alignment would be 100 kilometres per hour east of McKanes Falls Road and 80 kilometres per hour west of McKanes Falls Road. The posted speed limit for the whole of the new highway alignment would be 80 kilometres per hour
- Widening of the existing alignment predominantly to the south of the Great Western Highway. The total proposal footprint of the widening works would vary from about 40 metres to 90 metres.
- A central median along the length of the proposal of varying widths, ranging up to 9.5 metres. Carriageways would be separated by a combination of vegetated, depressed and paved medians.

- Construction of new twin, five-span bridges, about 150 metres in length across Whites Creek. The new bridges would comprise four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction. The total width of the two bridges would be about 30 metres. Shoulders on the bridges would be between 2.5 and 3.25 metres (off-side) and 1.0 metres on the near side.
- Rehabilitation works along the existing alignment of Whites Creek following the removal of the redundant section of the existing Highway. This would include creating a rehabilitated, natural creek bed in this location linking the existing alignment of Whites Creek prior to passing under the new Whites Creek bridge.
- Upgrades to four existing local road intersections, including two intersections with Forty Bends Road, Daintree Close and McKanes Falls Road, to provide connection to the upgraded highway and property access points. Upgrades would include minor widening and u-turn facilities located along the western end of Forty Bends Road and about 150 metres south of the intersection of the Great Western Highway and McKanes Falls Road.
- New or improved access from the existing highway to nine properties along the length of the proposal. The proposal includes provision of new or reconstructed driveways to retain existing property access.
- Closure and relocation of two intersections of Forty Bends Road with the Great Western Highway. These include:
    - Closure of the existing intersection at the eastern end of Forty Bends Road to general traffic (except for emergency vehicles) and a new cul-de-sac constructed on Forty Bends Road.
    - Relocation of the existing intersection at the western end of Forty Bends Road to a point about 200 metres west of the existing intersection.
- Five major cuts 14 metres to 19 metres in height located on the northern side of the proposed alignment.
- Five major fill embankments 10 metres to 15 metres in height located predominantly on the southern side of the proposed alignment.
- Three retaining walls would be required at the following locations
    - Retaining wall 1 – between approximate chainages 32080 and 32190 (about 110 metres long and up to 7.0 metres high).
    - Retaining wall 2 – between approximate chainage 32560 and 32725 (about 165 metres long and up to 5.6 metres high).
    - Retaining wall 3 – between approximate chainage 33040 and 33240 (about 200 metres long and up to 7.0 metres high).

- Removal of about 300 metres of redundant Great Western Highway pavement from about 100 metres east of Whites Creek to about 200 metres west of Whites Creek, and associated culvert. This would include rehabilitation works to link this area to the existing alignment of Whites Creek.
- Construction of three temporary and five permanent construction basins in addition to temporary access tracks along the length of the proposal.
- Construction of nine new culverts along the length of the proposal to manage cross-drainage flows and six new culverts across access roads and service roads as part of the proposal. One existing culvert would be retained at the western end of the proposal. A total of 23 existing drainage culverts under the Great western Highway would be either decommissioned or removed.
- Measures to mitigate the formation of black ice, including the relocation of the road alignment to the south away from the Hassans Walls escarpment in key locations and an active maintenance program.
- A main compound site located east of the western end of Forty Bends Road, in addition to smaller stockpile areas along the length of the proposal during construction.
- A combination of wildlife crossing structures, which would include three fauna underpasses (box culverts), canopy rope bridges at Whites Creek and the western underpass and glider poles located at Whites Creek and near the western fauna underpass.
- Relocation and/or temporary diversion of existing underground utilities including water, powerlines and telephone cables.

Figure 1-1 shows the proposal

Figure 1-1 The proposal

1.3. Study area

Throughout this report reference is made to the terms ‘proposal footprint’, ‘study area’ and ‘locality’. The ‘proposal footprint’ refers to the road infrastructure, including any drainage structures and ancillary sites. The term ‘study area’ refers to the general location around the proposal footprint and includes any adjacent areas of land or waterway that may be potentially directly or indirectly impacted by the proposal construction and operation. Finally, the ‘locality’ is discussed in terms of the broader bioregional context defined by Thackway and Creswell (1995) as the Sydney Bioregion. For the purpose of this assessment, the study locality is considered to be a radius of 10 kilometres from the study area.

The study area is located within the South Eastern Highlands bioregion (Thackway and Cresswell 1995) adjacent to the western edge of the Sydney Basin bioregion. The study area is located entirely within the Hawkesbury-Nepean Catchment Management Area (CMA) and traverses the Wollemi and Burragorang (Part A) CMA sub-regions. The region is important for biodiversity because it provides a transition from the mountains in the east to the western slopes and the plains.

The study area is located on the lower slope of the escarpment area of Hassans Walls. The geology is dominated by sandstone and shale. The dominant vegetation types comprise dry and wet sclerophyll forests in escarpment areas and on steeper slopes and grassy woodlands in valleys.

1.4. Scope of the study

This report details the methods and results of the biodiversity field survey and assessment to identify the extent and magnitude of ecological impacts associated with the proposed Forty Bends upgrade. This report addresses the requirements for assessment of significance under the EP&A Act and the EPBC Act. Mitigation measures to ameliorate ecological impacts arising from the proposed Forty Bends upgrade are also proposed. The general aims of this biodiversity impact assessment comprise:

- Describe the characteristics and ecological condition of the vegetation communities and habitats within the study area.
- Determine the occurrence, or likelihood of occurrence of Threatened species, populations and communities listed under the TSC Act, FM Act and EPBC Act within the study area.
- Describe the potential impacts on biodiversity in the study area as a result of the proposal.

- Undertake significance assessments for threatened biodiversity that occur or have potential habitat within the study area.
- Propose further investigations and/or mitigation measures to mitigate impacts on the ecological values of the study area.

1.5. Legislative context

The information presented in this report identifies the potential ecological impacts of the proposed upgrade in relation to the relevant State and Commonwealth environmental and threatened species legislation and policy. Relevant legislation and policy includes the:

- NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).
- NSW *Threatened Species Conservation Act 1995* (TSC Act).
- NSW *Fisheries Management Act 1994* (FM Act).
- NSW Noxious Weeds Act 1993 (NW Act).
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- State Environment Planning Policy 44 (SEPP 44) - Koala Habitat Protection.

1.5.1. Environmental Planning and Assessment Act 1979

Under Part 5 of the EP&A Act (s.111 and s.112), all proposals must include an assessment of threatened flora and fauna and their habitats that are likely to occur within the area of the activity or that may be indirectly affected by the construction and operation of an activity. The assessment has to address whether the proposed activity 'is likely to have a significant effect' on the threatened biodiversity identified, and a decision made on whether an Environmental Impact Statement (EIS) or Species Impact Statement (SIS) is required. In order to make this decision, a determining authority must consider the effect of an activity on:

- Threatened species, populations and ecological communities, and their habitats (listed under the TSC Act or FM Act) and whether there is likely to be a significant effect on these (as determined in Section 5A of the EP&A Act).
- Critical habitat (listed under the TSC Act or FM Act).
- Any other protected fauna or protected native plants within the meaning of the National Parks and Wildlife Act 1974 (NPW Act).

Section 5A of the EP&A Act outlines the seven factors that must be taken into account when deciding whether a proposal would be likely to have a significant impact on threatened species, populations or communities or their habitats (significance assessments).

1.5.2. NSW Threatened Species Conservation Act, 1995

The TSC Act identifies threatened species, populations and ecological communities, as listed under Schedules 1, 1A and 2 that are to be identified as potential subject species and therefore require a significance assessment under section 5A of the EP&A Act.

1.5.3. Fisheries Management (FM) Act, 1994

The FM Act establishes provisions for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. This Act also covers the identification and management of key threatening processes which affect threatened species or could cause other species to become threatened (Department of Primary Industries (DPI)).

The Minister for Fisheries would need to be notified of any proposed dredging (Part 7 Division 3 of the FM Act) or reclamation works associated with the proposed upgrade in accordance with Section 199 of the Act.

1.5.4. Environment Protection and Biodiversity Conservation (EPBC) Act 1999

The EPBC Act protects the environment, particularly Matters of National Environmental Significance (NES matters) and assessment of the environment on Commonwealth land. It streamlines the national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places. The EPBC Act identifies seven NES matters:

- World Heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).
- Great Barrier Reef

The EPBC Act is triggered by actions that would be likely to have a significant impact upon NES matters. Under the EPBC Act, such actions require approval from the Commonwealth Environment Minister and should be referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for consideration. Actions deemed by the SEWPAC to require Commonwealth approval would be ‘controlled actions’ which require an environmental assessment.

1.5.5. NSW Noxious Weeds Act 1993

The objectives of the Noxious Weeds Act (NW Act) are to reduce the negative impact of weeds on the economy, community and environment of NSW. This involves: establishing control mechanisms to prevent the establishment of significant new weeds; prevent, eliminate or restrict the spread of particular significant weeds; effectively manage widespread significant weeds; and to provide for the monitoring of and reporting on the effectiveness of the management of weeds in NSW.

1.5.6. State Environment Planning Policy (SEPP) 44 - Koala Habitat Protection

SEPP 44 aims to encourage the 'proper conservation and management of areas of natural vegetation that provide habitat for Koalas (*Phascolarctos cinereus*) to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline'.

Schedule 1 of SEPP 44 identifies areas of land that are classified as being 'Core Koala Habitat' or 'Potential Koala Habitat'. 'Core Koala Habitat' is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females and recent sightings of and historical records of a population. Potential Koala Habitat' comprises areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15 per cent of the total number of trees in the upper or lower strata of the tree component.

While SEPP 44 does not apply to projects that are being assessed under Part 5 of the EP&A Act, the intent of the SEPP was considered during the assessment of the Project.

2. Methodology

2.1. Personnel

Field surveys have been undertaken over a range of seasons for different components of the Mount Victoria to Lithgow Great Western Highway upgrade including geotechnical investigations, corridor studies and the concept design. Field surveys undertaken to date comprise:

- Geotechnical investigations 5 and 7 of April 2011 by Andrew Carty (Senior Botanist, SKM) and James Wallace (Graduate Ecologist, SKM).
- Geotechnical investigations and corridor studies 10 to 13 May 2011 by Andrew Carty (Senior Botanist, SKM) and Julie Anne Harty (Senior Ecologist, SKM).
- Corridor studies 8 to 10 August 2011 by Andrew Carty (Senior Botanist, SKM) and Chris Thomson (Senior Ecologist, SKM).
- Detailed surveys for concept design 31 October to 4 November 2011 by Andrew Carty (Senior Botanist, SKM), Chris Thomson (Senior Ecologist, SKM) and Josie Stokes (Senior Biodiversity specialist, RMS).
- Targeted orchid surveys 14 to 16 November 2011 by Andrew Carty (Senior Botanist, SKM) and Alice Busby Smith (Graduate Environmental Scientist, SKM).
- Targeted surveys for Purple Copper Butterfly (*Paralucia spinifera*) conducted during suitable weather conditions on the 21 September 2011 and 19 October 2011 by Ray Mjadwesch (Director, Mjadwesch Environmental Service Support), Andrew Carty (Senior Botanist, SKM) and Josie Stokes (Senior Biodiversity specialist, RMS).

SKM ecologists and botanists are licensed to conduct field surveys under the National Parks and Wildlife Service Scientific Research Permit SL100044 and the Department of Primary Industries Animal Research Authority (09/1895).

2.2. Database searches and literature reviews

The first stage of the assessment involved a review of relevant background reports and government databases pertaining to the biodiversity of the bioregion and specifically the locality comprising a 10 kilometre radius surrounding the study area. Database records were accessed and assessed in April 2012.

The literature and data reviewed included:

- Roads and Maritime Services (2011). Great Western Highway Upgrade, Mount Victoria to Lithgow Alliance, Corridor Study, Biodiversity.
- GIS data layer of the Regional Biodiversity Corridors in the Hawkesbury-Nepean Catchment Management Authority Area (DECC 2005).
- Vegetation types database [Biometric] (DECC 2009a). http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm.
- Threatened species database. NSW Office of Environment and Heritage (DECC 2009b). http://www.environment.nsw.gov.au/biobanking/biobankingtspd.htm.
- Native vegetation of south-east NSW: a revised classification and map for the coast and eastern tablelands (Tozer *et al.* 2010).
- The Vegetation of the Western Blue Mountains (DEC 2006).
- NSW BioNet (OEH September 2012).
- Atlas of NSW Wildlife Database (OEH October 2011).
- EPBC Act Protected Matters Search Tool (accessed June 2012).

Following collation of database records and species and community profiles a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the study area. This was further refined following field surveys and assessment of habitat present (refer to Section 2.3.4).

2.3. Taxonomy and nomenclature

Names of plants used in the following sections are taken from Harden (1992, 1993, 2000, and 2002) with reference to PlantNet (Royal Botanic Gardens and Domain Trust 2012) or recent taxonomic changes. Common and scientific names are used for plant species in the first instance followed by scientific names. Scientific and common names (where available) are provided in plant lists in Appendix B. Names of vertebrate fauna follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of Sustainability, Environment, Water, Populations and Communities (2012). Common names are frequently used in the report for fauna. Scientific names are included in species lists found in Appendix D.

2.4. Field survey

During October and November 2011 biodiversity field investigations were undertaken between the base of Mount Victoria and South Bowenfels (RMS 2011), which included the Forty Bends study area. Further detailed studies were also undertaken in the Forty Bends area as part of this assessment. The field surveys aimed to identify the biodiversity values within and in the vicinity of the proposal footprint with the objective of assembling quantitative and qualitative data on flora and fauna diversity and the distribution of vegetation and habitat associations. Particular focus was given to areas that may potentially be impacted by the proposal footprint.

Field surveys were undertaken in accordance with state and federal government survey guidelines for threatened species (DEC 2004, DEHWA 2010/2011). The surveys were designed to use a range of methods within larger intact native vegetation remnants, as well as less intensive methods within smaller isolated remnants. Field methods included trapping, targeting a range of faunal groups, spotlighting, call playback, habitat assessments, plot based quantitative surveys, flora transects and targeted searches for flora and fauna species.

2.4.1. Vegetation

Stratification

Vegetation mapping undertaken during October and November 2011, in addition to existing broad-scale vegetation mapping (Tozer *et al.* 2010), aerial photographs and topographic maps, were used to stratify the vegetation and habitats in the study area to identify appropriate flora and fauna sampling sites. The stratification units were based on broad vegetation map units such as open forest, riparian forest and woodland and specific vegetation communities associated with the dominant flora.

Vegetation community mapping

Transect sampling was used to identify the distribution of vegetation community types and boundaries between communities. Plot sampling was used to describe the composition and structure of vegetation communities. The number of plots and transects sampled was proportional to the size of the stratification units identified in accordance with the draft *Threatened Biodiversity Survey and Assessment Guidelines* (DEC 2004) (see Section 2.6).

Digital mapping of vegetation community boundaries was conducted using the ArcGIS software package. Vegetation community boundaries were identified in the field using a Trimble Yuma handheld GPS with ArcPad software. A combination of field data, existing broad-scale vegetation mapping (Tozer *et al.* 2010), aerial photograph interpretation and biophysical data such as elevation and soil type was used to map the boundaries of vegetation communities. Description of the vegetation communities were based on their structure and dominant canopy species as per Specht (1981) and correlated with the NSW

Vegetation Classification Assessment project (Keith 2006). The data was then correlated with local and regional vegetation classification maps (Tozer *et al*. 2010; DEC 2006), and the Biometric vegetation types. The identified vegetation communities were compared with reference to the scientific committee descriptions for Threatened Ecological Communities (TECs) listed under the TSC Act and EPBC Act.

Plot sampling

Standard quadrat based sampling was used in conjunction with general traverses/transects of the study area, and in particular those areas associated with the proposal footprint. Quantitative data on plant species richness were collected from a series of 20 x 20 metre plots (400 square metres) sampled within each vegetation association (refer to Figure 2-1 and Section 2.6). All flora species within each plot were given a cover abundance score using a modified six-point Braun-Blanquet cover scale (Braun-Blanquet 1965). Data collected within each plot included:

- Heights of structural layers (i.e. canopy, sub-canopy, shrub and groundcovers).
- The abundance/cover of each layer.
- Landscape features (e.g. slope, gully, and aspect).
- Soil features (e.g. soil type, rocks, organic matter).
- Geographical coordinates and a photographic record.

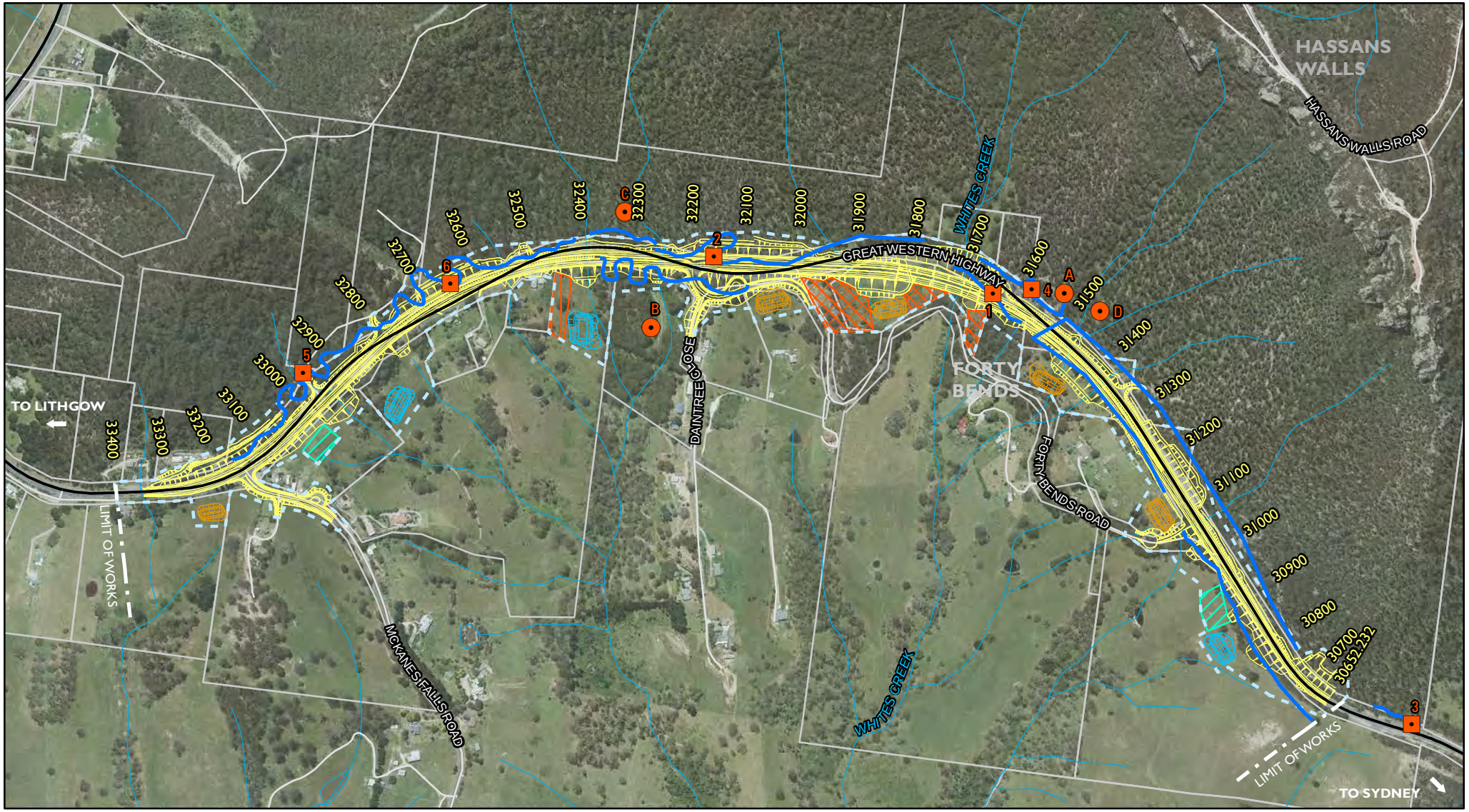

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Figure 2-1 Location of flora and fauna surveys

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

LEGEND

- 31300 Chainage
- Proposal
- Proposal site
- Existing highway
- Waterways
- Property boundary
- Permanent sedimentation basins
- Temporary sedimentation basins
- Compound site and stockpile locations
- Potential compound
- Potential stockpile
- Potential stockpile and compound
- Fauna survey site
- Flora plot
- Flora transects

GDA 94 | MGA 56

0 200
Metres

Aerial Photograph:AUSIMAGE/SKM 2011

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Vegetation condition

Vegetation condition was broadly assessed within each of the vegetation communities, based on the degree of modification and disturbance observed in these areas. A basic scale was established to quantify the condition of each patch of native vegetation. The scale for vegetation condition is defined in Table 2-1.

Table 2-1 Vegetation condition classes

Condition class	Description	Criteria			
		Flora diversity	Canopy cover	Mid-storey	Weed abundance
High	Vegetation still retains the majority of native species and structural characteristics of the pre-European equivalent. Such vegetation is usually in a near natural state and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers and lack of soil disturbance. Some limited weed cover is present in edge habitats.	High	Intact	Intact	Low
Moderate	Vegetation generally still retains most of its structural integrity but has been partially disturbed and has lost some component of its original species complement. Weed invasion varies from slight to high.	Moderate	Intact	Partial - Intact	Moderate - High
Low	Modified areas where most of the native diversity and vegetation structure has been lost. Includes thin strips of roadside vegetation, areas of derived grassland and shrubby vegetation in the power easement. Environmental weeds are often co-dominant with the original indigenous species.	Low-Moderate	Partial	Absent - Sparse	High - Moderate
Very Low	Includes cleared paddock areas and roadside clearings dominated by exotic species including noxious weeds. Some regenerating shrubs and native groundcovers may be present in low abundance. Some of these areas support planted trees and shrubs including native and exotic species.	Low	None	Absent - Sparse	High

2.4.2. Flora

The flora survey aimed to provide baseline flora data with particular emphasis on the presence of threatened plant species, populations and ecological communities as well as describe the attributes of the existing environment. The location of flora and fauna surveys and methods is shown in Figure 2-1**.**

The following steps were implemented as part of the vegetation and flora surveys:

- A thorough review of previous specialist reports, other available literature and scientific databases to gain an appreciation of the composition of local vegetation communities and flora diversity.
- Determine threatened flora species to be targeted during surveys (refer to Appendix A).
- Stratified sampling techniques to classify and map vegetation communities, threatened species habitat and develop an inventory of flora species specific to each vegetation association.
- Targeted searches for threatened flora species in areas of suitable habitat.

Any species that could not be identified in the field were collected for later identification or for lodgement with the National Herbarium of NSW at the Royal Botanic Gardens Sydney.

Transects and traverses
General traverses comprised random searches throughout targeted areas to develop a flora inventory and to target threatened species, as well as to opportunistically record the distribution of vegetation communities, significant habitat attributes and any other factors that may be of interest. The location of all threatened species, vegetation community boundaries and any other ecological factors were recorded using a GPS.

Cryptic species
Surveys were undertaken in the study area over a range of seasons including appropriate seasons for detecting potentially occurring cryptic orchid surveys.

2.5. Fauna survey and habitat assessment

The objective of the terrestrial fauna survey was to identify the type and distribution of the terrestrial fauna habitats and features within proximity to the study area, as well as the fauna species, and their distribution and abundance in relation to the identified habitats. Targeted survey techniques also aimed at identifying threatened species listed under the TSC Act and EPBC Act and known from the regional area based on results from the OEH Atlas of NSW Wildlife database.

Stratification and site selection

Habitat for fauna in the study area varies in type and condition from north and south of the existing highway. To the north, the habitat comprises part of a large contiguous dry open forest habitat on skeletal sandstone soils positioned on the footslopes of a sandstone ridge. On the southern side of the road, this same habitat type has been extensively cleared and modified for agricultural and settlement, leaving a mosaic of small, fragmented and disturbed open forest habitats. Riparian forest was not discernible from the open forest habitat through smaller creeks and tributaries in the Forty Bends study area. These habitat types were stratified to identify suitable fauna survey sites. The fauna species which were identified from the literature review and targeted during the surveys are listed in Appendix A.

Detailed fauna surveys were conducted at four sites as shown in Figure 2-1 and detailed in Table 2-2, while opportunistic observations of fauna were recorded across the entire study area during the field survey program. Where possible, surveys were conducted across the different range of floristic types associated with these habitats, in particular at any change in dominant tree species or unique habitat features such as exposed rocky boulders or waterbodies. Cleared and modified agricultural landscapes were targeted for incidental fauna sightings during both diurnal and nocturnal surveys. Aquatic habitats (creeks and dams) provided opportunity for additional targeted survey effort and incidental data, mainly frogs and waterbirds. Targeted fish and macroinvertebrate surveys were not conducted. The survey effort and conformance with survey guidelines is detailed in Section 2.6.

Table 2-2 Open forest survey sites

Field Survey Technique	Site Number			
	A	B	C	D
Ground mammal trapping	✓	✓		
Arboreal mammal traps	✓	✓		
Camera traps	✓		✓	
Hair-tubes			✓	
Harp traps	✓	✓	✓	
Bat call recording (Anabat)	✓	✓	✓	
Bird survey	✓	✓	✓	✓
Reptile survey	✓	✓	✓	✓
Spotlight	✓	✓	✓	✓
Call playback	✓		✓	✓
Scat search	✓	✓	✓	✓

Survey period and conditions

The fauna survey of the study area was conducted during the spring season of 2011 (31 October to 4 November), and habitat assessments were undertaken during Autumn/Winter 2011. A combination of sampling techniques was employed which included diurnal and nocturnal surveys including live mammal trapping. Details of survey techniques, effort and localities are outlined below. Habitat assessments were conducted concurrently at each fauna survey site and aimed to provide a landscape assessment of the habitats in the study area and identify the suitability of the habitat for threatened fauna species.

Targeted surveys for Purple Copper Butterfly (*Paralucia spinifera*) were conducted during suitable weather and seasonal conditions on the 21 September 2011 and 19 October 2011.

Details of the weather (temperatures and rainfall conditions) during field surveys are provided in Table 2-3**.** Conditions were generally dry and mild with cool overnight periods. The survey conditions were considered suitable for detection of the large majority of fauna groups and species expected in the study area, particularly threatened birds and mammals.

Table 2-3 Weather conditions during the survey

Dates	Mean temp (°C)		Rainfall (mm)	Conditions	Sunrise/Sunset	Moon Phase
	Min	Max				
31 October to 4 November	2.0	21.5	0	Partly Cloudy	05:56 / 19:29	Waning gibbous to waxing gibbous

Mammals

The techniques used to survey mammal populations included live trapping of ground-dwelling small to medium sized mammals and arboreal mammals, motion sensor camera stations, hair-tube sampling (ground and tree based), harp traps (insectivorous bats), bat call recording and spotlighting. Details of the techniques employed are provided at Section 2.6**,** and the location of each site is mapped at Figure 2-1.

Live trapping of small to medium sized terrestrial mammals used a standardised plot arrangement (2 x 200 metre transects 50 metres apart) in which 20 Elliott traps (type A, 33 x 10 x 9 centimetre, aluminium folding traps) spaced 10 metres apart and two cage traps (30 x 30 x 60 centimetre) were placed at opposite ends of the plot. All Elliott traps were baited with peanut butter, rolled oats and honey and cage and camera stations were baited with tinned sardines or chicken necks. Traps and cages were placed in or under cover wherever possible. Traps were open for a three-night period at each site and were checked each morning. Captured animals were measured, weighed, identified and released.

The species and location of mammal scats, scratches and other evidence of fauna presence when encountered were noted to provide locality records for native and feral species.

Live trapping of arboreal mammals was conducted using two lines of tree traps 100 metres apart each consisting of four traps spaced approximately 50 metres apart along the line resulting in a 1.5 hectare trapping grid. At each trap point, one Elliott trap (type B, 15 x 16 x 45 centimetre aluminium folding trap) was mounted on a platform attached to a tree trunk at a height of 3.5 metres. Each trap was baited with a mixture of peanut butter, rolled oats and honey, and the trunk of the tree adjacent to the trap sprayed with a mixture of water and honey to act as an attractant. Traps were inspected each morning and the tree re-sprayed with the honey-water mixture. Any animal captured was measured, weighed, identified and released at the capture site the following night. Each trap grid was active for three consecutive nights.

Spotlighting and dusk census for arboreal mammals was conducted at three sites. Spotlighting was foot-based and comprised a concentrated survey across the entire trapping grid and general survey through adjacent areas, utilising 50 watt spotlights. Two observers conducted the survey for a minimum period of 60 minutes per site following dusk (approximately 1930 hours). All fauna heard or observed were recorded, with direct observations aided by the use of binoculars.

Remote sensor camera stations were set up at two locations (A and C) each for a three-night period. The cameras (Scoutguard 3) were attached to trees approximately 0.5 metres above ground level directly facing a bait station loaded with chicken necks. The cameras were set to trigger both day and night, with infra-red lighting used at night.

Standard two-bank 4.2 metre squared harp traps were used to sample for microchiropteran bats. A total of two harp trap locations were sampled. Harp traps were placed in forested areas along narrow gaps such as vehicle and walking tracks or along creeks. Such locations are generally associated with natural flyways for microchiropteran bats. Harp traps were placed at each location for between one and three nights. Captured bats were collected early the following morning, identified and measured. Captured individuals were held that day and released at the capture point that night.

Two stationary ultrasonic bat call detectors (Anabat II, Titley Electronics) were used with a storage ZCAIM unit to record bat calls at three sites. Calls were recorded continuously between 1800 and 0500 hours on each occasion for between one and three nights. Calls were identified to genus or species level where possible using computer frequency analysis software (Analook v.4.0) by Chris Thomson (Senior Ecologist, SKM).

Spotlighting and listening for calls of megachiropteran bats (*Pteropus* spp.) was conducted during all spotlighting activities.

Searches for evidence of Koalas (*Phascolarctos cinereus*) were conducted at each survey sites by searching a randomly placed grid (50 x 50 metres) for Koala faecal pellets, as a modified version of the Spot Assessment Technique (Phillips 2011). Searches were concentrated around the base of trees greater than 20 centimetre diameter at breast height, until a total of 20 trees were searched. Where several tree species occurred in the quadrat, preference was given to known Koala browse species, including Ribbon Gum (*Eucalyptus viminalis*). Monkey Gum (*Eucalyptus cypellocarpa*) and Blaxland's Stringybark (*Eucalyptus blaxlandii*) are identified as providing secondary/supplementary food sources (DECC 2008b).

Birds

A bird survey was conducted at each of the four open forest sites. This involved an observer moving along a transect approximately 200 metres long and recording all birds seen and heard up to 100 metres either side of the transect. Each transect was surveyed over a minimum period of 20 minutes and surveys were conducted during early morning sessions between 0600 and 1000 hours. Birds were also recorded opportunistically throughout the rest of the day during all site visits, which included dusk. Opportunistic surveys were conducted over cleared agricultural land. Binoculars were carried in the field at all times to assist in identification.

Call playback of the threatened species Powerful Owl (*Ninox strenua)*, Barking Owl (*Ninox connivens)*, Masked Owl (*Tyto novaehollandiae)* and Bush Stone Curlew (*Burhinus grallarius*) was conducted during spotlighting surveys at two sites. Pre-recorded calls were broadcast via a portable MP3 player and megaphone for a period of five minutes for each species, followed by a five minute listening period. Spotlighting was conducted briefly between calls and then following completion of the call playback series for a period of 10 minutes. Quiet listening for dusk calls of species was also undertaken whilst conducting other field activities such as spotlight searches.

Reptiles

A dedicated time-based search for reptiles was conducted at four sites. This involved a 30 minute person search centred near the trapping grid by for active or basking reptiles by searching logs, rocks, trees and raking through leaf litter. Rocks in the form of large and small boulders were targeted during the searches.

Frogs

Frog surveys were conducted during spotlighting surveys which comprised listening and spotlight survey of the margins of wet areas for active frogs. Nocturnal surveys for frogs were conducted by two people using spotlights and battery powered head torches to survey along Whites Creek and any nearby soak depressions. Farm dams along the existing highway (refer to Figure 3-2) were also targeted.

Frogs were identified by call, and/or capture. All active frogs were identified where possible, identified and immediately released. At potentially suitable locations throughout the study area, a period of listening for the calls of frog species was undertaken, especially at dusk.

Frog surveys were conducted according to the Department of Environment and Climate Change (DECC) (2008a) *Hygiene Protocol for the Control of Disease in Frogs*.

Aquatic fauna

Considering the absence of permanent aquatic habitats along drainage lines in the study area, no targeted aquatic fauna surveys were undertaken for threatened fish species. Considering the disturbed and modified nature of the aquatic habitats within the farm dams in the study area, and the low potential for these to support threatened aquatic species no aquatic surveys were done in farm dams.

Habitat assessment and mapping

Habitat assessment data were collected from all sites to gather information on the type and condition of fauna habitat present. At each survey site a 50 x 50 metre quadrat was used to investigate and document fauna habitat features, by assessing the condition and abundance of a set of habitat criteria which included the:

- Type and structure of the vegetation, including an assessment of the 'naturalness' in terms of the presence of remnant vegetation or planted and re-growth areas and the extent of logging.
- Presence and frequency of large mature trees, tree hollows and their size classes, standing dead trees (stags) and logs or boulders.
- Dominant flora species and a subjective assessment of floristic diversity at different structural layers, flowering and fruiting resources.
- Presence of significant keystone species and critical habitat elements for threatened fauna.
- Representation of the habitat type on a local and regional scale.
- Disturbance regimes, both past and ongoing including fire regime and weed abundance.
- Density of each vegetation strata (structural diversity).
- Presence and quality of wet areas or waterbodies, significant aquatic habitats where present.
- Size of remnant patches and extent of connectivity, movement corridors and refuge value.

The habitat assessment data were used in combination with field survey results to identify potential habitats for threatened species. The surveys identified and mapped the distribution of broad habitat types in relation to the predicted presence of threatened fauna species. This included identifying important habitat characteristics required for each species (i.e. keystone food plants, locations with abundant tree hollows or logs, or preferences for a particular habitat type and structure). This information, in conjunction with targeted fauna surveys and a review of regional records, was used to assess the extent and magnitude of impacts on threatened species habitat. The fauna species which were identified from the literature review and targeted during the surveys are listed in Appendix A.

Purple Copper Butterfly

Numerous areas of potential habitat within and directly adjacent to the study area were identified previously during the corridor studies. Targeted surveys for Purple Copper Butterfly (*Paralucia spinifera*) were undertaken by Ray Mjadwesch (Director, Mjadwesch Environmental Service Support).

Surveys were undertaken during optimal ‘flying’ conditions comprising sunny and warm conditions with low wind between 1000 hours and 1600 hours in spring. Before commencing surveys in the study area a spot check at known reference sites supporting Purple Copper Butterfly (Vickers Street and/or Bowenfels) was undertaken to confirm butterflies were flying on the day of assessment. The Purple Copper Butterfly was observed flying at the reference sites on the day of the assessment.

Areas of potential habitat (Blackthorn patches) were identified in the study area during the corridor studies (refer to Figure 3-5) and these areas were traversed on foot with the aim of disrupting vegetation to flush out butterflies if present. Periods of stationary observations over a wider area were also undertaken within each area of potential habitat. Searches for signs of caterpillars, including early instar and other grazing, and presence of the attendant ant *Anonychomyrma itinerans* were undertaken at each of the sites.

The location of any Purple Copper Butterfly observed was recorded using a handheld GPS and the location of better quality habitat with a higher potential to support the species was also recorded and photographed.

Detailed methods and results for these surveys are provided in Appendix E.

2.5.1. Targeted threatened species

State and nationally listed threatened species identified from the background reviews were considered in terms of their likelihood to occur in the habitats present within the study area based on their identified habitat requirements. The results of this review are provided in Appendix A**.** The likelihood of occurrence was classified according to the criteria described in Table 2-4. The presence of all potentially occurring threatened species were targeted during the surveys with particular emphasis on those species with a high or moderate likelihood of occurrence. Species with a high or moderate likelihood of occurrence were subject to assessments of significance under the relevant legislation (TSC Act and/or EPBC Act).

Table 2-4 Likelihood of occurrence includes one or more of the following criteria

Likelihood of Occurrence	Criteria
Unlikely	▪ Species highly restricted to certain geographical areas not within the proposal area ▪ Specific habitat requirements are not present in the study area
Low	Species not recorded during field surveys and fit one or more of the following criteria: ▪ Have not been recorded previously in the study area/surrounds and for which the study area is beyond the current distribution range ▪ Use specific habitats or resources not present in the study area ▪ Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded
Moderate	Species not recorded during the field surveys that fit one or more of the following criteria: ▪ Have infrequently been recorded previously in the study area/surrounds ▪ Use specific habitats or resources present in the study area but in a poor or modified condition ▪ Are unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration ▪ Are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded
High	Species recorded during the field surveys or species not recorded that fit one or more of the following criteria: ▪ Have frequently been recorded previously in the study area/surrounds ▪ Use habitat types or resources that are present in the study area that are abundance and/or in good condition within the study area ▪ Are known or likely to maintain resident populations surrounding the study area ▪ Are known or likely to visit the site during regular seasonal movements or migration

2.6. Survey effort

Specific details of survey effort with respect to the number of quadrats and transects sampled per habitat type are summarised in Table 2-5.

Table 2-5 Flora survey effort per habitat stratification unit

Map Unit	Vegetation Community/Habitat	Area (ha)	Survey Effort	
			Quadrat	Transects
1	Blaxland's Stringybark – Monkey Gum Open Forest	7.19	4	5
2	Silvertop Ash Open Forest	0.15	1	6
3	Ribbon Gum Grassy Woodland	0.05	1	2
TOTAL		**7.39**	**6**	**13**

The total fauna survey effort per technique is summarised in Table 2-6. Note that one habitat type occurs in the study area.

Table 2-6 Summary of fauna survey effort

Technique	Fauna group	Target Species	Survey Effort
Tree-traps	Arboreal mammals	Squirrel Glider	48 trap nights
Ground traps (Elliotts)	Small terrestrial mammals	All species	120 trap nights
Ground traps (cages)	Medium terrestrial mammals	Spotted-tailed Quoll	12 trap nights
Harp-traps	Microchiropteran bats	Eastern False Pipistrelle	6 trap nights
Bat call recording	Microchiropteran bats	All species	3 all night sessions
Spotlighting	All groups	Yellow-bellied Glider, Squirrel Glider, large forest owls, Spotted-tailed Quoll	4 person hours
Diurnal birds	Diurnal birds	Woodland birds	5 sites (each session minimum 20 mins)
Call playback	Nocturnal birds	Large forest owls	2 sites (each session minimum 20 mins)
Reptile search	Reptiles	Rosenberg's Goanna	5 sites (30 min search)
Frog search	Frogs	Giant Burrowing Frog	4 person hours
Scat search	Arboreal mammals	Koala	2 person hours

3. Existing Environment

3.1. Landscape context

The study area is located within the South Eastern Highlands bioregion (Thackway and Cresswell 1995) adjacent to the western edge of the Sydney Basin bioregion. The study area is located entirely within the Hawkesbury-Nepean Catchment Management Area (CMA) and includes the Wollemi and Burragorang (Part A) CMA sub-regions. The region is important for biodiversity because it provides a transition from the mountains to the western slopes and the plains.

The study area is located on the lower slope of the escarpment area of Hassans Walls. The geology includes areas of sandstone and shale. The dominant vegetation types in the area comprise dry and wet sclerophyll forests in escarpment areas and on steeper slopes and grassy woodlands dominate the lower elevated valleys.

3.2. Land use

The study area supports a variety of land uses. Areas on the northern side of the Great Western Highway predominantly support vacant forested lands including private and crown land which are contiguous with Hassans Walls. Land use on the southern side of the Great Western Highway includes rural residential properties, agricultural lands used predominantly for cattle grazing, and some smaller patches of intact forest. The study area also includes the road reserve of the existing Great Western Highway and Forty Bends Road.

3.3. Vegetation communities

Three vegetation communities were identified within the study area. These are listed in Table 3-1 along with the equivalent map units identified in regional vegetation community mapping projects and the conservation status of each community according to information provided in Tozer *et al.* (2010), DEC (2006) and the TSC Act and EPBC Act. Full descriptions of each of the vegetation communities are provided in Appendix C, including the dominant species, landscape position and conservation status. The distribution of vegetation communities in the study area is depicted in Figure 3-1.

Approximately 8.4 hectares of the study area comprise cleared and modified vegetation with a mix of native and exotic flora not corresponding to the three natural vegetation communities. These areas are generally dominated by exotic weeds and pasture with a low abundance of disturbance tolerant native flora.

Table 3-1 Vegetation communities in the study area

Map Unit	Vegetation Community	Equivalent Vegetation Communities	Conservation Status	Area in proposal footprint (ha)
1	Blaxland's Stringybark – Monkey Gum Open Forest (**Plate 3-1**)	Biometric: No closely equivalent biometric vegetation types, closest match is Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin DEC 2006: MU 24 Montane Slopes Stringybark Forest Tozer *et al*. (2010): possibly DSF p76 Moist Montane Sandstone Forest and/or WSF p73 Cool Montane Wet Forest	Clearing has not greatly affected the extent of this community given its favoured steep and infertile habitat (DEC 2006). Tozer *et al*. (2010) estimates there is approximately 70-90 per cent of the pre-clearing area of these closest equivalent vegetation communities (WSF p73 and DSF p76) remaining, and 35-55 per cent of the pre-clearing area is in conservation reserves.	7.96
2	Silvertop Ash Open Forest	Biometric: Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands and South East Corner Tozer *et al*.(2010): DSF p8 Tableland Ridge Forest	Tozer *et al*. (2010) estimates there is approximately 80-90 per cent of the pre-clearing area of this vegetation community (DSF p8) remaining, and 40-60 per cent of the pre-clearing area is in conservation reserves.	0.21
3	Ribbon Gum Grassy Woodland (**Plate** 3-2)	Biometric: Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands, South Eastern Highlands Tozer *et al*. (2010): GW p420 Tableland Granite Grassy Woodland	This community is consistent with the TEC Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions listed as Endangered under the TSC Act. This community is regarded as being highly cleared with only 20-35 per cent of the pre-European extant estimated to remain and <1 per cent of the pre-European extant estimated to occur in conservation reserves (Tozer *et al*. 2010).	0.05
4	Modified habitats	n/a	n/a	8.4

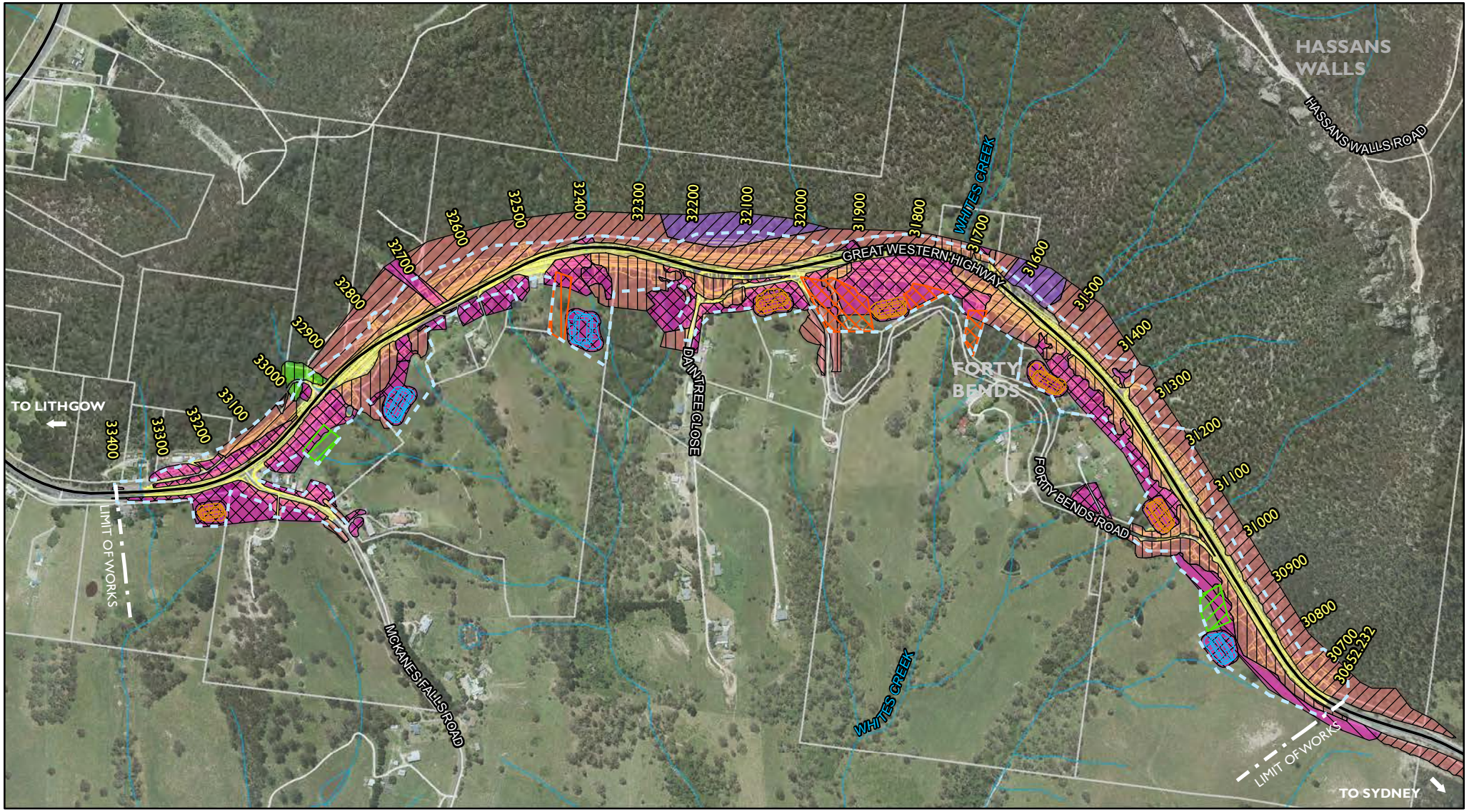

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Figure 3-1 Vegetation communities

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

LEGEND

- Chainage
- Proposal
- Proposal site
- Existing highway
- Local roads
- Waterways

Vegetation communities

- Map Unit 1: Blaxland's Stringybark – Mountain Gum Open Forest
- Map Unit 2: Silvertop Ash Open Forest
- Map Unit 3: Ribbon Gum Grassy Woodland
- Map Unit 4: Modified Habitats

Vegetation condition

- High
- Moderate
- Low
- Very Low

- Temporary drainage basins
- Permanent drainage basins

Compound site and stockpile locations

- Potential compound
- Potential stockpile
- Potential stockpile and compound

GDA 94 | MGA 56

0 200
Metres

Aerial Photograph:AUSIMAGE/SKM 2011

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Plate 3-1 Map Unit 1 – Blaxland's Stringybark-Monkey Gum Open Forest on the southern side of the Great Western highway in the central portion of the study area

Plate 3-2 Map Unit 2 – Ribbon Gum Woodland (TEC) in the western portion of the study area

3.4. Floral diversity

The floral diversity of the study area has been documented in surveys from late autumn 2011 to early/mid spring 2011, therefore increasing the chances of detecting and identifying a large majority of flora species present including threatened and common species. For example, autumn-flowering orchid species such as Mosquito Orchid (*Acianthus exsertus*) and Small Autumn Greenhood (*Pterostylis reflexa*) were observed as well as spring-flowering orchid species such as Tiger Orchid (*Diuris sulphurea*), Hooded Caladenia (*Caladenia cucullata*), Pink Fingers (*Caladenia carnea*) and Leopard Orchid (*Diuris pardina*).

A total of 161 flora species from 57 families was recorded in the study area, of which 28 are exotic species and two are non-indigenous native species and have been introduced (Appendix B. No threatened flora species listed under the TSC Act or the EPBC Act was recorded in the study area.

3.5. Exotic species

Of the 161 flora species identified in the study area, 28 are exotic species and two are non-indigenous native species. Noxious weed species were observed in the study area with some species occurring in relatively high abundance within disturbed areas such as roadside areas, disturbed areas of remnant vegetation and unmaintained areas on private property.

The five noxious weed species recorded in the study area are listed in Table 3-2, including the noxious class for each species.

Table 3-2 Noxious weed species present in the study area

Species	Prevalence on Site	Noxious Class in the Upper Macquarie County Council control area
Hemlock *Conium maculatum*	Recorded in low-moderate abundance mainly in disturbed roadside areas.	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed.
Patterson's Curse *Echium plantagineum*	Recorded in low abundance mainly in disturbed roadside areas.	
African Lovegrass *Eragrostis curvula*	Recorded in high abundance within road easements and disturbed areas of remnant vegetation.	
St John's Wort *Hypericum perforatum*	Recorded in moderate to high abundance in disturbed road easements, disturbed areas of remnant vegetation and agricultural areas.	
Blackberry *Rubus fruticosus*	Recorded in moderate to high abundance in unmaintained road easements and disturbed areas of remnant vegetation especially in modified drainage lines. Blackberry is also a Weed of National Significance.	

3.6. Fauna habitats

Fauna habitats were identified from a combination of the field surveys and broad-scale mapping of vegetation communities in the region (Tozer *et al.* 2010) as well as classification of priority fauna habitats (Department of Environment and Climate Change 2005). The main fauna habitats present within the study area include:

- Dry open forest (Plate 3-3).
- Aquatic habitats – ephemeral creeks and farm dams (Plate 3-4).
- Agricultural land.

Fauna habitats in the study area are mapped at Figure 3-2.

Plate 3-3 Dry open forest habitats (Map Unit 1) supporting a shrubby understorey including Blackthorn (Bursaria spinosa subsp. lasiophylla)

Plate 3-4 Farm dam near the study area

Hollow trees in the study area occur in moderate abundance, comprising small to medium sized hollows suitable for larger arboreal mammals, as well as a range of bird species, herpetofauna and microbats. Trees supporting larger trunk hollows suitable for large forest owls were not observed in the study area. Based on calculations using data collected in habitat assessment plots, the density of hollow trees in the study area is estimated to comprise approximately five hollow trees per hectare across all forest types. This density equates to the potential impact on up to 39 hollow-bearing trees, across the length of the upgrade.

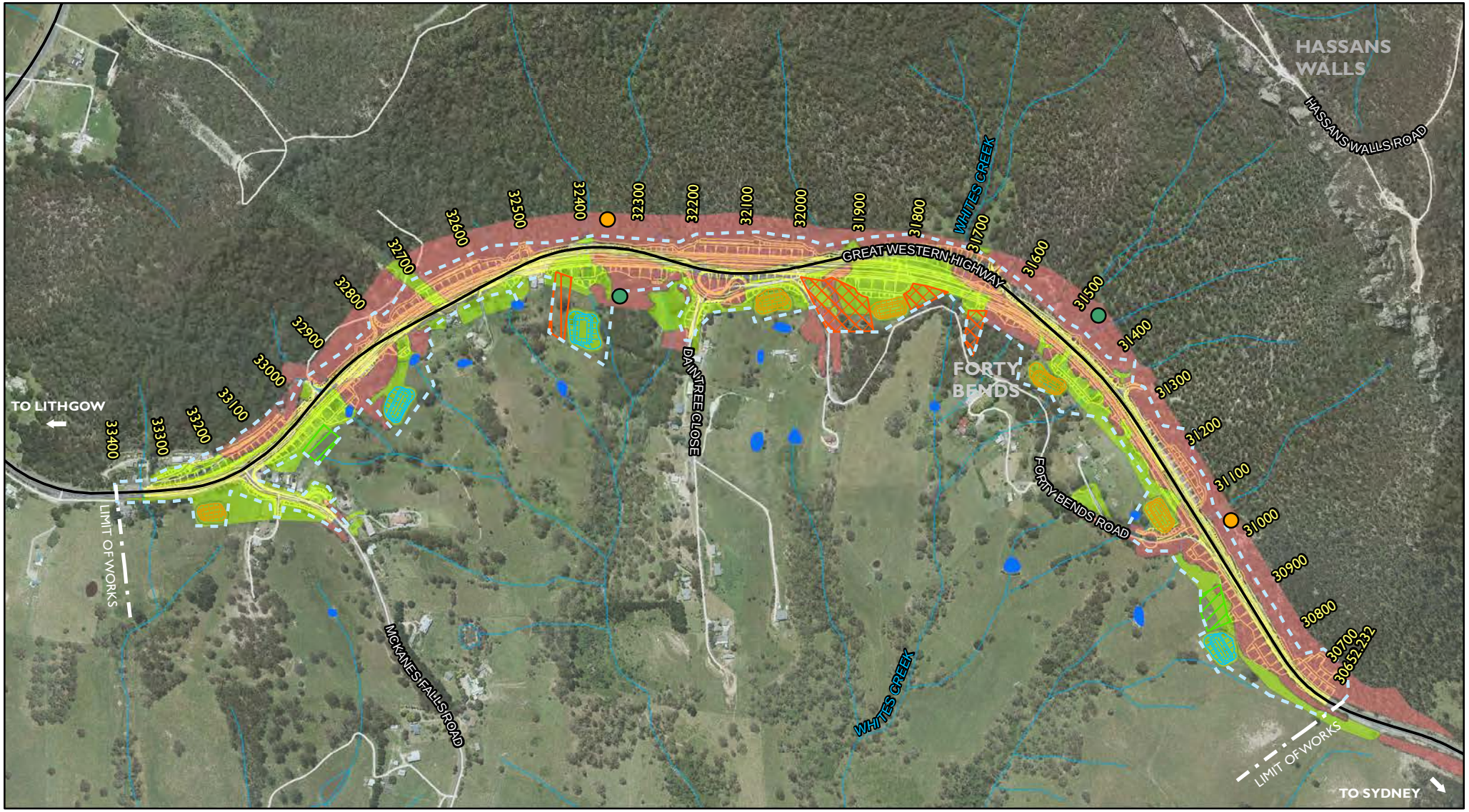

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Figure 3-2 Fauna habitats and threatened fauna

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

LEGEND

- 31800 Chainage
- Proposal
- Proposal site
- Existing highway
- Local roads
- Waterways

Threatened fauna
- Bathurst Copper Butterfly
- Eastern False Pipistrelle

Fauna habitat
- Dry Open Forest
- Modified Habitats
- Farm Dams

- Permanent drainage basins
- Temporary drainage basins

Compound site and stockpile locations
- Potential compound
- Potential stockpile
- Potential stockpile and compound

GDA 94 | MGA 56

0 200
Metres

Aerial Photograph:AUSIMAGE/SKM 2011

3.6.1. Dry open forest

Mature dry sclerophyll forest dominates the steeper slopes around the Forty Bends area. The sandy soils on the northern side of the road were dominated by Monkey Gum (*Eucalyptus cypellocarpa*) and Blaxland's Stringybark (*Eucalyptus blaxlandii*) and a varied understorey of shrubs, grasses and herbs. These areas support a moderate cover of large and mid-sized trees and shrubs such as Wattles (*Acacia* spp.) and Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*). A summary of the habitat assessment data averaged across the four plots is presented below. The forest habitat exhibits a low abundance of large tree hollows, generally associated with trunk hollows, and a moderate abundance (5-25 percent cover) of small tree hollows in the size range of 5-15 centimetres, these are generally associated with outer branches. Similarly there are a moderate proportion of dead trees representing between 5-25% of the tree cover and between 25-50% cover of rocks and / or woody debris on the ground. These features are critical for shelter and breeding sites for hollow-dependent fauna and reptiles. The groundcover varied from tussock grasses, to bare soil, rocks, and leaf litter. Grassy groundcover vegetation is scattered throughout with a sparse distribution of medium and large rocks as well as logs. Medium-sized sandstone boulders are present in some areas (mainly outside the proposal footprint) and these form an abundance of shallow caves, crevices and overhangs. The habitat assessment results for the study area are provided in Table 3-3.

Table 3-3 Habitat assessment results

Habitat features	Per cent cover	Notes
Large tree hollows Small tree hollows Mistletoe Epiphytes Logged stumps Large stags Decorticating Bark Rocks/logs	0% 5-25% 0% 0% 0% 5-25% 50-75% 25-50%	• Regenerating forest dominated by *E.cypellocarpa* and *E.blaxlandii* with E. piperita with juveniles of each species scattered throughout the mid-storey. • Shrub layer largely dominated by *Bursaria spinosa* providing potential habitat for small birds. • Abundant groundcover comprising tussock grass and herbs/grasses with extensive shallow leaf litter as potential habitat for small reptiles. • Some logs throughout the habitat. • Minimal disturbance as a result of a moderate intensity fire of less than five years.

The feed-tree species for the threatened Glossy Black-cockatoo (*Calyptorhynchus lathami*), namely Black She-oak (*Allocasuarina littoralis*) were observed at several locations in the study area with the greatest density and abundance present on the southern side of the highway in the central area east of Whites Creek. Despite this, there are few records of Glossy Black-cockatoos in the locality and the species was not confirmed during the survey either through direct observation or evidence of feeding (i.e. chewed She-oak cones).

The dry open forest typically has a high structural and floristic diversity with abundant evidence of macropods and bandicoots. Native small mammals were present including Brown Antechinus (*Antechinus stuartii*) and Bush Rat (*Rattus fuscipes*) and arboreal mammals such as the Common Brushtail Possum (*Trichosurus vulpecula*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and Greater Glider (*Petauroides volans*).

A moderate diversity of birds was identified with the most common species including Eastern Rosella (*Platycercus eximius*), Spotted Pardalote (*Pardalotus punctatus*), Sulphur-crested Cockatoo (*Cacatua galerita*), White-throated Treecreeper (*Cormobates leucophaea),* Yellow-faced Honeyeater (*Lichenostomus chrysops*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Superb Fairy-wren (*Malurus cyaneus*). This habitat is likely to provide habitat for a range of threatened mammals and birds, which includes, but is not limited to, Spotted-tailed Quoll (*Dasyurus maculatus*), Koala (*Phascolarctos cinereus*) Gang-Gang Cockatoo (*Callocephalon fimbriatum*) and Powerful Owl (*Ninox strenua*) which have been recorded in the locality.

The dry sclerophyll open forest provides important habitat for a range of fauna groups, particularly hollow-dependent species such as large forest owls, arboreal mammals, hollow-dependent bats and nectivorous birds. Dry open forest habitats also provide a range of food resources for fauna including a diversity of eucalypt species providing a year-round seasonal supply of nectar and pollen, and food resources for ecological specialists such as Koalas and Glossy Black-cockatoo. The structural diversity offers a range of foraging substrates (such as peeling bark, fallen logs, leaf litter, shrubby understorey, and grassy groundcover) and cover for fauna.

3.6.2. Aquatic habitat

Considering the absence of permanent aquatic habitats along drainage lines in the study area these areas provide little habitat value for threatened fish species. The vegetation along drainage lines such as Whites Creek was similar to the surrounding vegetation on slopes and crests and only a low degree of riparian influence was observed such as the presence of small sedges and rushes in ephemeral drainage lines in some small, localised areas. The locations of dams in the study area are provided in Figure 3-2.

Farm dams in and adjacent to the study area occur in a range of sizes and condition and provide a range of refuge, foraging and breeding opportunities, depending on their condition and context. In the study area farm dams are generally small, occur adjacent to the existing highway, and typically have some minor areas of littoral and riparian vegetation in some areas supporting mesic species such as small sedges and rushes. These provide seasonal and permanent refuge and breeding habitat for frogs, and a freshwater resource for a range of mammals, reptiles and birds.

Farm dams support limited ecological values for threatened fauna species, and are likely to support several common fauna species such as Long-necked Turtle (*Chelodina longicollis*). Any reduction to the existing hydrological regimes associated with these farm dams is unlikely to result in a significant impact to any threatened species or populations.

3.6.3. Modified habitat

Cleared and semi-cleared farmland is present on the southern side of the existing Great Western Highway. The habitat is dominated by cleared and modified pasture land with vegetation cover restricted to scattered mature paddock trees, small fragments of re-growth woodland or planted shelter rows along fences and driveways. Tree hollows and logs are present in very low abundance and restricted to the immediate areas surrounding remnant trees. Farm dams are scattered throughout.

These habitats would still be utilised by a range of native fauna for foraging and dispersal such as macropods and Spotted-tail Quoll.

3.7. Threatened Ecological Communities

One Threatened Ecological Community (TEC) listed under the TSC Act was identified in the study area (refer to Table 3-4). Further discussion regarding the composition, distribution and identification of this TEC is provided below. The equivalent map unit identified for the Tablelands Grassy Woodland TEC in the study area is Map Unit 3 Ribbon Gum Grassy Woodland displayed in Figure 3-1.

Table 3-4 Threatened ecological communities in the study area and corresponding map units and legal status

Threatened Ecological Community	Equivalent Map Units	Legal Status	
		TSC Act	EPBC Act
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions (Tablelands Grassy Woodland)	Map Unit 3: Ribbon Gum Grassy Woodland	Endangered	--

3.8. Tablelands Grassy Woodland

A small area dominated by Ribbon Gum (*Eucalyptus viminalis*) at the western end of the proposal footprint is consistent with the Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions (herein referred to as Tablelands Grassy Woodland) TEC listed as Endangered under the TSC Act. This TEC occurs in a gully area on alluvium/metasediments in the study area and is relatively disturbed from understorey clearance, track formation and weed invasion. The condition and floristic composition of Tablelands Grassy Woodland varies, with portions in the study area closest to the existing highway in a poorer condition due to edge effects and weed invasion. The equivalent map unit identified for the Tablelands Grassy Woodland TEC in the study area is Map Unit 3 Ribbon Gum Grassy Woodland displayed in Figure 3-1.

3.9. Groundwater-dependent ecosystems

Vegetation communities in the study area are considered to have a low-level of groundwater dependence considering the dry nature of these communities, the occurrence on relatively steep undulating terrain, and the lack of any evidence of groundwater expression at the base of slopes and /or in drainage lines, with no water observed in drainage lines during the surveys. The drainage lines in the study area do not have defined drainage channels or form wetlands, and support similar floristic diversity as the surrounding slopes.

3.10. Fauna

3.10.1. Non-flying mammals

A total of 10 terrestrial mammal species were recorded in the study area through trapping, visual observation and secondary indications (e.g. scats, tracks and diggings). Ground-dwelling small mammals were present in low abundance in the open forest habitat on sandy soils. Two native species were identified on sandy soils, the Brown Antechinus and Bush Rat.

Macropods were common, with Eastern Grey Kangaroo (*Macropus giganteus*), Swamp Wallaby (*Wallabia bicolour*), Red-necked Wallaby (*Macropus rufogriseus*) and Common Wallaroo (*Macropus robustus*) recorded. Bandicoot diggings, probably Long-nosed Bandicoot (*Perameles nasuta*) were particularly common in the open forest habitat on sandy soils. Other common species recorded include Common Brushtail Possum (*Trichosurus vulpecula)*, Common Ringtail Possum (*Pseudocheirus peregrinus*) and Greater Glider (*Petauroides volans*). Ringtail and Brushtail Possums were present on both sides of the highway, while the Greater Glider was restricted to the larger intact habitats on the northern side of the road.

3.10.2. Flying mammals

The use of harp traps and ultrasonic call recording identified a total of four microchiropteran bat species (Table 3-5; Appendix D). All of these are known to roost in forest habitats, using tree hollows, spouts and crevices in trees as refuge. One of the bat species detected is listed as vulnerable under the TSC Act: the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*). All species detected will likely use forested habitats across the entire study area for foraging.

Table 3-5 Bat trapping survey results

Species	Common Name	Legislative Status	Total Captures	Proportion of Total Captures (%)
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable (TSC Act)	5	45.4
Nyctophilus geoffroyi	Lesser Long-eared Bat	-	2	18.2
Vespadelus darlingtoni	Large Forest Bat	-	1	9.1
Vespadelus vulturnus	Little Forest Bat	-	2	18.2
Chalinolobus gouldii	Gould's Wattled Bat	-	1	9.1
TOTAL			**11**	**100**

The distribution of bat captures is primarily a function of the quality of trap sites and does not accurately reflect the distribution of roosting and foraging habitat for bats. The use of bat call detectors indicated that activity is more evenly distributed across the study area with bats recorded at all sites particularly near water and open areas adjoining forest such as tracks and clearings.

Analysis of 335 call recordings positively identified six species and an additional two probable/possible species (Table 3-6) including calls of a long-eared bat (*Nyctophilus* sp.) and forest bat (*Vespadelus* sp). Calls of these species are difficult to separate on the basis of call frequency alone. However, *N. geoffroyi* was captured using harp traps and its presence is confirmed in addition to *V. vulturnus* and *V. darlingtoni*. Another common species, the White-striped Freetail-bat (*Nyctinomus australis*), was detected whilst spotlighting (this species has an audible and distinctive call).

Table 3-6 Bat species recorded by ultrasonic call recording

Species/Species Complex	TSC Act Status	No. of calls	Confidence Level [1]		
			CL1	CL2	CL3
Long-eared Bat (*Nyctophilus* sp.)	--	51	13	37	1
Eastern Forest Bat (*Vespadelus* sp.)	--	20	4		16
Vespadelus darlingtoni/V. regulus	--	39	5	34	
Falsistrellus tasmaniensis/Scotorepens orion/Scotorepens sp.	Vulnerable	29		29	
Gould's Wattled Bat (*Chalinolobus gouldii*)	--	96	54	40	2
Chocolate Wattled Bat (*Chalinolobus morio*)	--	86	53	33	
Freetail-bat (*Mormopterus* sp.2)	--	7		7	
White-striped Freetail Bat (*Nyctinomus australis)*	--	4	4		

Note 1 – Confidence Level: CL1 = Positive; CL2 = Probable, CL3 = Possible

3.10.3. Birds

A total of 60 bird species was recorded in the study area. A list of the species is provided in Appendix D. This list represents a moderate species richness given the small area and degree of disturbance. The diversity of species is a function of the availability of different habitats and the condition, and the presence of multiple food resources and sheltering microhabitats. The dominant bird groups noted included foliage insectivores also present were granivores, nectarivores, diurnal and nocturnal raptors, and aerial foragers. Honeyeaters (Meliphagidae), Fantails/Flycatchers (Dicruridae), and Australasian Warblers (Acanthizidae) were particularly abundant. Common species included the Buff-rumped Thornbill (*Acanthiza reguloides*), Striated and Spotted Pardalote (*Pardalotus striatus* and *P. punctatus*), Yellow-faced Honeyeater (*Lichenostomus chrysops*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Australian Magpie (*Gymnorhina tibicen*). No threatened bird species was recorded in the study area, however several threatened bird species were recorded in the locality at Hartley and River Lett Hill including Varied Sittella (*Daphoenositta chrysoptera*) and Gang Gang Cockatoo (*Callocephalon fimbriatum*).

3.10.4. Reptiles and amphibians

The reptile diversity within the study area was dominated by skinks (Scincidae). A number of these species are generalists found in a variety of forest and woodland habitats where there is generally an adequate cover of trees, leaf litter and logs. This includes the Tree Skink (*Egernia striolata*) and garden gunskinks (*Lampropholis delicata* and *L. guichenoti*). Lace Monitors (*Varanus varius)* were widespread throughout all forested habitats and Eastern Water Skink (*Eulamprus quoyii*) was restricted to ephemeral creek habitats on the southern side of the road. No threatened reptile or amphibian was identified in the study area.

Four frog species were identified within the study area. The Leaf-green Tree Frog *(Litoria phyllochroa*) occupied stream habitats, while the remaining three species occupied dams (Eastern Banjo Frog *Limnodynastes dumerilii,* Common Eastern Froglet *Crinia signifera*, and Striped Marsh Frog *Limnodynastes peronii*). The most common of the frog species recorded was the Common Eastern Froglet. No threatened frog species were identified within the study area.

3.11. Threatened species and endangered populations

3.11.1. Threatened flora

On the basis of regional records, literature review and the presence of suitable habitat, a total of 17 threatened flora species is known to occur or potentially occur in the locality. The list of species considered in the study is provided in Table A-1 of Appendix A along with an assessment of the likelihood for each species to occur. The predicted presence is based on the known geographical distribution, preferred habitats for each species and the corresponding habitats in the study area. No threatened flora species is considered to have a high or moderate potential to be present, with all species considered to have a low or unlikely likelihood of occurrence, based on the categories listed in Table 2-4. The distribution of threatened flora records (OEH 2012) within the locality (10 kilometre radius) is shown in Figure 3-3.

No threatened flora species were recorded in the study area despite targeted searches during optimal periods.

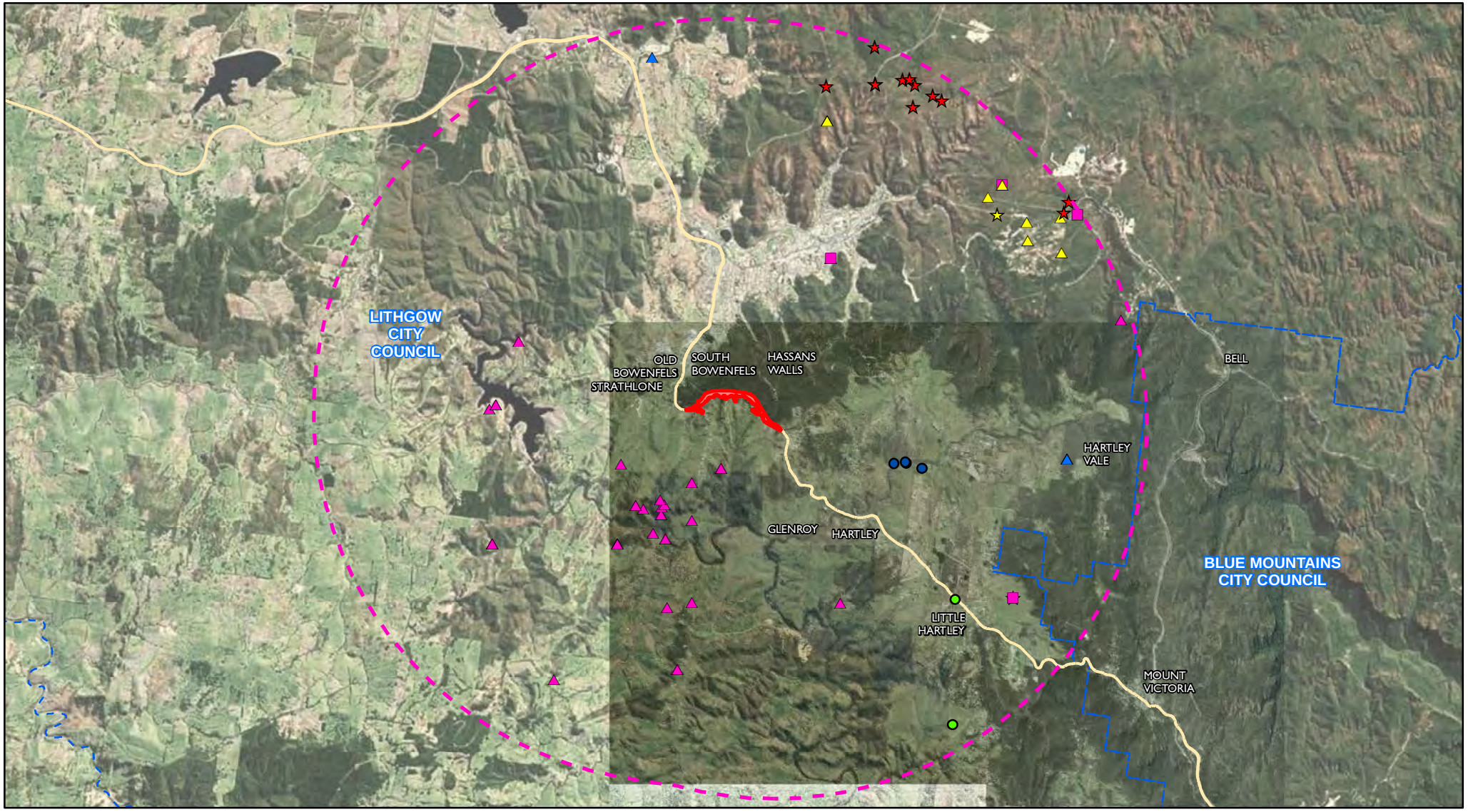

Figure 3-3 Threatened flora records (OEH 2012**)

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

LEGEND

- Existing highway
- Study area
- 10 k buffer

Threatened flora

- Acacia flocktoniae
- Asterolasia buxifolia
- Derwentia blakelyi
- Eucalyptus aggregata
- Eucalyptus pulverulenta
- Persoonia acerosa
- Persoonia hindii
- Persoonia marginata
- Pultenaea glabra

** Office of Environment and Heritage NSW 2012

GDA 94 | MGA 56

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Kilometres

Aerial Photograph:
1. High resouloution imagery: SKM AUSIMAGE 2011
2. (c) 2010 Microsoft Corporation and its data suppliers

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3.11.2. Threatened fauna

On the basis of regional records, reports and the presence of suitable habitat, a total of 44 threatened fauna species are known to occur or potentially occur in the locality. The list of species considered is detailed in Table A-2 of Appendix A along with the known geographical distribution, preferred habitats for each species and the potential occurrence in the study area. Of the 44 threatened species identified, two species have been recorded during the surveys, 18 species have a high potential to utilise habitats within the study area, four have a moderate potential, 16 have a low potential of occurrence and four are considered unlikely to occur based on the absence of suitable habitat and/or lack of evidence for this species being distributed in the locality (10 kilometre radius). Threatened fauna with a high-moderate potential to occur were specifically targeted during the surveys. The distribution of threatened fauna records (OEH 2012) within the locality (10 kilometre radius) is shown in Figure 3-4.

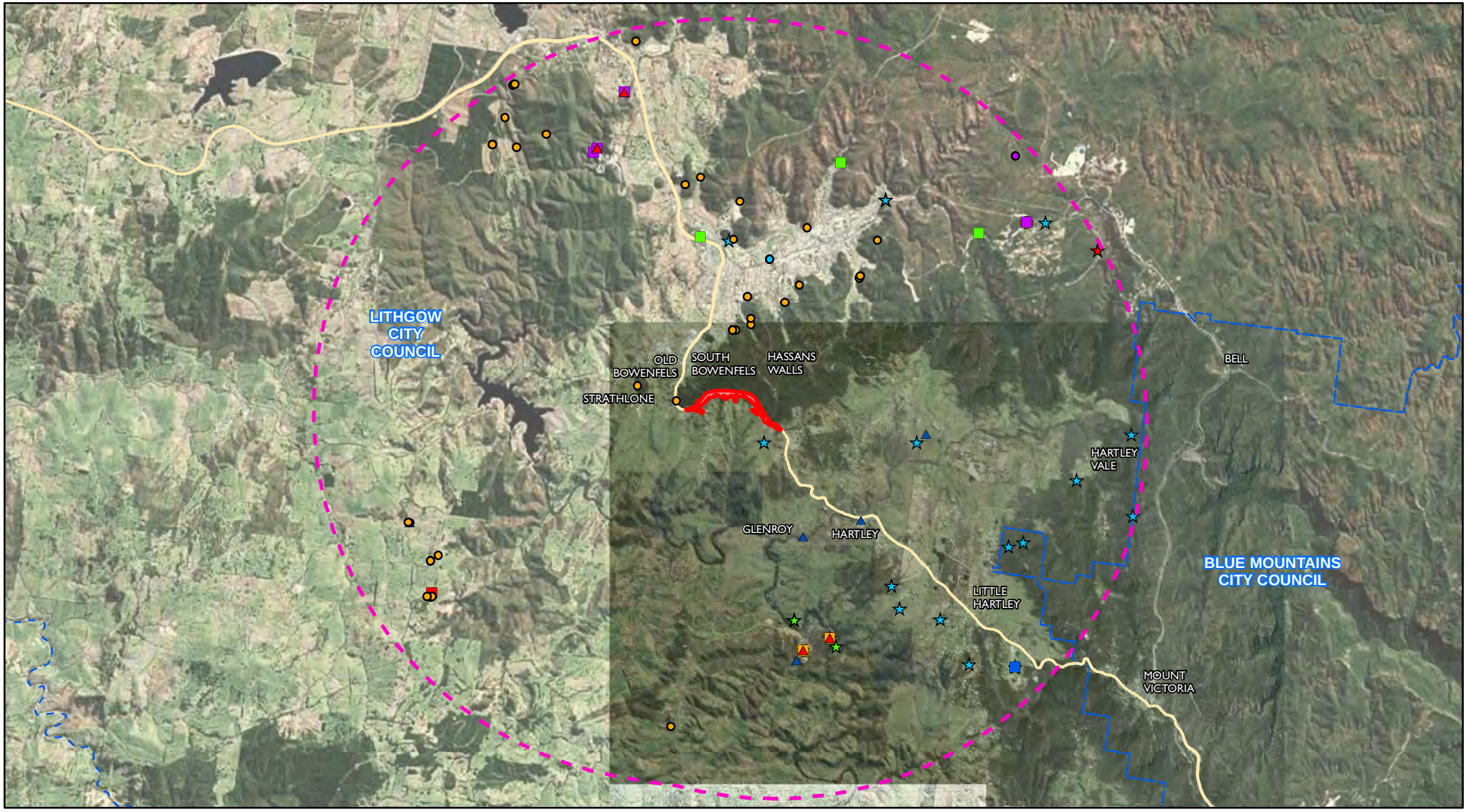
While the fauna survey conducted in spring 2011 was comprehensive and covered a broad area and diversity of habitats, it is likely that other threatened fauna species occur based on the type and condition of the habitats present. The following 24 species listed in Table 3-7 were recorded or considered to have a moderate to high likelihood of occurring.

Table 3-7 Threatened fauna recorded or considered to have a moderate to high likelihood of occurring

Species	Status		Potential to occur in the study area
	EPBC Act	TSC Act	
Barking Owl (*Ninox connivens*)	-	V	Recorded in locality
Black-chinned Honeyeater (*Melithreptus g. gularis*)	-	V	Moderate
Brown Treecreeper (*Climacteris picumnus victoriae*)	-	V	Moderate
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	Recorded in locality
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	Recorded
Eastern Freetail-bat (*Mormopterus norfolkensis*)	-	V	High
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	-	V	Recorded in locality
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	-	V	High
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V	High
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Moderate
Koala (*Phascolarctos cinereus*)	V	V	Moderate

Species	Status		Potential to occur in the study area
	EPBC Act	TSC Act	
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	High
Little Lorikeet (*Glossopsitta pusilla*)	-	V	Moderate
Masked Owl (*Tyto novaehollandiae*)	-	V	High
Powerful Owl (*Ninox strenua*)	-	V	Recorded in locality
Purple Copper Butterfly (*Paralucia spinifera*)	V	E	Recorded
Regent Honeyeater (*Anthochaera phrygia*)	E	CE	Moderate
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V	Moderate
Spotted-tail Quoll (*Dasyurus maculatus*)	E	V	High
Southern Myotis (*Myotis macropus*)	-	V	High
Swift Parrot (*Lathamus discolour*)	E	E	Moderate
Varied Sittella (*Daphoenositta chrysoptera*)	-	V	Recorded in locality
Yellow-bellied Glider (*Petaurus australis*)	-	V	Moderate
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	-	V	High

The fauna survey conducted in spring 2011 identified eight threatened fauna species between Little Hartley and South Bowenfels (Table 3-8). Of these eight species, two were recorded in the Forty Bends study area - Purple Copper Butterfly (*Paralucia spinifera*) listed as Endangered under the TSC Act and Vulnerable under the EPBC Act and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) listed as Vulnerable under the TSC Act (Figure 3-2). Impacts on these species have therefore been addressed under the provisions of the TSC Act and EPBC Act.



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Transport Roads & Maritime Services
NSW GOVERNMENT

Figure 3-4 Threatened fauna records (OEH 2012**)

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

Aerial Photograph:
1. High resouloution imagery: SKM AUSIMAGE 2011
2. (c) 2010 Microsoft Corporation and its data suppliers

LEGEND

- Existing highway
- Study area
- 10 k buffer

Threatened fauna

- Bathurst Copper Butterfly
- Blue-billed Duck
- Brown Treecreeper (eastern subspecies)
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Gang-gang Cockatoo
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Grey-headed Flying-fox
- Koala
- Little Lorikeet
- Powerful Owl
- Scarlet Robin
- Southern Myotis
- Spotted-tailed Quoll
- Tasmanian Bettong
- Yellow-bellied Glider
- Yellow-bellied Sheathtail-bat

** Office of Environment and Heritage NSW 2012

GDA 94 | MGA 56

0 2
Kilometres

Table 3-8 Threatened fauna recorded during the targeted surveys in the study area and the locality

Species	Status	Distribution and Habitat
	TSC Act/EPBC Act	
Recorded in study area		
Purple Copper Butterfly (*Paralucia spinifera*)	Endangered/Vulnerable	Confirmed from three sites at Forty Bends and South Bowenfels. Full details of the results are provided at Appendix E.
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	Vulnerable	Five individuals were captured in open forest habitat in the Forty Bends area. May prefer steeper forests on sandstone, with higher elevated sandstone outcrops and tree hollows or dead trees for roosting.
Recorded in the locality for preferred route corridor study		
Varied Sitella (*Daphoenositta chrysoptera*)	Vulnerable	Confirmed from two grassy woodland sites at Little Hartley and Hartley in small flocks of 3-6 birds. A wide ranging species typically occurring in larger woodland fragments. A foliage insectivore which could potentially forage on a diversity of eucalypt species and woodland types.
Gang-Gang Cockatoo (*Callocephalon fimbriatum*)	Vulnerable	A pair observed in grassy woodland at Little Hartley, Hartley and a single male at River Lett Hill. A widespread species which occurs in both elevated forests on the mountains and slopes and migrating locally to more flatter floodplain areas such as the Hartley Valley in the cooler months.
Powerful Owl (*Ninox strenua*)	Vulnerable	Recorded on the basis of an adult bird responding to call playback between the River Lett and Old Forty Bends Road. May occur in open forest and riparian areas. No tree hollows suitable for nesting for large forest owls were observed in habitats in the study area. Commonly preys on Common Ringtail Possums which were found to occur in both the grassy woodland and open forest habitats.

Species	Status	Distribution and Habitat
	TSC Act/EPBC Act	
Barking Owl (*Ninox connivens)*	Vulnerable	A tentative record based on a response during call playback, although only heard once. The response came from the Boxes Creek area, close to the River Lett in woodland habitat on crown land. May occur throughout lightly wooded habitats and particularly where there are larger trees near watercourses.
Eastern Bent-wing Bat (*Miniopterus australis*)	Vulnerable	Recorded from a single call recording in grassy woodland/riparian habitat near River Lett. Likely to occupy a range of forest and woodland habitats which occur in the study area and surrounding landscape. A predominantly cave-roosting species identified from natural and man-made structures, particularly maternity / breeding sites. No caves or underground shafts were located near the highway and the location of roost sites for this species in the region is not documented. At least one report of tree roosting has been made (Schulz 1997).

Koala

The interim referral guidelines for this species (SEWPAC 2012) require an assessment to identify whether the population in the study area is an important population or whether critical habitat will be removed. An important population is defined as a key source population either for breeding or dispersal, populations that are necessary for genetic diversity or populations that are near the limit of the species range.

There are three historical records of Koalas in the locality surrounding the upgrade (Atlas of NSW Wildlife OEH 2012) located between 4.2 and 7.6 kilometres from the study area. Anecdotal evidence of a Koala roadkill was reported in 2012 less than 0.5 kilometres to the east of the proposed upgrade, although this has not been confirmed. Suitable food resources are present in one section of the study area, comprising a small area of forest (refer to Map Unit 3 in Figure 3-1) dominated by Ribbon Gum (*Eucalyptus viminalis*). More extensive areas of marginal habitat may provide some foraging opportunities based on the fact that the dominant tree species across most of the vegetation in the study area are Monkey Gum (*Eucalyptus cypellocarpa*) and Blaxland's Stringybark (*Eucalyptus blaxlandii*), which have been identified as providing secondary/supplementary food sources (DECC 2008b).

Lithgow Local Government Area is not listed in Schedule 1 of SEPP No. 44, and this SEPP does not apply to Part 5 activities. Regardless, the intent of the SEPP was considered and the potential for Koalas to occur in the subject site was assessed during field surveys and potential impacts on the Koala have been considered in this report.

One vegetation community supports Ribbon Gum (*Eucalyptus viminalis*) at a density of greater than 15% of the canopy cover and therefore this area is classed as 'potential Koala habitat' as defined under SEPP 44. Notwithstanding, no evidence of Koala use of the habitat was recorded from the field surveys and there is little evidence to support the presence of a local breeding population of Koalas in the study area or immediate surrounds. On this basis the habitat does not meet the definition of 'core Koala habitat' as defined under SEPP 44. Any Koala population that may occur in this locality is most likely to be widely dispersed over a large area which would extend to the north, east and south of the proposal site and/or the study area constitutes part of a temporary refuge or within the dispersal range for Koalas moving to better quality habitat. In conclusion, there is no evidence of an important population of the Koala occurring within the study area.

Purple Copper Butterfly

Numerous areas of potential habitat within and directly adjacent to the study area were identified during the preferred route corridor studies. Targeted surveys for Purple Copper Butterfly (*Paralucia spinifera*) were undertaken by Ray Mjadwesch (Director, Mjadwesch Environmental Service Support). Of the eight sites of identified potential habitat between Little Hartley and South Bowenfels surveyed during the spring 2011, three sites were identified with active Purple Copper Butterfly of which two are in the study area. Some of these areas were considered to support only marginal habitat due to several key habitat attributes being limited such as a sunny, warm aspect and altitudes above 900 metres. Full details of background, methods, results and discussion for the Purple Copper Butterfly surveys are provided in Appendix E.

The location of Purple Copper Butterfly and potential habitat in the study area are provided in Figure 3-5 with habitats identified as:

- Occupied Habitat: Areas of habitat where Purple Copper Butterfly was confirmed as present.
- High Potential Habitat: Areas of habitat which support highly suitable habitat attributes for Purple Copper Butterfly such as a sunny, warm aspect at altitudes above 900 metres where Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*) is present and the attendant ant species was observed.
- Potential Habitat: Areas where Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*) is present in various densities. These areas include habitats that are regarded as unsuitable or marginal habitats due to the lack of sufficient warmth and sunlight, lower elevated areas below 900 metres altitude, absence of the attendant ant species, vegetation structure and/or disturbance history.

The populations in the study area are considered to be viable considering the high site fidelity of the species, occupying discrete and often small areas of habitat. These small populations form part of a larger intermixing metapopulation. Genetic studies confirm that there is little genetic differentiation among the populations, indicating genetic exchange between populations does occur (Clarke & Grosse 2003).

There is potential for Purple Copper Butterfly to occur in areas of habitat which were not observed to be utilised in 2011, particularly following certain disturbance events such as bushfire which could potentially reinvigorate potential habitat areas, resulting in changes to the distribution and abundance of the local population.

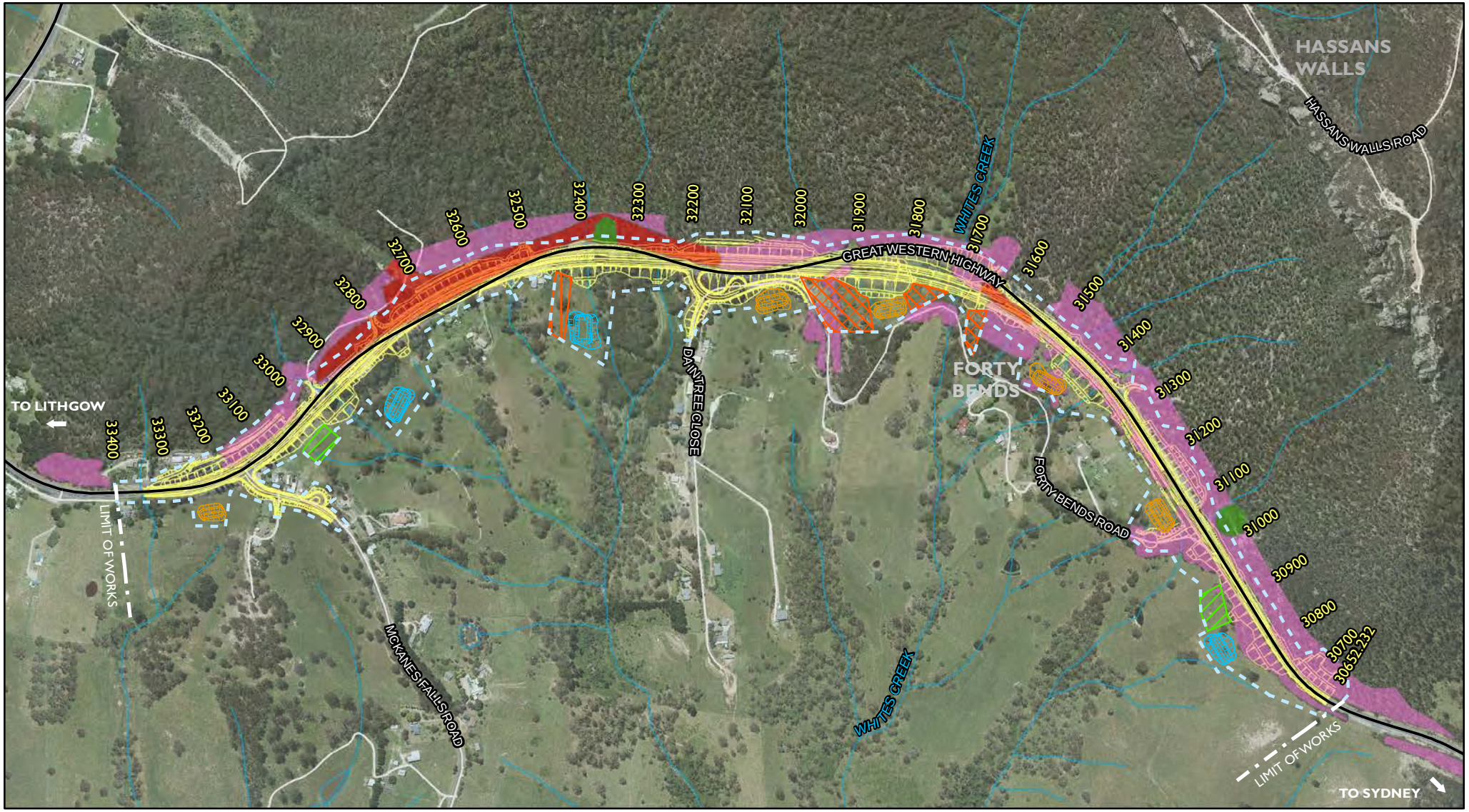

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Figure 3-5 Purple Copper Butterfly Habitat

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

LEGEND

- 31900 Chainage
- Proposal
- Proposal site
- Existing highway
- Local roads
- Waterways

Purple Copper Butterfly Habitat
- High Potential Habitat
- Occupied Habitat
- Potential Habitat - Blackthorn shrubs present

- Permanent drainage basins
- Temporary drainage basins

Compound site and stockpile locations
- Potential compound
- Potential stockpile
- Potential stockpile and compound

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0 200
Metres

Aerial Photograph:AUSIMAGE/SKM 2011

3.12. Migratory species

The background searches revealed the potential presence of 13 migratory species which are known to occur or potentially occur in the locality. The list of species considered is detailed in Table A-3 of Appendix A along with the known preferred habitats for each species and the potential occurrence in the study area and the presence of important habitat as defined under the EPBC Act. Of these 13 migratory species, none is considered to have a high potential to utilise habitats within the study area, six have a moderate potential, four have a low potential of occurrence and three are considered unlikely to occur (refer to Table A-3 in Appendix A) based on the absence of suitable habitat and/or lack of evidence for this species being distributed in the locality. Migratory fauna were specifically targeted during the surveys.

A total of 13 migratory species was identified in the EPBC Act Protected Matters Report (June 2012) as potentially occurring in the habitats surrounding the study area. These migratory species are listed in Table A-3 of Appendix A along with their preferred habitat requirements and a preliminary assessment of their likely presence within the study area, including the presence of 'important habitat' as defined under the EPBC Act.

As defined under the EPBC Act an area of 'important habitat' for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

None of the migratory species potentially occurring in the locality are likely to have important habitat in the study area. The habitats in the study area are unlikely to be important habitats, as defined above, for various reasons as described in Table A-3 of Appendix A.

The Regent Honeyeater is a listed migratory and a threatened species, and impacts on this species have been addressed under the threatened species provisions of the EPBC Act.

3.13. Critical habitat

No areas of declared critical habitat are present in the study area.

3.14. Regional wildlife connectivity corridors

Priority fauna habitats and wildlife corridors have been mapped within the region (DECC 2005). Priority fauna habitats have exceptional importance for the conservation of vertebrate fauna, particularly threatened species, and can be used to guide conservation efforts toward areas that would have the greatest outcomes for fauna. Priority fauna habitats were identified by the fauna field assessment projects undertaken in the Greater Southern Sydney Region, and habitats were then mapped across the whole of the CMA region using existing vegetation mapping.

No priority fauna habitats and wildlife corridors have been mapped within the study area, however two types of priority fauna habitat have been identified within the locality comprising Riverflat Forests and Grassy Woodlands. There are remnant patches of Riverflat Forests (an identified priority habitat) in the locality situated along the River Lett in the vicinity of Hartley and Grassy Woodlands (another identified priority habitat) has been identified to the south of the study area. The Blue Mountains Western Escarpment wildlife corridor has been identified by DECC (2005) as a fauna movement corridor within the region and crosses the Great Western Highway to the south of the study area at Victoria Pass near Little Hartley.

3.15. Local wildlife connectivity corridors

The northern side of the existing Great Western Highway in the study area adjoins a very large patch of remnant vegetation contiguous with several state forests and national parks. Much of the southern side of the existing highway has been largely cleared for agricultural purposes, and supports several corridors of partially fragmented/disturbed vegetation along drainage lines and gullies which are contiguous with riparian vegetation along River Lett and larger patches of habitat. There are opportunities to facilitate fauna movements across the Great Western Highway as part of the proposal.

Connectivity across the existing Great Western Highway within the study area is limited with underpass structures largely absent and restricted to a few small pipes at drainage lines (Plate 3-5). Some areas of the highway in the study area also have a concrete barrier in the median (Plate 3-6) which prevents some fauna species crossing the road, particularly smaller species which are unable to go over or under the structure. Larger embankments on the existing highway, including a large gabion wall at the south-eastern end of the proposal and several large cuttings limit fauna connectivity by creating a barrier which is likely to direct fauna crossing the highway back into traffic. Observations of roadkill wildlife and aerial photograph interpretation indicate that fauna crossings of the highway mostly occur in the central part of the proposal between the east and west intersections with the Forty Bends Road and to the immediate west of Daintree Close.

Plate 3-5 Existing pipe culverts

Plate 3-6 Existing concrete barrier in median

4. Potential Impacts

4.1. Loss of vegetation/habitat

The loss of vegetation communities and habitats in the study area is summarised in Table 4-1. The construction footprint is approximately 22.66 hectares of which 7.39 hectares supports remnant forest vegetation in varying degrees of condition and 15.27 hectares of cleared and highly modified habitats. Impacts to threatened ecological communities are limited to approximately 0.05 hectare of moderate condition vegetation (Map Unit 3).

Table 4-1 Loss of vegetation communities and fauna habitats

Vegetation Community Type	Fauna Habitat Type	Biometric Vegetation Type	Conservation Status/Percentage Cleared	Condition	Area (ha)
Map Unit 1: Blaxland's Stringybark – Monkey Gum Open Forest	Dry Open Forest	Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin	5% of original extent estimated to be cleared	High	4.07
				Moderate	3.08
				Low	0.04
Map Unit 2: Silvertop Ash Open Forest	Dry Open Forest	Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands and South East Corner	20% of original extent estimated to be cleared	High	0.15
Map Unit 3: Ribbon Gum Grassy Woodland	Dry Open Forest	Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands, South Eastern Highlands	Endangered (TSC Act) / 80% of original extent estimated to be cleared	Moderate	0.05
SUBTOTAL (Forested)					**7.39**
Map Unit 4: Modified Habitats	Modified Habitat	n/a	n/a	Low	0.54
				Very Low	7.69
n/a	Farm Dams	n/a	n/a	n/a	0.02
Other disturbed areas supporting little/no vegetation cover (i.e. existing road infrastructure, trails, stockpile areas, residential areas)					**7.02**
SUBTOTAL (Modified)					**15.27**
TOTAL (Entire Footprint)					**22.66**

4.1.1. Loss of foraging habitat

As discussed the proposal would result in the clearing of about 7.39 hectares of native vegetation, thereby affecting areas of habitat for fauna. There will also be impacts to areas of modified habitats and farms dams comprising approximately 8.25 hectares, and other disturbed areas supporting little vegetation (i.e. existing infrastructure) comprising 7.02 hectares. The loss of fauna habitat according to habitat type is presented in Table 4-1.

This potential impact includes approximately 0.05 hectares of potential foraging habitat for Koala and approximately 1 hectare of habitat supporting foraging habitat (feed-trees) for Glossy Black-cockatoo.

4.1.2. Loss of hollow-bearing trees

Hollow-bearing trees are a critical habitat feature for a number of threatened species (Gibbons and Lindenmayer 2002), providing breeding and/or sheltering habitat. Gibbons and Lindenmayer (2002) found that hollow bearing trees were more common in older stands, gullies, vegetation that has not been logged previously, and on flat terrain. Habitats with high productivity were also noted to support a higher number of hollow bearing trees.

Based on calculations using data collected in habitat assessment plots, the density of hollow trees in the study area is estimated to comprise approximately five hollow trees per hectare across all forest types. This density equates to an estimated potential impact of up to 39 hollow trees along the upgrade. Hollow-bearing trees are present in habitats to be cleared by the proposal. The loss of hollow-bearing trees is listed as a key threatening process under the TSC Act.

In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 81 birds, 31 reptiles and 16 frogs (Gibbons and Lindenmayer 1997, 2002). Of these, 15 listed threatened species (TSC Act or EPBC Act) have either been identified within the study area or considered likely to occur (Table 4-2).

Table 4-2 Threatened species potentially affected by loss of hollow-bearing trees

Common name	Species	TSC Act	EPBC Act
Glossy Black-cockatoo	*Calyptorhynchus lathami*	V	
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	
Brown Treecreeper (eastern subsp.)	*Climacteris picumnus picumnus*	V	
Powerful Owl	*Ninox strenua*	V	
Masked Owl	*Tyto novaehollandiae*	V	
Barking Owl	*Ninox connivens*	V	
Large-eared Pied Bat	*Chalinolobus dwyeri*		V
Spotted-tailed Quoll	*Dasyurus maculatus*	V	V

Common name	Species	TSC Act	EPBC Act
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	
Eastern Freetail-bat	*Mormopterus norfolkensis*	V	
Large-footed Myotis	*Myotis macropus*	V	
Yellow-bellied Glider	*Petaurus australis*	V	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	

4.2. Wildlife connectivity and habitat fragmentation

The existing Great Western Highway is typically a two-lane road, with concrete barriers between the lanes in some sections. The upgraded highway would incorporate a third lane, central median and wider shoulders. Hence, habitats in the locality would be further fragmented by the proposed upgrade, because it would create a wider barrier between habitats on either side of the Great Western Highway.

Roads decrease the amount and quality of habitat available to wildlife, and can subdivide populations, leading to reduced genetic exchange. Smaller, more isolated populations also experience higher risk of local extinction from significant disturbance events such as bushfire. Edge effects further affect the quality of the remaining habitat for species that are sensitive to disturbance, and/or require particular microhabitat features found in forested areas.

The most vulnerable species are those with poor dispersal abilities, sedentary habits, specialised needs, and those endemic to an area (such as the Purple Copper Butterfly) (Andrews 1990). The most robust species to habitat fragmentation are highly mobile generalists, such as some of the more common birds, and pest species such as foxes and cats.

However, the proposed Forty Bends upgrade would include mitigation measures to facilitate wildlife connectivity through the the provision of two fauna underpasses, a rope bridge at Whites Creek and glider poles located at Whites Creek and near the western underpass to encourage fauna passage (See Section 5.7 for proposed connectivity strategies.). Barriers to fauna movement such as solid median barriers would not be included in the design, and existing concrete barriers would be removed.

4.2.1. Connectivity loss

The proposal would have some potential impacts to wildlife connectivity. The proposal would increase the width of the Great Western Highway in the study area, and therefore increase the distance for any wildlife crossing the road. There will also be several large cuttings and retaining walls which will create a barrier to terrestrial fauna movements. The main fauna species potentially impacted from the increased width of the road and the retaining walls / cuttings would be terrestrial species such as Spotted-tail Quoll, reptiles and macropods, as well as arboreal species such as Koala, possums and gliders.

The proposed mitigation measures would ameliorate some of the potential impacts to wildlife connectivity (refer to Section 5.6). Mitigation measures include significant improvements to the number and quality of underpasses for fauna movements two dedicated fauna underpasses, and canopy rope bridges at Whites Creek and glider poles for arboreal specieslocated at Whites Creek near the western fauna underpass (refer to Section 5.6).

4.2.2. Habitat fragmentation

The proposed upgrade involves widening of the existing road corridor for 2.8 kilometres. The intact areas of remnant vegetation and habitat on the northern side of the road are part of a very large expanse of continuous habitat stretching to the east, north and south eventually connecting with the Blue Mountains World Heritage Area. The proposal would not fragment this existing expanse of habitat. The landscape to the south of the upgrade is predominantly cleared with a mosaic of scattered small remnants and limited connectivity. Given the existing road in this location and the proposal to widen and upgrade this section, the proposal would not result in isolated patches of habitat in the locality, but maintain the existing level of fragmentation associated with the existing road corridor. Measures to maintain connectivity in the landscape have been included in the design and are discussed in chapter 5.

4.2.3. Edge effects

Edge effects are zones of changed environmental conditions (i.e. altered light levels, wind speed, temperature and noise) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds), allow invasion by pest animals specialising in edge habitats, and/or change the behaviour of resident animals (Moenting and Morris 2006). Edge zones may also be subject to higher levels of predation by introduced mammalian predators and native avian predators.

Species with excellent dispersal abilities, capable of invading and colonizing disturbed habitats, are attracted to edges, and move into the core of natural habitat if a road or utility corridor carries the edge into a previously undisturbed area (Andrews 1990). The edge experiences a different wind and radiation effect, leading to a different microclimate. If habitats become too fragmented such that the ratio of edge to interior favours edges, the habitat will no longer be suitable for the interior species (Ranney *et al.* 1981).

Edge effects have been recorded at distances greater than 1000 metres from road surfaces (Forman *et al.* 2000). However in a comparison of edge effects in a variety of different habitat types, Bali (2000; 2005) estimated that average edge effects generally occur up to 50 m away from the road edge.

There is an existing edge effect evident along the northern edge of the highway in this section of Forty Bends associated with increased weed abundance and areas of soil disturbance and erosion. The proposed upgrade at Forty Bends would involve widening the road along the proposal length and potentially increasing the extent of the edge effect on the northern side, which based on a nominal 50 metre disturbance zone, could increase edge effects up to 14.5 hectares on the northern side where vegetation is intact including potential weed invasion and modified habitat characteristics. Edge effects are expected to be less evident of the southern side of the road where vegetation is currently edge affected habitat clearing is extensive and weeds abundant.

4.3. Injury and mortality

Fauna injury or death can occur during the clearing phase of construction via the removal of habitat trees, as well as throughout the life-time of the road operation as a result of collision with vehicles. There is also potential for increased fauna injury and mortality as a result of further habitat fragmentation, degradation and loss.

There is potential for injury and mortality to fauna species during vegetation clearing activities. The most vulnerable species are those who take refuge in trees (e.g. hollows, under bark, in nests, and in fallen logs) and in the ground, and/or have low agility. A range of ground-dwelling mammals, microbats, possums, reptiles, birds (particularly fledglings) and frogs are likely to be affected. Macropods, larger reptiles and adult birds are least likely to be affected by vegetation clearing activities because they are able to flee to unaffected areas of suitable habitat.

As there are currently several barriers to fauna crossing the existing highway at Forty Bends, implementation of the proposed wildlife connectivity mitigation measures may assist in reducing the number of fauna injuries and/or mortality associated with vehicle collisions.

4.3.1. Construction impacts

While some diurnal and mobile species, such as birds and large reptiles, may be able to move away from the path of clearing, other species that are less mobile or those that are nocturnal, or have smaller home ranges and/or strong site fidelity, are less inclined to move rapidly or disperse large distances away from the activity. This includes species such roosting microchiropteran bats, arboreal mammals, small reptiles and frogs. The RMS has developed biodiversity guidelines to protect and manage biodiversity on RMS projects (RTA 2011). Further details on the procedures to be implemented are outlined in Section 5.

4.3.2. Operation impacts

Mortality due to vehicle strike during operation of the upgraded highway has the potential to affect fauna species at the sub-population level. In general, rates of vehicle strike mortality are likely to be directly proportional to the distance of native vegetation/fauna habitat crossed by the proposal (Forman *et al.* 2000). However, other factors such as the design of the road (e.g. through cut or fill, presence of adjacent fences, safety barriers, fauna exclusion fences or fauna crossing structures), vegetation in close proximity to the road, cleared areas where grazing animals forage such as macropods also influence vehicle strike mortality rates. Estimates of road mortality in Australia, based on a single pass survey, have suggested that one bird is lost every 13 kilometre and one mammal lost every 30 kilometre (Disney and Fullagar 1978; Vestjens 1973). Burgin and Brainwood (2008) reported a roadkill frequency of 6.32 animals per 100 kilometres in central western NSW and 3.39 animals per 100 kilometres in peri-urban Sydney. These authors reported more mammals being killed than birds, and identified significantly higher numbers of animals killed on medium traffic volume roads such as major secondary roads and minor highways than on high volume major highways (Burgin and Brainwood 2008).

However, simple counts of road mortality fail to consider the impacts that such mortality can have in the wider populations through lost breeding (Forman *et al.* 2000; Taylor and Goldingay 2004) and the impacts on discrete populations where recruitment is reliant on breeding rather than influx of more animals from adjacent populations.

Threatened fauna that could be potentially affected by vehicle strike in this location are species that are reported as road kill and include Koala (Canfield 1991) and Spotted-tailed Quoll (Beckers 2008).

4.4. Weeds

There are currently five Key Threatening Processes listed under the *NSW Threatened Species Conservation Act 1995* (NSW) (TSC Act) that relate to the invasion and establishment of weeds. Each of these has potential to be exacerbated by construction and operation of the proposal. They are:

- Invasion and establishment of exotic vines and scramblers.
- Invasion of native plant communities by Bitou Bush and Boneseed.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*).
- Invasion, establishment and spread of Lantana (*Lantana camara*).

Noxious species recorded in the study area are listed in Table 3-2. Some of these species are relatively common in roadside habitats and paddock areas, and all are known to occupy disturbed areas. During construction there is potential to disperse weed seeds and plant material into adjoining areas of remnant vegetation where weed species do not currently occur. The most likely causes of weed dispersal are associated with clearing of vegetation and stockpile of contaminated mulch and topsoil during earthworks, and movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery.

There is a risk these species could be spread during construction of the upgrade. However, mitigation measures would be implemented to limit the spread and germination of noxious weeds (refer to Section 5.4). Landscaping of surrounding disturbed areas including weed management would limit the establishment and spread of weed species during operation.

4.5. Pests and pathogens

4.5.1. Pests

There are currently five Key Threatening Processes listed under the *NSW Threatened Species Conservation Act 1995* (NSW) (TSC Act) that relate to the invasion and establishment of pests. Each of these has potential to be exacerbated by construction and operation of the proposal, which includes:

- Competition and grazing by the feral European Rabbit.
- Competition from feral honeybees.
- Predation by feral cats.
- Predation by the European Red Fox.
- Predation by the Plague Minnow (*Gambusia holbrooki*).

Feral honeybees are introduced bees which originally escaped from hives and have subsequently established in the wild. While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. This is of particular concern for species which are threatened and include tree-dwelling microbats, and several bird, reptile and frog species.

The proposal may contribute to increased levels of predation on native fauna from foxes and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris *et al.* 2010). However, these authors consider this is less likely where multiple structures are used, as proposed, possibly minimising the potential for predation.

The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*) in the study area over the long-term. As rabbits tend to colonise more disturbed and modified habitats, any increase in the population of this pest species is more likely to impact on native fauna tolerant of modified habitats. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing Rabbit populations.

4.5.2. Pathogens

Pathogens are agents that cause disease in flora and fauna and are usually living organisms such as bacterium, virus or fungus. Several pathogens known from NSW have potential to impact on biodiversity as a result their movement and infection during construction of the proposal. Of these three are listed as a key threatening process under either the EPBC Act and/or TSC Act including:

- Dieback caused by *Phytophthora* (Root Rot; EPBC Act and TSC Act).
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and TSC Act).
- Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae (TSC Act).

The potential for pathogens to occur should be considered a high likelihood and treated as a risk during construction. The risk is especially high in construction areas affecting waterways (Table 4-3).

Table 4-3 Pathogens that may affect flora and fauna during construction

Pathogen	Description	Potential disease transmission
Phytophthora (*Phytophthora cinnamomi*)	A soil-borne fungus that causes tree death (dieback). Attacks the roots of a wide range of native plant species.	Spores can be dispersed over relatively large distances by surface and sub-surface water flows. Infected soil/root material may be dispersed by vehicles (e.g. earth moving equipment)
Myrtle rust (*Uredo rangelli*)	An introduced fungus that attacks the young leaves, short tips and stems of Myrtaceous plants eventually killing the plant.	Myrtle rust is an air-borne fungus that may be spread by moving infected plant material, contaminated clothing, equipment and vehicles.
Fusarium wilt/Panama disease (*Fusarium exysporum*)	Widespread in banana plantations in North coast region including Woolgoolga and Coffs Harbour.	Spread when spores are moved in soil by water, workers, vehicles and movement of infected plant material.
Chytrid fungus (*Batrachocytrium dendrobatidis*).	A soil and water-borne fungus which attacks keratin in frog skin and organs, causing death.	Chytrid is a water-borne fungus that may be spread as a result of handling frogs or through cross contamination of water bodies by vehicles and workers.

4.6. Changed hydrology

Drainage lines in the study area are highly ephemeral because the local terrain is steep, thereby facilitating rapid drainage during storm events. The existing culverts are generally small, causing water to pond and gradually drain after rainfall events. The introduction of larger culverts and the Whites Creek bridge structure during the upgrade would facilitate quicker passage of water and greater flows of water beneath the highway during storm events. Hence, local streams are likely to experience briefer, higher velocity flows as a result of the upgrade. This would result in briefer wet periods, and longer dry periods for streams, and greater potential for scouring of the stream bed during wet periods.

4.7. Groundwater-dependent ecosystems

Considering the likely low dependence of vegetation communities in the study area on groundwater resources, there is unlikely to be a significant impact to groundwater dependant ecosystems.

4.8. Aquatic impacts

Riparian vegetation and in-stream flora in the study area are largely absent and limited to thin strips of small sedges and rushes along drainage swales where present. Impacts to aquatic habitats and riparian vegetation would be very minor considering these habitats are largely absent.

Disturbances to the drainage gully of Whites Creek would result from construction of the new bridge and excavation of existing road infrastructure. The proposed bridge has been designed to minimise impacts on the drainage line, and landscaping/restoration of this area is proposed to improve habitat connectivity. The light levels beneath the proposed bridge structure will be relatively low and may limit the growth of any plantings associated with landscaping activities.

Construction of the bridge at Whites Creek could indirectly affect riparian and aquatic habitats immediately downstream. Potential impacts that could cause the decline in aquatic habitat value include altered hydrology (see Section 4.6) and reduced water quality from nutrient and sediment pollution.

Several farm dams would be impacted and therefore need to be drained and filled. Mitigation measures would be implemented to minimise injury and mortality of aquatic fauna in farm dams during construction and operation of the proposed upgrade (refer to Section 5.3.4). Habitats would be somewhat reinstated with the construction of permanent sediment basins (designed as wet basins) along the length of the proposed upgrade. These permanent basins would be landscaped with aquatic and mesic species and would have similar habitat characteristics as the existing farm dams.

4.9. Noise, vibration and light

Considering the existing levels of noise, vibration and light from the Great Western Highway it is unlikely there would be a significant increase to the existing levels which would result in any significant impacts to native fauna species. There is potential for impacts to local fauna from noise and vibration during construction, which may result in fauna temporarily avoiding habitats adjacent to the proposal.

The light levels beneath the proposed bridge structure will be relatively low and may limit the growth of any plantings associated with landscaping activities. The low light levels are not envisaged to significantly deter fauna movements or foraging activities in this area.

4.10. Impact on relevant key threatening processes

Key threatening processes listed under the TSC Act and EPBC Act and considered likely to be increased by the proposed upgrade are listed in Table 4-4. Key threatening processes identified as being impacted by the proposal comprise those associated with habitat degradation including vegetation clearing, bushrock removal and removal of hollow-bearing trees and fallen timber. Mitigation measures would be implemented to minimise the extent of vegetation clearing and habitat disturbance (refer to Section 5.2), and relocate important fauna habitats (refer to Section 5.6).

There is also potential for other key threatening processes to be increased (e.g. weed invasion, introduction of pests and diseases and alteration of hydrological regimes). However, where these are predictable, mitigation measures would be implemented to minimise their effect.

Table 4-4 Enaction of key threatening processes

Threatening Process	Legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Bushrock removal	TSC Act	Yes	Section 5.2 and Section 5.6
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Feral Invertebrate Fauna			
Competition from feral honey bees (*Apis mellifera*)	TSC Act	Potential	
Hydrology and Riparian Zones			
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act	Unlikely	Section 5.5
The degradation of native riparian vegetation along NSW water courses	FM Act	Unlikely	Section 5.5
Pathogens			
Infection of amphibians with chytrid fungus resulting in chytridiomycosis/Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	EPBC Act, TSC Act	Potential	Section 5.5
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi*	EPBC Act, TSC Act	Potential	
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	

Threatening Process	Legislation	Increased by the proposal?	Proposed Mitigation
Weeds			
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act	Potential	Section 5.4
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	TSC Act	Potential	
Climate Change			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

4.11. Cumulative impacts

The proposed upgrade at Forty Bends would increase the existing area of disturbance created by the Great Western Highway in the Forty Bends area and other local roads in the area including Forty Bends Road. There would also be cumulative impacts from potential future upgrades to the Great Western Highway along the 20 kilometre section from Mount Victoria to Lithgow including safety works in the Hartley Valley.

4.12. Impacts to threatened species and ecological communities

The potential impacts from the proposal on threatened fauna subject species are discussed in Table 4-5. Species are discussed individually, however where a group of species share similar habitat requirements and life-cycle strategies, these are discussed together (e.g. hollow-roosting microchiropteran bats, large forest owls, or wetland birds). Where there is insufficient information on the size and extent of the population in order to make an informed decision regarding the significance of the impact, the potential impact is based on the precautionary principle. There is potential to minimise the likely impacts discussed through appropriate and targeted mitigation and management actions during construction and operation and this is discussed in Section 6.

All threatened species confirmed in the study area or regarded as having a high or moderate likelihood of occurrence have been subject to assessments of significance and these are provided in Appendix F.

Table 4-5 Impacts to threatened species and ecological communities

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
THREATENED ECOLOGICAL COMMUNITIES				
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions	-	E	Approximately 0.05 hectares of this community would be impacted. Impacts would be limited to the disturbed edges of this community where weed species are dominant. There are also potential for edge effects to impact the retained areas of this community adjacent to the proposal.	Recorded
MAMMALS				
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Removal of approximately 7.39 hectares of potential foraging habitat. There are no records of this species (OEH 2012) or roost camps within the locality. However the dry sclerophyll forests provide potential foraging habitat for this species at different times of the year. Flying-foxes are found in a variety of habitats, including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas. Potential foraging habitat is common and widespread. Notwithstanding, the RMS has submitted a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts to the Grey-headed Flying-fox within the study area.	Moderate

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Koala (*Phascolarctos cinereus*)	V	V	Removal of approximately 0.05 hectares of forest dominated by Ribbon Gum (*Eucalyptus viminalis*) a known feed tree (90-100% of canopy cover) listed under SEPP 44, and an additional 7.3 hectares of marginal habitat which may provide some foraging opportunities as Monkey Gum (*Eucalyptus cypellocarpa*) and Blaxland's Stringybark (*Eucalyptus blaxlandii*) (80-100% of canopy cover) are identified as providing secondary/supplementary food sources (DECC 2008b). There are three records of Koala in the locality (OEH 2012). Koalas occur in a variety of forest and woodland types that contain appropriate tree species. Potential impacts to the species include permanent loss, modification and fragmentation of habitat, increased incidence of fires, road kill and predation by feral and domestic dogs. Currently connectivity for the Koala is highly limited in the study area with concrete barriers in the median and no suitable underpasses. The proposed upgrade would improve connectivity for larger fauna species including the Koala with suitable underpasses including a large bridge structure and fauna fencing to guide fauna species into the dedicated underpasses. No evidence of the Koala was observed in the study area or in the larger patches of Ribbon Gum dominated woodland in the Hartley Valley area) despite targeted searches for scats. Nevertheless the RMS has submitted a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts on any potential Koala population within the study area.	Moderate

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Spotted-tail Quoll (*Dasyurus maculatus*)	E	V	Removal of approximately 7.39 hectares of potential foraging habitat with some potential sheltering and denning opportunities. There is a high potential for the Spotted-tail Quoll to forage in habitats within and surrounding the proposal footprint. Potential shelter sites are also present including large fallen hollow tree trunks and rocky outcrops/boulders which may be relocated within the road corridor to accommodate the proposal. There are 15 records for the Spotted-tail Quoll in the locality (OEH 2012). The Spotted-tailed Quoll is a cryptic species that occurs in a variety of habitats including rainforests, open woodlands, coastal heath and inland riparian forests. The species is known to den in hollow logs, caves and rocky ledges. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. They usually traverse their ranges along densely vegetated creek lines and edges of cleared farmland. Likely impacts include permanent loss, fragmentation and degradation of habitat, and increased risk of road kill. The proposal would remove only a very small portion of potential habitat for this species compared to the extent of available habitat in the locality. The quality of the habitat increases with increasing distance from the existing road, including higher quality habitat structure, feeding resources and potential denning habitat. The habitat along the road edge is unlikely to be critical for this species and the provision of a fauna underpass structure would in fact improve the current connectivity. Neverthless the RMS has submitted a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts to the Spotted-tail Quoll within the study area.	High

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Yellow-bellied Glider (*Petaurus australis*)	-	V	Removal of approximately 7.39 hectares of potential foraging habitat with some potential sheltering opportunities. This species potentially occupies forested habitats in the Forty Bends area, although none were detected during targeted surveys. There is a single record for the Yellow-bellied Glider in the locality at Clarence (OEH 2012) approximately 8.5 kilometres from the study area. The Yellow-bellied Glider occurs in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. They feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. There is potential habitat on the northern side of the highway only in this location, although it is considered likely that only marginal populations exist. Potential impacts may include permanent loss of hollow-bearing trees containing small to medium sized hollows and loss of feed trees if available however impacts on movements and dispersal are not expected. No sap feeding trees as determined by presence of feeding scars were noted.	Moderate
Cave-dwelling Microbats				
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	Removal of potential foraging habitat including about 7.39 hectares of forest, 8.25 hectares of modified habitats including paddock areas, roadside verges and farm dams. Roost sites are limited in and surrounding the proposal footprint to larger rock outcrops and existing culverts. Better quality cave habitats for roosting and nesting are present to the north and east of the proposal footprint in the escarpment area at Hassans Walls. There are four records of both Eastern Bent-wing Bat and Southern Myotis in the locality (OEH 2012) with the closest record approximately 5.5 kilometres from the study area. These bats inhabit a range of habitats from tropical mixed woodland and wet sclerophyll forest, and *Melaleuca* swamps to drier forests, and woodlands. All roost in domes in the roofs of caves as well as in cracks and crevices, and in mines. Some also roost in culverts and under bridges and occasionally tree hollows.	Recorded
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V		High
Southern Myotis (*Myotis macropus*)	-	V		Moderate

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
			Clearing of foraging habitats and loss of roosting areas is a threat. The likely impact of the proposal would include disturbance to foraging habitat only, some of which will be reinstated through the proposed landscaping activities. There are no caves or potential roosting locations within the actual proposal footprint. The disturbance would be temporary only, and long-term impacts on prey availability of movements are not expected.	
Tree-dwelling Microbats				
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	Removal of potential foraging habitat including about 7.4 hectares of forest, and disturbance to 8.25 hectares of modified habitats including paddock areas, roadside verges and farm dams. Eastern False Pipistrelle was recorded in the proposal footprint in areas of dry open forest. There are 1 to 2 records of each of these species in the locality (OEH 2012). These bats occupy a wide range of habitats from rainforest, floodplains, tall open forest, savannah woodlands and grasslands. Some exhibit preferences for riparian zones, others are known to frequent coastal scrub and sand dunes. However, all rely on the presence of mature trees with hollows, or other fissures, cracks and crevices in living or dead vegetation for roosting. Clearing of roosting and foraging habitats is a threat. Likely impacts from the proposal include permanent loss of a small area of habitat containing potential roost trees and temporary disturbance to foraging habitat and habitat for insect prey species in the study area, potentially leading to a short- term reduction in habitat and feeding resources across the study area for these species.	Recorded
Eastern Freetail-bat (*Mormopterus norfolkensis*)	-	V		High
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V		High
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	-	V		High

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
BIRDS				
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	-	V	Removal of approximately 7.39 hectares of foraging habitat of which only a small proportion (approximately 1 hectare) supports suitable feed tree species. Tree hollows potentially suitable as nesting habitat are present. There is a single record for this species in the locality (OEH 2012) approximately 8.5 kilometres from the study area.	High
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	-	V	Removal of approximately 7.39 hectares of potential foraging habitat with tree hollows potentially suitable as nesting habitat. The species prefers mature, old growth forest for nesting. There eight records of this species in the locality (OEH 2012) including recent sightings as part of the corridor studies approximately 2 kilometres from the study area.	Recorded
Regent Honeyeater (*Anthochaera phrygia*)	EM	CE	There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. The species is an occasional visitor to the region during peak flowering events of the dominant trees, particularly winter flowering species. There are no resident populations known from the actual proposal site or immediately surrounding lands and the habitat on site would constitute a small percentage of the available non-breeding habitat for transient populations. The current potential for this species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be impacted suggesting that the proposal would not lead to a long-term decrease in the size of regional populations. Nothwithstanding the RMS has submitted a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts to the Regent Honey Eater within the study area.	Moderate

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Swift Parrot (*Lathamus discolour*)	EM	E	The Swift Parrot migrates to mainland Australia from Tasmania in winter and is an occasional visitor to the region during peak flowering events of the dominant trees, particularly winter flowering eucalypt species. There are no resident populations known from the actual proposal site or immediately surrounding lands and the habitat on site would constitute a small percentage of the available non-breeding foraging habitat for a small portion of the known population. The current potential for this species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be impacted suggesting that the proposal would not lead to a long-term decrease in the size of the known population. Notwithstanding, the RMS has submitted a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts to the Swift Parrot within the study area.	Moderate
Little Lorikeet (*Glossopsitta pusilla*)	-	V	The Little Lorikeet is occupies a diversity of forest and woodland habitats, including old-growth and logged forests, and remnant woodland patches and roadside vegetation. The species is generally considered to be nomadic, with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability (DECC 2008). However, they do exhibit some site fidelity, with breeding pairs resident from April to December, and even during their non-resident period some individuals will return to the nest area for short periods if there is some tree-flowering in the vicinity. No individuals were reported during the survey on the site, however could potentially visit on occasion. They feed in small flocks, often with other species of lorikeet, primarily on nectar and pollen in the tree canopy. They prefer profusely flowering eucalypts but will also feed in other species such as melaleucas and mistletoes. The species breeds in tree hollows in living trees (DECC 2008). Major threats to the Little Lorikeet are loss of breeding sites and food resources from	Moderate

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
			ongoing land clearing. The study area would constitute potential breeding and non-breeding habitat for the little lorikeet. The loss of hollow-bearing and feed trees would directly affect the species opportunity to feed and breed in the area. However the study area is not considered a critical breeding area for the little lorikeet as extensive areas of suitable habitat occur elsewhere in the region. The current potential for the species to occur based on the presence of potential foraging and breeding habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be impacted.	
Large Forest Owls				
Barking Owl (*Ninox connivens*)	-	V	Removal of approximately 7.39 hectares of habitat which may be used for hunting and roosting. A Powerful Owl was recorded to the south of the upgrade approximately 2-3 kilometres from the upgrade and a Barking Owl was tentatively recorded near Jenolan Caves Road, also 2-3 kilometres south east of the upgrade. Both species could potential utilise habitat along the road edge for hunting prey but are unlikely to roost or nest in these locations. Several potential prey species were recorded in the study area (Possums, Gliders) and Powerful Owls are likely to forage in the forested habitats in the proposal footprint. There are four records for this species in the locality (OEH 2012). Large forest owls are threatened by loss of habitat for prey species in particular large tree hollows which provide potential roost and nest locations. Large tree hollows potentially suitable as nesting sites were not identified from the survey of the upgrade area. The small area of habitat removal associated with the upgrade is considered unlikely to be a significant loss for these species in terms of reducing habitat for prey and significant reduction in potential nest hollows.	High
Masked Owl (*Tyto novaehollandiae*)	-	V		High
Powerful Owl (*Ninox strenua*)	-	V		Recorded

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Woodland Birds				
Black-chinned Honeyeater (*Melithreptus g. gularis*)	-	V	Removal of approximately 7.39 hectares of foraging habitat including potential nesting opportunities. Typically woodland bird species that favour open understorey but also known from open forests with sparse understorey and scattered shrubs as is present on the northern side of the upgrade. For Varied Sittella, feeding territories and movements are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 ha. The species is susceptible to clearing of remnant open forest and woodland habitats. The proposal would involve the clearing of around 7.39 hectares of open forest habitats however this is a very small percentage of the area of available habitat for these species. Brown Treecreepers are hollow-dependent, and sedentary. The species also has preferred foraging sites rather than randomly foraging throughout their range. The species was not recorded in the study area despite targeted surveys and the habitat is only considered marginal. The habitat to be removed is not expected to present critical or important habitat for local populations and the current potential to occur in the study area is considered to remain post-construction.	Moderate
Brown Treecreeper (*Climacteris picumnus victoriae*)	-	V		Moderate
Varied Sittella (*Daphoenositta chrysoptera*)	-	E		High
REPTILES				
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V	Found in heath, open forest and woodland, and associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Termite mounds were found to be in very low density along the preferred corridor. Removal of approximately 7.39 hectares of potential habitat. Not recorded in the locality (OEH 2012).	Moderate

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
INVERTEBRATES				
Purple Copper Butterfly (*Paralucia spinifera*)	V	E	There would be impacts to potential habitat for Purple Copper Butterfly, however all known active locations (Occupied Habitat) would be avoided. Potential habitat has been identified as Occupied Habitat, High Potential Habitat and Potential Habitat (refer to Section 3.6.5 and Figure 3.5). Potential impacts to habitat comprises: ▪ 0 hectares of Occupied Habitat ▪ 2.01 hectares of High Potential Habitat ▪ 4.62 hectares of Potential Habitat There are 37 records for this species in the locality (OEH 2012). The proposal has been designed to avoid areas of occupied habitat and minimise impacts to areas of potential habitat in particular areas of high potential habitat. Retaining these areas of potential habitat where possible will reduce the capacity for lost habitat to limit the species potential to disperse or colonise un-utilised habitats. To this effect the final design has minimised the footprint of the proposed works. Suitable habitat for the species does not only consist of the presence of Blackthorn (*Bursaria spinosa* subsp. lasiophylla), habitat has a range of components, including an attendant ant species which tends to larvae, and suitable conditions with regard to incident sunlight and structural characteristics of the vegetation (both canopy and groundcover). Blackthorn plants which will be removed by the proposal are considered to be of moderate importance locally, and could potentially support populations under changed or more optimal habitat conditions (for example after a fire).	High - recorded

Species	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
			However while having high value as potential habitat, the importance of these areas to the species, given the wide occurrence of the host plant (Blackthorn) locally, non-use in 2011, and a tendency for the species to be dependent on often small and discrete habitat areas, potential habitat which will be lost is not considered to be likely to be significant for the long term survival of the species at this locality. Notwithstanding, the RMS will submit a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts on the Purple Copper Butterfly within the study area.	

5. Proposed Mitigation Measures

The proposed mitigation measures specified below are consistent with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).

5.1. Avoid and minimise

The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to specific threatened species and ecological communities present in the study area. Specific avoidance and minimisation measures associated with the proposed upgrade design, comprise:

- Avoidance of identified areas of habitat currently occupied by the Purple Copper Butterfly.
- Minimise impacts to areas of high quality habitat for Purple Copper Butterfly where possible.
- Minimise vegetation/habitat clearing where possible to minimise impacts to numerous threatened fauna species which potentially utilise these habitats.
- Minimise impacts to the threatened ecological community through appropriate road design to avoid this area.

5.2. Detailed design

The concept design has been developed to minimise vegetation clearing where possible and minimise potential impacts to specific threatened species and ecological communities present in the study area. However several details need to be refined during detailed design, including but limited to:

- The design and locations of fauna underpasses, glider poles and rope bridges, including details on habitat augmentation, appropriate landscaping and location and extent of fencing.
- Landscaping of Whites Creek including embankment treatments.
- Detailed tree surveys that will inform which mature trees may be retained within the subject site.

5.3. Vegetation and habitat removal

5.3.1. Pre-clearing

The pre-clearing process would involve the development of a Contractor Environmental Management Plan (CEMP). This would include pre-clearing field surveys to confirm the appropriate management measures to minimise impacts to biodiversity. The results of the pre-clearing surveys would feed into the management measures specified in the CEMP. The following items need to be adequately addressed by the CEMP and the pre-clearing surveys:

- Pre-clearing surveys would be undertaken by an experienced ecologist to identify the location and extent of important habitats in the construction footprint to be salvaged for reuse/relocation, such as bushrock, hollow trees and woody debris.
- Prior to clearing thorough surveys would be conducted for Purple Copper Butterfly during the adult flying and juvenile larval seasons (September and October-November, respectively). Appropriate management and protection/mitigation measures should be implemented if the species is present in or directly adjacent to the proposal footprint including a translocation strategy if deemed necessary.
- Identify and mark habitat features to be protected during construction.
- Check for the presence of threatened flora and fauna species on a site immediately before clearing begins.
- Provide input into the location and extent of exclusion zones (refer to Section 5.3.2).
- Identify nearby habitats on both sides of the existing highway along the length of the proposal suitable for the release of fauna that may be encountered during the pre-clearing process or habitat removal (refer to Section 5.3.4).
- Develop planning and procedures for the staged habitat removal process (refer to Section 5.3.3).
- Ensure that the location of any threatened flora and/or fauna species, threatened ecological communities and habitat are mapped and identified in the CEMP.
- Develop an unexpected threatened species finds procedure to be included in the CEMP as outlined in the RMS Biodiversity Guidelines (RTA 2011).
- Determine any additional management measures that may need to be incorporated into the CEMP.
- No parking of vehicles and/or machinery and storage of equipment and resources under the dripline of any trees (incorporate into CEMP).
- For further details regarding the pre-clearing process and the scope of the CEMP with regards to biodiversity protection refer to the RMS Biodiversity Guidelines (RTA 2011).

5.3.2. Exclusion zones

The location of exclusion zones would be determined and established to avoid damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Basic temporary fencing would be installed to indicate the limits of clearing. Permanent fauna exclusion fencing for some areas of the proposal where practical should be installed prior to clearing to function as exclusion fencing.

The location and type of exclusion fencing to be installed would be identified on plans in the CEMP and the function and importance of the exclusion zones communicated to construction personnel. For further information regarding the establishment of exclusion zones refer to the RMS Biodiversity Guidelines – Guide 2 Exclusion Zones (RTA 2011).

5.3.3. Staged habitat removal

A staged habitat removal process would be implemented consistent with the procedures identified in the RMS Biodiversity Guidelines (RTA 2011). The staged habitat removal process would be incorporated into the CEMP and communicated to construction personnel. The staged habitat removal procedure is summarised in Table 5-1.

5.3.4. Minimising fauna injury and mortality

To prevent injury and mortality of fauna during the clearing of vegetation and drainage of farm dams an experienced and licensed wildlife carer and/or ecologist would be present to supervise vegetation clearing and capture and relocate fauna where required. Further details regarding fauna handling and vegetation clearing procedures are provided in the RMS Biodiversity Guidelines (RTA 2011). The following would be implemented to avoid injury and mortality of fauna:

- Allow fauna to leave an area without intervention as much as possible.
- In circumstances where the handling of fauna is completely unavoidable, best practice methods need to be followed as outlined in the RMS Biodiversity Guidelines – Guide 9 Fauna Handling (RTA 2011).
- Include the procedures in project inductions for construction staff to implement if fauna is found or injured on site and also the importance of not feeding any wildlife that may be encountered on construction sites.
- Never deliberately kill a snake as all snakes are protected under the NSW *National Parks and Wildlife Act 1974*.
- Keep records of fauna captured and relocated.
- Report any injury to or death of a threatened species to the RMS environmental staff.

Table 5-1 Staged habitat removal process (adapted from RTA 2011)

Stage	Details
1. Contact vet and/or wildlife carers	Vet and/or wildlife carers need to be contacted prior to construction commencing to ensure they are willing to assist in treating injured animals if necessary. Their contact details would included in the CEMP, be given to the site manager and clearly displayed in the site office.
2. An experienced and licensed wildlife carer and/or ecologist would be present	An experienced and licensed wildlife carer and/or ecologist should be present on site during all habitat removal activities to capture and relocate fauna that may be encountered (refer to Section 5.3.4).
3. Remove non-habitat vegetation first	Progressive habitat removal would take place around habitat identified and marked during the pre-clearing process. Remove non-hollow-bearing trees, undergrowth, feed-trees, regrowth and grass. Do not fell trees towards exclusion zones.
4. Leave habitat for a minimum of 24 hours	Identified habitat (e.g. hollow-bearing trees) would be left for at least 24 hours after removing non-habitat vegetation to allow fauna to escape. A licensed wildlife carer and/or ecologist would check hollow-bearing trees are not being used by fauna before felling. If necessary, fauna may need to be trapped and relocated to pre-determined habitat identified for fauna release (refer to Section 5.3.1).
5. Remove habitat	Fell habitat trees as carefully as possible to avoid injury to any fauna still remaining in trees. Use equipment that would allow the habitat trees to be lowered to the ground with minimal impact (e.g. claw extension). Do not fell trees towards exclusion zones.
6. Inspect habitat	An experienced and licensed wildlife carer and/or ecologist would inspect habitat once it is removed e.g. after a tree is felled). Animals that emerge would be captured, inspected for injury then relocated to pre-determined habitat identified for fauna release.
7. Relocate habitat	All hollows have the potential to support fauna and would be placed in adjacent habitat until the following day for further inspection by a licensed wildlife carer and/or ecologist to verify no fauna is present. If possible, the hollows would be permanently relocated in adjacent areas in accordance with the RMS Biodiversity Guidelines (RTA 2011). Inspect woody debris for fauna immediately before chipping to avoid injury or death to fauna that may be present.
8. Reporting	The construction project manager and/or environment manager would ensure that the outcomes of the clearing process are recorded. Reporting is usually the responsibility of an ecologist or environment officer. Reports are to be submitted to relevant personnel (e.g. environment manager or RMS regional environment staff).

5.4. Weed management

A weed management plan would be developed as part of the CEMP, the RMS Biodiversity Guidelines (RTA 2011) and the Introductory Weed Management Manual (Natural Heritage Trust 2004) provide guidance for developing weed management plans. As part of the weed management plan a site assessment by an ecologist or person trained in weed identification and management would be required to assess the extent and severity of weed species in the construction footprint with particular emphasis on noxious weed species.

The weed management plan would include descriptions and mapping of major weed infestations during pre-clearing surveys and appropriate management actions to be undertaken for each infestation. The details of the weed management plan would vary for each site but should include:

- Taxa and potential sources of the weed species.
- Weed management priorities and objectives.
- Sensitive environmental areas within or adjacent to the site.
- Location of weed infested areas.
- Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance.
- Measures to prevent the spread of weeds.
- A monitoring program to measure the success of weed management.
- Strategic management with adjacent landowners.
- Appropriate disposal of weed infested materials and soils to be identified in the CEMP.
- Communication strategies to improve contractor awareness of weeds and weed management.

5.5. Pest and disease management

No pests and diseases are known from the proposal footprint but could potentially be present. There have been reports of Myrtle Rust spreading from the coast to more western districts. Measures to prevent the introduction and/or spread of pests and disease causing agents such as bacteria and fungi need to be incorporated into the CEMP for the proposal. A background search of government-maintained websites for the most up-to-date hygiene protocols for each pathogen and for the most recent known locations of contamination should be undertaken prior to construction.

Advice from government departments regarding the most practical hygiene management measures would be required if pathogens are found to be present. Testing from a National

Association of Testing Authorities (NATA) approved laboratory may be required to confirm the presence of pathogens in the soil and/or water. If pathogens are identified exclusion zones with fencing and signage to restrict access into contaminated areas would be required.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include:

- Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site.
- The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks.
- Construction works would be programmed to move from uninfected areas to any known infected areas.
- Restrict vehicles to designated tracks, trails and parking areas.
- The above pathogen management measures need to be implemented throughout the entire construction period.

5.6. Habitat re-establishment

5.6.1. Re-establishment of native vegetation

A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. This would include details for the appropriate restoration of Whites Creek. The landscape management plan would need to consider a range of constraints and opportunities associated with the proposed upgrade including collection and propagation of local seed, salvage and reuse of topsoil, leaf litter and woody debris, threatened species habitat, wildlife connectivity zones, cold air drainage, black ice formation and local vegetation community composition.

There is potential for the proposed landscaping to be designed to provide suitable habitat for Purple Copper Butterfly, by incorporating the larvae-feed species Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*), and creating and maintaining open sunny habitats. This section of the Great Western Highway has been identified as being a high risk area for the formation of black ice on the road surface, creating dangerous driving conditions. Proposed mitigation measures to limit the potential for black ice formation include design features to redirect cold air drainage and minimising shading from trees. Therefore it is proposed that no trees be included in the landscaping on the northern side of the proposal to minimise shading which would potentially have a positive impact on the quality of habitat created for Purple Copper Butterfly.

Detailed guidelines for the re-establishment of native vegetation on road projects are provided in the RMS Biodiversity Guidelines – Guide 3 (RTA 2011) and supporting documentation, and includes the following:

- Ecologists and landscape architects would work together on the preparation of the landscape management plan that clearly identify the locations and composition of revegetation activities.
- Allocate sufficient time for the collection of local seed and propagation of tube stock to be used in revegetation, in particular local provenance seed of the high-altitude subspecies of Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*) to function as habitat for Purple Copper Butterfly.
- Collect local native topsoil and leaf litter which is free of invasive weed species and store for use in revegetation works.
- Allow sufficient time to prepare the ground for revegetation.
- Soils in areas to be revegetated should match surrounding soil conditions as closely as possible unless adjacent areas are weedy or contaminated.
- Ensure areas to be revegetated have an appropriate level of natural drainage.
- Avoid compaction of soils in areas identified for revegetation and where compaction has occurred, the soil should be loosened.
- When planting consider seasonal risks of frost, drought, flooding and sun exposure to avoid damaging plants and to encourage growth.
- Adhere to relevant specifications and guidelines including but not limited to the RTA Landscape Planting QA Specification R179, RTA Seed Collection QA Specification R176, the Florabank Guidelines, Model Code of Practice and Construction Quality Technical Direction 007, Quality Alert 7 – Hydro-seeding, hydro-mulching and other slope stabilisation methods.
- Inspection, monitoring and maintenance of revegetated areas should be conducted biannually for a minimum of two years following the completion of construction in accordance with the landscape management plan. Outline the roles and responsibilities in landscape management and revegetation plans including the schedule for monitoring and maintenance activities.

5.6.2. Re-use of woody debris and bushrock

Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas. Guidelines for the re-use of woody debris and bushrock are provided in the RMS Biodiversity Guidelines (RTA 2011), and require:

- Implementing the removal, stockpiling, transportation and relocation of woody debris and/or bushrock in a manner that minimises disturbance to native vegetation or bushrock.
- Engaging an ecologist in the pre-clearing phase of the proposal to provide advice on the re-use of woody debris and bushrock including potential negative impacts and positioning of woody debris and bushrock at the relocation areas.
- When relocating woody debris, placing it evenly across the site whilst keeping topsoil disturbance to a minimum.
- Avoiding the spread of any weeds or pathogens that may be in the soil when relocating woody debris and bushrock from stockpiles.
- Mulching would include only native vegetation and separate stockpiles need to be established for weedy vegetation and the native vegetation to be mulched. Manage stockpiles in accordance with RMS's Stockpile Site Management Guideline, RMS Environmental Protection (Management System) QA Specification G36 and RMS Vegetation QA Specification R178.
- Preparing a mulch tannin management plan for the proposal where tannins are likely to be generated.

5.6.3. Nest boxes

As there would be removal and loss of hollow-bearing trees from the proposal, it is proposed that nest boxes be installed to compensate for this loss. Guidance regarding the dimensions of nest boxes, installation and maintenance are provided in the RMS Biodiversity Guidelines – Guide 8 Nest Boxes (RTA 2011).

A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. The nest box strategy would require the installation of 70% of nest boxes prior to the removal of any vegetation.

5.7. Wildlife connectivity

The proposed upgrade includes a combination of wildlife crossing structures, which would include two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass.

These measures would improve wildlife connectivity allowing a greater diversity of fauna species to pass beneath the highway and overpasses (canopy bridges and glider poles) would provide additional connectivity, avoiding injuries and mortalities. The design principles for the proposed wildlife connectivity mitigation measures are detailed in Table 5-2. The proposed locations of wildlife connectivity mitigation measures are shown in Figure 5-1, however the design and location of these will potentially change during detailed design.

Table 5-2 Design principles for the proposed wildlife connectivity mitigation measures

Structure	Details
Bridge structure over Whites Creek	▪ The bridge would be designed with a natural substrate at the abutment, such as dirt or vegetation, where possible, with refuge areas (scattered rocks, logs) and landscaping of the habitat corridor approaches. ▪ Where possible, the design would avoid placing piers in water channels and on stream banks, to minimise alteration to water flow and/or damage to stream bank vegetation. ▪ The bridges would be designed to allow unimpeded water flow, stream bank and riparian vegetation, preferably on both sides of the water course. ▪ Large woody debris is to be retained within watercourses and/or re-use of salvaged woody debris, where possible. ▪ Large rocks salvaged during construction would be used for scour protection as well as functioning as habitat for retiles/amphibians. ▪ Bridges would be designed (height, carriageway separation) to allow maximum light and moisture penetration to encourage growth of vegetation under the structures. ▪ Construction activities should not impede the creek, leaving at least a one metre buffer where possible. The area of the piling pad and temporary crossings should be minimised as much as possible. ▪ A canopy bridge and gliding pole structure would be established beneath the bridge. A minimum of 1 metre clearance should be provided between the rope and the bottom of the bridge to reduce disturbance from traffic noise and vibration.

Structure	Details
	▪ Conduct a tree survey within the proposal footprint areas and avoid removal of existing trees where possible, in particular those located in close proximity to the bridge as these are considered important for maintaining effective passage for gliders. ▪ The canopy bridge must be linked to adjacent habitat for the target species (i.e. habitat trees) via ropes or ladders tied off from the poles into surrounding trees. Nearby trees are essential to link the canopy bridge into the surrounding vegetation and are to be identified from the site tree survey.
Underpass structures	▪ Provide connectivity for fauna at least every 500 metres in areas of fauna habitat, where reasonable and feasible. ▪ Plan for maximum culvert size in identified wildlife corridor locations. This is dependent on available fill heights and the sensitivity of additional areas of vegetation/habitat that may be impacted. **Dedicated underpasses** ▪ As a minimum design principle, all dedicated underpasses would be designed to a minimum of 2.4 x 2.4 metres where fill heights will allow, taking into consideration the presence of sensitive vegetation. ▪ Maximum openness is to be provided where the length of the fauna underpasses is greater than 50 metres. In order to achieve a maximum length of 50 metres for fauna underpasses, the structure should be placed higher in the fill, where fill heights allow. ▪ Fauna underpasses to have a natural substrate, such as dirt or mulch. Sandy loam is preferable to prevent the generation of a mud substrate. ▪ Provide a mix of shelter and/or openness within culvert, specific to the target species, including larger species such as kangaroos and wallabies are likely to prefer more open structures, while small mammals require shelter to encourage use of culvert and reduce the risk of predation. ▪ In order to achieve dry passage in dedicated underpasses they should be located above flow lines, gullies and depressions ▪ Relocation or adjustment of the stream bed is to be avoided where possible. ▪ The minimum size for fauna underpasses is to be typically 1.2 metres diameter. **Furniture** ▪ Fauna furniture is to be incorporated into dedicated structure design and around the entrance, but scattered only and with an adequate setback to prevent any obstruction ▪ Provide a dry ledge or similar within dedicated underpasses to maintain dry passage.

Structure	Details
	▪ Place horizontal logs for passage as high above the base of the opening as practical, allowing 0.6 metre ceiling clearance for fauna passage. ▪ Vertical logs are secured to the invert of the concrete base slab and soffit of the culvert ceilings by attachment brackets. ▪ Interconnecting logs can provide a dry passage for Koalas whilst also providing refuge from predators. ▪ Outside and within the culvert: refuge poles (three metres tall and 200 mm diameter) are effective where introduced predators are likely to attack Koalas. It is important to ensure that the poles are located at least three metres away from Koala exclusion fencing.
Canopy Bridges	A canopy bridge is a rope or pole suspended above the traffic, either from vertical poles or from trees to provide canopy connectivity. This structure is used by arboreal and scansorial (climbing) species. ▪ Dimensions: Minimum 7 metres above the ground for sufficient height above traffic and traffic noise. Generally the greater the distance between the canopy bridge and traffic the more effective the structure. ▪ The canopy bridge is to be attached to suitable poles located at a safe distance from the road edge. The exact location of the poles is to be determined at the design stage. ▪ If support poles are used in the median metal guards should be used to prevent animals descending support poles to the ground in median strips. ▪ Canopy bridges must be linked to adjacent habitat for target species e.g. (habitat trees) via ropes or ladders tied off from the poles into surrounding trees. Nearby trees are essential to link the canopy bridge into the surrounding vegetation. ▪ Consider potential conflict with adjacent powerlines and other service infrastructure. ▪ Comply with safety requirements when structural supports are placed in the road median or road edge. These may need safety barrier or guardrail protection. ▪ Research indicates rope ladder design preferred over rope tunnel or single rope as this attracts more species than other types of canopy bridge structures.

Structure	Details
Glider Poles	▪ Types of construction: standard electricity pole (untreated timber preferable), or tree salvaged from site, steel cables suspended between poles and rope ladder attached to steel cables. ▪ Consider potential conflict with adjacent powerlines and other infrastructure. ▪ Dimensions: The height of the glider pole and cross beam is related to the length of the glide required to traverse the road (refer to Goldingay and Taylor 2009; and Goldingay et al 2011). Consider height of poles, height of crossbars and distance between poles. ▪ To minimise avian predation and provide greater protection, additional predator shields and pipes should be installed to discourage avian predators and provide shelter. Designs may include one or more cross bars, shelter pipes, and predator shields. ▪ Glider poles and landing points must be close enough together and high enough that glide trajectory does not intersect traffic or the ground. Research on sugar, mahogany and squirrel gliders shows an average glide angle is 30.5º with a one metre loss in height for every 1-2 metres in glide length. Use trigonometry to determine the specific requirements at each site. ▪ Height of structure is dependent on the length required to glide, using conservative estimates of glide capability. Use trigonometry to determine required height of pole/tree, assuming animals launch from the outer branches about ¾ the height of the tree. The glide trajectory must easily clear the traffic (i.e. at least 2 m above truck height) and any roadside fencing, with projected landings above the ground by 1 or 2 m), although parallel designs have been successful. ▪ Trees beside roads that create a tree-gap of 20 metres (two-lane road) or 43 m (four-lane road) will need to be at least 13 m and 25 m tall, respectively to enable animals to safely glide across the road. ▪ Habitat trees for gliders should be within gliding distance of poles in both directions. ▪ Additional poles may be required to enable link to habitat. ▪ Gliders are likely to prefer natural trees therefore revegetation is desirable around structures so that over time (e.g. 20–40 years), trees can replace artificial structures. Existing trees should be retained in the road verge or median wherever possible. ▪ Avoid ‘one-way’ crossings. Where poles may be high enough to glide from one side to the other, but not back. This occurs where poles or vegetation is shorter/lower on the landing side and therefore not high enough to facilitate the return glide. ▪ Safety barriers are required around poles if they are located close to the road.

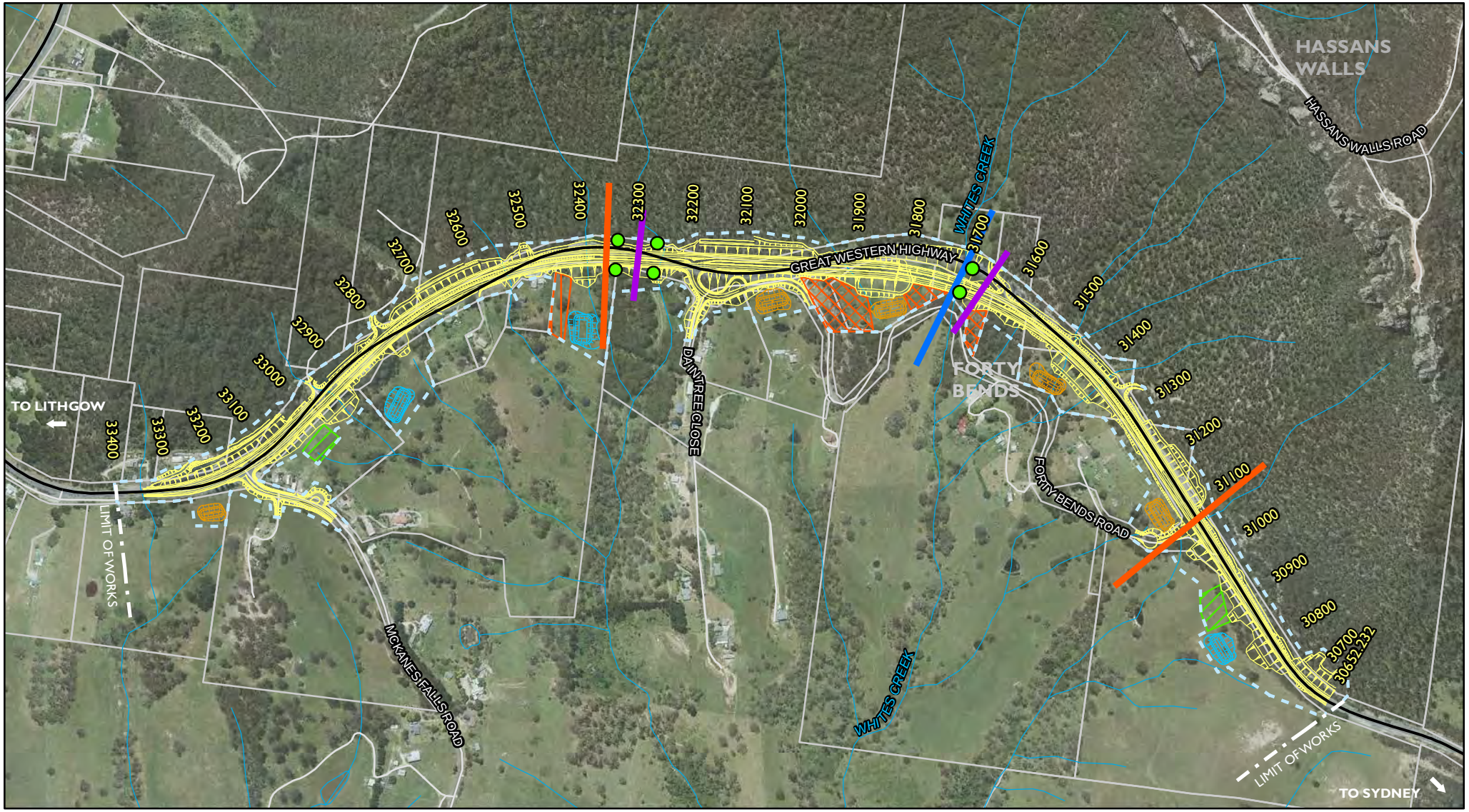
Structure	Details
Fauna Fencing	▪ Fauna fencing must be integrated with crossing structures by guiding animals towards the crossing structure and preventing access to the road. ▪ Fencing is typically constructed on both sides of the road; otherwise animals are easily trapped on the road. ▪ Fencing is to extend at least 100 metres either side of the structure, although this is dependent on topography and vegetation. Steep batters in cuttings may be used as natural barrier. ▪ Fencing should be continuous and at their ends have a 'return area' to guide animals back into habitat rather than onto the road. ▪ Fence height must prevent animals from jumping over (e.g. at least 1.8 m for kangaroos). ▪ The size of the mesh must prevent the target species from climbing through. A fence with large mesh for large animals can include fine mesh at the base to prevent small species from climbing through. ▪ The fence must prevent animals from digging underneath. Construct metal flaps at the base of fencing where the fence crosses drainage lines to ensure fauna cannot pass under the fence at these points. ▪ Fencing may need a floppy-top or overhang to prevent animals from climbing over. Koala fences need a floppy top. ▪ Fauna fencing must not endanger wildlife (e.g. barbed wire must not be used as birds, bats and gliders become entangled and die). ▪ Barbed wire is to be avoided on stock fencing near crossing zones, particularly near glider crossing points or alternatively cover the wire with poly pipe. ▪ Escape mechanisms must be provided to allow animals to exit the road corridor. Large tree stumps, built earthen berms or escape poles on the roadside of exclusion fencing can be utilised to allow fauna to escape the road corridor. **Maintenance** ▪ Fencing would require regular inspection and maintenance. A vehicle access track adjacent to the fence would facilitate rapid inspection and repair. Where overgrown vegetation that breaches the fence is likely, the vehicle track would also permit maintenance of vegetation. ▪ Maintenance of fencing is critical to identify and repair breaches, periodic inspections are likely to be required.

Structure	Details
Vegetation / Landscaping	▪ Riparian corridors to be protected during construction works and any areas of riparian vegetation impacted by construction are to be rehabilitated. ▪ Revegetation actions around crossing structures should consider the height and density of vegetation so as not to screen the structure from view, but also aim to provide some cover for fauna approaching and exiting the structure. ▪ It is important for landscaping at entrances not to obscure and shadow the window of the entrances, to allow maximum light penetration and provide a clear line of sight for fauna entering the structure. ▪ Landscaping should use locally indigenous species and should target key fauna food resources to encourage usage either side of the structure and thus provide the habitat linkage to the structure.

The proposed wildlife connectivity measures as specified in Table 5-2 would be implemented at specific locations as specified in Figure 5-1, in particular the provision of underpasses and overpass structures, however the design and location of these will potentially change during detailed design.

5.8. Biodiversity offset strategy

A biodiversity offset strategy would be developed to compensate for the proposed impacts from the upgrade. One potential offset location has been identified at South Bowenfels currently owned by RMS which supports a population of Purple Copper Butterfly. Further assessment and negotiation would be required to establish an appropriate biodiversity offset.



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Transport Roads & Maritime Services
NSW GOVERNMENT

Figure 5-1 Wildlife connectivity

Mt Victoria to Lithgow: Great Western Highway Forty Bends upgrade

LEGEND

- 31800 Chainage
- Proposal
- Proposal site
- Existing highway
- Local roads
- Waterways
- Glider poles (indicative locations)

Connectivity Zones - structure

- Bridge underpass
- Canopy bridges (indicative locations)
- Large culvert Underpass (2x2m or 3x3m)
- Permanent drainage basins
- Temporary drainage basins

Compound site and stockpile locations

- Potential compound
- Potential stockpile
- Potential stockpile and compound

GDA 94 | MGA 56

0 200
Metres

Aerial Photograph:AUSIMAGE/SKM 2011

6. Significance Assessments

The significance assessments are summarised in Table 6-1 for state-listed species and Table 6-2 for federally listed species and the full assessments are provided in Appendix F. The results of the significance assessments confirmed that there will be no significant impacts to any threatened species, populations or ecological communities and therefore there is no requirement for a Species Impact Statement.

Table 6-1 Assessments of significance summary (TSC Act)

Species/Ecological Community	*Assessment of significance questions (TSC Act) [1]							Likely Significant Impact	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	a	b	c	d	e	f	g			
THREATENED ECOLOGICAL COMMUNITIES										
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions	X	X	N	N	X	X	Y	No	Recorded	n/a
MAMMALS										
Grey-headed Flying-fox (*Pteropus poliocephalus*)	N	X	X	Y	X	Y	Y	No	Moderate	0
Koala (*Phascolarctos cinereus*)	N	X	X	Y	X	Y	Y	No	Moderate	3
Spotted-tail Quoll (*Dasyurus maculatus*)	N	X	X	Y	X	X	Y	No	High	15

Species/Ecological Community	*Assessment of significance questions (TSC Act) [1]							Likely Significant Impact	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	a	b	c	d	e	f	g			
Yellow-bellied Glider (*Petaurus australis*)	N	X	X	Y	X	Y	Y	No	Moderate	1
Cave-dwelling Microbats										
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	N	X	X	Y	X	X	Y	No	Recorded in locality	4
Large-eared Pied Bat (*Chalinolobus dwyeri*)	N	X	X	Y	X	X	Y	No	High	0
Southern Myotis (*Myotis macropus*)	N	X	X	Y	X	X	Y	No	High	4
Tree-dwelling Microbats										
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	N	X	X	Y	X	X	Y	No	Recorded	2
Eastern Freetail-bat (*Mormopterus norfolkensis*)	N	X	X	Y	X	X	Y	No	High	1
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	N	X	X	Y	X	X	Y	No	High	2
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	N	X	X	Y	X	X	Y	No	High	1

Species/Ecological Community	*Assessment of significance questions (TSC Act) [1]							Likely Significant Impact	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	a	b	c	d	e	f	g			
BIRDS										
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	N	X	X	Y	X	X	Y	No	High	1
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	N	X	X	Y	X	X	Y	No	Recorded in locality	8
Little Lorikeet ((*Glossopsitta pusilla*)	N	X	X	Y	X	X	Y	No	Moderate	1
Swift Parrot (*Lathamus discolour*)	N	X	X	Y	X	X	Y	No	Moderate	0
Regent Honeyeater (*Anthochaera phrygia*)	N	X	X	Y	X	X	Y	No	Moderate	0
Large Forest Owls										
Barking Owl (*Ninox connivens*)	N	X	X	Y	X	X	Y	No	Recorded in locality	0
Masked Owl (*Tyto novaehollandiae*)	N	X	X	Y	X	X	Y	No	High	0

Species/Ecological Community	*Assessment of significance questions (TSC Act) [1]							Likely Significant Impact	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	a	b	c	d	e	f	g			
Powerful Owl (*Ninox strenua*)	N	X	X	Y	X	X	Y	No	Recorded in locality	4
Woodland Birds										
Black-chinned Honeyeater (*Melithreptus g. gularis*)	N	X	X	Y	X	X	Y	No	Moderate	0
Brown Treecreeper (*Climacteris picumnus victoriae*)	N	X	X	Y	X	X	Y	No	Moderate	1
Varied Sittella (*Daphoenositta chrysoptera*)	N	X	X	Y	X	X	Y	No	Recorded in locality	0
REPTILES										
Rosenberg's Goanna (*Varanus rosenbergi*)	N	X	X	Y	X	X	Y	No	Moderate	0

Species/Ecological Community	*Assessment of significance questions (TSC Act) [1]							Likely Significant Impact	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	a	b	c	d	e	f	g			
INVERTEBRATES										
Purple Copper Butterfly (*Paralucia spinifera*)	N	X	X	Y	X	Y	Y	No	Recorded	37

* Y= Yes (negative impact), N = No (no or positive impact), X = not applicable, ? = unknown impact.

1. Significance Assessment Questions as set out in the *Threatened Species Conservation Act 1995/ Environmental Planning and Assessment Act 1979.*
   - a in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,
   - b in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,
   - c in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
     - (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
     - (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
   - d in relation to the habitat of a threatened species, population or ecological community:
     - (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
     - (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
     - (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
   - e whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
   - f whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,
   - g whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The results of the assessments of significance for federally listed species are summarised below in Table 6-2.

Table 6-2 Assessments of significance summary (EPBC Act)

Species/Ecological Community	*Assessment of significance questions (EPBC Act) [1]									Likely Significant Impact	Important Population [+]
	1	2	3	4	5	6	7	8	9		
VULNERABLE FAUNA											
Grey-headed Flying-fox (*Pteropus poliocephalus*)	N	N	N	N	N	N	N	N	N	No	Yes
Koala (*Phascolarctos cinereus*)	N	N	N	N	N	N	N	N	N	No	Yes
Large-eared Pied Bat (*Chalinolobus dwyeri*)	N	N	N	N	N	N	N	N	N	No	Yes
ENDANGERED FAUNA											
Spotted-tail Quoll (*Dasyurus maculatus*)	N	N	N	N	N	N	N	N	N	No	n/a
Swift Parrot (*Lathamus discolour*)	N	N	N	N	N	N	N	N	N	No	n/a

Species/Ecological Community	*Assessment of significance questions (EPBC Act) [1]									Likely Significant Impact	Important Population +
	1	2	3	4	5	6	7	8	9		
Regent Honeyeater (*Anthochaera phrygia*)	N	N	N	N	N	N	N	N	N	No	n/a
Purple Copper Butterfly (*Paralucia spinifera*)	N	N	N	N	N	N	N	N	N	No	n/a

* Assessment of significance questions

1) Lead to a long-term decrease in the size of a population;
2) Reduce the area of occupancy of the species;
3) Fragment an existing population into two or more populations;
4) Adversely affect habitat critical to the survival of a species;
5) Disrupt the breeding cycle of a population;
6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
8) Introduce disease that may cause the species to decline; or
9) Interfere with the recovery of the species.

\+ Important Population as determined by the EPBC Act is a population of a vulnerable species that:

is likely to be key source populations either for breeding or dispersal
is likely to be necessary for maintaining genetic diversity
is at or near the limit of the species range.

7. Conclusion

The biodiversity surveys for the proposal recorded the presence of two threatened fauna species in the study area and an additional five species were recorded in the locality during the corridor surveys. There is potential habitat for an additional 17 threatened fauna species to occur in the proposal area. No threatened flora species was recorded or is considered likely to be present. One small area of a threatened ecological community was recorded at the western end of the proposal.

Potential biodiversity impacts to accommodate the upgrade of the Great Western Highway at Forty Bends comprise:

- The removal of approximately 7.39 hectares of remnant vegetation.
- This remnant vegetation provides habitat for several threatened fauna species confirmed to occur in the proposal footprint or considered highly likely to occur based on local records and habitat preferences.
- The proposal would include the removal of approximately 0.05 hectares of an endangered ecological community listed under state legislation.

Key mitigation measures to minimise and avoid biodiversity impacts include but are not limited to (refer to Section 5):

- Pre-clearing surveys.
- Avoidance and minimisation of vegetation removal where possible.
- Habitat augmentation.
- Improvement of wildlife connectivity with the provision of large culvert underpasses, a bridge structure at Whites Creek, gliding poles and rope bridges.

A biodiversity offset strategy would be developed to compensate for the proposed impacts from the upgrade. One potential offset location has been identified at South Bowenfels currently owned by RMS which supports a population of Purple Copper Butterfly. Further assessment and negotiation would be required to establish an appropriate biodiversity offset.

Provided the mitigation measures detailed in Section 5 are adequately implemented, the proposal is unlikely to have a significant impact on any threatened species or ecological communities listed under the TSC Act, therefore a Species Impact Statement for is not required. Based on the assessment of the proposal's potential impacts on matters of national environmental significance and the environment of Commonwealth land (refer to Section 6.1 and Appendix A), the RMS will submit a referral to SEWPAC to determine whether or not the proposal constitutes a controlled action due to potential impacts on number of threatened fauna species including the Purple Copper Butterfly, Koala, Spotted Tail Quoll, Grey Headed Flying Fox, Regent Honeyeater and the Swift Parrot.

If the proposal is determined to be a controlled action, the approval of the Australian Government Minister for the Environment is required.

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Appendix A Threatened Species Potentially Occurring In The Study Area

Table A-1: Distribution and habitat requirements of potentially occurring threatened flora species

Species	Status			Distribution and Habitat Requirements*	Likelihood of occurrence in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act	RoTAP +			
Acacia bynoeana	V	E	3VC-	Found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include *Corymbia gummifera, Eucalyptus haemastoma, Eucalyptus parramattensis, Banksia serrata* and *Angophora bakeri.*	Low	0
Acacia flocktoniae	V	V	2VC-	The Flockton Wattle is found only in the Southern Blue Mountains at Mount Victoria, Megalong Valley and Yerranderie. Grows in dry sclerophyll forest on sandstone.	Low	3
Asterolasia buxifolia	-	E	-	Known from a single site at a granite outcrop in the riparian zone of the River Lett. Rediscovered in 2000, little is known about the species.	Low	4
Asterolasia elegans	E	E	2EC a	Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (*Syncarpia glomulifera subsp. glomulifera*), Smooth-barked Apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), Forest Oak (*Allocasuarina torulosa*) and Christmas Bush (*Ceratopetalum gummiferum*).	Low	0

Species	Status			Distribution and Habitat Requirements*	Likelihood of occurrence in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act	RoTAP +			
Boronia deanei	V	V	2VC	There are scattered populations of Deane's Boronia between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. Grows in wet heath, often at the margins of open forest adjoining swamps or along streams.	Unlikely	0
Caladenia tesselata	V	E	3VC a	Occurs in the Sydney area, Wyong, Ulladulla and Braidwood. Populations in Kiama and Queanbeyan are presumed extinct. Has been recorded in the Huskisson area in the 1930s. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, however the population near Braidwood is in low woodland with stony soil.	Low	0
Derwentia blakelyi	-	V	2K	Restricted to the western Blue Mountains, near Clarence, near Mount Horrible, on Nullo Mountain and in the Coricudgy Range. Occurs at fewer than 20 locations, none of which is in a conservation reserve. Occurs in eucalypt forest, often in moist areas.	Low	22
Eucalyptus aggregata	-	V	-	In NSW it occurs in the South Eastern Highlands Bioregion and on the western fringe of the Sydney Basin Bioregion. It has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands, for example in the Blayney, Crookwell, Goulburn, Braidwood and Bungendore districts. Grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Often grows with other cold-adapted eucalypts.	Low	7
Eucalyptus pulverulenta	V	V	3V	The Silver-leafed Gum is found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo, Bombala areas). Grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum (*Eucalyptus mannifera*), Red Stringybark (*E. macrorhyncha*), Broad-leafed Peppermint (*E. dives*), Silvertop Ash (*E. sieberi*) and Apple Box (*E. bridgesiana*).	Low	40

Species	Status			Distribution and Habitat Requirements*	Likelihood of occurrence in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act	RoTAP +			
Euphrasia arguta	CE	CE	3X	Grows in grassy areas near rivers, recorded from Bathurst to Walcha area (possibly extinct). It was rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008. The populations that are currently known are located in the Nundle State Forest and on nearby private land, in eucalypt forest with a mixed grass and shrub understorey.	Low	0
Persoonia acerosa	V	V	2VC-	The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mount Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area. Occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils.	Low	6
Persoonia hindii	-	E	2V	Restricted to the Newnes Plateau in the Blue Mountains, north of Lithgow. Was only discovered in 1989 and all known locations occur within Newnes State Forest. Occurs in dry sclerophyll forests and woodlands on sandy soils.	Low	13
Persoonia marginata	V	V	2V	Known from only four disjunct locations on the Central Tablelands and Central Coast. Core of the species distribution is within Clandulla State Forest, west of Kandons. Disjunct populations occur; to the north at Dingo Creek and Mount Dangar within the Wollemi and Goulburn River National Parks; to the south within Ben Bullen State Forest, south-east of Capertee; and to the south-east at Devils Hole, north of Colo Heights within Parr State Recreation Area. Grows in dry sclerophyll forest and woodland communities on sandstone.	Low	1
Prasophyllum sp. Wybong	CE	-	-	It is known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. Known to occur in open eucalypt woodland and grassland.	Low	0

Species	Status			Distribution and Habitat Requirements*	Likelihood of occurrence in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act	RoTAP +			
Pultenaea glabra	V	V	3VCa	Restricted to the higher Blue Mountains and has been recorded from the Katoomba-Hazelbrook and Mount Victoria areas, with unconfirmed sightings in the Mount Wilson and Mount Irvine areas. All known populations occur within the Blue Mountains Local Government Area. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	Low	1
Rhizanthella slateri	E	V	3KC-	Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest.	Low	0
Thesium australe	V	V	3VCi +	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (*Themeda australis*). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	Low	0

Sources:

* Distribution and habitat requirement information adapted from the Department of Environment and Climate Change (updated 2005) Threatened Species Website (http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx)

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Table A-2: Threatened fauna species distribution and habitat requirements and potential to occur in the corridor

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
MAMMALS						
Brush-tailed Rock-wallaby (*Petrogale penicillilata*)	E	E	Open forest habitats on steep terrain with exposed rocks, rock overhangs and platforms.	None	Low	0
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	Forages in a variety of habitat types including, dry sclerophyll forests and woodlands, as well as cleared and modified urban environments; a cave-roosting species requiring caves and artificial tunnels for breeding and roosting. Mainly found east of the Great Dividing Range	Dry open forests, and derived grasslands and agricultural areas	High	4
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	Occurs in a variety of open forest and woodland habitats, where hollow-bearing trees are present and required for roosting, may forage in younger re-growth and modified environments.	Dry open forests, and derived grasslands and agricultural areas	Recorded in locality	2
Eastern Freetail-bat (*Mormopterus norfolkensis*)	-	V	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in human-made structures.	Dry open forests, and derived grasslands and agricultural areas	High	1

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V	Inhabits a broad range of forest and woodland habitats, including adjacent cleared lands.	Dry open forests, and derived grasslands and agricultural areas	High	2
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.	Dry open forests	Moderate	0
Koala (*Phascolarctos cinereus*)	V	V	Open forests and woodlands with favoured food tree species. No records in the lower Blue Mountains although known from Wollemi National Park in the upper regions. There is also an anecdotal record of a roadkill just south of the study area.	Dry open forests	Moderate	3
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Forages over a broad range of open forest and woodland habitats. This species is a cave-roosting bat which favours sandstone escarpment habitats for roosting, in the form of shallow overhangs, crevices and caves.	Dry open forests, and derived grasslands and agricultural areas	High	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Long-nosed Potoroo (*Potorous t. tridactylus*)	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.	Dry sclerophyll forest and woodland.	Low	0
New Holland Mouse (*Psuedomys novaehollandiae*)	E	-	The New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sandunes.	Dry sclerophyll woodlands and heathland.	Low	0
Smoky Mouse (*Psuedomys fumeus*)	E	CE	The Smoky Mouse appears to prefer heath habitat on ridge tops and slopes in sclerophyll forest, heathland and open-forest from the coast (in Victoria) to sub-alpine regions of up to 1800 metres, but sometimes occurs in ferny gullies. Nesting burrows have been found in rocky localities among tree roots and under the skirts of Grass Trees *Xanthorrhoea* spp.	Dry sclerophyll and heathland	Low	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Spotted-tail Quoll (*Dasyurus maculatus*)	E	V	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated large expansive areas of habitat to sustain territory size.	Extensive areas of suitable habitat, and a considerable number of records in the corridor.	High	15
Southern Myotis (*Myotis macropus*)	-	V	Generally roost in groups of 10-15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	Freshwater wetlands, swamps, creeks and adjacent forest and woodland habitats.	High	4
Yellow-bellied Glider (*Petaurus australis*)	-	V	Tall open forest habitats, favours mature wet sclerophyll forest and dense gullies.	Wet and dry sclerophyll forest.	Moderate	1
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	-	V	Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Roost in tree hollows and buildings.	Wet and dry sclerophyll forest.	High	1

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
BIRDS						
Australian Painted Snipe (*Rostratula benghalensis*)	V	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Densely vegetated swamps.	Low	0
Barking Owl (*Ninox connivens*)	-	V	Forest and woodland habitats, particularly drier western slopes and riverine areas, hunts for birds and small mammals.	Dry sclerophyll forest, woodlands.	Recorded in locality	0
Black-chinned Honeyeater (*Melithreptus g. gularis*)	-	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	Dry sclerophyll forest and woodlands.	Moderate	0
Blue-billed Duck (*Oxyura australis*)	-	V	Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation.	Open dams in agricultural areas.	Low	3
Brown Treecreeper (*Climacteris picumnus victoriae*)	-	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and mature hollow-bearing trees.	Dry sclerophyll forest and woodlands.	Moderate	1

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Diamond Firetail (*Stagonopleura guttata*)	-	V	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	Dry sclerophyll forest and woodland and adjacent creeks, and agricultural areas.	Low	0
Flame Robin (*Petroica phoenicea*)	-	V	Prefers clearings or areas with open understoreys. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees (in valleys below the ranges, and to the western slopes and plains). Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes.	Dry sclerophyll forest and woodland.	Low	0
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	-	V	Moist and tall open forests, particularly in steep topographic areas. Numerous records in the corridor.	Wet and dry sclerophyll forest.	Recorded in locality	8

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Glossy Black-cockatoo (Calyptorhynchus lathami)	-	V	Open forest habitats with She-oak species (Allocasuarina spp.) required for food.	Wet and dry sclerophyll forest.	High	1
Grey-crowned Babbler (*Pomatostomus t. temporalis*)	-	V	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. Territories range from one to fifty hectares (usually around ten hectares) and are defended all year.	Dry sclerophyll woodland	Low	0
Hooded Robin (*Melanodryas c. cucullata*)	-	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	Dry sclerophyll forest and woodlands.	Low	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Little Lorikeet (*Glossopsitta pusilla*)	-	V	Forages primarily in the canopy of open *Eucalyptus* forest and woodland, finds food in Angophoras, Melaleucas and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, eg paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Roosts in treetops, often distant from feeding areas. Riparian trees often chosen for nesting, including species like Allocasuarina.	Wet and dry sclerophyll forests, woodlands and riparian areas.	Moderate	1
Masked Owl (*Tyto novaehollandiae*)	-	V	Lives in dry eucalypt forests and woodlands from sea level to 1100 metres elevation.	Dry sclerophyll forest and woodlands.	High	0
Powerful Owl (*Ninox strenua*)	-	V	Open forests with dense wet gullies and creek areas, requires large mature trees with hollows for breeding and dense areas of vegetation for prey and roosting	Wet and dry sclerophyll forests, woodlands and rainforest.	Recorded in locality	4
Regent Honeyeater (*Anthochaera phrygia*)	E	CE	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box and Red Ironbark	Dry sclerophyll forest and woodlands.	Moderate	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Scarlet Robin (*Petroica boodang*)	-	V	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees.	Dry sclerophyll forest and woodlands, agricultural areas with scattered tree remnants.	Low	1

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Speckled Warbler (*Pyrrholaemus saggitatus*)	-	V	The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	Wet and dry sclerophyll forest and woodland.	Low	0
Swift Parrot (*Lathamus discolour*)	E	E	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*.	Dry sclerophyll forest and woodlands.	Moderate	0
Varied Sittella (*Daphoenositta chrysoptera*)	-	V	Eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches.	Open forest	Recorded in locality	4

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
REPTILES						
Blue Mountains Water Skink (*Eulamprus leuraensis*)	E	E	Sedge swamps and hanging swamps in the upper Blue mountains area, Several records in the corridor and surrounding landscape.	Densely vegetated swamps.	Unlikely	0
Broad-headed Snake (*Hoplocephalus bungaroides*)	V	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 metres of escarpments in summer.	Dry sclerophyll forests on steep escarpments with exposed sandstone rocks, boulders and platforms.	Low	0
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V	Occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Also occurs in South Australia and Western Australia. Found in heath, open forest and woodland.	Heath, open forest and woodland.	Moderate	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
AMPHIBIANS						
Booroolong Frog (*Litoria booroolongensis*)	E	E	A highland species (200 – 1000 metres ASL) associated with western-flowing rocky streams on the slopes and tablelands of the Great Dividing Range. Streams are slow-flowing and bordered by grassy vegetation.	Streams through wet sclerophyll forests.	Low	0
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	Found in heath, woodland and open forest with sandy soils.	Heath and woodland.	Low	0
Littlejohn's Tree Frog (*Litoria littlejohni*)	V	V	It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops.	Streams in wet and dry sclerophyll forest and heath.	Low	0
FISHES						
Murray Cod (*Maccullochella australasica*)	V	-	Murray Cod habitat varies greatly from small clear rocky streams to the generally turbid, slow-flowing rivers and creeks. They are generally found in or near deep holes and prefer habitats containing cover such as rocks, fallen trees, stumps, and clay banks or overhanging vegetation.	Streams in wet and dry sclerophyll forest and woodland.	Unlikely	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
Macquarie Perch (*Macquaria australasica*)	E	-	Macquarie perch are found in both river and lake habitats, especially the upper reaches of rivers and their tributaries.	Permanent rivers and creeks.	Unlikely	0
Australian Grayling (*Prototroctes maraena*)	V	-	The Australian Grayling occurs in south-eastern Australia, in coastal rivers and streams in New South Wales, Victoria and Tasmania. On the mainland it occurs from the Shoalhaven River (NSW) south and west to the Hopkins River system (Vic). It is a diadromous species, migrating between rivers, their estuaries and coastal seas, so relies on free access to a range of freshwater, estuarine and marine habitats for its survival. Australian Grayling spend most of their lives in freshwater, inhabiting rivers and streams, usually in cool, clear waters with a gravel substrate and alternating pool and riffle zones but can also occur in turbid water. The species can penetrate well inland, and has been reported from over 100 kilometres upstream from the sea. Larvae and juveniles inhabit estuaries and coastal seas, and there appears to be an obligatory marine stage, although their precise habitat requirements are not known.	Permanent rivers and creeks. River Lett is a tributary of the Coxs River which is known to support this species.	Unlikely	0

Species	Status		Distribution and habitat requirements*	Suitable habitat in study area	Potential to occur in the study area	No. of records in the locality (OEH Atlas 2012)
	EPBC Act	TSC Act				
INVERTEBRATES						
Purple Copper Butterfly (*Paralucia spinifera*)	V	E	Inhabits open forest/woodland areas above 850 metres in elevation and prefers sites with a south-west to north-west aspect and with extremes of cold such as regular winter snowfalls or heavy frosts. Also requires the presence of the Native Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*) in the understorey because it is a critical host plant for its larvae.	Dry sclerophyll forest and woodland.	Recorded	37
* Distribution and habitat requirement information adapted from the Department of Environment and Climate Change (updated 2005) Threatened Species Website http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx)						

Table A-3: Potential occurrence of migratory species (EPBC Act)

Common Name	Species	Preferred habitat	Likelihood of occurrence in the study area	Presence of 'important habitat' in the study area*
MIGRATORY TERRESTRIAL SPECIES				
Black-faced Monarch	*Monarcha melanopsis*	Rainforests, eucalypt forests and coastal scrubs	Moderate chance of occurring at forested sites throughout the corridor. These habitats form part of the much larger habitat range of the species.	Unlikely: Considering the widespread nature of habitat for this species in the local area habitats in the corridor unlikely to be important.
White-bellied Sea Eagle	*Haliaeetus leucogaster*	Predominantly ocean shores and estuaries, occasionally inland rivers and streams.	Unlikely	Unlikely
White-throated Needletail	*Hirundapus caudacutus*	An aerial foraging species which occupies a range of habitats from open modified landscapes to woodland and forest.	Moderate: may intermittently fly over study area	Unlikely
Rufous Fantail	*Rhipidura rufifrons*	Predominantly rainforest and forests	Moderate chance of occurring at forested sites throughout the corridor. These habitats form part of the much larger habitat range of the species.	Unlikely: Considering the widespread nature of habitat for this species in the local area habitats in the corridor unlikely to be important.

Common Name	Species	Preferred habitat	Likelihood of occurrence in the study area	Presence of 'important habitat' in the study area*
Malleefowl	*Leipoa ocellata*	Semi-arid to arid shrublands and low woodlands	Unlikely	Unlikely
Rainbow Bee-eater	Merops ornatus	Predominantly woodland and timbered plains	Moderate, potential habitat for this species occurs in a diversity of habitats including remnant woodland and partially cleared agricultural areas provided there is a patchwork of small woodland remnants in the landscape. These habitats form part of the much larger habitat range of the species.	Unlikely: Considering the widespread nature of habitat for this species in the local area habitats in the corridor unlikely to be important.
Regent Honeyeater	*Xanthomyza phrygia*	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box and Red Ironbark	Low: may fly through habitats of the study area, but foraging species not optimal	Unlikely

Common Name	Species	Preferred habitat	Likelihood of occurrence in the study area	Presence of 'important habitat' in the study area*
Satin Flycatcher	*Myiagra cyanoleuca*	Predominantly forests, in particular thick vegetation in gullies	Moderate chance of occurring at forested sites throughout the corridor. These habitats form part of the much larger habitat range of the species.	Unlikely: Considering the widespread nature of habitat for this species in the local area habitats in the corridor unlikely to be important.
MIGRATORY WETLAND/MARINE SPECIES				
Latham's Snipe	*Galliago hardwickii*	Wetlands, wet meadows, flooded grassy paddocks, open grassland and drainage areas	Low: Potentially intermittently uses farm dams in study area	Unlikely: Farm dams in corridor unlikely to support an ecologically significant proportion of the population.
Painted Snipe	*Rostratula australis*	Wetlands, reedlands, marshes and swamps	Low: Potentially intermittently uses farm dams in study area	Unlikely: Farm dams in corridor unlikely to support an ecologically significant proportion of the population.
Cattle Egret	*Ardea ibis*	Grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Often seen with cattle.	Moderate, this species may forage over all open habitat types particularly those with isolated paddock trees and small habitat patches.	Unlikely: Farm dams in the corridor lack fringing trees suitable for a breeding colony

Common Name	Species	Preferred habitat	Likelihood of occurrence in the study area	Presence of 'important habitat' in the study area*
Great Egret	*Ardea alba*	Prefers shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	Low: Potentially intermittently uses farm dams in study area	Unlikely: Farm dams in the corridor lack fringing trees suitable for a breeding colony
Fork-tailed Swift	*Apus pacificus*	The species breeds in Asia and migrate to Australia in the summer from which they spend their entire life-cycle on the wing, hunting, resting and sleeping.	Unlikely	Unlikely

* As defined under the EPBC Act an area of 'important habitat' for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

Appendix B Flora Species List

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
Ferns											
ADIANTACEAE	*Adiantum aethiopicum*	Maidenhair Fern							3		
ADIANTACEAE	*Cheilanthes sieberi subsp. sieberi*	Slender Cloak-fern			2						
ASPLENIACEAE	*Asplenium flabellifolium*	Necklace Fern		x							
DENNSTAEDTIACEAE	*Pteridium esculentum*	Bracken						2	3		4
Flowering Plants - Dicotyledons											
APIACEAE	*Conium maculatum*	Hemlock	i x	x							
APIACEAE	*Foeniculum vulgare*	Fennell	i	x							
APIACEAE	*Hydrocotyle laxiflora*	Stinking Pennywort			2			2	3		
APOCYNACEAE	*Vinca major*	Greater Periwinkle	i						4		
ARALIACEAE	*Polyscias sambucifolia* subsp. *leptophylla*			x							
ASTERACEAE	*Bidens pilosa*	Cobblers Peg	i	x							
ASTERACEAE	*Brachyscome spathulata*				1						
ASTERACEAE	*Chrysocephalum apiculatum*	Yellow Buttons			1						
ASTERACEAE	*Chrysocephalum semipapposum*	Yellow Buttons		x							
ASTERACEAE	*Cirsium vulgare*	Spear Thistle	i		1						
ASTERACEAE	*Conyza spp.*	Fleabane	i		2						

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
ASTERACEAE	*Coronidium scorpioides*	Button Everlasting			2	2	2				
ASTERACEAE	*Hypochoeris radicata*	Catsear	i		2	1	2	2			
ASTERACEAE	*Lactuca serriola*	Prickly Lettuce	i	x							
ASTERACEAE	*Lagenophora gracilis*	Slender Bottle-daisy					1				
ASTERACEAE	*Podolepis jaceoides*	Showy Copper-wire Daisy			2			2			
ASTERACEAE	*Senecio diaschides*							1			
ASTERACEAE	*Senecio linearifolius*	Fireweed Grounsel									
ASTERACEAE	*Senecio madagascariensis*	Fireweed	i	x							
ASTERACEAE	*Senecio quadridentatus*	Cotton Fireweed									
ASTERACEAE	*Sonchus oleraceus*	Common Sow-thistle	i								
BORAGINACEAE	*Echium plantagineum*	Pattersons Curse	i, x	x							
BRASSICACEAE	*Hirschfeldia incana*	Buchan Weed	i	x							
CAMPANULACEAE	*Wahlenbergia luteola*				1			2			
CAPRIFOLIACEAE	*Lonicera japonica*	Honeysuckle	i						3		4
CARYOPHYLLACEAE	*Stellaria media*	Common Chickweed	i	x							
CARYOPHYLLACEAE	*Stellaria pungens*	Prickly Starwort							2		
CASUARINACEAE	*Allocasuarina littoralis*	Black She-oak			2						
CHENOPODIACEAE	*Einadia hastata*	Shrubby Berry-saltbush									
CLUSIACEAE	*Hypericum gramineum*	Narrow-leaf St. Johns Wort			2						

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
CLUSIACEAE	*Hypericum japonicum*	Matted St. Johns Wort				2					
CLUSIACEAE	*Hypericum perforatum*	St. Johns Wort	i, x						2		
CONVOLVULACEAE	*Dichondra repens*	Kidney Weed						2	2		
CRASSULACEAE	*Crassula sieberiana*	Australian Stonecrop									
DILLENIACEAE	*Hibbertia obtusifolia*	Blunt-leaf Guinea-flower			2	1	2				
DROSERACEAE	*Drosera peltata*	Rosette Sundew		x							
ERICACEAE	*Astroloma humifusum*	Prickly Pine Heath		1		1		1			
ERICACEAE	*Leucopogon lanceolatus var. lanceolatus*	Lance-leaf Beard-heath			2	1	2	1		2	1
ERICACEAE	*Monotoca scoparia*	Prickly Broom-heath					1				
EUPHORBIACEAE	*Poranthera microphylla*	Small Poranthera			2	2		2			
FABACEAE-FABOIDEAE	*Bossiaea prostrata*			x							
FABACEAE-FABOIDEAE	*Daviesia latifolia*	Broad-leaf Bitter-pea				1		2		1	
FABACEAE-FABOIDEAE	*Daviesia ulicifolia*	Gorse Bitter-pea					2				
FABACEAE-FABOIDEAE	*Desmodium gunnii*	Slender tick trefoil									
FABACEAE-FABOIDEAE	*Glycine clandestina* agg.	Twining Glycine									

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
FABACEAE-FABOIDEAE	*Glycine tabacina* agg.				2	2		2			
FABACEAE-FABOIDEAE	*Hardenbergia violacea*	Purple Twining-pea			2	2	2	2		2	
FABACEAE-FABOIDEAE	*Podolobium ilicifolium*	Prickly Shaggy-pea			2	3	3	4			
FABACEAE-MIMOSOIDEAE	*Acacia dealbata*	Silver Wattle									
FABACEAE-MIMOSOIDEAE	*Acacia decurrens*	Fine-leaf Green Wattle						1			
FABACEAE-MIMOSOIDEAE	*Acacia falsiformis*	Broad-leaf Hickory			3	1					
FABACEAE-MIMOSOIDEAE	*Acacia gunnii*	Ploughshare Wattle			1						
FABACEAE-MIMOSOIDEAE	*Acacia melanoxylon*	Blackwood								2	
GERANIACEAE	*Geranium homeanum*	Native Cranesbill						1	2		
GERANIACEAE	*Geranium solanderi* var. *solanderi*	Native Cranesbill									2
GOODENIACEAE	*Goodenia bellidifolia* subsp. *bellidifolia*	Goodenia				1					
HALORAGACEAE	*Gonocarpus tetragynus*	Poverty Raspwort			2	1	1	1			
LAMIACEAE	*Mentha diemenica*	Slender Mint		x							

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
LINACEAE	*Linum marginale*	Native Flax			1						
LOBELIACEAE	*Pratia purpurescens*	White Root									
LYTHRACEAE	*Lythrum hyssopifolia*	Hyssop Loosestrife		x							
MALACEAE	*Cotoneaster glaucophyllus*	Cotoneaster	i								
MYRSINACEAE	*Anagallis arvensis*	Pimpernell	i		1						
MYRTACEAE	*Eucalyptus blaxlandii*	Blaxlands Stringybark			3	3	1	3		4	
MYRTACEAE	*Eucalyptus cinerea*	Argyle Apple	n	x							
MYRTACEAE	*Eucalyptus consideniana*	Yertchuk		x							
MYRTACEAE	*Eucalyptus cypellocarpa*	Monkey Gum			3	3	2	3	3	3	
MYRTACEAE	*Eucalyptus dalrympleana*	Mountain Gum		x							
MYRTACEAE	*Eucalyptus fastigata*	Brown Barrel							4		
MYRTACEAE	*Eucalyptus globoidea*	White Stringybark		x							
MYRTACEAE	*Eucalyptus radiata* subsp. *radiata*	Narrow-leaved Peppermint		x							
MYRTACEAE	*Eucalyptus sieberi*	Silvertop Ash				3	4			1	
MYRTACEAE	*Eucalyptus viminalis*	Ribbon Gum									4
MYRTACEAE	*Leptospermum polygalifolium*	Yellow Tea-tree					2		3		2
MYRTACEAE	*Leptospermum rotundifolium*	Round Leaf Tea-tree	n	x							
OXALIDACEAE	*Oxalis perennans*				1						
PITTOSPORACEAE	*Billardiera scandens*	Apple-berry			1	1	2	2			

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
PITTOSPORACEAE	*Bursaria spinosa* subsp. *lasiophylla*	Blackthorn			3	2	1	4	2	2	
PITTOSPORACEAE	*Bursaria spinosa* subsp. *spinosa*	Blackthorn		x							
PITTOSPORACEAE	*Rhytidosporum procumbens*	Marianthus					2				
PLANTAGINACEAE	*Plantago debilis*	Slender Plantain						2			
POLYGALACEAE	*Comesperma volubile*	Climbing Comesperma			1						
POLYGONACEAE	*Rumex crispus*	Curled Dock	i	x							
PROTEACEAE	*Lomatia myricoides*	River Lomatia					2		2	2	
PROTEACEAE	*Persoonia linearis*	Narrow-leaf Geebung			1		2			2	
PROTEACEAE	*Persoonia myrtilloides* subsp. *myrtilloides*	Myrtle Geebung		x						1	
RANUNCULACEAE	*Clematis aristata*	Toothed Clematis			2						
RANUNCULACEAE	*Clematis glycinoides*	Entire-leaf Clematis						2			
RANUNCULACEAE	*Ranunclulus plebeius*	Hairy Buttercup						1			
RHAMNACEAE	*Pomaderris elliptica*	Pomaderris		x							
RHAMNACEAE	*Pomaderris ferruginea*										
ROSACEAE	*Acaena novae-zelandiae*	Bidgy-widgy							2		3
ROSACEAE	*Rubus fruticosus* agg.	Blackberry	i, x						4		3
ROSACEAE	*Rubus parviflorus*	Small-leaf Bramble						2			
RUBIACEAE	*Asperula scoparia*	Prickly Woodruff						2	2	2	
RUBIACEAE	*Asperula ambleia*	Stiff Woodruff		x							

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
RUBIACEAE	*Coprosma quadrifida*	Prickly Currant Bush		x						2	3
RUBIACEAE	*Galium binifolium*			x							
RUBIACEAE	*Galium leptogonium*			x						2	
RUBIACEAE	*Galium propinquum*	Maori Bedstraw	i			1					
RUBIACEAE	*Opercularia hispida*	Hairy Stinkweed			1	1					
SANTALACEAE	*Exocarpos cupressiformis*	Cherry Ballart			1						
SCROPHULARIACEAE	*Verbascum virgatum*	Twiggy Mullein	i	x							
SCROPHULARIACEAE	*Veronica derwentiana* subsp. *derwentiana*			x							
SCROPHULARIACEAE	*Veronica plebeia*	Trailing Speedwell									
SOLANACEAE	*Solanum prinophyllum*	Forest Nightshade							2		
STACKHOUSIACEAE	*Stackhousia monogyna*				2	2	2	2		2	
VERBENACEAE	*Verbena bonariensis*	Purple Top	i								
VIOLACEAE	*Viola betonicifolia*	Showy Violet			2			2		2	
VIOLACEAE	*Viola hederacea*	Ivy-leaf Violet						1			
ALLIACEAE	*Agapanthus* spp.	Agapanthus	i	x							
ANTHERICACEAE	*Arthropodium milleflorum*	Vanilla Lily						2			
COLCHICACEAE	*Wurmbea dioica* subsp. *dioica*	Early Nancy		x							
CYPERACEAE	*Carex appressa*	Tussock Tassel-sedge		x							
CYPERACEAE	*Schoenus apogon*	Common Bog-rush						1			

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
IRIDACEAE	*Patersonia sericea* var. *sericea*	Basal-leaf Purple-flag					2				
JUNCACEAE	*Juncus* spp.										
LOMANDRACEAE	*Lomandra confertifolia* subsp. *pallida*										
LOMANDRACEAE	*Lomandra filiformis* subsp. *filiformis*	Wattle Mat-rush			2	3	3				
LOMANDRACEAE	*Lomandra glauca* subsp. *glauca*	Glaucous Mat-rush								3	
LOMANDRACEAE	*Lomandra longifolia* subsp. *longifolia*	Spiny Mat-rush			2		2			1	2
LOMANDRACEAE	*Lomandra multiflora* subsp. *multiflora*	Many-flowered Mat-rush			1			2			
ORCHIDACEAE	*Acianthus exsertus*	Gnat Orchid		x							
ORCHIDACEAE	*Caladenia carnea*	Pink Fingers								1	
ORCHIDACEAE	*Caladenia congesta*	Black Tongue Caladenia		x						1	
ORCHIDACEAE	*Caladenia cucullata*	Hooded Caladenia				2	1				
ORCHIDACEAE	*Caladenia fuscata*	Dusky Fingers					1				
ORCHIDACEAE	*Caladenia gracilis*	Musky Caladenia		x							
ORCHIDACEAE	*Chiloglottis* spp.	Ant Orchid		x							
ORCHIDACEAE	*Dendrobium striolatum*	Streaked Rock Orchid		x							
ORCHIDACEAE	*Diuris pardina*	Leopard Orchid						1			
ORCHIDACEAE	*Diuris sulphurea*	Tiger Orchid			2			1			
ORCHIDACEAE	*Pterostylis longifolia*	Tall Greenhood		x							
ORCHIDACEAE	*Pterostylis reflexa*	Small Autumn Greenhood		x							

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
ORCHIDACEAE	*Thelymitra pauciflora*	Slender Sun-orchid								1	
PHORMIACEAE	*Dianella caerulea* var. *caerulea*	Leafy Blue Flax Lily			1		1				
PHORMIACEAE	*Dianella longifolia* var. *longifolia*	Long-leaf Flax Lily								2	1
PHORMIACEAE	*Dianella revoluta* var. *revoluta*	Black-anther Flax Lily			3	2	3	2			
PHORMIACEAE	*Dianella tasmanica*					2		2			
PHORMIACEAE	*Stypandra glauca*	Nodding Blue Lily					2	1			
POACEAE	*Anthoxanthum odoratum*	Sweet Vernal Grass	i		1			2	3	2	2
POACEAE	*Austrodanthonia* spp	Wallaby Grass						2			
POACEAE	*Austrostipa rudis* subsp. *nervosa*	Speargrass			3	2		2			1
POACEAE	*Bromus diandrus*	Great Brome	i		1						
POACEAE	*Dichelachne parva*				2						
POACEAE	*Echinopogon caespitosus*	Hedgehog Grass									
POACEAE	*Echinopogon ovatus*	Hedgehog Grass			1						
POACEAE	*Entolasia stricta*	Wiry Panic									
POACEAE	*Eragrostis curvula*	African Lovegrass	i, x								
POACEAE	*Joycea pallida*	Red-anthered Wallaby Grass			3	4	4			4	
POACEAE	*Microlaena stipoides* var. *stipoides*	Weeping Grass									
POACEAE	*Paspalum dilatatum*	Paspalum	i	x							

FAMILY	SPECIES	COMMON NAME	*	Quadrat Number							
				x	1	2	3	4	5	6	7
POACEAE	*Pennisetum clandestinum*	Kikuyu	i	x							
POACEAE	*Phalaris aquatica*	Canary Grass		x							
POACEAE	*Poa induta*										1
POACEAE	*Poa labillardieri*	Tussock Grass		x							
POACEAE	*Poa sieberiana*	Snowgrass					2			2	1
POACEAE	*Themeda australis*	Kangaroo Grass			4			3		3	

* i = introduced, x = noxious weed; n = non-indigenous native species

Appendix C Vegetation Descriptions

Map Unit 1: Blaxland's Stringybark – Monkey Gum Open Forest

General Description:

This unit is a eucalypt forest with an open understorey of sclerophyll shrubs, forbs, sedges and grass. This community has affinities to several described vegetation communities (Tozer *et al*. 2010; DEC 2006). DEC (2006) describes this community as commonly occupying semi-sheltered positions on steep slopes, or exposed lower slopes, occurring on the side ridges of the Great Dividing Range and Boyd Plateau east of Oberon, favouring substrates of Silurian era tuff, phyllite and slate (metasediments) at elevations from 750 to 1200 metres ASL receiving between 850 to 1100 millimetres mean annual rainfall. This is the most abundant vegetation community in the dominating the slopes surrounding the Great Western Highway at Forty Bends. The majority of this community in the study area is in a high condition, with the exception of edges where minor weed invasion is present and several smaller disturbed patches on the southern side of the existing highway which have been partially cleared or under-scrubbed and support a moderate-high density of weed invasion.

Equivalent Map Units:

Regional: MU 24 Montane Slopes Stringybark Forest (DEC 2006); possibly DSF p76 Moist Montane Sandstone Forest and/or WSF p73 Cool Montane Wet Forest (Tozer *et al.* 2010)

Biometric: No close equivalent communities listed, closest match Narrow-leaved Peppermint - Silvertop Ash - Mountain Grey Gum shrubby open forest of the upper Blue Mountains, Sydney Basin

State: South East Dry Sclerophyll Forests (Keith 2004)

Dominant Canopy Species:

Eucalyptus blaxlandii, Eucalyptus cypellocarpa

Other Canopy Species:

Acacia falciformis, Eucalyptus sieberi, Eucalyptus fastigata, Eucalyptus piperita

Dominant Shrub Species:

Persoonia linearis, Bursaria spinosa subsp. lasiophylla Leucopogon lanceolatus, Lomatia myricoides, Leptospermum polygalifolium, Podolobium illicifolium, Polyscias sambucifolia, Daviesia latifolia, Hibbertia obtusifolia

Common Groundcover Species:

Poa siebriana, Pterostylis reflexa, Acianthus exsertus, Gonocarpus tetragynus, Hardenbergia violacea, Viola betonicifolia, Lomandra longifolia, Lomandra multiflora, Dichondra repens, Clematis glycinoides, Galium propinquum

Common Introduced Species:

Eragrostis curvula, Hypericum perforatum (restricted to disturbed edges)

Conservation Status:

Clearing has not greatly affected the extent of this community given its favoured steep and infertile habitat (DEC 2006). Tozer *et al.* (2010) estimates there is approximately 70-90 per cent of the pre-clearing area of this vegetation community (WSF p73 and DSF p76) remaining, and 35-55 per cent of the pre-clearing area is in conservation reserves.

Map Unit 2: Silvertop Ash Open Forest

General Description:

This map unit has affinities to Dry Sclerophyll Forest/Tableland Ridge Forest as described by Tozer *et al.* (2010). This unit is a eucalypt forest with an open understorey of sclerophyll shrubs, forbs, sedges and grass, found at elevations from 600 to 1200 metres ASL along drier parts of the Great Diving Range receiving 700 to 1100 millimetres mean annual rainfall (Tozer *et al*. 2010). It occurs from Hartley to Big Badja, primarily on sandy-loams derived from sedimentary, acid-volcanic or granitic substrates (Tozer *et al*. 2010). This community occurs on the drier and exposed ridges and spurs in the Forty Bends area, with several minor occurrences on top of some of the cuttings adjacent to Great Western Highway. The condition of this community is generally high in the study area occurring in the large patch of vegetation on the northern side of the existing highway.

Equivalent Map Units:

Regional: DSF p8 Tableland Ridge Forest (Tozer *et al.* 2010); MU 25 Montane Exposed Silvertop Ash Forest (DEC 2006)

Biometric: Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands and South East Corner

State: Sydney Montane Dry Sclerophyll Forest

Dominant Canopy Species:

Eucalyptus sieberi

Other Canopy Species:

Eucalyptus radiata, Eucalyptus cypellocarpa, Eucalyptus blaxlandii, Acacia falciformis

Dominant Shrub Species:

Podolobium illicifolium, Persoonia linearis, Leucopogon lanceolatus, Hibbertia obtusifolia, Daviesia ulicifolia, Coronidium scorpioides, Patersonia sericea

Common Groundcover Species:

Joycea pallida, Poa siebriana, Dianella revoluta, Lomandra glauca, Stackhousia monogyna, Billardiera scandens

Common Introduced species:

Hypochaeris radicata

Conservation Status:

Tozer *et al.* (2010) estimate there is approximately 80-90 per cent of the pre-clearing area of this vegetation community (DSF p8) remaining, and 40-60 per cent of the pre-clearing area is in conservation reserves.

Map Unit 3: Ribbon Gum Grassy Woodland

General Description:

This unit is a eucalypt woodland with a sparse shrub layer and grassy groundcover, found on the tablelands in the Coxs River valley south of Lithgow and the Crookwell and Taralga districts (Tozer *et al*. 2010). This community has affinities to Tableland Granite Grassy Woodland (GW p420) as described by Tozer *et al.* (2010) however the occurrence in the study area has more of a open forest structure and has a relatively disturbed groundcover. Throughout its distribution this woodland occurs on rolling terrain on granite-derived soils, at elevations from 550 to 1050 metres ASL and with average annual rainfall ranging from 700 to 950 millimetres (Tozer *et al*. 2010). Though once extensive, Tableland Granite Grassy Woodland is now highly fragmented by land clearing. The remaining areas are almost exclusively on freehold land, being exposed to continued small-scale clearing, grazing and weed invasion. This community occurs in a gully area at the western end of the study area, and is generally in a low-moderate condition disturbed from weed invasion, track construction, selective clearing and under-scrubbing. The extant of this community in the study area comprises only 0.3 hectares, with the main distributions in the locality in the Hartley Valley.

Equivalent Map Units:

Regional: GW p420 Tableland Granite Grassy Woodland (Tozer *et al.* 2010)

Biometric: Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north-east of the South Eastern Highlands

State: Southern Tableland Grassy Woodlands (Keith 2004)

Dominant Canopy Species:

Eucalyptus viminalis

Other Canopy Species:

Eucalyptus melliodora, Eucalyptus dives, Eucalyptus bridgesiana, Acacia falciformis

Dominant Shrub Species:

Acacia melanoxylon, Pteridium esculentum, Persoonia linearis

Common Groundcover Species:

Poa siebriana, Themeda australis, Austrodanthonia spp., Hydrocotyle laxiflora, Microlaena stipoides, Acaena novae-zelandiae, Geranium solanderi, Aristida ramosa

Common Introduced species:

Eragrostis curvula, Hypericum perforatum, Hypochaeris radicata, Dactylis glomerata, Anthoxanthum odoratum

Conservation Status:

This community is consistent with the TEC Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions listed as Endangered under the TSC Act.

This community is regarded as being highly cleared with only 20-35 per cent of the pre-European extant estimated to remain and <1 per cent of the pre-European extant estimated to occur in conservation reserves (Tozer *et al.* 2010).

Appendix D Fauna Species List

Family/Scientific Name	Common name	Status	Open Forest	Aquatic habitat
BIRDS				
Columbidae				
Phaps chalcoptera	Common Bronzewing		X	
Cacatuidae				
Cacatua galerita	Sulphur-crested Cockatoo		X	
Cacatua sanguinea	Little Corella		X	
Eolophus roseicapillus	Galah		X	
Psittacidae				
Alisterus scapularis	Australian King-Parrot		X	
Platycercus elegans	Crimson Rosella		X	
Platycercus adscitus eximius	Eastern Rosella		X	
Cuculidae				
Cacomantis flabelliformis	Fan-tailed Cuckoo		X	
Chalcites basalis	Horsfield's Bronze-Cuckoo		X	
Scythrops novaehollandiae	Channel-billed Cuckoo		X	
Centropodidae				
Centropus phasianinus	Pheasant Coucal		X	
Strigidae				
Ninox boobook	Southern Boobook		X	
Ninox connivens	Barking Owl	V (TSC Act)	X	X
Ninox strenua	Powerful Owl	V (TSC Act)	X	X
Podargidae				
Podargus strigoides	Tawny Frogmouth		X	
Aegothelidae				
Aegotheles cristatus	Australian Owlet-nightjar		X	

Family/Scientific Name	Common name	Status	Open Forest	Aquatic habitat
Alcedinidae				
Dacelo novaeguineae	Laughing Kookaburra		X	
Todiramphus sanctus	Sacred Kingfisher		X	
Climacteridae				
Cormobates leucophaea	White-throated Treecreeper		X	
Maluridae				
Malurus cyaneus	Superb Fairy-wren		X	
Malurus lamberti	Variegated Fairy-wren		X	
Pardalotidae				
Pardalotus punctatus	Spotted Pardalote		X	
Pardalotus striatus	Striated Pardalote		X	
Acanthizidae				
Gerygone olivacea	White-throated Gerygone		X	
Smicrornis brevirostris	Weebill		X	
Acanthiza lineata	Striated Thornbill		X	
Acanthiza nana	Yellow Thornbill		X	
Sericornis frontalis	White-browed Scrubwren		X	
Meliphagidae				
Acanthorhynchus tenuirostris	Eastern Spinebill		X	
Meliphaga lewinii	Lewin's Honeyeater		X	
Lichenostomus fuscus	Fuscous Honeyeater		X	
Lichenostomus chrysops	Yellow-faced Honeyeater		X	
Lichenostomus leucotis	White-eared Honeyeater		X	X
Lichenostomus penicillatus	White-plumed Honeyeater		X	
Manorina melanocephala	Noisy Miner		X	
Anthochaera carunculata	Red Wattlebird		X	
Philemon corniculatus	Noisy Friarbird		X	
Philemon citreogularis	Little Friarbird		X	

Family/Scientific Name	Common name	Status	Open Forest	Aquatic habitat
Petroicidae				
Eopsaltria australis	Eastern Yellow Robin			
Eupetidae				
Psophodes olivaceus	Eastern Whipbird			
Neosittidae				
Daphoenositta chrysoptera	Varied Sittella	V (TSC Act)	X	
Pachycephalidae				
Pachycephala pectoralis	Golden Whistler		X	
Pachycephala rufiventris	Rufous Whistler		X	
Colluricincla harmonica	Grey Shrike-thrush		X	
Falcunculus frontatus	Eastern Shrike-tit		X	
Dicruridae				
Rhipidura albiscapa	Grey Fantail		X	
Rhipidura leucophrys	Willie Wagtail		X	
Myiagra cyanoleuca	Satin Flycatcher			
Grallina cyanoleuca	Magpie-lark			
Campephagidae				
Coracina novaehollandiae	Black-faced Cuckoo-shrike		X	X
Oriolidae				
Oriolus sagittatus	Olive-backed Oriole		X	
Artamidae				
Strepera graculina	Pied Currawong		X	X
Gymnorhina tibicen	Australian Magpie		X	X
Corvidae				
Corvus coronoides	Australian Raven		X	
Ptilonorhynchidae				
Ptilonorhynchus violaceus	Satin Bowerbird		X	

Family/Scientific Name	Common name	Status	Open Forest	Aquatic habitat
Motacillidae				
Anthus australis	Australian Pipit			
Dicaeidae				
Dicaeum hirundinaceum	Mistletoebird		X	
Hirundinidae				
Hirundo neoxena	Welcome Swallow			
Sylviidae				
Acrocephalus australis	Australian Reed-Warbler			X
Zosteropidae				
Zosterops lateralis	Silvereye		X	
MAMMALS				
Dasyuridae				
Antechinus stuartii	Brown Antechinus		X	
Peramelidae				
Perameles nasuta	Long-nosed Bandicoot		X	
Vombatidae				
Vombatus ursinus	Common Wombat		X	X
Pseudocheiridae				
Pseudocheirus peregrinus	Common Ringtail Possum		X	X
Petauroides volans	Greater Glider		X	
Phalangeridae				
Trichosurus vulpecula	Common Brushtail Possum		X	X
Macropodidae				
Wallabia bicolor	Swamp Wallaby		X	
Macropus rufogriseus	Red-necked Wallaby		X	
Macropus giganteus	Eastern Grey Kangaroo		X	
Macropus robustus	Common Wallaroo		X	
Molossidae				
Tadarida australis	White-striped Freetail-bat		X	

Family/Scientific Name	Common name	Status	Open Forest	Aquatic habitat
Vespertilionidae				
Nyctophilus sp.	Long-eared Bat		X	
Nyctophilus geoffroyi	Lesser Long-eared Bat		X	
Chalinolobus gouldii	Gould's Wattled Bat		X	
Chalinolobus morio	Chocolate Wattled Bat		X	
Scotorepens sp.	Broad-nosed Bat		X	
Scotorepens orion	Eastern Broad-nosed Bat		X	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V (TSC Act)	X	
Vespadelus regulus	Southern Forest Bat		X	
Vespadelus vulturnus	Little Forest Bat		X	
Vespadelus darlingtoni	Large Forest Bat		X	
Muridae				
Rattus fuscipes	Bush Rat		X	
INTRODUCED MAMMALS				
Canidae				
Vulpes vulpes	Fox		X	X
FROGS				
Myobatrachidae				
Crinia signifera	Common Eastern Froglet			X
Limnodynastes dumerilii dumerilii	Eastern Banjo Frog			X
Limnodynastes peronii	Brown-striped Frog			X
Hylidae				
Litoria phyllochroa	Leaf-green Tree Frog			X

Family/Scientific Name	Common name	Status	Open Forest	Aquatic habitat
REPTILES				
Varanidae				
Varanus varius	Lace Monitor		X	
Scincidae				
Egernia striolata	Tree Skink		X	
Lampropholis delicata	Dark-flecked Garden Sunskink		X	
Eulamprus quoyii	Eastern Water-skink			X
Elapidae				
Pseudechis porphyriacus	Red-bellied Black Snake		X	
INVERTEBRATES				
Paralucia spinifera	Purple Copper Butterfly	E1 (TSC Act) V (EPBC Act)	X	

Appendix E Purple Copper Butterfly Survey Report

The Purple Copper Butterfly
Paralucia spinifera (Edwards & Common 1978)

Great Western Highway
Mount Victoria – Lithgow Realignment
Part 1 - Survey

MJADWESCH
ENVIRONMENTAL
SERVICE SUPPORT

This Purple Copper Butterfly survey report has been produced by Raymond Mjadwesch (BAppSci – Env Tech 1994), principal consulting ecologist, Mjadwesch Environmental Service Support.

The information contained herein is complete and correct to the best of my knowledge. I accept full responsibility for any errors or omissions, however this document has been prepared in good faith and on the basis that neither MESS nor its personnel are liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which may occur in respect of any representation, statement or advice herein.

Signed:

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Acknowledgments: Andrew Carty (Botanist SKM) conducted preliminary assessments, identifying areas of potential habitat, and guiding fieldwork – assistance during survey was appreciated. Josie Stokes (RMS Environment Officer – Biodiversity) also provided assistance during field assessment for the October session.

All photos by the author, other than where indicated otherwise (S Nally, DSEWPC recovery planning) in text. SKM, PB and RMS provided useful comments on DRAFTS of this report, and SKM provided base layers for mapped / air photo representations herein, as well as Habitat Maps (pp 11-13) and Attachment 1 (The Preferred Route).

Cover: *Purple Copper Butterfly, Bowenfels 19th September 2011*

Table of Contents

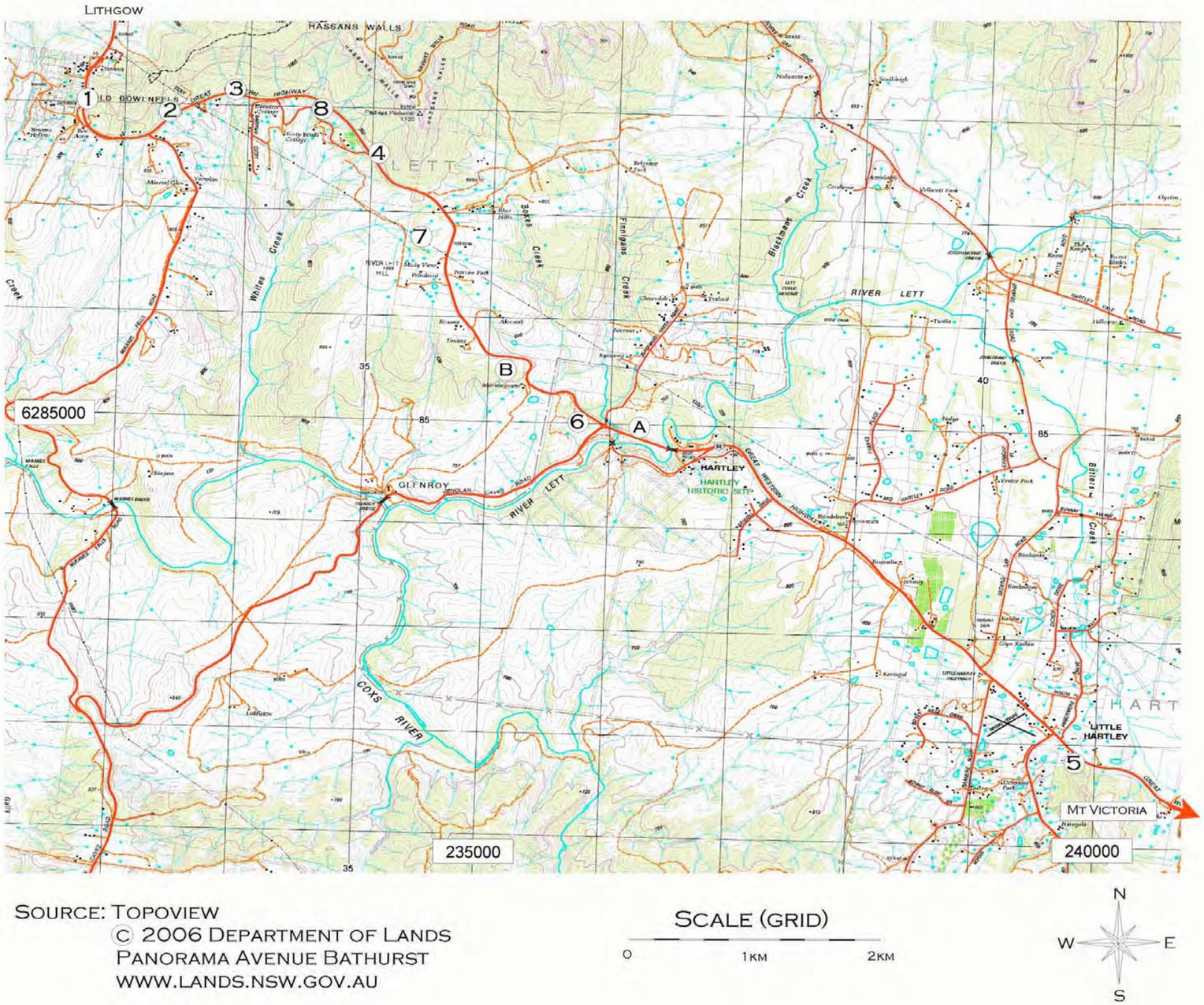
1. Background

In February 2011 the Roads & Maritime Services (RMS) entered into a partnership with Sinclair Knight Merz (SKM) and Parsons Brinckerhoff (PB) – the MV2L Alliance – to assess, plan and implement a realignment of the Great Western Highway between Mount Victoria (western Blue Mountains) and Bowenfels (on the outskirts of Lithgow), via the Hartley Valley (see Figure 1 and Attachment 1).

The Purple Copper Butterfly (*Paralucia spinifera*) is listed as ENDANGERED under the NSW *Threatened Species Conservation Act 1995* and as VULNERABLE under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*; a "Bowenfels" population is "known" at the western end of the proposed work corridor. Otherwise potential habitat for the butterfly (characterised by the presence of Native Blackthorn) was identified in a variety of situations, by SKM in mapping vegetation along the "preferred route" (SKM's Figure 4-4a-c *Bathurst Copper Butterfly distribution and habitat* has been reproduced here on pages 11-13).

Mjadwesch Environmental Service Support (MESS) was engaged to conduct habitat assessment and butterfly survey along the proposed preferred route, within identified areas of potential habitat. This report (Part 1) describes the butterflies distribution within and around the proposed route, and assesses the suitability of habitat. A supplementary report (Part 2 *in prep*) will consider impacts on the butterfly and its habitat, and the significance of impact, providing also recommendations for management of the threatened butterfly, under the proposed development scenario.

Figure 1. GWH Re-Alignment Preferred Route: Purple Copper Butterfly Inspection



nb: numbers along the alignment in the Figure above indicate map numbers, according to the discussion which follows.

2. Species Overview

The Purple Copper Butterfly, *Paralucia spinifera*, (hereafter PCB) is a small butterfly with a wingspan up to 20mm; colouring is copper to purple on the upper side (see cover), and light and dark brown mottled on the underside (Figure 2). Listed on state and federal threatened species schedules in 1996, a Recovery Plan (2001) has directed the species management for the last 10 years. The PCB is known only from open woodland, forest and grassland at higher altitudes of the NSW Central Tablelands, in an area roughly bounded by Lithgow, Oberon and Bathurst.

The butterflies rarely venture far from the host plant, almost always being found in direct association with Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*) on which the females lay their eggs, and on which the caterpillars feed. They are active on sunny days from August to November, when they can be seen sunning themselves, defending their little territories (energetically and acrobatically chasing each other), feeding from flowers, performing courtship chases, mating and laying eggs.

Figure 2. *The Purple Copper Butterfly* (Paralucia spinifera),
showing underside of wing; ♀ on left, ♂ on right (photo Yetholme 2008)

The species, as with many other Lycaenids (being a family of related butterflies), has a symbiotic relationship with a small ant, *Anonychomyrma itinerans,* which attend the caterpillars constantly (see Figure 3). The ants protect the caterpillars from predators, for which service the ants are “paid” with honeydew, which is excreted from a small gland on the rump of the caterpillar.

When the caterpillars grow larger they become nocturnal, retreating to the ants nest at the base of the plant during the day. The pupae subsequently undergoes metamorphosis underground, in upper chambers of the ants nest.

Figure 3. *Caterpillars grow to around 20mm in length, and are constantly tended by ants* (photo S Nally)

The host plant, Blackthorn, *Bursaria spinosa* subsp*. lasiophylla,* (Figure 4) grows on open and disturbed sites across the Central Tablelands. It occurs at altitudes of 850m and more, producing sprays of white flowers in summer and purse-like seedpods in early autumn. This species can be differentiated from other Blackthorn species by the tiny hairs on the underside of its leaves, giving them a whitish appearance. New growth is characterised by reddish, shiny stems and thorns; older plant stems turn grey, and may become susceptible to sooty mould or covered with lichen in old age.

Figure 4. *Native Blackthorn* (Bursaria spinosa subsp. lasiophylla)*: flowers (left) and close up of leaves (right)* (photos S Nally)

3. Limitations

Preliminary survey of the preferred route corridor had been conducted by SKM, which identified target areas for survey, characterised by presence of the threatened butterfly's host plant Native Blackthorn (*Bursaria spinosa lasiophylla*). Sections of the preferred route were traversed on foot during this assessment, however butterfly survey was directed by SKM to those areas identified as potential habitat. MESS did not inspect the entire run of the preferred route to identify potential habitat, instead relying on the SKM vegetation assessment to identify areas to be targeted for butterfly survey (see following pages).

4. Planning

The Purple Copper flies around Lithgow between mid-August and December – this is the period when it is most easily detected, and during which survey should occur. Some small sites (for example the Eusdale Road population at Yetholme) have been observed to have very short flying periods, most likely on the basis of small numbers of butterflies producing only a single or few small clutches of larvae each year.

For these reasons, sessions for survey of the Preferred Route were planned for September and October, in order to maximise the chances of intercepting the flying period of any small populations, which may only have a short flying period.

5. Methodology

1. Survey was undertaken under optimal "flying" conditions (sunny and warm, low wind, between 10:00am and 4:00pm)

2. Spot check at known sites (Vickers Street &/or Bowenfels) to confirm that butterflies were active and flying on the day of the assessment

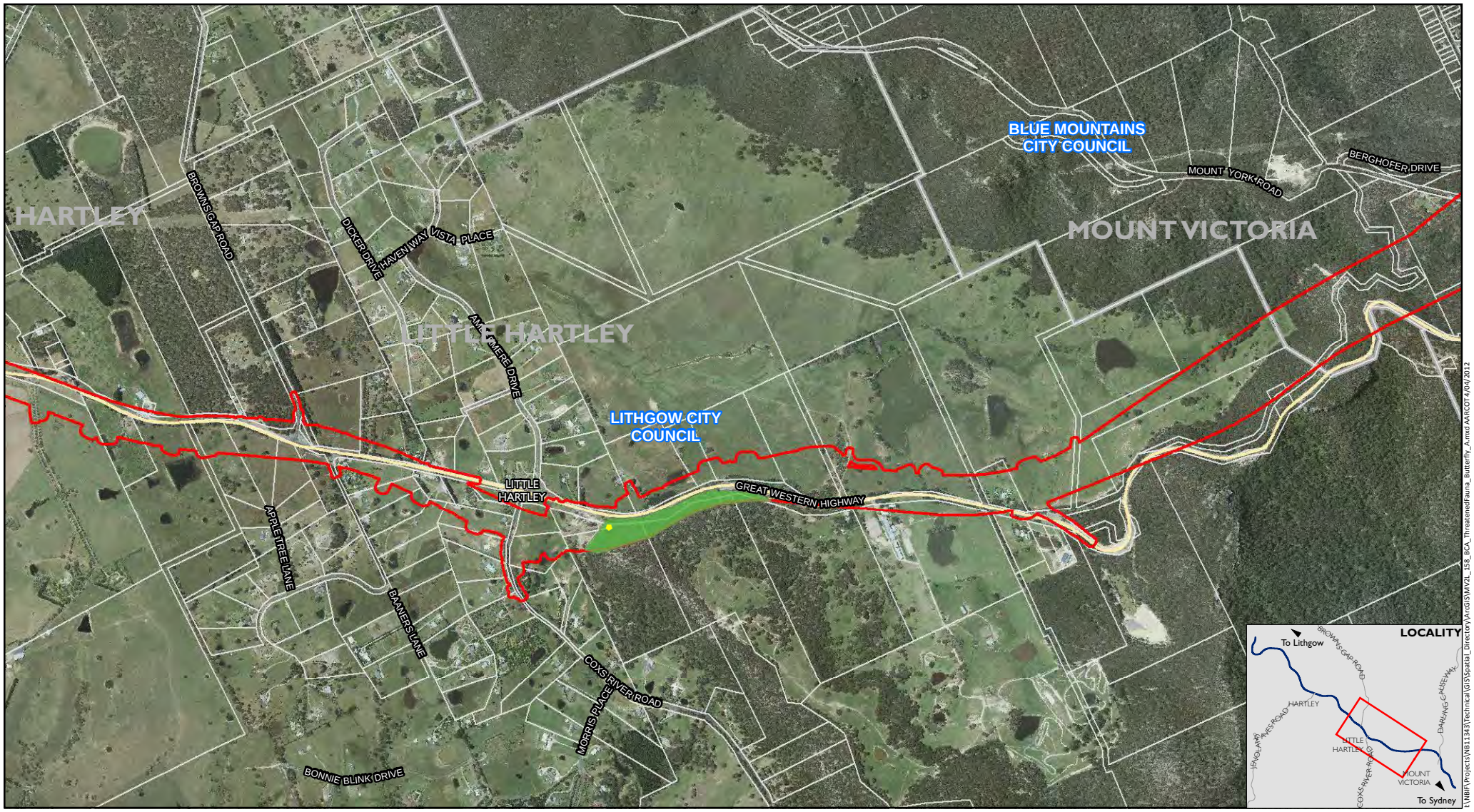
3. Inspection of Blackthorn patches on foot. Many of the better (higher potential) habitat units were GPS'ed (all waypoint units and map grids are Geodetic Datum of Australia) and photographed

4. Walk through habitat, disruption to vegetation to scare up butterflies if present

5. Periods of stationary / wide observation within each habitat unit

6. Record presence / absence and distribution of PCB's

7. Searches for signs of caterpillars, including early instar and other grazing, and presence of the attendant ant *Anonychomyrma itinerans*



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Transport Roads & Maritime Services

SKM PARSONS BRINCKERHOFF

FIGURE TITLE

Figure 4-4a Bathurst Copper Butterfly distribution and habitat

BIODIVERSITY CORRIDOR ASSESSMENT

PROJECT TITLE

Mt Victoria to Lithgow: Great Western Highway upgrade

LEGEND

- Preferred route corridor
- Bathurst Copper Butterfly survey locations

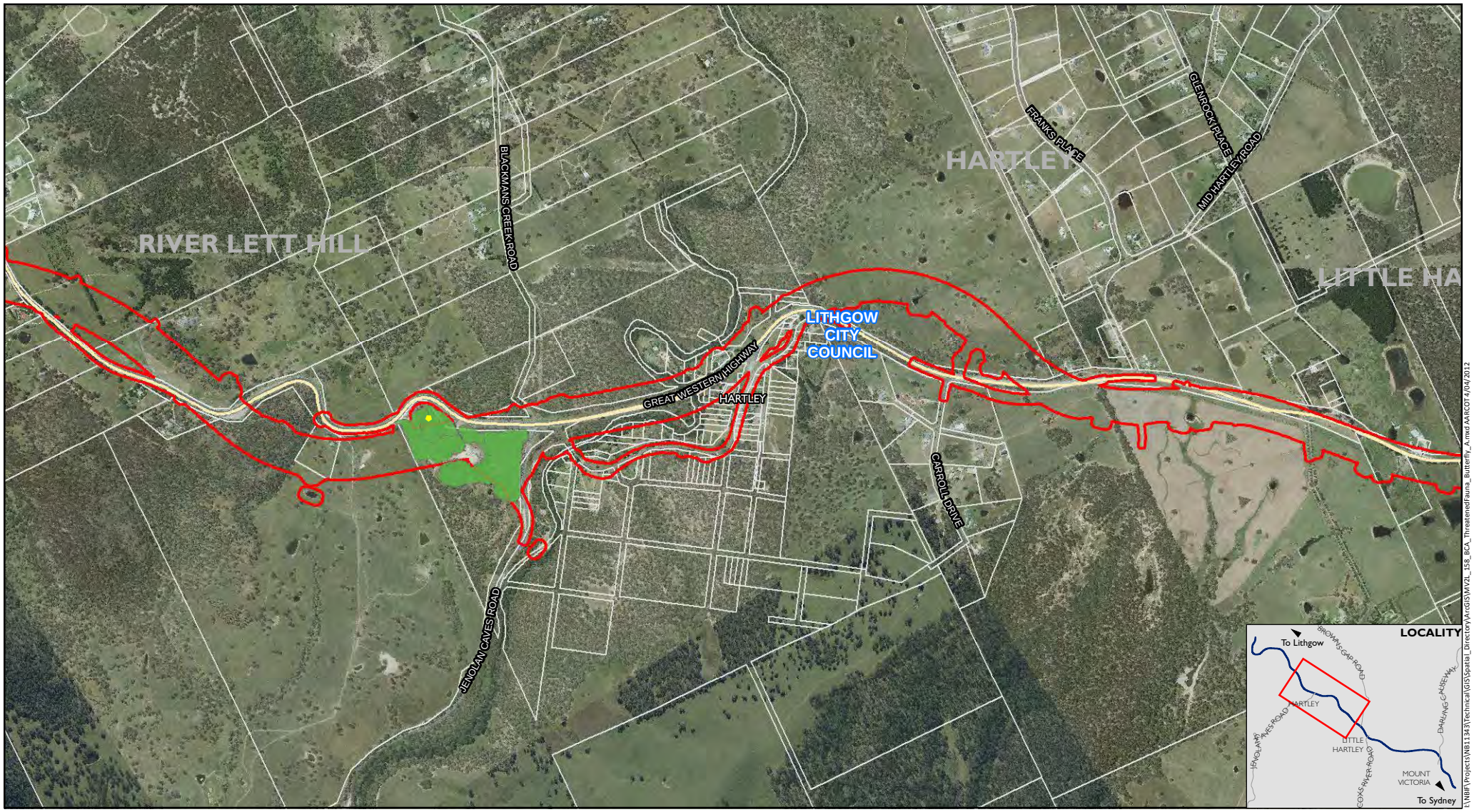
Habitat

- High Potential Habitat
- Occupied Habitat
- Potential Habitat - Blackthorn shrubs present

GDA 94 | MGA 56
A4 1:20,000

0 250 500
Metres

Aerial Photograph: SKM AUSIMAGE 2011



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Transport Roads & Maritime Services
NSW GOVERNMENT

SKM PARSONS BRINCKERHOFF

FIGURE TITLE
Figure 4-4b Bathurst Copper Butterfly distribution and habitat
BIODIVERSITY CORRIDOR ASSESSMENT

PROJECT TITLE
Mt Victoria to Lithgow: Great Western Highway upgrade

LEGEND

- Preferred route corridor
- Bathurst Copper Butterfly survey locations

Habitat

- High Potential Habitat
- Occupied Habitat
- Potential Habitat - Blackthorn shrubs present

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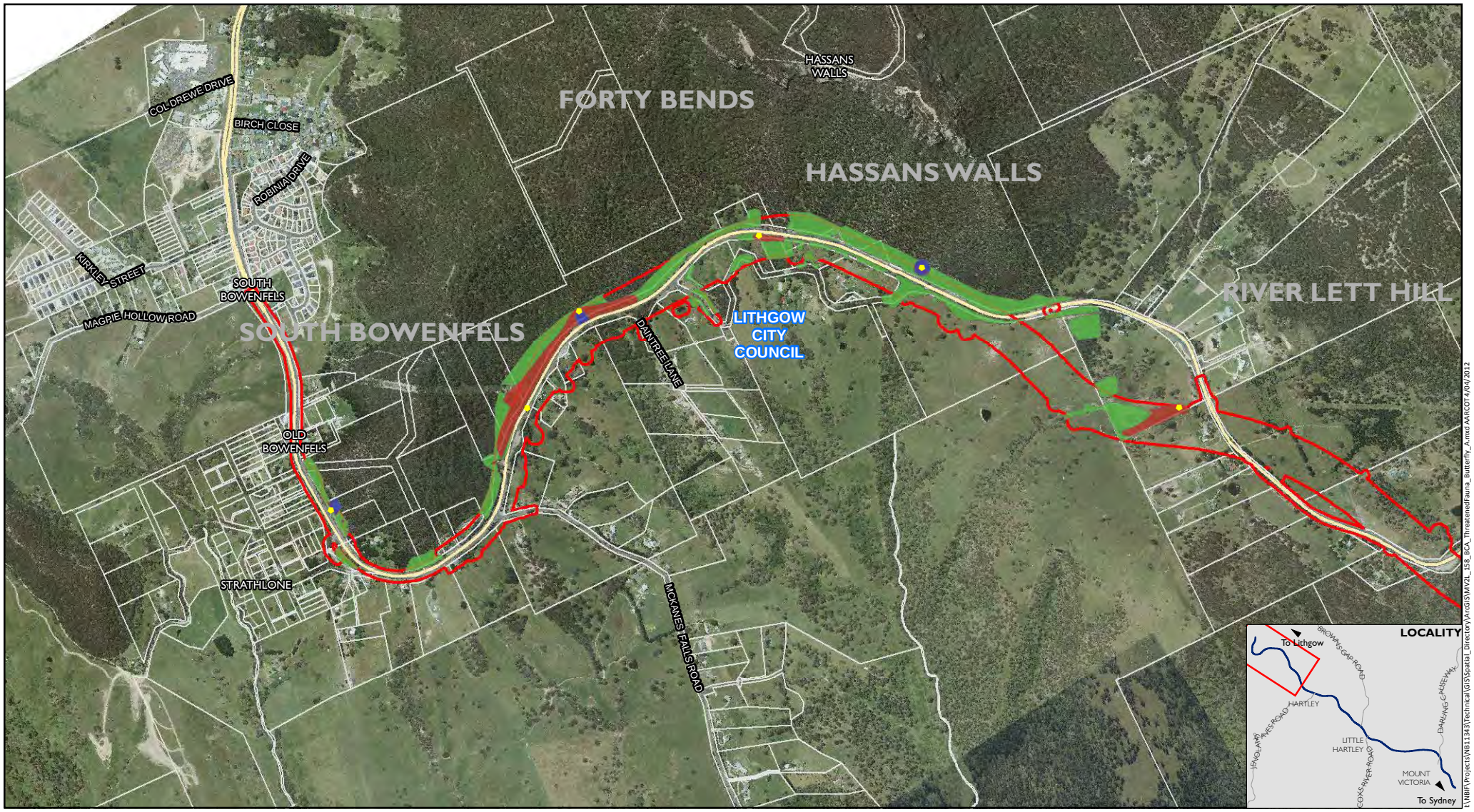
0 250 500
Metres

Aerial Photograph: SKM AUSIMAGE 2011



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Transport Roads & Maritime Services
NSW GOVERNMENT

SKM PARSONS BRINCKERHOFF

FIGURE TITLE
Figure 4-4c Bathurst Copper Butterfly distribution and habitat
BIODIVERSITY CORRIDOR ASSESSMENT

PROJECT TITLE
Mt Victoria to Lithgow: Great Western Highway upgrade

LEGEND

- Preferred route corridor
- Bathurst Copper Butterfly survey locations

Habitat

- High Potential Habitat
- Occupied Habitat
- Potential Habitat - Blackthorn shrubs present

GDA 94 | MGA 56
A4 1:20,000

0 250 500
Metres

Aerial Photograph: SKM AUSIMAGE 2011

6. Results

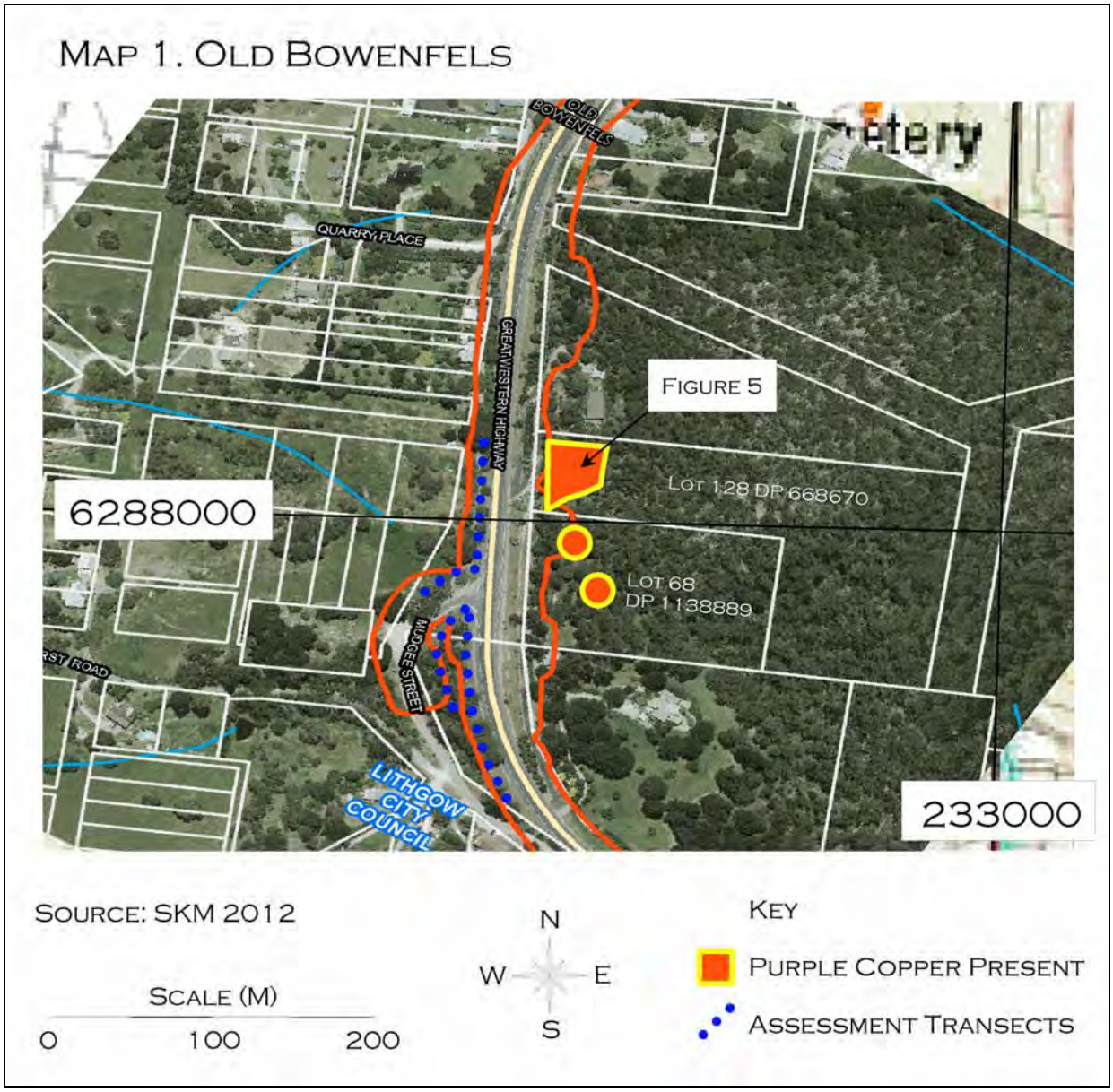
21st October 2011

Spot check (confirmation of PCB flying at nearby "known" population)

Location				PCB	Notes
Vickers Street				Y	PCB's start flying at 10:00am

Other species which characterise suitable conditions (adequately warm and sunny days in early spring) were observed flying prior to the PCB becoming active at Vickers Street (blowflies and Dusky Blue (*Candalides hyacinthina*)).

Map 1	Easting	Northing	Alt (m)	PCB	Notes
Old Bowenfels	232692	6288040	968	Y	Flying throughout known site
Old Bowenfels	232706	6287980	971	Y	1PCB to south of main site
Old Bowenfels	232724	6287943	974	Y	2PCB further south of main site
Western Reserve	232639	6287926	951	N	None observed, Blackthorn looks planted, no ants observed



Map 1 illustrates the location of the Bowenfels population and population satellites (to the south) as observed in 2011, and the extent of habitat and survey in the western roadside reserve.

Figure 5. *Most of the Bowenfels PCB population occurs within the adjacent private property, on the open, grassy, west-facing slope*

The known Bowenfels PCB population occupies the eastern roadside reserve of the Great Western Highway at Old Bowenfels, and a clearing in the property adjoining (Lot 125 DP 668670, pictured in Figure 5 above). Two small satellite PCB populations were observed in 2011 utilising small and isolated units of Blackthorn within the forest on the portion adjoining to the south (Lot 68 DP 1138889); the attendant ant was observed at all locations.

Across the highway (the western roadside reserve), Blackthorn occurs around the edges of the vegetation, however much of it looks like it may have been planted (Figure 6). No butterflies were observed; inspections of Blackthorn stems and foliage, targeting the attendant ant, did not provide positive identifications of this species, nor were diagnostic early instar and other grazing patterns observed in the foliage.

While Blackthorn in the western roadside reserve represents potential habitat, the absence of butterflies, absence of the attendant ant, and no signs of use from the butterfly, provide that habitat here is sub-optimal.

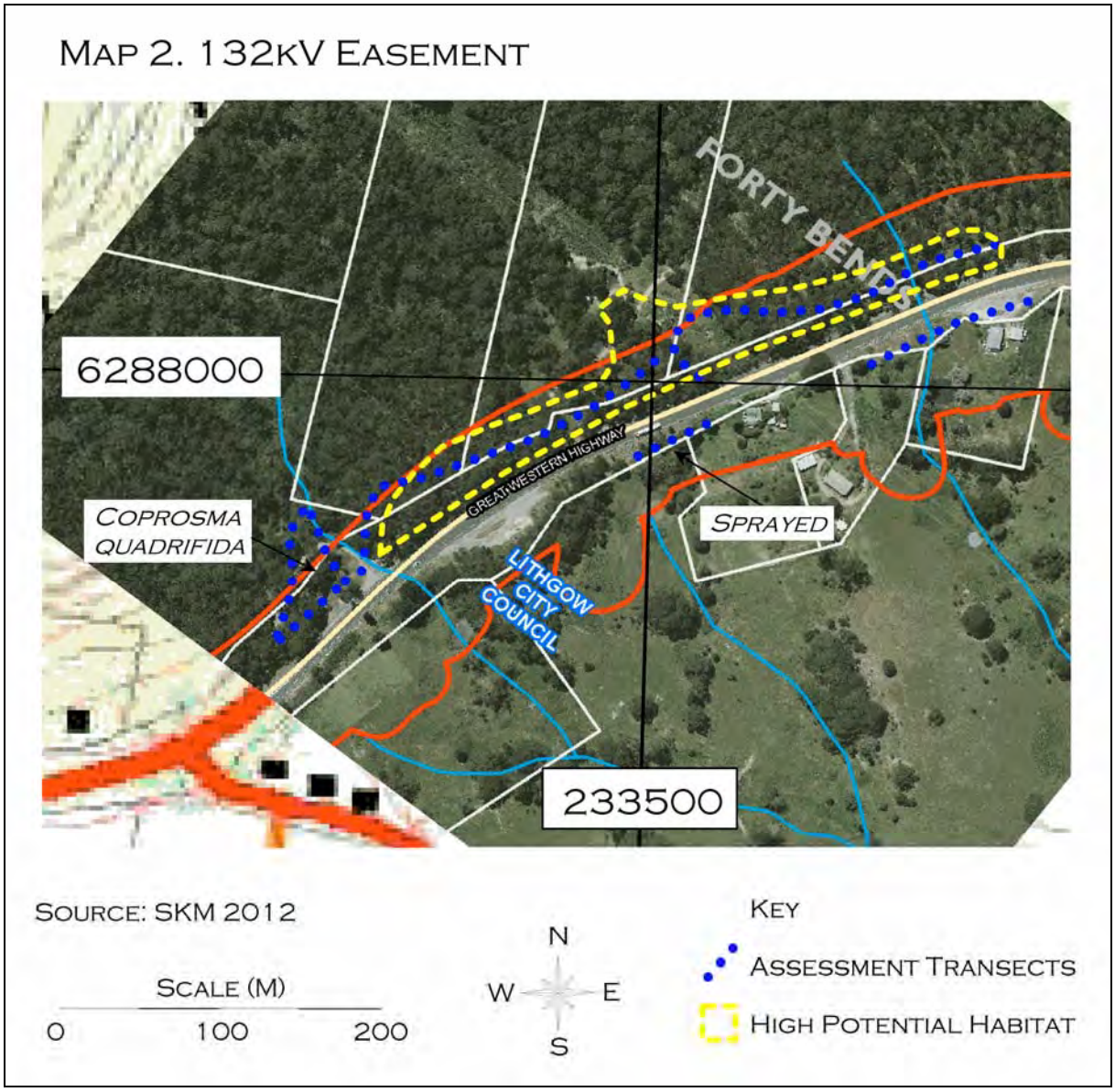
Figure 6. *The western roadside reserve at Old Bowenfels has Blackthorn, however it does not appear to be utilised, some of it may have been planted, and some will probably be subject to management (slashing) periodically, where it grows under the powerline easement*

Map 2 illustrates a section of the Great Western Highway, where Blackthorn was observed in the roadside reserves, including scattered plants throughout the majority of the length of assessment transects, and including very high potential habitat (in the case of Blackthorn growing in the 132kV powerline easement).

Map 2	Easting	Northing	Alt (m)	PCB	Notes
North Reserve	233251	6287880	952	N	*Coprosma quadrifida*
Dead Blackthorn	233507	6287960	946	N	Blackthorn mostly dead (sprayed?)
132kV Easement	233524	6288040	950	N	High potential habitat, no PCB observed

Prickly Currant Bush (*C. quadrifida*) is superficially similar to Blackthorn, but tends to occupy wetter more sheltered forest situations (Figure 7); it grows in the gully and lower slopes indicated at left in Map 2. This unit was targeted as potentially containing habitat for the butterfly (Prickly Currant Bush and Blackthorn sometimes grow together); no Blackthorn was observed.

The sprayed and mostly dead Blackthorn in the southern reserve was growing with Blackberry (*Rubus fruticosus*, which was probably the target of the spraying program), and Bracken Fern (*Pteridium esculentum*), which was also dead or dying (Figure 8). This unit provides extremely poor habitat values for the butterfly; no attendant ants were observed in this unit; the PCB was not observed at this location.



The northern roadside reserve provides extensive and scattered areas of potential habitat, including high potential units, particularly along and adjacent to the 132kV powerline easement, which provides optimal bright and sunny open and grassy aspects.

If possible impacts on this area of habitat should be avoided, to provide opportunities for the butterfly to occupy this potential habitat if conditions improve (for example after the structural change that would come with a regional fire – more open canopy, changed groundcover composition and structural arrangement, re-invigorated Blackthorn, etc). See Part 2.

Figure 7. *Prickly Currant Bush in wet forest*

Figure 8. *Sprayed Blackthorn growing with sprayed Blackberry and sprayed Bracken*

Map 3	Easting	Northing	Alt (m)	PCB	Notes
Forty Bends 1	233865	6288157	949	Y	5 PCB flying at this location

Map 3 illustrates the location of a new PCB population which was observed during survey in 2011 (Forty Bends 1), the distribution of high potential habitat in the northern reserve and the extent of survey along the northern and southern roadside reserves. The eastern limit of survey shown on Map 3 corresponds with a change in vegetation type from the grassy forest type in which Blackthorn is a common shrub, to a less fertile sandstone soil type, on which species such as Prickly Shaggy Pea (*Oxolobium ilicifolium*) become dominant.

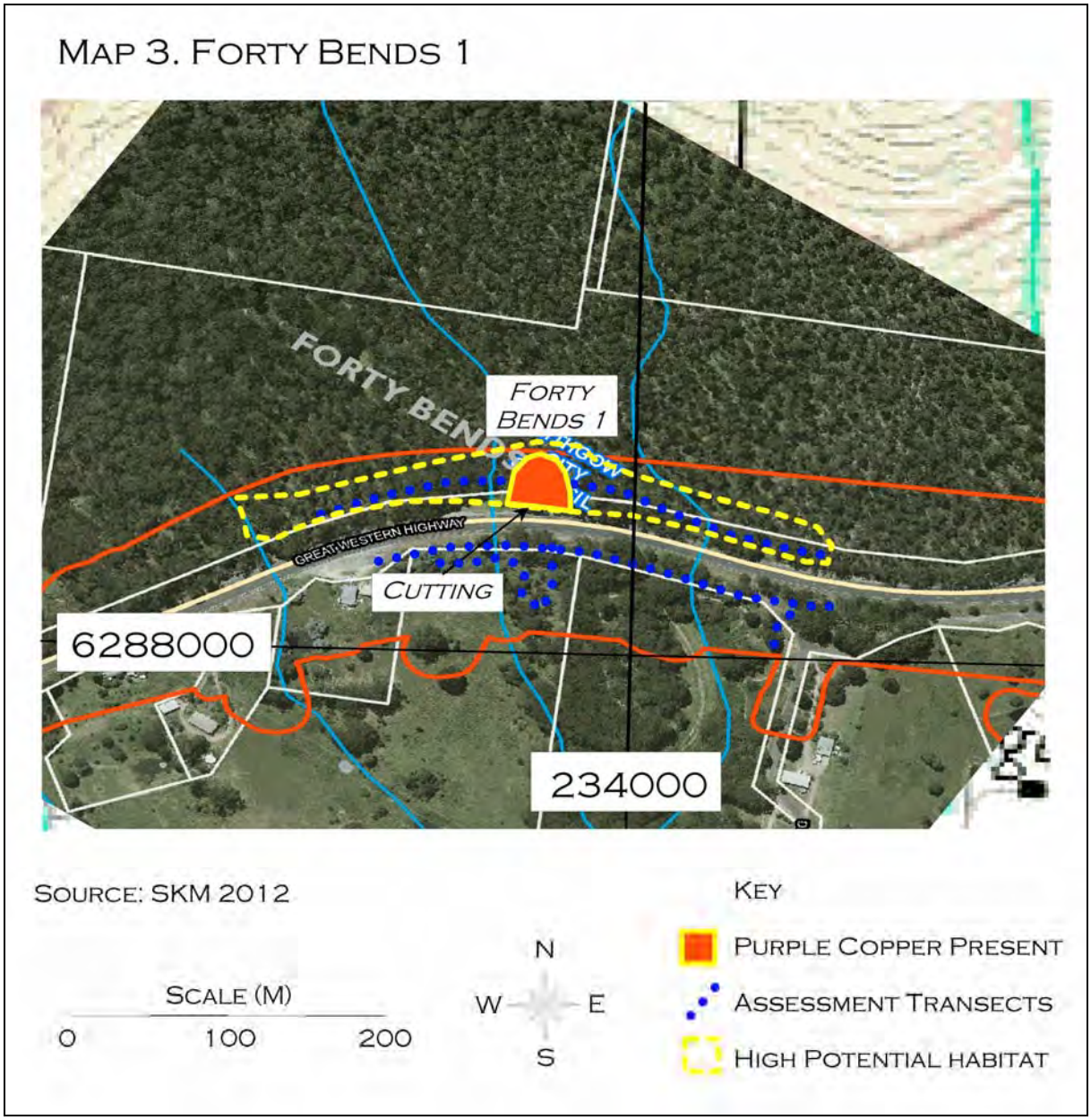


Figure 9 shows the cutting on the top of which the Forty Bends 1 Purple Copper Butterfly population is located, the attendant ant *A. itinerans* was also observed to be active on plants and on the ground.

Across the highway in the southern roadside reserves potential habitat also lines the edge of the forest (Figure 10) and occurs elsewhere in clearings. No butterflies or evidence of their utilising the Blackthorn to the south of the existing highway alignment, such as presence of the attendant ant or characteristic caterpillar grazing patterns, were observed.

Figure 9. *The small cutting on top of which the Forty Bends 1 population was observed*

Figure 10. *Blackthorn with good habitat attributes is not always utilised by the Purple Copper*

Map 4	Easting	Northing	Alt (m)	PCB	Notes
Forty Bends 2	235019	6287601	894	Y	3 PCB flying in sunny glade

Map 4 illustrates the location of a second Purple Copper Butterfly population found during survey in 2011, and the extent of survey along the northern and southern roadside reserves. This population lies in an area with a more open lower shrub strata with Blackthorn, within an area dominated generally by a denser shrubby sandstone vegetation type, dominated by Prickly Shaggy Pea; the attendant ant *A. itinerans* was also observed.

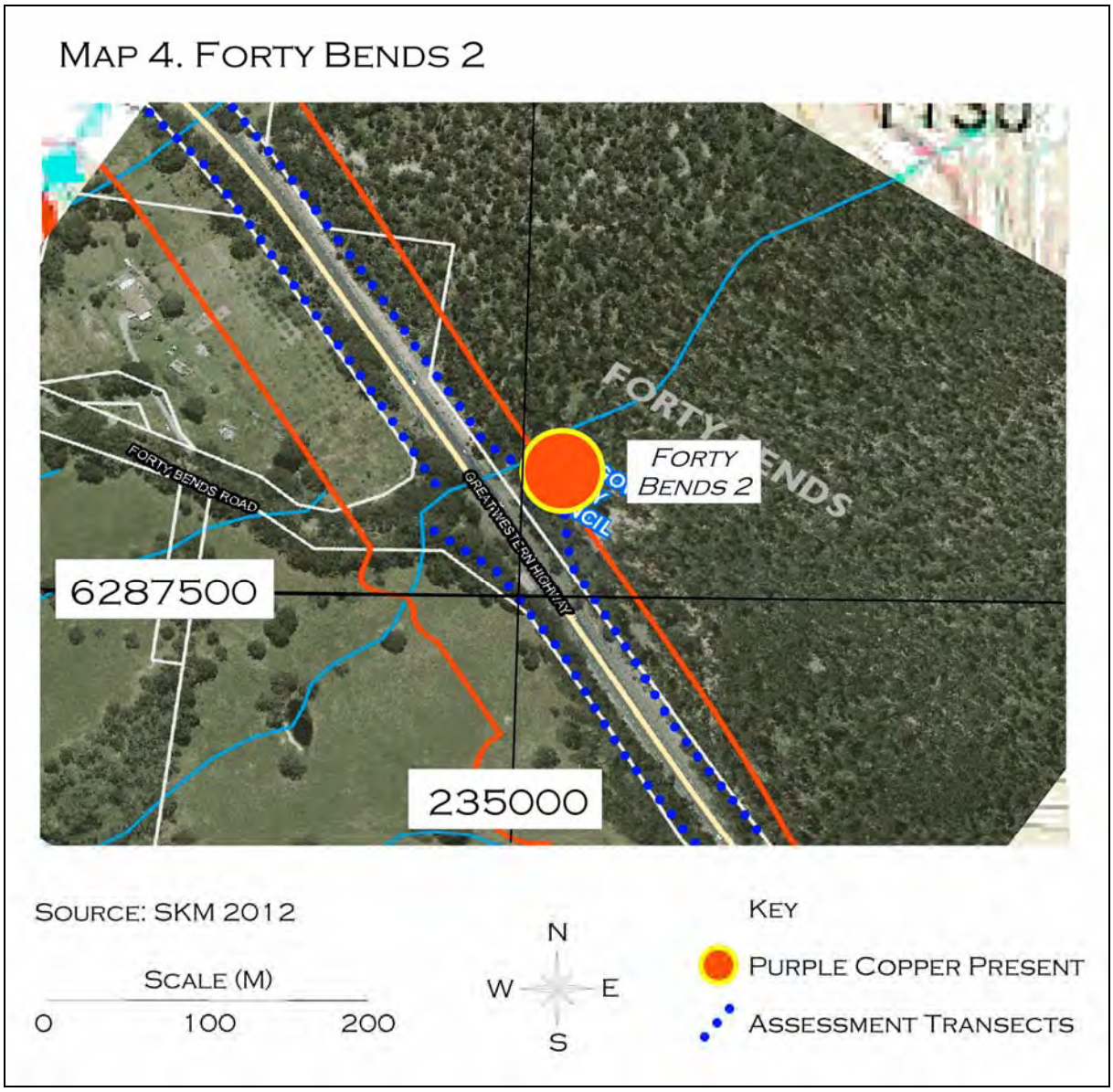
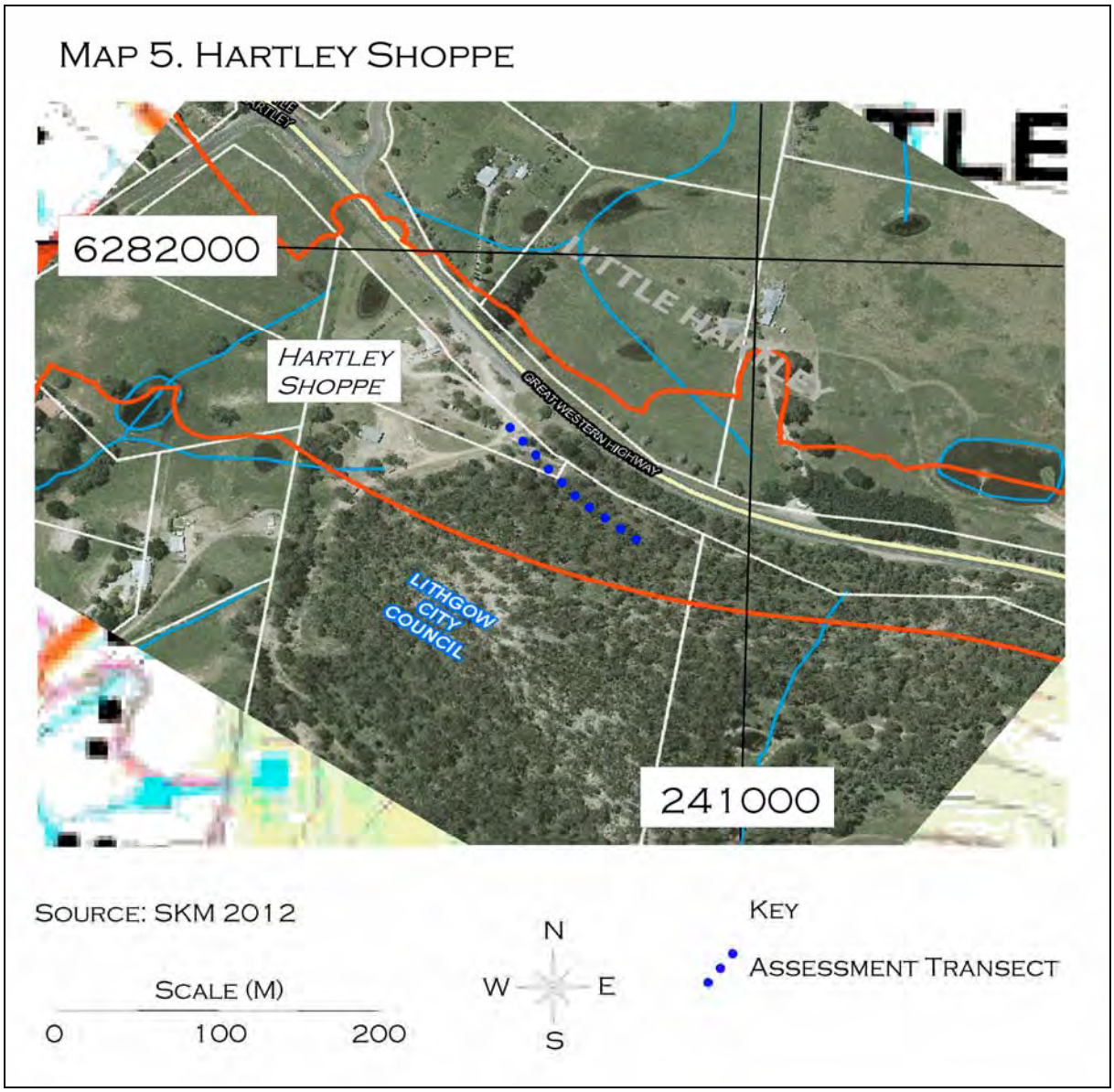


Figure 11 illustrates the character of the open glade in which the second Forty Bends Purple Copper Butterfly population was observed flying in 2011. Other areas, including locations in the southern roadside reserves, were observed to contain scattered plants and patches of Blackthorn. These units represent potential habitat, however the threatened butterfly was not observed in the other nearby roadside habitats, nor were the attendant ant, nor were signs of use recorded.

Figure 11. *A sunny glade with a south-westerly aspect, and bounded along the western edge by a track, is utilised by the Purple Copper*

Map 5	Easting	Northing	Alt (m)	PCB	Notes
Hartley Shoppe	240862	6281822	825	N	*Paralucia aurifer* observed

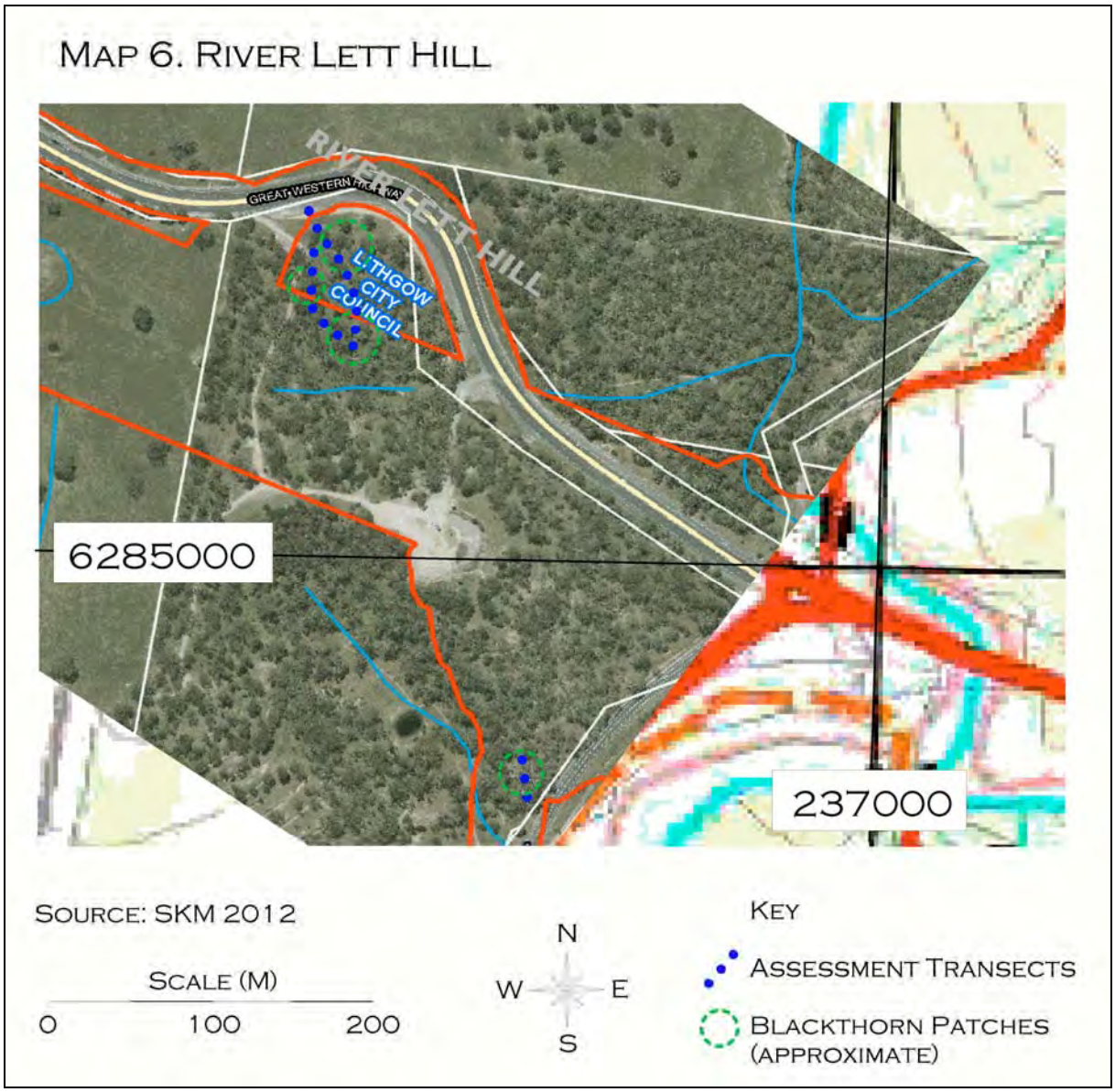
Map 5 illustrates the location of an extensive patch of Blackthorn on the lower flanks of a steep hill, with a sunny open northerly aspect – optimal seeming habitat. Nonetheless the low altitude (well below 900m – a guideline altitude below which the threatened butterfly rarely occurs) makes this lower slope habitat marginal at best. The Purple Copper was not observed at this location, nor was the attendant ant.



Map 6	Easting	Northing	Alt (m)	PCB	Notes
River Lett Hill	236623	6285216	760	N	Grassy woodland
Jenolan Road	236753	6284820	725	N	Grassy woodland

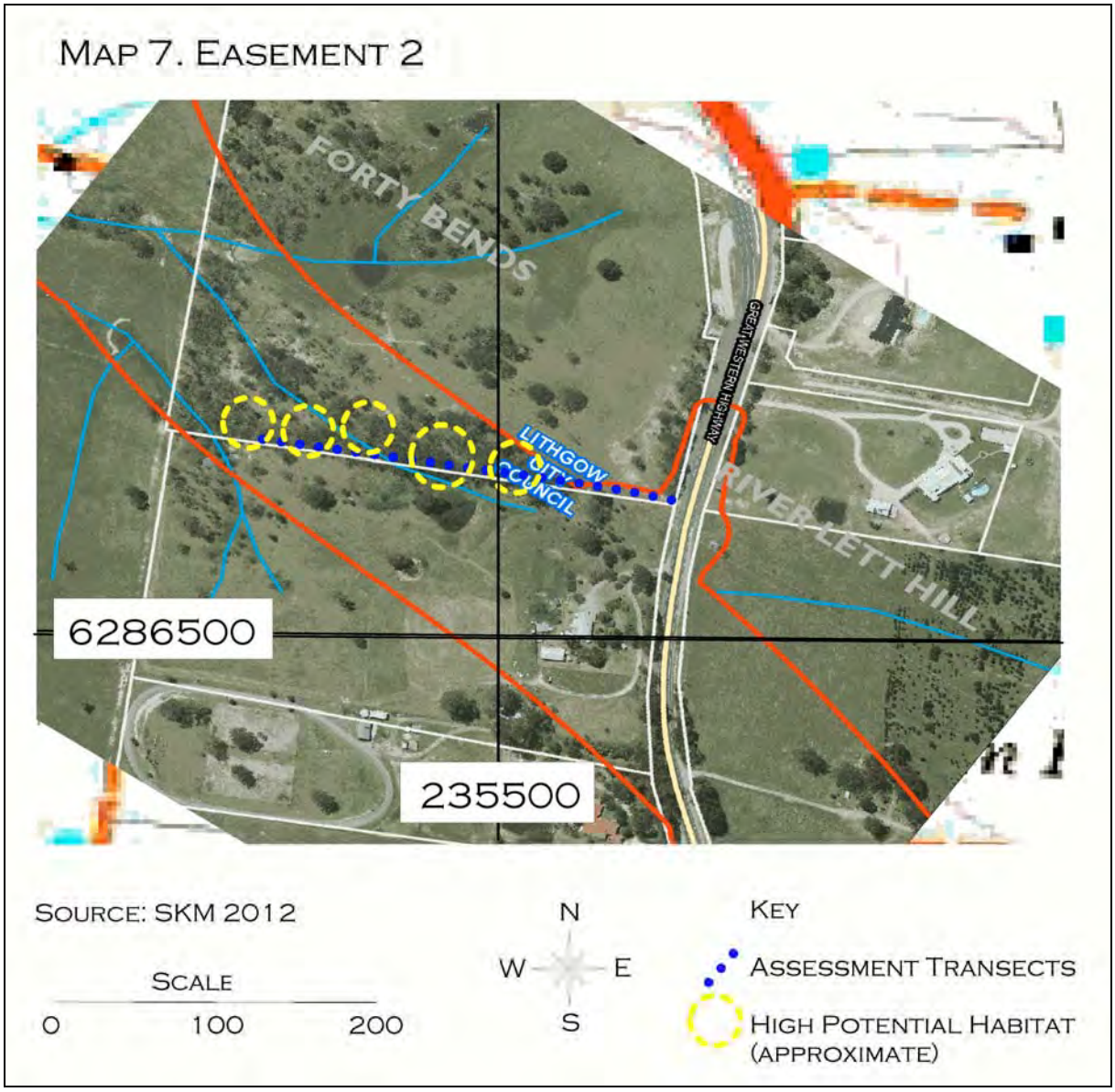
Map 6 illustrates the location of several patches of Blackthorn on the steep slopes which descend to the River Lett, and near to the Great Western Highway intersection with Jenolan Caves Road.

Neither the PCB, nor the attendant ant, nor signs of grazing, were observed here. The habitat has marginal value, being well below the 900m altitude usually indicative of optimal habitat conditions.



Map 7	Easting	Northing	Alt (m)	PCB	Notes
Start Blackthorn	235536	6286646	890	N	Blackthorn along boundary fence
Easement	235525	6286638	903	N	*A. itinerans*, high quality habitat
Close to Preferred Route	235367	6286659	889	N	Several patches of high quality habitat

Map 7 illustrates where Blackthorn occurs in a tree lane growing alongside a fence; this assessment transect intersected the same 132kV power line easement which is featured in Map 2.



The aspects of various of the Blackthorn patches were often open and sunny (Figure 12), and the attendant ant *A. itinerans* was observed on several occasions. However none of the ants observed were found to be tending caterpillars of the Purple Copper, neither were signs of grazing evident, nor was the Purple Copper Butterfly itself observed.

The altitude of these potential habitat units is suitable for the PCB, and while the butterfly was apparently absent from these areas in 2011, the patches are considered to have high potential as habitat for the butterfly.

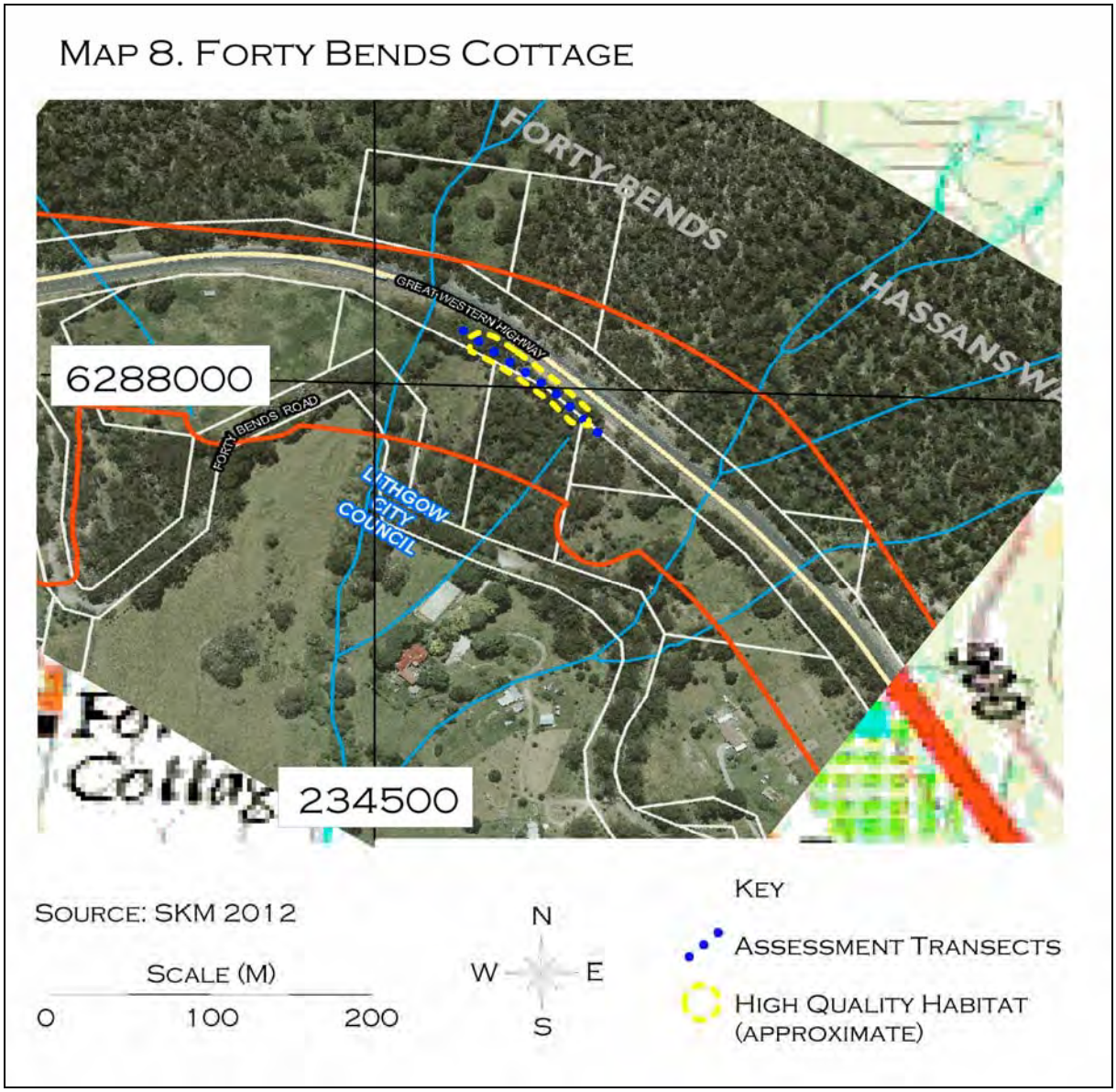
Figure 12. *Habitat in the tree lane / easement to the south of the known (Bowenfels and Forty Bends) butterfly populations seems optimal, however the Purple Copper was not observed here, despite careful inspections of potential habitat areas.*

19th October 2011

Map 8					
Old Bowenfels				Y	PCB's start flying at 10:00am

Map 8	Easting	Northing	Alt (m)	PCB	Notes
Forty Bends Cottage	234577	6288029	909	N	High potential, *A. itinerans*
South Reserve	234643	6287985	872	N	End of branch grazing (beetles)

Map 8 illustrates the approximate location of a section of high quality habitat (open sunny north-east aspects) on the top of a cutting in the southern reserve of the Great Western Highway in proximity to Forty Bends Cottage. Despite the attendant ant being observed in very low numbers, and suitable altitude, no butterflies or signs of caterpillar activity (grazing) were observed.



Location	Easting	Northing	Alt (m)	PCB	Notes
Forty Bends 2	235026	6287599	946	Y	2 active at 11:30, by careful search
Forty Bends 1	233871	6288154	944	Y	1 found by careful search

Populations located during the September site assessment at Forty Bends were revisited in October. In both instances the Purple Copper was not immediately noticeable.

At the Forty Bends 2 site (Map 4) three ecologists searching the central clearing and perimeter, particularly along the track and including disturbance to vegetation did not provide observations of the PCB. The attendant ant *A. itinerans* was observed on some small bushes in the centre of the clearing. A period of stationary watching allowed time for a pair of butterflies to become active; their activity seemed to be centred around plants in the eastern (uphill) end of the clearing.

At Forty Bends 1 (Map 3) the Bright Copper (the closely related *Paralucia aurifer*) was noted as present immediately. A careful search here included repeated transects through the known utilised habitat area, with disruption to vegetation, and periods of stationary but wide observation, to no avail. A final check provided an observation of a single butterfly at the northern (uphill) end of the mapped unit (Map 3) on *Comesperma ericinum* flowers.

The PCB was not observed in the unit of potential habitat in the southern reserve (across the GWH from FB2) – this unit was mostly deeply shaded at the time of this assessment, no ants were observed (not optimal PCB habitat conditions).

Blackthorn near to the Jenolan Road intersection was inspected only at this point (discussed previously and appearing on Map 6). Low altitude (725m) and most Blackthorn with hairless underside to leaf (low altitude form), and apparent absence of the attendant ant, precludes any potential for this area, and areas supporting Blackthorn on River Lett Hill, to be utilised by the Purple Copper Butterfly.

132kV powerline easement locations (illustrated on Map 2 and Map 7) and other sections of the roadside reserves with Blackthorn which had been inspected previously (in September) were all re-inspected in October (Map 1 and Map 5), except for the sprayed / dead unit (location illustrated on Map 2). While still sometimes representing high quality habitat (Map 2 and Map 7), no PCB's were observed at these locations during the October assessment period.

7. Other Inspection Locations

Several other locations were also inspected for presence of the Purple Copper. These included a high cutting in the eastern roadside reserve near the speed cameras (open and grassy, with eucalypt regeneration), and at the top of River Lett Hill (Stringy Bark (*Eucalyptus macrorhyncha*) and Nodding Blue Lily (*Stypandra glauca*) dry forest interspersed with Yellow Box (*E. melliodora*) grassy woodland). These locations are indicated "A" and "B" in Figure 1; Blackthorn was not observed at these locations.

8. Conclusion

The "known" Bowenfels population was observed to be active during both the September and October assessment periods. Inspections of roadside reserves within the corridor defining the preferred route for realignment of the Great Western Highway provided two additional Purple Copper Butterfly populations at Forty Bends (Map 3 and Map 4).

High quality habitats were observed, including along the 132kV power line easement which twice intersects the preferred route, as well as other sunny, partially wooded slopes, at and around 900m ASL (Map 2, Map 3, Map 4, Map 7 and Map 8). Habitat here could potentially be colonised by the butterfly if conditions change, for example if regional fire were to modify the structure of habitat.

Other habitats units were inspected at lower altitudes and in shaded situations; these factors and apparent absence of the attendant ant renders these units sub-optimal (Map 5 and Map 6). The PCB would not be expected to occur along the entire range of habitat situations represented along the preferred route.

Potential impacts of road-works within the preferred route corridor will be considered as part of the projects environmental impact assessment.

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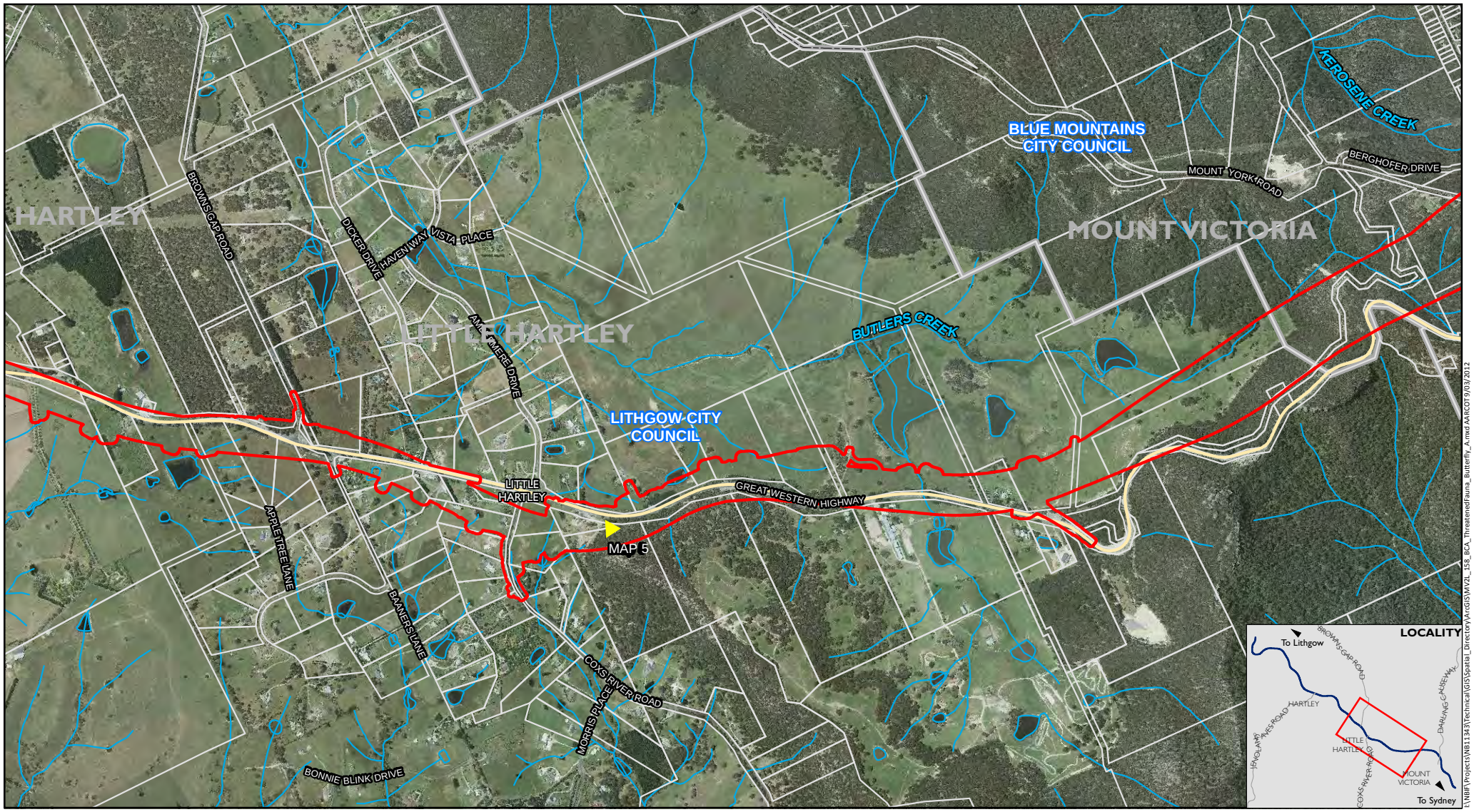
Attachment 1. The Preferred Route
(MV2L Alliance 2011)



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Transport Roads & Maritime Services
NSW GOVERNMENT

SKM PARSONS BRINCKERHOFF

PLAN TITLE

Figure 4-1a Purple Copper Butterfly survey locations
BIODIVERSITY CORRIDOR ASSESSMENT

PROJECT TITLE

Mt Victoria to Lithgow: Great Western Highway upgrade

LEGEND

- Preferred route corridor
- PURPLE COPPER BUTTERFLY SURVEY LOCATIONS

GDA 94 | MGA 56
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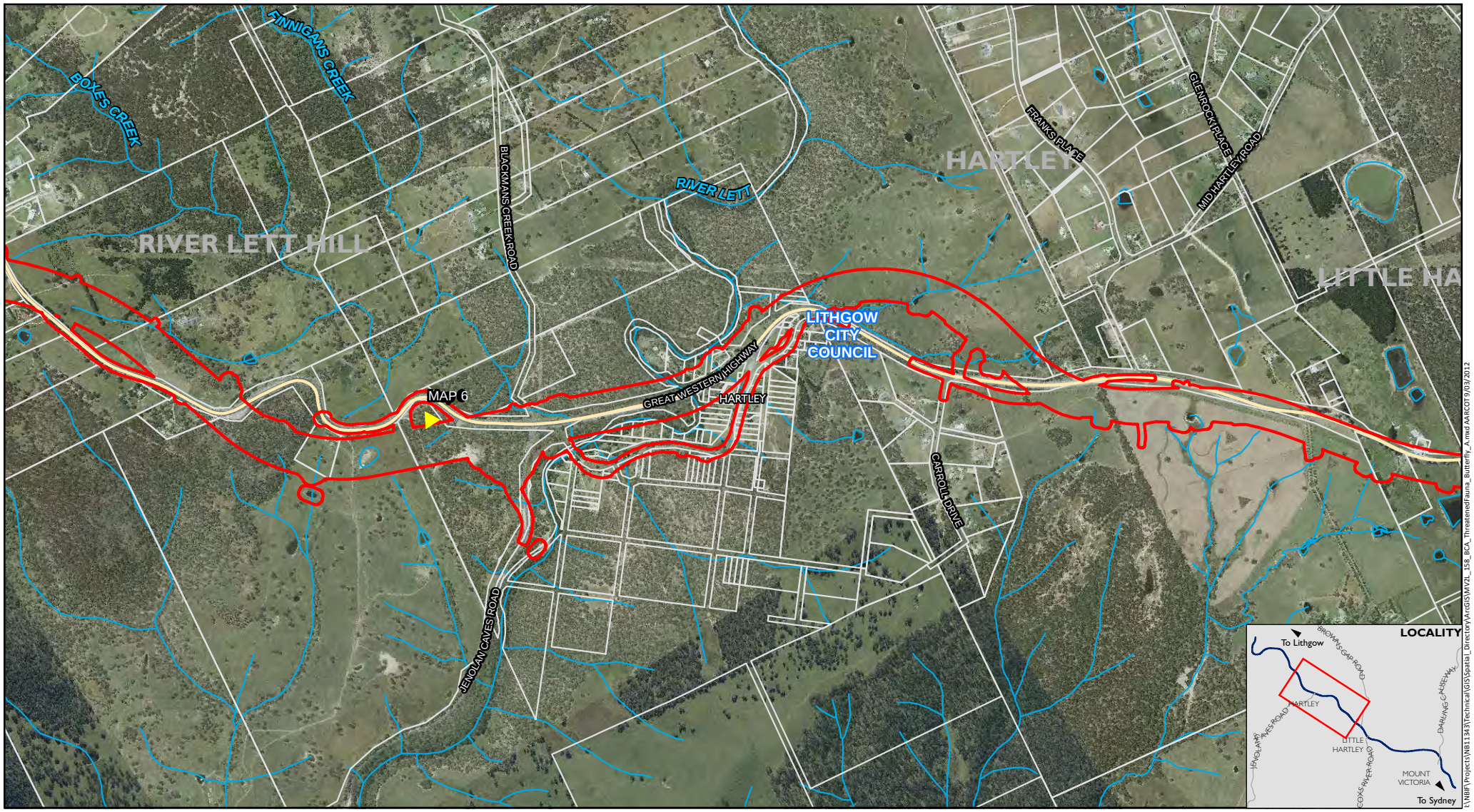
Metres

Aerial Photograph: SKM AUSIMAGE 2011



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NSW GOVERNMENT

SKM PARSONS BRINCKERHOFF

PLAN TITLE

Figure 4-1b Purple Copper Butterfly survey locations
BIODIVERSITY CORRIDOR ASSESSMENT

PROJECT TITLE

Mt Victoria to Lithgow: Great Western Highway upgrade

LEGEND

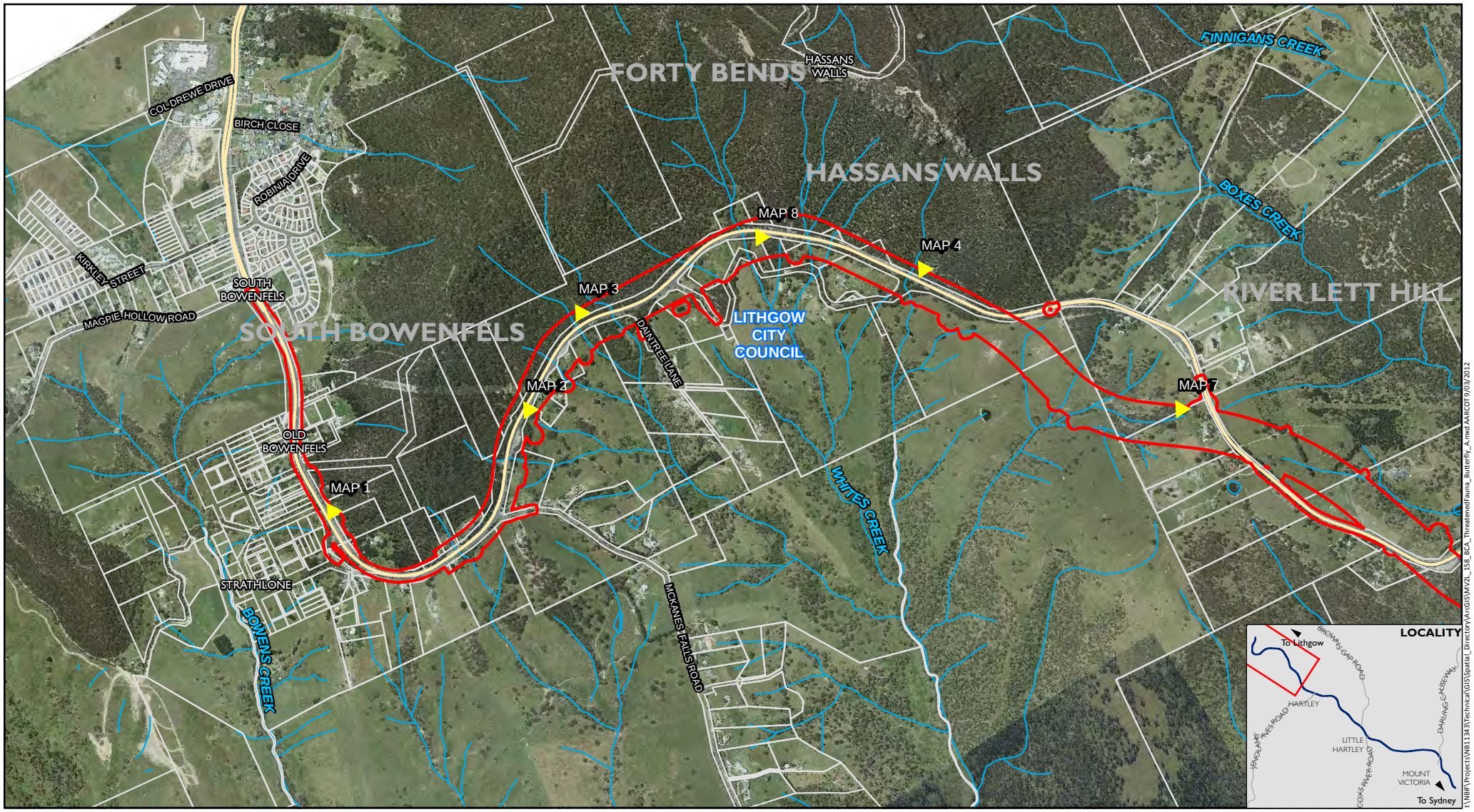
Preferred route corridor

PURPLE COPPER BUTTERFLY SURVEY LOCATIONS

GDA 94 | MGA 56
A4 1:20,000

0 250 500
Metres

Aerial Photograph: SKM AUSIMAGE 2011



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PLAN TITLE

Figure 4-1c Purple Copper Butterfly survey locations
BIODIVERSITY CORRIDOR ASSESSMENT

PROJECT TITLE

Mt Victoria to Lithgow: Great Western Highway upgrade

LEGEND

Preferred route corridor

PURPLE COPPER BUTTERFLY SURVEY LOCATIONS

GDA 94 | MGA 56
A4 1:20,000

0 250 500
Metres

Aerial Photograph: SKM AUSIMAGE 2011

Additional Note

A closely related and much more widespread and common species the Bright Copper (*Paralucia aurifer*) was observed on the lower slopes near the Hartley Shoppe, at the eastern limit of the Purple Copper Butterfly assessment area (see Map 5) during both survey sessions, and at the Forty Bends 1 PCB site (Map 3) during the October assessment period.

Appendix F Significance Assessments

For species, populations and communities that have a moderate or high potential to occur in the study area, the potential impacts to these have been evaluated and assessed. Subject species and communities are listed in Table F-1. The significance of impacts was assessed with reference to the NSW Office of Environment and Heritage *Threatened Species Assessment Guidelines: the Assessment of Significance* (DECCW 2007) and the significance assessment guidelines under the provisions of the EPBC Act (DEWHA 2009). Species with similar taxonomy or ecological requirements have been assessed together, for example tree-roosting microchiropteran bats (Table F-1).

Table F-1. Subject species and ecological communities

Species	Status		Likely significant impact
	EPBC Act	TSC Act	
THREATENED ECOLOGICAL COMMUNITIES			
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions	-	E	No
MAMMALS			
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	No
Koala (*Phascolarctos cinereus*)	V	V	No
Spotted-tail Quoll (*Dasyurus maculatus*)	E	V	No
Yellow-bellied Glider (*Petaurus australis*)	-	V	No
Cave-roosting Microbats			
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	No
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	No
Southern Myotis (*Myotis macropus*)	-	V	No
Tree-roosting Microbats			
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	No
Eastern Freetail-bat (*Mormopterus norfolkensis)*	-	V	No
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V	No
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	-	V	No
BIRDS			
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	-	V	No
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	-	V	No
Little Lorikeet (*Glossopsitta pusilla*)	-	V	No
Regent Honeyeater (*Anthochaera phrygia*)	EM	CE	No
Swift Parrot (*Lathamus discolour*)	E	E	No
Large Forest Owls			
Barking Owl (*Ninox connivens*)	-	V	No

Species	Status		Likely significant impact
	EPBC Act	TSC Act	
Masked Owl (*Tyto novaehollandiae*)	-	V	No
Powerful Owl (*Ninox strenua*)	-	V	No
Woodland Birds			
Black-chinned Honeyeater (*Melithreptus g. gularis*)	-	V	No
Brown Treecreeper (*Climacteris picumnus victoriae*)	-	V	No
Varied Sittella (*Daphoenositta chrysoptera*)	-	E	No
REPTILES			
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V	No
INVERTEBRATES			
Purple Copper Butterfly (*Paralucia spinifera*)	V	E	No

F.1 Section 5A EP&A Act Assessments of Significance

Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions

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

n/a

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South-eastern highlands, Sydney Basin, South-east Corner and NSW South Western Slopes Bioregions occurs as an open-forest, woodland or open woodland. This community may also occur as secondary grassland where the trees have been removed, but the groundlayer remains. The main tree species are Snow Gum (*Eucalyptus pauciflora*), Candlebark (*Eucalyptus rubida*), Back Sallee (*Eucalyptus stellulata*) and Ribbon Gum (*Eucalyptus viminalis*), either alone or in various combinations. Other eucalypt species may occur. A shrub layer may be present and sub-shrubs are common and the ground layer is grassy, with sites in high condition having a range of forb species (OEH 2012). The community commonly occurs on valley floors, margins of frost hollows and on footslopes and undulating hills. It occurs between approximately 600 and 1400 metres in altitude on a variety of substrates, including basalt, sediments, granite, colluvium and alluvium (OEH 2012).

This community occurs in the South Eastern Highlands Bioregion including part of the Southern and Northern Tablelands. There are outlying occurrences of this community in the Sydney Basin, South East Corner and NSW South Western Slopes Bioregions, where suitable habitat exists.

Approximately 0.05 hectares of this community will be affected. Impacts would be limited to the disturbed edges of this community where weed species are dominant. This community is relatively extensive in the locality with over 100 hectares of vegetation with strong affinities to this community identified within 1.5 kilometres of the project footprint (Tozer *et al*. 2010), and when considering the extent of this community in the locality (10 kilometre radius) the impact is likely to comprise a very small proportion (<0.05 per cent) of this threatened ecological community.

Considering the currently disturbed nature of this community in the project footprint, the very small area potentially being impacted and the relatively extensive extant of the community in the locality, the proposal is unlikely to place the local occurrence of this community at risk of extinction.

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

Approximately 0.05 hectares of this community would be cleared, comprising an edge-affected area adjoining the existing Great Western Highway. The project would involve clearance only on the edge of this community and no areas would be fragmented or isolated from other areas of habitat for this ecological community. Considering the small and disturbed nature of this community in the project footprint it is unlikely to be important for the long-term survival of the ecological community.

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

Critical habitat has not been declared for this ecological community.

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

There is no recovery plan or priority action statements for this ecological community.

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

Key threatening processes that are relevant to this ecological community are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance of the ecological community including habitats for flora and fauna. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality and species composition, increased competition and habitat degradation by feral herbivore and invertebrate pests, and increased predation to native fauna from feral predators.

<table>
<tr><th>Threatening Process</th><th>Potential impacts, and proposed avoidance and mitigation measures</th></tr>
<tr><td>DIRECT IMPACT</td><td></td></tr>
<tr><td>Clearing of native vegetation</td><td rowspan="4">The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include:
The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat.
A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance.
Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.</td></tr>
<tr><td>Loss of hollow-bearing trees</td></tr>
<tr><td>Bushrock removal</td></tr>
<tr><td>Removal of dead wood and dead trees</td></tr>
</table>

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	
Predation by the European red fox (*Vulpes vulpes*)	
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the currently disturbed nature of this community in the project footprint, the very small area (0.05 hectares) potentially being affected and the relatively extensive occurrence of the community in the locality, the proposal is unlikely to significantly impact the local occurrence of this community such that it is placed at risk of extinction.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

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

The Grey-headed Flying-fox is Australia's only endemic flying-fox and occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (Tidemann 1998). However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years. At a local scale, the species is generally present intermittently and irregularly (Eby & Lunney 2002). At a regional scale, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration (Eby & Lunney 2002).

The species is widespread throughout its range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW associated with flowering Spotted Gum (*Corymbia maculata*) and on the northwest slopes generally associated with flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*Eucalyptus sideroxylon*) (NSW DECCW 2010).

The national population of the Grey-headed Flying-fox is spatially structured into colonies (Parry-Jones & Wardle 2004). However, there are no separate or distinct populations due to the constant genetic exchange and movement between camps throughout the species' entire geographic range. This indicates that there is one single interbreeding population (Webb & Tidemann 1995; DSE 2005).

The Grey-headed Flying-fox is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits (Eby 1998). None of the vegetation communities used by the Grey-headed Flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources (Eby 1996, 1998; Nelson 1965).

Flying foxes roost communally in open canopy vegetation and the location of day roosts or camps is generally stable through time (Eby 2002). Flying fox camps serve a number of functions for the animals including resting habitat within suitable commuting distance of feeding areas which is typically within 20 kilometres but as far as 50 kilometres (Eby 1996), they are sites of behaviours associated with reproduction and maternal care and they provide refuge at night for flightless young who remain in camps for many weeks while adults feed during the night (Nelson 1965).

The proposal would involve the removal of approximately 7.40 hectares of potential foraging habitat for the Grey-headed Flying-fox. There are over 780 hectares of potential foraging habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010).

Foraging resources for the Grey-headed Flying-fox occur throughout all naturally vegetated areas of the study area and it is likely that the vegetation to be cleared provides a portion of the foraging range of local populations of Grey-headed Flying-foxes. The projected removal of 7.40 hectares is considered a sustainable loss of potential foraging habitat in the context of available habitat in the surrounding region, including several state forests and conservation reserves and considering the broad foraging requirements of the species. The proposed action would not result in a decrease in the size of a local population and would not impact on a known roost site.

Life-cycle characteristics of the species at threat from habitat clearing relate to the loss of critical foraging habitat within a 50 kilometre radius of known camps (DECCW 2009). This is the expected maximum foraging distance of the species from a roost site (Eby 1996).

Given the absence of a roost camp in the proposal study area, the impacts of construction and operation of the proposal relate to loss of feeding habitat caused by 1) direct clearing or damage to native vegetation during the construction phase and 2) edge effects during operation related to degradation of habitat at the interface with cleared land and altered feeding behaviours of flying-foxes.

The affected area of foraging habitat would represent a small percentage of the total extent of these vegetation types within a 50 kilometre radius of the proposal study area. Similarly, vegetation types containing known diet species as dominants or subdominants are widespread in the study area and the overall impact of loss of these species will be ameliorated by their prevalence in a broad range of vegetation types such that this proposal is unlikely to lead to a long-term decrease in the size of the population.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal would involve the removal of approximately 7.40 hectares of potential foraging habitat. There are over 780 hectares of potential foraging habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010).

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway, Grey-headed Flying-foxes are highly mobile and can readily cross cleared areas such as broad road corridors, and no new-edges would be created and no areas of habitat would become isolated.

Given the absence of a roost camp in the proposal study area, the impacts of construction and operation of the proposal relate to loss of feeding habitat caused by 1) direct clearing or damage to native vegetation during the construction phase and 2) edge effects during operation related to degradation of habitat at the interface with cleared land and altered feeding behaviours of flying foxes.

The affected area of foraging habitat is likely to represent marginal habitat, with preferred habitat mainly comprising more fertile floodplain areas. The potential impact represents a small percentage of the total extent of these vegetation types within a 50 kilometre radius of the proposal area, with surrounding habitat on more fertile soils likely to be support higher quality foraging habitat. Considering the small proportion of habitat being impacted relative to available habitats in the locality, the relatively marginal nature of the foraging habitats being impacted, no evidence for the presence of a Flying-fox camp within 50 kilometres of the proposal area, and lack of local records (OEH 2012) the habitat potentially being impacted is unlikely to be important for the long-term survival of the species.

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

Critical habitat has not been declared for this species.

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

There is a national recovery plan for the Grey-headed Flying-Fox. Considering the low potential impact to habitat for this species the proposal is consistent with the objectives of the recovery plan.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat resilience and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of potential foraging habitat. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering there are no known records of this species (OEH 2012) or roost camps within the project locality, and the extensive areas of habitat surrounding the project footprint, the habitats potentially impacted by the project footprint are unlikely to constitute a significant impact for this species.

Koala (*Phascolarctos cinereus*)

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

Distributed from about Townsville, Queensland to the Victorian/ South Australian border, from the coast to the western slopes and plains (within River Red Gum Forest) in New South Wales, this species is rare in the north and south of its range and nowhere can it be considered abundant. The Koala is a foliovore, feeding on a select range of Eucalypt species, and the presence of suitable Eucalypt forests influences the distribution of Koala populations. The Koala is found in a variety of habitats where suitable food trees occur and is often sighted in younger trees, which may have leaves of a higher palatability and nutrient value. The more abundant populations have been associated with vegetation communities growing on high nutrient soils, but Koalas also occur in forests of the poorer coastal soils (Martin & Handasyde 1995).

The Koala is adversely affected by habitat loss and fragmentation, wild fire, predation and disease. Hunting for pelts and shooting for sport is likely to have caused the local extinction of some populations (i.e. Wallalong area - as suggested in Callaghan et al 1994). In fragmented habitats, roadkills and dog attacks are significant problems. Genetic introgression can be a serious threat to high density populations in isolated habitats. Habitat preservation and linking of isolates with habitat corridors is essential for the long term survival of Koala populations (Martin & Handasyde 1995). Clearing of the forests from the high nutrient soils of valleys for agriculture probably removed prime habitat areas for Koalas, and forced individuals into areas of sub-optimal habitat.

Koalas are generally solitary except during the mating season and have a home range of about 3 hectares (although the size of this area is influenced by the distribution, abundance and quality of feeding resources). In dense populations, home ranges may overlap but appear to be discrete at lower densities (Martin & Handasyde 1995). Long movements in search of a mate or new food source are sometimes undertaken, signifying the importance of dispersal corridors in secure Koala habitat (Phillips 1990). The breeding season begins about September, when males commence calling and searching for reproductive females, and ends about April. Mating depends on the weaning of the previous years cub. Females can produce one young per year, but this has been jeopardized in some populations by Chlamydia which causes ovarian cysts, reducing fertility. Young leave the pouch permanently at about 8 - 9 months and are independent at 12 months although still remain in the vicinity of the mother (Lee & Martin 1988). Males leave the natal range at about 2 to 3 years old with the females often remaining and breeding nearby.

There is some mortality associated with the dispersal of young males, especially in fragmented habitats. Longevity is around 18 years of age for females and probably a few years less for males (Martin & Handasyde 1995).

The proposal will result in the removal of approximately 0.05 hectares of forest dominated by Ribbon Gum (*Eucalyptus viminalis*) a known feed tree (DECC 2008b). There are relatively extensive areas of optimal habitat (Ribbon Gum Grassy Woodland) in the project locality, including approximately 100 hectares within 1.5 kilometres of the project footprint in addition to over 680 hectares of marginal habitat (Tozer *et al*. 2010).

There are more extensive areas of marginal habitat which may provide some foraging opportunities, as the dominant tree species in the majority of vegetation in the study area are Monkey Gum (*Eucalyptus cypellocarpa*) a secondary food tree in other Koala Management Areas (Central Coast; Northern Tablelands; South Coast), and Blaxland's Stringybark (*Eucalyptus blaxlandii*) a supplementary species in the Central Coast Koala Management Area (DECC 2008b). Secondary food tree species listed for the Koala Management Areas of the locality (Central and Southern Tablelands; Western Slopes and Plains) occurring in the proposal area in low abundance comprise Mountain Gum (*Eucalyptus dalrympleana*) and several planted Argyle Apple (*Eucalyptus cinerea*).

There are three historical records of Koalas in the locality surrounding the upgrade as recent as 2006 (Atlas of NSW Wildlife OEH 2012) located between 4.2 and 7.6 kilometres from the study area. Anecdotal evidence of a Koala roadkill was reported in 2012 less than 0.5 kilometres to the east of the proposed upgrade, although this was not confirmed.

No evidence of Koala use of the habitat was recorded from the field surveys and there is little evidence to support the presence of a local breeding population of Koalas in the study area or immediate surrounds. On this basis the habitat does not meet the definition of 'core koala habitat' as defined under SEPP 44. Any koala population that may occur in this locality is most likely to be widely dispersed over a large area which would extend to the north, east and south of the proposal and/or the study area constitutes part of a temporary refuge or within the dispersal range for Koalas moving to better quality habitat.

Other life-cycle attributes includes movements and dispersal. The proposed upgrade will remove the current barrier effect of the highway through Forty Bends through the provision of two underpass structures targeting a range of fauna species including the Koala.

Considering the small area of optimal habitat that would be removed relative to the extent of similar habitats in the locality, the limited number of records, lack of core habitat or the presence of a local breeding population, the proposal is unlikely to place the local population at risk of extinction.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 0.05 hectares of forest dominated by Ribbon Gum (*Eucalyptus viminalis*) a known feed tree, and an additional 7.34 hectares of marginal habitat which may provide some foraging opportunities. There are relatively extensive areas of optimal habitat (Ribbon Gum Grassy Woodland) in the locality including approximately 100 hectares within 1.5 kilometres of the project footprint in addition to over 680 hectares of marginal habitat (Tozer *et al*. 2010).

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which would result in greater distance between habitats on either side of the highway. However, no new-edges would be created and no areas of habitat would become isolated. Connectivity for Koala is likely to be improved with the construction of large underpasses including a bridge at Whites Creek

with fauna fencing to guide animals to these locations and the removal of existing concrete barriers in the median, potentially reducing the potential for vehicle strike.

Considering the small area of optimal habitat that would be removed relative to the extent of similar habitats in the locality the habitats in the project footprint are unlikely to be important for the local population.

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

Critical habitat has not been declared for this species.

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

There is a recovery plan for the Koala. Considering the low potential impact to habitat for this species and the proposed mitigation measures to minimise habitat removal and improve connectivity, the proposal is consistent with the objectives of the recovery plan where relevant to the project. The objectives of the recovery plan are discussed below:

Recovery Plan Objective	**Relevance to project**
Objective 1: To conserve Koalas in their existing habitat.	Habitat removal has been minimised where possible and the proposal potentially contributes to the conservation of Koala through facilitating safe passage across the Great Western Highway.
Objective 2: To rehabilitate and restore Koala habitat and populations.	Koala feed trees (*Eucalyptus viminalis*) will be included in the landscaping for the project.
Objective 3: To develop a better understanding of the conservation biology of koalas.	n/a
Objective 4: To ensure that the community has access to factual information about the distribution, conservation and management of koalas at a national, state and local scale.	n/a
Objective 5: To manage captive, sick or injured koalas and orphaned wild koalas to ensure consistent and high standards of care.	n/a
Objective 6: To manage over-browsing to prevent both koala starvation and ecosystem damage in discrete patches of habitat.	n/a
Objective 7: To coordinate, promote the implementation, and monitor the effectiveness of the NSW Koala Recovery Plan across NSW.	n/a

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat resilience, habitat degradation from feral herbivores and increased predation from feral predators.

Threatening Process	**Potential impacts, and proposed avoidance and mitigation measures**
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting primary and secondary feed tree species. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to koala habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ Landscaping will include the primary feed tree species Ribbon Gum (*Eucalyptus viminalis*) in addition to other secondary feed tree species.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Predation by the European red fox (*Vulpes vulpes*)	underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of optimal habitat that would be removed relative to the extent of similar habitats in the locality, the limited number of records, lack of core habitat or the presence of a local breeding population, the proposal is unlikely to constitute a significant impact to this species.

Spotted-tail Quoll (*Dasyurus maculatus*)

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

The current distribution of this species is the coast and ranges of eastern Australia from southern Queensland to the Victorian/ South Australian border and Tasmania. The mainland range of this species has been fragmented and significantly reduced and is now disjunct over much of its former distribution. Spotted-tail Quolls have been reported inhabiting a wide range of habitats including rainforest, wet and dry sclerophyll forest, woodland, coastal heathland and inland riparian forest. Occasionally, the species has been recorded in rock outcrops or other treeless areas (Edgar & Belcher 1995). The species requires extensive home ranges, and is generally so confined to localities which contain extensive and continuous tree cover.

Populations of the Spotted-tail Quoll have been much reduced through habitat loss, and the species is currently sparsely distributed and rare. Land clearance for agricultural and urban development, as well as disease (possibly a form of toxoplasmosis - which is caused by a protozoan parasite prevalent in feral cats) and persecution have significantly reduced populations of this species, and the distribution of the Spotted-tail Quoll is heavily fragmented as a result. Spotted-tail Quolls compete for resources and shelter with Foxes, Feral Dogs and Feral Cats, and competition with these species may have an adverse impact on populations (Edgar & Belcher 1995). Spotted-tail Quolls are also susceptible to baits laid for wild dogs.

A solitary, generally nocturnal (although some foraging, and sun-basking takes place during the day) and semi-arboreal species, the Spotted-tail Quoll preys on a variety of species, ranging in size from small wallabies to reptiles and insects, as well as plants. Medium-sized terrestrial and arboreal mammals, such as Brushtail Possums, Rats, small macropods and Rabbits, comprise about two-thirds of the diet in south-east Australia, with birds (and their young) and carrion also being important dietary components. The species has been persecuted as a result of attacks on domestic poultry. Much of the foraging of this species is undertaken on the ground, but some foraging in trees is undertaken, and trees are also used as vantage points to detect prey and pounce on prey. Spotted-tail Quolls, as opportunistic predators, utilise extensive home ranges which are estimated to be between 500 - 1 000 hectares (Australian Museum Business Services 1995). Movements of up to several kilometres in a single night have been recorded.

Both males and females mature when about one year old and mating occurs between April and July. The average litter size is five and young are fully independent at 18 weeks. Den and nest sites have been recorded in caves, rock crevices, tree hollows and hollow logs (Edgar & Belcher 1995).

Spotted-tail Quolls have been frequently recorded in the locality. The range of habitats including large patches of native vegetation including several forest types, heathland and rainforest as well as farmland and isolated patches of grassy woodland render the area suitable for this species. Potential impacts for the species are associated with the loss of habitat including potential den sites, habitat for prey species, fragmentation and the barrier effect of the highway potentially leading to increased genetic isolation and decreased dispersal ability. The species is known to frequent roadsides feeding on roadkill, thereby placing them at risk of vehicle strike. The severity of the impact in the locality is likely to be minor considering the large home-range of the species occurring at low densities and wide ranging dispersal abilities. The potential barrier effect and fragmentation impacts should be adequately mitigated with the installation of targeted connectivity measures for this species (e.g. underpasses and bridge).

The species typically has a large home range and occupies a diversity of habitat types. It is therefore difficult to identify the area of occupancy. Theoretically, quolls could occur in any of the larger forest fragments of the study area. Preferred habitat includes dry and moist sclerophyll forests and may include adjacent modified patches of forest on farmland. Suitable habitat is well represented in the larger fragments of forest in the study area, Indeed there are over 780 hectares of potential habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010). The potential impact to habitat for prey species and life-cycle activities represents approximately 1 per cent of the available habitat within 1.5 kilometres of the project footprint.

Other life-cycle attributes include movements and dispersal. The proposed upgrade will partly remove the current barrier effect of the highway through Forty Bends with the removal of the existing concrete jersey barriers in the median and the provision of two underpass structures targeting a range of fauna species including the quoll.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal would involve the removal of approximately 7.40 hectares of potential habitat for prey species. The habitat to be cleared along the roadside is not suited to denning or sheltering for this species due to an absence of caves or large hollow logs. There are over 780 hectares of potential foraging habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010). There are numerous records for this species in the locality and the study area is likely to be part of a home range for the local population. The potential impact to habitat represents approximately 1 per cent of the available habitat within 1.5 kilometres of the project footprint and would be significantly less when considering the extent of potential habitats in the entire locality (10 kilometre radius) which includes extensive areas of Newnes State Forest to the north.

Vegetation clearing for the project would be limited to edge effected habitats currently surrounding the existing Great Western Highway. Although this clearing would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. The project involves widening and upgrade of an existing road corridor in which there is currently a barrier effect. Connectivity for Spotted-tail Quoll is likely to be improved from this current situation with the construction

of large underpasses including a bridge at Whites Creek and two large (2.4 x 2.4 metre) culverts.

Habitats adjacent to the road and within the project footprint provide potential resources for this species in terms of an area of habitat for likely prey species and an area of potential shelter in the form of habitat hollows (logs, trees or stags), however this area of habitat is currently positioned adjacent an existing highway which may reduce its suitability particularly when considering it is part of a large expanse of remnant habitat continuing to the west

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

Critical habitat has not been declared for this species.

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

A draft national recovery plan for the Spotted-tailed Quoll is currently being prepared. In NSW, the Threatened Species Priorities Action Statement lists recovery actions for all threatened species. A total of 33 recovery actions are listed for the Spotted-tailed Quoll. These actions focus on addressing current knowledge gaps and managing the threats to quoll populations as identified through scientific research. Mortality from collisions with vehicles is a known threat to this species and has been considered in this project the provision of dedicated underpass structures targeting this species. The current proposed project is consistent with the objectives of the draft recovery plan.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging and sheltering habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral honey bees for hollow resources, habitat degradation from feral herbivores and increased predation from and competition with feral predators.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. ▪ Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.
Loss of hollow-bearing trees	
Removal of dead wood and dead trees	
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	
Predation by the European red fox (*Vulpes vulpes*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
	proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of potential habitat for prey species and shelter or denning habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to this species.

Yellow-bellied Glider (*Petaurus australis*)

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

Yellow-bellied Gliders are distributed along the coast and montane ranges of eastern Australia from central Queensland to south-east Victorian, with isolated populations also occurring in the Atherton Tablelands, Queensland and south-west Victoria. This species has a patchy distribution. Known to occur in a variety of habitats, Yellow-bellied Gliders are usually associated with tall, mature wet eucalypt forest in high rainfall areas. They are present at low densities, even in areas of preferred habitat, probably as a result of the low food availability and their territorial nature.

The low nutritional value of the major food of this species (sap) requires individuals to spend large amounts of time foraging within extensive home ranges. As a result, this species is apparently declining mainly through the loss and fragmentation of habitat (Russell 1995). Clearance for agricultural and urban development and intensive forestry practices has probably had a significant effect on Yellow-bellied Glider populations. Loss of tree hollows and foraging areas poses the greatest threats to remnant populations. Fire may adversely affect some populations of this species.

The diet of this species includes plant exudates (sap, nectar, honeydew and manna) as well as insects. Sap is tapped from the trunks of trees via chewed "V" shaped incisions or in some cases extended vertical incisions (Goldingay & Kavanagh 1991). Tree species used varies according to locations and habitats, and although none of the species in the study area have been identified as food trees, some of these species may potentially be utilised by the species. The shedding of bark by tree species is considered important for the gathering of invertebrates and honeydew. Hollows for nest sites are essential, as are suitable food trees. Den sites are often, but not always, located in mature, living smooth-barked eucalypts.

This species is known to have a large home range of more than 35 hectares and may travel in excess of 2 kilometres from the den to forage in a single night. The resident pair and their offspring are territorial and home ranges do not overlap. Population density is low (0.05 - 0.14 individuals per hectare), with family groups of 3 - 4, and sometimes 6, animals usual for New South Wales. The largest trees within the home range are used for both roosting and feeding, and certain tree species are selected for these purposes (Goldingay & Kavanagh 1993). In south-eastern New South Wales young are born between June and December and this may be tied to the availability of exudates for food. Weaning may coincide with the availability of arthropods (Goldingay & Kavanagh 1991). The litter size is one, pouch life is about 100 days and young are left in the nest for a further 2 months. Dispersal from the family group occurs at 18 - 24 months when full body size is reached (Craig 1985).

The proposal would involve the removal of approximately 7.40 hectares of potential habitat including hollow trees which may support hollows suitable for this species. There are over 780 hectares of potential foraging habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010). There is a single record for this species from December 1999 on the escarpment at Clarence approximately 8.8 kilometres from the proposal area. The potential impact to habitat represents approximately 1 per cent of the available habitat within 1.5 kilometres of the project footprint and would be significantly less when considering the extent of potential habitats in the entire locality (10 kilometre radius) which includes extensive areas of Newnes State Forest to the north.

Other life-cycle attributes includes movements and dispersal. The proposed upgrade will partly remove the current barrier effect of the highway through forty bends through the provision of a glider crossing structure targeting a range of glider species.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal would involve the removal of approximately 7.40 hectares of potential habitat including up to 39 hollow trees of which several may support large hollows suitable for this species. There are over 780 hectares of potential foraging habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010). There is a single record for this species on the escarpment at Clarence. The potential impact to habitat represents approximately 1 per cent of the available habitat within 1.5 kilometres of the project footprint and would be significantly less when considering the extent of potential habitats in the entire locality (10 kilometre radius) which includes extensive areas of Newnes State Forest to the north.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway. This clearing would result in greater distance between habitats on either side of the highway potentially impacting connectivity for this species. The connectivity strategy addresses the potential impacts to connectivity for Yellow-bellied Glider through the provision of gliding poles to facilitate this species and other glider species in the locality. The road would result in a distance of greater than 50 metres which may limit the ability of this species to effectively glide across the road between habitats. Although there is no evidence that Yellow-bellied Glider use artificial structures such as rope bridges and gliding poles, the proposed installation of these wildlife

connectivity mitigation measures will potentially facilitate the movement of this species if they were to occur in the study area.

Habitats in the project footprint are unlikely to be highly important for any local population of Yellow-bellied Glider, considering the lack of evidence for the presence of the species and the small proportion of habitat being removed relative to available habitats in the locality. There are potential foraging and sheltering opportunities in the proposal area, however relative to the extent of habitat in the locality the impacts represents a small proportion of the available habitat for the local population (<1 per cent)

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

Critical habitat has not been declared for this species.

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

There is a recovery plan for the Yellow-bellied Glider. Considering the low potential impact to habitat for this species and the proposed mitigation measures to minimise habitat removal and improve connectivity, the proposal is consistent with the objectives of the recovery plan.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging and sheltering habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral honey bees for hollow resources, habitat degradation from feral herbivores and increased predation from feral predators.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. ▪ Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.
Loss of hollow-bearing trees	
Removal of dead wood and dead trees	
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Invasion and establishment of exotic vines and scramblers	should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	
Predation by the European red fox (*Vulpes vulpes*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of optimal habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to this species.

Cave-roosting Microbats

Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)
Large-eared Pied Bat (*Chalinolobus dwyeri*)
Southern Myotis (*Myotis macropus*)

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

Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)

Eastern Bent-wing Bat is widely distributed from the coast and ranges of eastern Australia, extending from Cape York Peninsula, through Queensland, New South Wales and Victoria, to far eastern South Australia. A separate subspecies occurs in northern Western Australia and the Northern Territory. In New South Wales, it is found from the coast to the western slopes of the Great Dividing Range.

Eastern Bent-wing Bat is widespread and can be locally common where suitable caves or tunnels are available as roost sites. However, the major threat to this species is the loss of roost sites, and nursery caves. The dependence on relatively few nursery caves suggests that threats to the existence or structural integrity of these may place populations in jeopardy (Dwyer 1995). Frequent disturbance of roosts used for winter hibernation is known to significantly increase winter mortality. Toxic accumulation of agricultural chemicals in body fat used during winter torpor may also reduce populations. Habitat loss through clearing for development or agriculture and subsequent reductions in insect prey availability may also adversely affect this species. The Eastern Bent-wing Bat is reportedly preyed upon by feral Cats and occasionally Foxes.

Eastern Bent-wing Bats are known to forage within a variety of habitat types adjoining roost sites. This appears to include rainforest, moist and dry eucalypt forest, swamp sclerophyll forest as well as heath. Known roost sites include caves, old mines, stormwater channels, road culverts and comparable structures including buildings. Dwyer (1995) regards typical habitat as well-timbered valleys. This species has been reported utilising bushland remnants in urban areas.

Eastern Bent-wing Bats are known to feed on moths, cockroaches, grasshoppers and ants and forages above the tree canopy (Australian Museum Business Services 1995). This is a mobile species and is estimated to forage within a 20 km radius in a single night.

The limiting factor is the availability of roost sites, with suitable caves, mines, road culverts and occasionally buildings being essential. Long migrations between roosts, according to seasonal needs or reproductive status, have been recorded. With the onset of Spring, adult females move from numerous widely scattered roosts to specific nursery caves, which provide high temperature and humidity or have an internal conformation which retains air warmed by the bats activities (Dwyer 1995). Within nursery caves, the density of young bats can be up to 3 000 per square metre.

In New South Wales mating occurs in late May and early June, prior to hibernation. With delayed implantation, development of the young does not commence until late August. Birth of a single young occurs in December and juveniles are independent between February and March when nursery colonies disband and disperse over long distances. They are sexually mature in their second year and may live to 17 years of age. Predators include owls, pythons, cats and foxes (Dwyer 1995). Cool caves are utilised during the winter hibernation, when the bats go into torpor, relying on body reserves of fat. Bats in this state are particularly vulnerable to disturbance.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes (OEH 2012).

Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*) (OEH 2012). Large-eared Pied Bats frequent low to mid-elevation dry open forest and woodland, and well-timbered areas containing gullies close to roosts. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.

The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. This species is likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring (OEH 2012).

Southern Myotis (*Myotis macropus*)

The Southern Myotis is known to occur in a wide coastal band from northern Western Australia, across the Northern Territory, Queensland, New South Wales, Victoria, and into far south-eastern South Australia. The distribution of this species extends inland from coastal South Australia, along the Murray River. A variety of foraging habitats are used by this species although it is usually found near large bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. The species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used by this species.

The species is apparently widespread but uncommon in northern New South Wales (Australian Museum Business Services 1995) and considered comparatively rare over its limited national range (Richards 1995). The species is considered rare and sparsely distributed in a variety of habitats associated with water in Victoria (Lumsden & Menkhorst 1995). Generally small colony sizes, relatively low reproductive rates (one young per year), and the specific roost requirements suggest that local populations are susceptible to impacts from even minor modifications or disturbances to roosting and foraging habitats.

Loss of roost sites and foraging habitats are considered the major threats to this species. The specific nature of its foraging habits suggest that this species is adversely impacted by habitat degradation through water pollution, and foraging habitat is likely to have been lost through nutrient enrichment, oil spills and pollutant rich run-off entering waterways. The accumulation in body fat of herbicides, pesticides and heavy metals may affect populations

of this species which forage within affected waterbodies. Disturbance of colonies, especially during the colder months when the bat is hibernating, may cause populations to desert roost sites, and can result in heavy mortality. The degradation of waterways through sedimentation, eutrophication, acidification and pollution may have altered the aquatic biota of foraging habitats or affected the abundance of prey populations. Widespread clearing of riparian forests may have affected the diversity of insect prey in these areas, which in turn may affect the densities of Myotis populations in these areas. The modification of hydrological regimes may also affect the prey resources of this species.

Recorded roost sites include caves, mines, tunnels, spaces under bridges and in buildings, in dense foliage in tropical areas, and from tree hollows in Victoria (Lumsden & Menkhorst 1995). Colonies usually number between 10 and 15 individuals, but colonies of up to several hundred individuals have been reported in a single roost (Richards 1995). Small breeding clusters form within these colonies, consisting of a male and a harem of females. This territory is defended from other males by the dominant male. In New South Wales breeding occurs in November - December and only a single young is produced. When not breeding the males roost alone, still defending their territory. Lactation lasts some eight weeks, and after weaning the young forms a strong bond with its mother for at least four weeks, when it is probably taught how to catch food (Richards 1995). In the cooler southern latitudes, individuals enter torpor to survive adverse weather conditions.

In southern populations, the period of female activity is very long, with heavily pregnant females recorded as early as October and lactating females as late as March in Victoria (Lumsden & Menkhorst 1995). It is not known if this reproductive period represents two separate litters, or if it is an extended and unsynchronised birthing season (Lumsden & Menkhorst 1995a).

The Southern Myotis has been reported feeding on flying insects (including beetles, flies, moths and grasshoppers), aquatic insects (such as boatmen) and small fish (such as the introduced Mosquito Fish, which has been reported in the diet of individuals from North Queensland and from the Murray River in South Australia) (Australian Museum Business Services 1995). Small fish have been found to comprise a large proportion of the diet of this species (Robson 1984). Observations of the feeding behaviour of this species found that it foraged predominantly just above the water (average height of 9 cm from the water surface), but also raked the surface of the water with the recurved claws of its large feet and sometimes also used its tail membrane as a scoop (Lumsden & Menkhorst 1995). Flying insects are also caught as the bats spiral downwards through the air. This species feeds alone or in pairs, and some group foraging has been observed. The species has a slow and manoeuvrable flight pattern (Lumsden & Menkhorst 1995).

The study area provides known and potential foraging habitat for the assessed species. These species are predominantly cave-roosting bats, although they may roost in artificial structures such as bridges and culverts. There is potential for a roosting site to occur in existing culverts under the highway, however these will not be impacted by the proposal. No caves or abandoned mine shafts have been recorded in the project boundary and the project is not expected to impact on the maternity life-cycle activities of these species. The location of any roost sites for these species in the regional area is not known.

The loss of 7.40 hectares of forest habitat may impact on the potential breeding habitat for prey species (invertebrates) and therefore potentially lead to reduction of populations associated with increased pressure on a local scale. However comparable habitats are well represented throughout the locality and region. Therefore foraging habitat and prey abundance may be impacted by the proposal however the overall magnitude of this impact is very small relative to the extent of insect breeding resources in the study area.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The project will result in the removal of potential foraging habitat comprising 7.40 hectares of forest and 8.25 hectares of modified habitats including paddock areas, roadside verges and farm dams. Potential habitats in the locality are extensive with over 780 hectares of forested habitats and up to 775 hectares of modified habitats within 1.5 kilometres of the project footprint.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway. Although this clearing would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. Microbat species are readily able to fly across fragmented habitats including major roads.

Habitats adjacent to the road and within the project footprint provide potential resources for these species in terms of an area of habitat for insect prey species however it is unlikely that the proposal area contains an important roost site, such as a maternity or hibernation roost. There is potential for a roosting site to occur in existing culverts under the highway, however these will not be impacted by the proposal.

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

Critical habitat has not been declared for these species.

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

There is no recovery plan for these species. There are 15-25 priority action statements for each of species related to scientific research, community awareness and protection of these species. Considering the low potential impact to habitat for these species and the proposed avoidance and mitigation measures to minimise habitat removal including appropriate design of the infrastructure to avoid ecological impacts, the re-establishment of

native vegetation and reuse of habitat attributes, the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to these species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to these species that are directly enacted by the proposal are those associated with clearance and degradation of foraging and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

<table>
<tr><th>Threatening Process</th><th>Potential impacts, and proposed avoidance and mitigation measures</th></tr>
<tr><td>DIRECT IMPACT</td><td></td></tr>
<tr><td>Clearing of native vegetation</td><td rowspan="4">The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include:
The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat.
A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance.
Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.</td></tr>
<tr><td>Loss of hollow-bearing trees</td></tr>
<tr><td>Bushrock removal</td></tr>
<tr><td>Removal of dead wood and dead trees</td></tr>
</table>

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of foraging habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to these three microbat species.

Tree-roosting Microbats

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
Eastern Freetail-bat (*Mormopterus norfolkensis)*
Greater Broad-nosed Bat (*Scoteanax rueppellii*)
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)

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

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

Distributed from far south-eastern Queensland, through eastern New South Wales to south-western Victoria and Tasmania, this species appears to be more common at cool elevations. This species is also found in south-western Western Australia. Records from New South Wales have been reported from east of, and along, the Great Dividing Range. Most authenticated records from the north of the State are from higher elevations of the Ranges (Australian Museum Business Services 1995). Little is known of this species, which seems to be uncommon, localised and in low numbers throughout its range (Phillips 1995). Potential pressures on this species arise from the clearing and modification of forested lands and apiary (through competition for tree hollows by expanding colonies), which reduce available foraging habitat and actual and potential roost hollows.

Habitat requirements of this species are poorly known although it has been reported from rainforest, wet and dry sclerophyll forests and woodland. The species tends to be more common at higher altitudes than on the coast. Studies suggest that this species prefers wet habitats, especially riparian or high rainfall areas, where trees are greater than 20 metres in height (Menkhorst & Lumsden 1995), although a range of other habitats are used, including woodland.

Given the shape and size of its wings, the Eastern False Pipistrelle is likely to be a fast flying but not very manoeuvrable species, and probably forages above or just below the forest canopy, in open woodland or over water (Phillips 1995). This species has been reported feeding on moths, beetles, chafers, weevils, plant bugs, flies and ants (Australian Museum Business Services 1995). Attacking manoeuvres probably involve a deviation of the flight path rather than acrobatic movements. Eastern False Pipistrelle roost

predominantly in tree hollows, where groups of up to 10 individuals have been reported (Phillips & Inwards 1985). Individuals have also been reported utilising caves and abandoned buildings (Australian Museum Business Services 1995).

Observations of this species in roosts in the stems of living eucalypts indicate that sexual segregation in roosting behaviour may occur for at least part of the year, where females roost together at the complete exclusion of males, probably in maternity colonies (therefore coinciding with the birth and rearing of young). In southern Australia, Eastern False Pipistrelles apparently hibernate during winter. Males of this species appear not to be sexually active in the first year, with mating taking place in subsequent years. Females are pregnant during late spring and early summer (November) and lactating in mid-January. The young are free-flying by late January or early February (Phillips 1995; Australian Museum Business Services 1995).

Eastern Freetail-bat (*Mormopterus norfolkensis)*

The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range (OEH 2012). Roosts mainly in tree hollows but will also roost under bark or in man-made structures (OEH 2012). Usually solitary but also recorded roosting communally, probably insectivorous (OEH 2012).

Greater Broad-nosed Bat (*Scoteanax rueppellii*)

Distributed on the coast and ranges of eastern Australia from northern Queensland to the New South Wales/ Victorian border. This species is most common in the gullies and river systems draining the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland in tropical Queensland, but it extends to the coast over much of its range (Hoye & Richards 1995). It is regarded as uncommon to rare, but may prove to be more widespread than currently indicated (Hoye & Richards 1995; Parnaby 1992). The main threat to this species is the loss of tree hollows, which are used as roost sites, through clearing or apiary. Habitat modification and clearing for agriculture may reduce foraging habitat and insect prey availability.

This species has been recorded in a variety of habitat types including rainforest, moist and dry eucalypt forest and woodland. Favoured foraging areas for this species appears to be tree-lined creeks and the junction of woodland and cleared paddocks. Large emergent trees, including dead trees, with hollows are likely to be essential as roost sites. Greater Broad-nosed Bats feed on moths, beetles and other large slow-flying insects, and possibly other bats. A low, slow-flying species which utilises a large foraging area, the open nature of eucalypt woodland suits its direct flight pattern. Within denser vegetation types use is made of natural and man-made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1995).

The reproductive cycle is poorly known, but a single young is produced in January and prior to birth, females congregate at maternity sites, which are located in suitable trees. Males are excluded during birth and rearing of the young.

Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)

The Yellow-bellied Sheathtail-bat is a large, insectivorous bat, which is distributed throughout a large portion of eastern and northern Australia. It is widely distributed throughout a range of habitats in New South Wales but the relative infrequency of recorded sightings suggests that the species is sparse and rare. The high and rapid flight habits make the species difficult to record and it may prove more common than previously thought. The species is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats.

This species is thought to forage for prey above the tree canopy and is therefore difficult to catch using conventional trapping techniques. Analysis of wing morphometry indicate that this species flight habitats would be similar to the more common White-striped Free-tailed Bat (*Tadarida australis*), and the species tends to fly straight and fast (estimated at 25 - 30 km/h). The species has poor manoeuvrability, and a distinctive rapid flight, which are characteristic of species with high body mass and long narrow wings. The flight pattern is best suited to open areas (i.e. above the canopy in forests; and lower in cleared areas and over rivers). Most foraging observations have been estimated at 15 - 20 metres above the ground, however the bat has been recorded lower in cleared areas and stunted vegetation types (mangroves). This species has been captured close to the ground presumably when drinking from a nearby waterhole. Flying insects (particularly beetles, grasshoppers, chafers and bugs) are taken above the forest canopy, and closer to the ground in low vegetation types (mallee, heath, mangroves). The fast direct flight pattern allows for prey to be encountered at a greater rate in cleared and open areas (Rhodes & Hall 1997).

This species is apparently usually solitary, but small colonies of up to 10 individuals are not uncommon. In one case, a colony of 29 individuals was found within a hollow in the top of a dead eucalypt in predominantly cleared grazing land south-west of Brisbane. This clumping may have resulted from a lack of suitable roosting hollows in the locality or aggregations during winter by this species (Rhodes & Hall 1997).

Little is known of the nightly foraging movements or seasonal and regional movements of this species. Some regional migrations have been suspected, but no observations have been documented which conclusively demonstrate this. Similarly, the breeding biology is poorly known, with births occurring from December to March.

There is likely to be some competition between this species and the more common White-striped Free-tailed Bat, however some limited results appear to suggest that the Yellow-bellied Sheathtail-bat may emerge later in the night. This may be a result of a change in prey type or density during the night. The favoured prey of the Yellow-bellied Sheathtail-bat may emerge later. Apparently, the height of insect prey decreases with time after sunset, and the Yellow-bellied Sheathtail-bat may be better suited than White-striped Free-tailed Bat for foraging at low prey densities above the canopy (Rhodes & Hall 1997).

Populations may have been reduced through clearing for agriculture and development, which has removed roost trees and foraging areas. This loss of habitat is likely to be the most significant threat to this species, but predation by cats may also constitute a localised threat to some colonies. The Yellow-bellied Sheathtail-bat may have always occurred at low numbers (populations may have been limited by the low availability of high-flying late emerging insect prey or by interspecific and intraspecific competition). The species may be more common than records indicate as flight habits and late emergence from roosts may make observation of this species difficult during general fauna surveys.

Eastern False Pipistrelle which is listed as vulnerable under the TSC Act was recorded in the project footprint in areas of dry open forest. There are 1-2 records of each of these four microbat species in the locality (OEH 2012), and all species are considered likely to utilise the area for foraging and potentially roost in hollow trees in the proposal area.

The proposal will result in the removal of potential foraging habitat comprising 7.4 hectares of forest and 8.25 hectares of modified habitats including paddock areas, roadside verges and farm dams. There would also be the removal of up to 39 hollow trees potentially used as roosting habitat and maternity sites by these species. Potential habitats in the locality are extensive with over 780 hectares of forested habitats and up to 775 hectares of modified habitats within 1.5 kilometres of the project footprint. Considering the small proportion of habitat being impacted in the proposal area relative to the available habitat in the locality, viable local populations of these species are unlikely to be placed at risk of extinction.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of potential foraging habitat comprising 7.4 hectares of forest and 8.25 hectares of modified habitats including paddock areas, roadside verges and farm dams. Potential habitats in the locality are extensive with over 780 hectares of forested habitats and up to 775 hectares of modified habitats within 1.5 kilometres of the project footprint.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. Microbat species are readily able to fly across fragmented habitats including major roads and therefore the proposal will not create a barrier to these species.

Habitats in the project footprint potentially have some importance for the local population for foraging and potentially for shelter, however relative to the extent of habitat in the locality the impacts represents a small proportion of the available habitat for the local population (<1 per cent).

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

Critical habitat has not been declared for these species.

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

There is no recovery plan for these species. There are 16-21 priority action statements for each of species related to scientific research, community awareness and protection of these species. Considering the low potential impact to habitat for these species and the proposed avoidance and mitigation measures to minimise habitat removal including appropriate design of the infrastructure to avoid ecological impacts, the re-establishment of native vegetation and reuse of habitat attributes, the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to these species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to these species that are directly enacted by the proposal are those associated with clearance and degradation of foraging and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral honey bees for hollow resources and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

Threatening Process	**Potential impacts, and proposed avoidance and mitigation measures**
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces,
Loss of hollow-bearing trees	
Bushrock removal	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Removal of dead wood and dead trees	surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. ▪ Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
	▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to these four microbat species.

Glossy Black-cockatoo (*Calyptorhynchus lathami*)

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

The Glossy Black-cockatoo occupies forests of south-eastern Australia, from Shoalwater Bay in central Queensland to the Victorian border region. Isolated populations also exist in the Eungella district of Queensland and on Kangaroo Island, South Australia.

The Glossy Black-cockatoo is considered rare in the national context (Garnett 1992) but moderately common in New South Wales (Morris et al 1981), Blakers et al (1984) suggests the species is as widely distributed now as in the recent past but dependence on one type of food makes it vulnerable. The Glossy Black-cockatoo relies almost entirely on the seeds of a few species of She-oak for food and any factor that reduces the quantity, quality or availability of the seed crop of these trees must have a direct impact on local populations, through starvation or reduced fecundity. Land clearance for agriculture has substantially reduced available habitat and the species is likely to be sensitive to continued habitat destruction in the future. Regular fire may also reduce the presence of fruiting She-oaks. The bird is also dependent upon large cavities in mature eucalypts for nesting. The destruction of hollows through timber removal, apiary practices and fire may also adversely affect populations.

Habitat for this species generally consists of moist and dry eucalypt forest types with a She-oak understorey. Glossy Black-cockatoos require hollows for nesting and She-oak fruit, on which it usually feeds in small groups. This species roosts communally at night, travelling at dawn to groves of seeding She-oaks to spend the day feeding. The birds are very quiet when feeding and can be easily approached. Their feeding method is highly ritualised, with the cone being held in the left foot whilst being fragmented by the specialised bill. In areas where She-oaks are abundant, this species is sedentary, however, in other areas, Glossy Black-cockatoos can be nomadic, moving between food sources.

The breeding season is between March and August with eggs usually being laid between April and June. The nests are located in hollow limbs or trunks, often in tall dead trees standing in clearings. The nests are usually between 13 and 22 metres above the ground. A single egg is laid and the male visits the brooding female at dusk, calling to her. Both male and female fly to a nearby tree where the male feeds the female. Incubation takes approximately four weeks and the young are fledged at around 9 - 10 weeks (Australian Museum Business Services 1995).

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat of which only a small proportion supports suitable feed tree species (*Allocasuarina littoralis*). Successful breeding requires feed trees, nesting trees and water to be located together, and hollow trees in the study area are potentially suitable as nesting habitat. There is a single record for this species in the locality (OEH 2012). The main distribution of feed tree species in the project footprint is limited to approximately 0.40 hectares in the central area of the study area on the southern side of the existing Great Western Highway. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint which are likely to support suitable feed tree species (*Allocasuarina* spp.) at various densities. Considering the small proportion of habitat being impacted in the proposal area relative to the available habitat in the locality a viable local population of this species is unlikely to be placed at risk of extinction.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 7.4 hectares of foraging habitat of which only a small proportion supports suitable feed tree species (*Allocasuarina littoralis*). The main distribution of feed tree species in the project footprint is limited to approximately 0.40 hectares in the central area of the study area on the southern side of the existing Great Western Highway. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint which are likely to support suitable feed tree species (*Allocasuarina* spp.) and hollows suitable for nesting at various densities.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. This species can readily fly across fragmented habitats including major roads, and therefore the proposal is unlikely to create a major barrier to this species. The proposal is unlikely to place the species at further risk of vehicle strike considering the grade and elevations of the proposal will be similar to existing conditions.

Habitats in the project footprint potentially has some importance for the local population for foraging and for nesting, however relative to the extent of habitat in the locality the removal of this habitat represents a small proportion of the available habitat for the local population (<1 per cent). Therefore the habitat impacted by the proposal is considered unlikely to be highly important to the species.

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

Critical habitat has not been declared for this species.

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

There is no recovery plan for this species. There are 10 priority action statements for this species related to scientific research, community awareness, habitat restoration and protection of this species. Considering the low potential impact to habitat to this species and the proposed mitigation measures to minimise habitat removal and restored foraging habitat (feed trees), the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging, nesting and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral honey bees for hollow resources and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

Threatening Process	**Potential impacts, and proposed avoidance and mitigation measures**
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance.
Loss of hollow-bearing trees	
Removal of dead wood and dead trees	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area 0.40 hectares of direct foraging habitat (feed trees) that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to the Glossy Black-cockatoo.

Gang-gang Cockatoo (*Callocephalon fimbriatum*)

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

The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee (OEH 2012).

In summer this species is generally found in tall mountain forests and woodlands, and may occur at lower altitudes in winter in drier more open eucalypt forests and woodlands, with old growth habitats being favoured for nesting and roosting (OEH 2012). There are eight records of this species in the locality (OEH 2012) and it was recorded in the locality during the surveys at Little Hartley, Hartley and River Lett Hill.

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat with tree hollows potentially suitable as nesting habitat. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint. There is potential for the life-cycle of the species to be impacted during the breeding season if found to be utilising hollow trees in the proposal area, however mitigation measures including pre-clearance surveys will ensure these impacts are avoided.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat. This species requires large tree hollow cavities for nesting. Based on observations of hollow trees in the study area, nesting resources are expected to be very limited if present. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. This species can readily fly across fragmented habitats including major roads and therefore the proposal will not create a major barrier to this species. The proposal is unlikely to place the species at further risk of vehicle strike considering the grade and elevations of the proposal will be similar to existing conditions.

Habitats in the project footprint potentially have some importance for the local population for foraging and potentially for shelter, however relative to the extent of habitat in the locality the impacts represents a small proportion of the available habitat for the local population (<1 per cent). Therefore the habitat impacted by the proposal is considered unlikely to be highly important to the species.

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

Critical habitat has not been declared for this species.

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

There is no recovery plan for this species. There are 11 priority action statements for this species related to scientific research, community awareness, habitat restoration and protection of this species. Considering the low potential impact to habitat to this species and the proposed mitigation measures to minimise habitat removal and restore foraging habitat through the re-establishment of native vegetation including potential feed trees (*Eucalyptus* spp.), the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging, nesting and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral honey bees for hollow resources and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance.
Loss of hollow-bearing trees	
Removal of dead wood and dead trees	
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
	mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of habitat (7.40 hectares) that would be removed relative to the extent of similar habitats in the locality (780 hectares) the proposal is unlikely to constitute a significant impact to this species.

Little Lorikeet (*Callocephalon fimbriatum*)

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

Little Lorikeets are known to occupy a diversity of forest and woodland habitats, including old-growth and logged forests, and remnant woodland patches and roadside vegetation (Pizzey & Knight 1997, DECC 2008). The species is generally considered to be nomadic, with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability (DECC 2008). However, they do exhibit some site fidelity, with breeding pairs resident from April to December, and even during their non-resident period some individuals would return to the nest area for short periods if there is some tree-flowering in the vicinity. No individuals were reported during the targeted bird surveys on the site, despite several other nectivorous bird species being present such as honeyeaters.

Major threats to Little Lorikeets are loss of breeding sites and food resources from ongoing land clearing. The study area would constitute potential breeding and non-breeding habitat for the Little Lorikeet. However the loss of hollow-bearing and feed trees for this proposal is a very small scale loss when considering the extent of similar and better quality habitats available in the region. On this basis the study area is not considered a critical breeding area for the little lorikeet as extensive areas of suitable habitat occur elsewhere in the region. The current potential for the species to occur based on the presence of potential foraging and breeding habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be affected.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat with tree hollows potentially suitable as nesting habitat. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. This species can readily fly across fragmented habitats including major roads, and therefore the proposal will not create a major barrier to this species. The proposal is unlikely to place the species at further risk of vehicle strike considering the grade and elevations of the proposal will be similar to existing conditions.

Habitats in the project footprint potentially have some importance for the local population for foraging and potentially for shelter, however relative to the extent of habitat in the locality the impacts represents a small proportion of the available habitat for the local population (<1 per cent). Therefore the habitat impacted by the proposal is considered unlikely to be highly important to the species.

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

Critical habitat has not been declared for this species. The study area would constitute potential breeding and non-breeding habitat for the little lorikeet. However the loss of hollow-bearing and feed trees for this proposal is a very small scale loss when considering the extent of similar and better quality habitats available in the region. On this basis the study area is not considered a critical breeding area for the little lorikeet as extensive areas of suitable habitat occur elsewhere in the region.

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

There is no recovery plan or priority action statements for this species.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging, nesting and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral honey bees for hollow resources and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

Threatening Process	**Potential impacts, and proposed avoidance and mitigation measures**
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance.
Loss of hollow-bearing trees	
Removal of dead wood and dead trees	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to the Little Lorikeet.

Swift Parrot (*Lathamus discolour*) and Regent Honeyeater (*Anthochaera phrygia*)

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

Swift Parrot *Lathamus discolour*

The Swift Parrot occurs from Tasmania north to south-eastern Queensland and west to Adelaide. In New South Wales, the Box - Ironbark Open Forests of the inland slopes of the Great Dividing Range are often used. This species breeds in Tasmania and over-winters in south-eastern mainland Australia, occasionally being recorded as far north as Queensland (Garnett 1992). This species has been greatly affected as a result of the clearing of suitable habitat, often to facilitate agriculture. The Swift Parrot inhabits Eucalypt forests, breeding in hollows in mature and senescent trees, particularly Blue Gums (*Eucalyptus globulus*) in Tasmania. On the mainland, forages in forests containing winter flowering Eucalypts such as Red Ironbark (*Eucalyptus sideroxylon*), Spotted Gum (*Corymbia maculata*), Yellow Gum (*Eucalyptus leucoxylon*), White Box (*Eucalyptus albens*) and Swamp Gum (*Eucalyptus ovata*) (Garnett 1992).

This species is generally very gregarious and can occur, at times, in populations of several hundred individuals, feeding on flowering Eucalypts. Swift Parrots will also feed on lerps and the secretions of hemipterans, however the nectar of flowering Eucalypts is preferred (Garnett 1992). All breeding by this species occurs in southern and eastern Tasmania. Following breeding, this species disperses throughout Tasmania, and in late March almost the entire population moves to mainland Australia, although some individuals remain in Tasmania. Most of the population over-winter in Victoria and central and eastern New South Wales, however a few may reach south-eastern Queensland and as far west as Adelaide. The mainland migrants return to Tasmania in September (Garnett 1992). The movements of this species are little understood, although it appears that this species congregates in areas where winter-flowering Eucalypts are blossoming profusely and is therefore tied to areas which contain winter-flowering species of Eucalypt.

Regent Honeyeater (*Anthochaera phrygia*)

Formerly, most breeding of the Regent Honeyeater appears to have occurred in the coastal parts of south-eastern Australia and adjacent inland scarps of the Great Dividing Range, with post-breeding dispersal to the north and west, from the Mount Lofty Ranges in South Australia to about Dalby in Queensland. Sightings now centre on a few sites in north-eastern Victoria, along the western slopes of the Great Dividing Range to Tenterfield, the Warrumbungle Ranges and Parkes in the west, and the central coast of New South Wales. Minor irruptions occasionally occur elsewhere (Garnett 1992; Australian Museum Business Services 1995).

Once considered abundant, and recorded in flocks of 'thousands', this species underwent a drastic decline from the mid 1900's (Australian Museum Business Services 1995). The Regent Honeyeater is currently considered to be Endangered in the national context (Garnett 1992), and has disappeared from some parts of its former range. Though widely dispersed, population estimates suggest that fewer than 1,000 individuals remain and, due to the small population size and widespread movement habits, the species is difficult to conserve. The causal factors involved in the drastic decline of Regent Honeyeater populations are not well understood, but habitat loss, degradation and fragmentation of habitat, would have contributed. Other suggested contributory factors include disease, trapping, egg-collecting, timber-removal and predation by feral cats, but little evidence has been collected (Australian Museum Business Services 1995).

Temperate Eucalypt Woodland and Open Forest including forest edges, woodlands, farmlands and urban areas which contain mature Eucalypts are utilised by this species. Associations of Red Ironbark (*Eucalyptus sideroxylon*), White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*), Yellow Gum (*Eucalyptus leucoxylon*) and Red Box (*Eucalyptus polyanthemos*) appear to be essentially important. In New South Wales, Regent Honeyeaters also use riparian forests of River Oak (*Casuarina cunninghamiana*) and Swamp Mahogany (*Eucalyptus robusta*).

One study, comparing occupied sites to nearby unoccupied sites, found that areas occupied appear to have noticeably larger trees, a greater percentage of trees in flower, and a taller shrub layer than surrounding unoccupied sites. Webster & Menkhorst (1992) found that structure appeared to be more important than floristics, and the density of the shrub layer of habitats varied from luxuriant but scattered to almost non-existent, and did not appear to be a critical factor. The birds did appear to seek large, mature, copiously flowering eucalypts, with an abundant nectar flow.

Both species are regarded as winter-visitors to this region, and their presence would depend predominantly on the key winter-flowering eucalypt species to provide food resources. None of the tree species in the project footprint have been identified as being winter-flowering species important for Swift Parrot or Regent Honeyeater, and therefore habitat is considered only marginal for both the Swift Parrot and Regent Honeyeater. Potential impacts constitute approximately 7.40 hectares of non-breeding habitat for a proportion of the population of both species. There are extensive areas of potential habitat in the locality which may provide more favourable foraging opportunities. Considering the above the proposal is unlikely to lead to a long-term decrease in the size of the populations of Swift Parrot and Regent Honeyeater.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat with tree hollows potentially suitable as nesting habitat. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. This species can readily fly across fragmented habitats including major roads, and therefore the proposal will not create a major barrier to this species. The proposal is unlikely to place the species at further risk of vehicle strike considering the grade and elevations of the proposal will be similar to existing conditions.

Habitats in the project footprint potentially have some importance for the local population for foraging, however relative to the extent of habitat in the locality the impacts represent a small proportion of the available habitat for the local population (<1 per cent). Therefore the habitat impacted by the proposal is considered unlikely to be highly important to the species.

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

None of the tree species in the project footprint have been identified as being winter-flowering species important for Swift Parrot or Regent Honeyeater, and therefore habitat is considered only marginal for both the Swift Parrot and Regent Honeyeater. The study area is unlikely to constitute a critical area of habitat for the Swift Parrot and Regent Honeyeater.

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

The proposal \ would not conflict with the recovery plans for these species. The upgrade would avoid recognised critical areas for these species including breeding, and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the proposal boundary.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality and habitat degradation from feral herbivores. It is considered unlikely that the proposal will increase the likelihood of predation on this species by feral carnivores.

Threatening Process	**Potential impacts, and proposed avoidance and mitigation measures**
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to the Little Lorikeet.

Large Forest Owls

Barking Owl (*Ninox connivens*)
Masked Owl (*Tyto novaehollandiae*)
Powerful Owl (*Ninox strenua*)

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

Barking Owl (*Ninox connivens*)

The distribution of the Barking Owl occurs mainly from a broad coastal strip in forest and woodland around eastern, northern and western Australia. The species is apparently rare, or absent from, arid, treeless or heavily forested regions (Pizzey and Knight 1997). The species is most abundant in tropical; northern Australia and New Guinea.

The species is generally considered to inhabit open forests, woodlands, dense scrubs, foothills, river red gums, and other large trees near watercourses. Tends to penetrate otherwise open country and also paperbark woodland. The Barking Owl prefers drier and more open habitats than does the Powerful Owl and appears more tolerant of human activity (Debus 1997). Kavanagh et al (1995) suggests that the species is particularly associated with coastal lowland or riparian woodland dominated by various red gum species.

Unlike other large forest owl species, the Barking Owl tends to roost in dense foliage in either eucalypts or non-eucalypts including midstorey shrubs. It also roosts in Rough-barked Apple which generally exhibits a more densely foliaged canopy than most eucalypts. There are records of Barking Owls roosting in Wilga trees (Geijera parviflora, in gully rainforest, and in various introduced trees around farm buildings and even in largely urban areas. However in general it appears that roost trees are commonly selected that have denser daytime cover than is usually provided by eucalypts (Debus 1997), although the species is does roost in eucalypts as well.

The diet of the Barking Owl consists of mammals, birds and insects the percentage of which depends largely on seasonal availability. For instance insects are more readily taken during the warmer months of the year and vertebrates appear to be more important during the post-fledging phase of the breeding cycle when the adults owls are still feeding young. Mammal prey consists of mostly arboreal species, particularly the Sugar Glider (Petaurus breviceps). The species is known to prey also on large birds such as galahs, various parrot species including cockatoos, and kookaburras. Dietary records suggest the Barking Owl to be an adaptable and generalised predator that is able to switch to introduced prey species, take more diurnal birds than most Australian owls, and subsist on insects in the warmer post-breeding months (Debus 1997).

Most recorded breeding events of the Barking Owl in NSW have been in live river red gums on riparian woodland of that species. In general the species nest in large tree-hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997). Compared to the other *Ninox* species, the Barking Owl is strictly a seasonal breeder raising a single brood per year. Most eggs are laid in late winter and early spring. The post fledging dependency period is considered to last up to 3-4 months (Debus 1997).

The Barking Owl is threatened with loss of habitat, particularly on flatter topography on and adjacent to floodplains, and changes to the age structure of tree cover, resulting in the decline of old growth and dead trees. Other threats include the loss and degradation of habitat, including the loss of hunting habitat and potential roosting and nest sites and habitat occupied by its prey base. The major factor is further clearing for agriculture in inland NSW, compounded by suppression of eucalypt regeneration by grazing, decline of remnant trees in cleared areas, and reduction of prey (decline of small native mammals) in woodland remnants.

Masked Owl (*Tyto novaehollandiae*)

The southern subspecies of this bird is recorded as thinly distributed over much of eastern Australia however the majority of records are located over a broad coastal strip in forest and woodland around southern and eastern Australia. Generally considered to be a bird of forest margins and in this region recorded mostly in drier open forest and woodland habitat types. It is believed that this species prefers a more open vegetative structure than either the Powerful or Sooty Owl. This species has been particularly recorded in areas with a diversity of vegetation structural types and/or a mosaic of dense and sparse ground cover (Debus 1993). Debus & Rose (1994) analysed habitat types from confirmed nocturnal records and found that the majority of observations of this species were located within wet and dry forest and woodland, and many of the remainder were made from forest and woodland edge or adjacent open country. This species has been recorded utilising treed urban areas. The high prevalence of road-kills of this species suggests that it makes use of the edge effect created by roads through wooded habitats (Debus & Rose 1994).

Known threats to this species includes the loss of foraging habitat and nest sites (suitable tree hollows). Any activity which reduces the prey of this species has the potential to influence survival rates and breeding fecundity. Road-kills are a particular problem in fragmented habitats as the hunting technique makes this species susceptible to collisions with vehicles.

The Masked Owl breeds in a variety of wooded habitats, but most of the recorded nest sites have been within live Eucalypts in open or tall open forest, on average some 17 metres from the ground. Laying of eggs extends from late February/ early March to late September/ early October, commonly in the period from March to July. Recorded clutch size is three or four, and brood size at fledgling is one or two. Loss of potential and actual nest sites is a significant threat to this species.

Prey items in eastern New South Wales largely consist of small to medium-sized terrestrial mammals (less than 600g), including rats, mice and Rabbits but arboreal mammals such as Sugar Gliders and Common Ringtail Possums, as well as birds, may also be taken. An analysis of diet samples of this species analysed by Debus & Rose (1994) suggests that the majority of predation, by biomass, was of terrestrial species. The Masked Owl has adapted well to forage on introduced species such as Black Rat (*Rattus rattus*) and Rabbits, particularly within disturbed coastal sites. It is evident that this species opportunistically preys upon the most abundant or available ground mammals (Debus & Rose 1994). Masked Owls apparently make use of the edge effect created by roads through forest and the interface between forest and cleared land when foraging for prey. The Masked Owl is believed to be a stationary hunter, using a series of regular low perches within its territory to wait for prey, which it locates by sound. Prey appears to be taken in a slow deliberate attack without the need of pursuit (Debus 1993).

Powerful Owl (*Ninox strenua*)

This species ranges over a broad coastal and sub-coastal strip in south-eastern Australia, from southern Queensland to western Victoria where it is generally confined to altitudes below 1,500 metres. The majority of records have been located east of the Great Dividing Range however a few recorded observations have been made on the inland slopes. Powerful Owls have been observed to inhabit and breed in forested areas within major urban centres such as Sydney, Brisbane and Newcastle. Within New South Wales, the majority of records have been located within open forests, but woodland, ecotones with cleared areas, riparian habitats and closed forests are also utilised (Debus & Chafer 1994). This species apparently reaches optimum population densities in gullies in dense, undisturbed mountain eucalypt forest, but is not confined to this habitat (Australian Museum Business Services 1995).

The low annual reproductive rate and dependence upon suitable prey items, which are obtained in an extensive home range, suggests that this species is vulnerable to human pressures arising from reductions in nest sites or prey availability. Furthermore, habitat loss and fragmentation may cause problems for young owls dispersing and successfully finding a mate (Debus & Chafer 1994). Widespread clearance and habitat fragmentation throughout its known range has reduced populations in the past. Fire can reduce prey numbers, and inappropriate burning regimes can lead to a simplification in the habitat structure and quality and removing resources used by prey species.

Powerful Owls are sedentary, living either alone or in pairs, and occupying a permanent territory which contains a number of roost sites. Pairs occupy permanent mutual territories although they commonly roost separately. Several roosts are used in rotation, several days at a time. A typical roost is on a horizontal limb several metres from the ground, uncluttered laterally but screened from above by dense foliage (Australian Museum Business Services 1995). The bird requires a large home range to obtain sufficient abundance of prey items and the size of the territory appears to be related to the availability of suitable prey items (Blakers et al 1984). Medium-sized arboreal mammals, particularly possums, gliders, and birds are common prey items. Records suggest that Powerful Owls are more inclined to forage within the tree canopy rather than utilise low perches beside breaks in ground cover (Debus & Chafer 1994).

Breeding records in New South Wales suggest that nesting generally occurs within open forest, in live eucalypts with hollow entrances 9 - 37 metres above the ground. Nest trees typically utilised are emergent, often the largest within a stand and oldest within a forest patch, and pairs are known to breed in the same nest for many years. Laying of eggs is undertaken in late autumn to mid winter and two young are usually produced in late winter. Powerful Owls reach sexual maturity at two years of age (Debus & Chafer 1994). Some mortality as a result of juvenile dispersal and subsequent difficulty in establishing a new territory is likely.

All three species are known to occupy very large territories particularly in fragmented areas, which is a reflection of their high mobility and diversity of prey species taken. Whilst the subject species are known to occasionally roost by day in dense thickets of vegetation or foliage their nesting requirements are more specialised being totally dependent on suitably large tree-hollows generally found in the trunks of tall, living, mature trees.

Their dependence on this specific habitat feature restricts the local distribution of the species at least for breeding life-cycle requirements and highlights their vulnerability to increased clearing and fragmentation. Generally foraging territory is more widespread and may occur throughout a variety of habitat types depending on the species, with the Powerful Owl ranging from swamp forest to wet and dry sclerophyll, preferably with wet gullies for roosting and the Barking Owl and Masked Owl favouring the more open forest and woodland types for foraging, particularly on the edge of open lands such as agricultural lands as was recorded by call playback in this survey.

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat for these species, supporting prey species such as possums and gliders, particularly for the Powerful Owl and Barking Owl. Tree hollows potentially suitable as nesting habitat were not identified in the project footprint and the survey revealed a lack of lack of large hollows from immediately adjoining areas, particularly on the south side of the road where the majority of the potential impacts will occur.

Several potential prey species were recorded in the study area including possums, gliders and small terrestrial mammals and both Powerful Owl and Barking Owl are considered the most likely of these species to forage in roadside areas to be removed by the proposal. There is a potential for increase roadkill of forest owls hunting in roadside areas. Potential habitats in the locality are extensive with over 780 hectares within 1.5 kilometres of the project footprint and the small loss of potential foraging habitat on the edge of the highway is not expected to place these species at risk of extinction.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 7.40 hectares of foraging habitat for these species. Tree hollows potentially suitable as nesting habitat for large forest owls are unlikely to be present, however tree hollows suitable for prey species are present and are important to maintain prey populations.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. These species can readily fly across fragmented habitats including major roads and therefore the proposal will not create a major barrier to these species. The proposal is unlikely to place these species at further risk of vehicle strike considering the grade and elevations of the proposal will be similar to existing conditions.

Habitats in the project footprint potentially have some importance for the local populations of these species for foraging, however relative to the extent of habitat in the locality the impacts represents a small proportion of the available habitat for the local population (<1 per cent). Therefore the habitat impacted by the proposal is considered unlikely to be highly important to these species.

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

Critical habitat has not been declared for this species.

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

There is a recovery plan for Large Forest Owls. Considering the low potential impact to habitat for this species and the minimisation of habitat removal, the proposal is consistent with the objectives of the recovery plan.

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

Key threatening processes that are relevant to these species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to these species that are directly enacted by the proposal are those associated with clearance and degradation of foraging, nesting and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral herbivore and invertebrate pests, and increased predation from feral predators on prey species.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. ▪ Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.
Loss of hollow-bearing trees	
Bushrock removal	
Removal of dead wood and dead trees	
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	
Predation by the European red fox (*Vulpes vulpes*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
	proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of foraging habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to these three large forest owl species.

Woodland Birds

Black-chinned Honeyeater (*Melithreptus g. gularis*)
Brown Treecreeper (*Climacteris picumnus victoriae*)
Varied Sittella (*Daphoenositta chrysoptera*)

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

Black-chinned Honeyeater (*Melithreptus g. gularis*)

The Black-chinned Honeyeater has two subspecies, with only the nominate (gularis) occurring in NSW. The other subspecies (laetior) was formerly considered a separate species (Golden-backed Honeyeater) and is found in northern Australia between central Queensland west to the Pilbara in Western Australia. The eastern subspecies extends south from central Queensland, through NSW, Victoria into south eastern South Australia, though it is very rare in the last state. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-

west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions, though it is very rare in the latter (OEH 2012).

Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*Eucalyptus albens*), Inland Grey Box (*Eucalyptus microcarpa*), Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*Eucalyptus blakelyi*) and Forest Red Gum (*Eucalyptus tereticornis*) (OEH 2012). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees. A gregarious species usually seen in pairs and small groups of up to 12 birds. Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least five hectares. Moves quickly from tree to tree, foraging rapidly along outer twigs, underside of branches and trunks, probing for insects. Nectar is taken from flowers, and honeydew is gleaned from foliage. Breeds solitarily or co-operatively, with up to five or six adults, from June to December (OEH 2012). The nest is placed high in the crown of a tree, in the uppermost lateral branches, hidden by foliage. It is a compact, suspended, cup-shaped nest. Two or three eggs are laid and both parents and occasionally helpers feed the young (OEH 2012).

Brown Treecreeper (*Climacteris picumnus victoriae*)

The Brown Treecreeper is an obligate hollow nesting species and the clearing of woodland and dry sclerophyll forest containing tree hollows would impact on the breeding resources and lifecycle of the Brown Treecreeper. However not all dry open forest habitats are suitable and the species mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey. These habitat types are well represented beyond the project boundary and only moderately present across the project area. The remaining woodland bird species are non-hollow breeding (nest builders).

Other life-cycle activities potentially affected by the project include breeding and roosting as a direct result of habitat loss and foraging activities due to a reduction in insect prey abundance. The clearing of habitat is unlikely to significantly alter dispersal activities as many woodland bird species, in particular Brown Treecreeper, are adapted to moving across gaps in woodland and forest and cleared habitats for dispersal and foraging forays (Doerr et al 2011). The number of birds affected in relation to the size of local populations is not known, however it could be reasonably expected if a population is impacted then this would be minor and not lead to a significant impact on the population as a whole.

Varied Sittella (*Daphoenositta chrysoptera*)

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (OEH 2012).

Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland (OEH 2012). Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (OEH 2012). Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (OEH 2012). Generation length is estimated to be 5 years.

The open forest habitats on the site provide only sub-optimal habitat for woodland birds particularly by nature of their dense canopy mid and ground-cover vegetation structure. Potential habitat for the species is more commonly encountered in lower slopes and plains of the region associated with several woodland habitat associations with a grassy understorey.

The majority of these species require habitat patches greater than 100 hectares in order to maintain variable populations, so if present, the core habitat for these species would occur to the north of the upgrade. In general, important habitat resources necessary for the life cycle of these three species are unlikely to be significantly affected by the proposal, and is therefore unlikely to place a viable local population at risk of extinction.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal will result in the removal of approximately 7.4 hectares of foraging habitat for these species. Tree hollows and other nesting opportunities for these species are present.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. These species can readily fly across fragmented habitats including major roads, and therefore the proposal will not create a major barrier to these species.

Habitats in the project footprint potentially have some importance for the local populations of these species for foraging, however relative to the extent of habitat in the locality the impacts represents a small proportion of the available habitat for the local population (<1 per cent). Therefore the habitat impacted by the proposal is considered unlikely to be highly important to the species. The majority of impacts are limited to currently fragmented landscapes on the southern side of the existing highway with extensive areas of habitat occurring to the north of the project footprint. The proposal is unlikely to reduce vegetation cover in the study area to the extent that a threshold would be reached where there is a decline in woodland bird populations.

Mitigation measures will be implemented to protect existing habitat and reinstate some habitat values into areas of the road corridor to be landscaped. These include landscaping with native vegetation, replacement of course woody debris and protection of existing vegetation/habitats.

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

Critical habitat has not been declared for these species.

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

There are no recovery plans for these species. There are 0-7 priority action statements for each of these species related to scientific research, community awareness and protection of these species. Considering the low potential impact to habitat for these species and the proposed mitigation measures to minimise habitat removal and improve connectivity, the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to these species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to these species that are directly enacted by the proposal are those associated with clearance and degradation of foraging, nesting and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral herbivore and invertebrate pests, and increased predation from feral predators.

Threatening Process	**Potential impacts, and proposed avoidance and mitigation measures**
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance
Loss of hollow-bearing trees	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Bushrock removal	and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. ▪ Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.
Removal of dead wood and dead trees	
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Scotch broom (*Cytisus scoparius*)	▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	
Predation by the European red fox (*Vulpes vulpes*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to these three woodland bird species.

Rosenberg's Goanna (*Varanus rosenbergi*)

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

The species utilises a wide diversity of habitats from heath to open forest and woodland. And is typically associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Individuals require large areas of habitat and feed on carrion, birds, eggs, reptiles and small mammals.

This species shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens. No termite mounds were noted within the proposed upgrade area and potential sheltering habitat only occurs in very low density suggesting that the habitats to be impacted are only marginal and may not support life-cycle activities around breeding, feeding and shelter.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The habitat to be removed is considered to be suitable as potential habitat for a range of prey species selected by Rosenberg's Goanna. However termite mounds are absent and this factor would reduce the likely significance or dependence on the habitat being removed. Removal of approximately 7.40 hectares of habitat for potential prey species is not considered a significant loss of habitat, particularly as this occurs along the edge of an existing highway and considerably larger areas of favourable habitat occur outside the construction corridor.

Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. Suitable habitat for this species is limited to the northern side of the project corridor. The proposal will include the provision of several fauna underpasses along the length of the project which would be suitable for larger reptile species.

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

Critical habitat has not been declared for this species.

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

There is no recovery plan for this species. There are nine priority action statements for this species related to scientific research, community awareness and protection. Considering the low potential impact to habitat for this species and the proposed mitigation measures to minimise habitat removal and improve connectivity, the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance and degradation of foraging, nesting and sheltering habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, increased competition with feral herbivore and invertebrate pests, and increased predation from feral predators.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	The proposal will result in the removal of approximately 7.4 hectares of native vegetation supporting hollow-bearing trees, dead wood and dead trees, and bushrock. Proposed avoidance and mitigation measures include: ▪ The proposed upgrade has been designed to minimise vegetation clearing where possible and minimise potential impacts to threatened species habitat. ▪ A landscape management plan would be developed as part of the Construction Environment Management Plan (CEMP) which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. ▪ A nest box management strategy would be developed as part of the CEMP. The number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed. The nest box management plan would detail the specifications for nest box dimensions, target species, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. ▪ Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use may include the approaches to fauna underpasses, beneath the proposed bridge structure at Whites Creek and rehabilitation areas.
Loss of hollow-bearing trees	
Bushrock removal	
Removal of dead wood and dead trees	
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition from feral honey bees (*Apis mellifera*)	While the proposal would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows by native fauna because the loss of tree hollows via occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. A nest box management strategy would be developed as part of the CEMP. The nest box management plan would detail ongoing monitoring and maintenance requirements including the removal of feral honey bees.
Predation by the feral cat (*Felis catus*)	The proposal may contribute to increased levels of predation on native fauna from foxes, wild dogs, pigs and cats, through the impact of habitat removal leading to displacement of resident fauna. There is some evidence of foxes preying on bandicoots at purpose built fauna underpasses that were placed in disturbed habitats (Harris et al. 2010). However, these authors consider this is less likely where multiple structures are used, as is proposed, possibly minimising the potential for predation. The proposed upgrade includes a combination of wildlife crossing structures, which would include a bridge structure, two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation surrounding fauna crossing structures with the aim of minimising the potential for predation. Woody debris and bushrock would be re-used on site for habitat improvement where applicable and would be detailed in the landscape management plan/CEMP. Suitable areas for re-use include the approaches to fauna underpasses, beneath the
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	
Predation by the European red fox (*Vulpes vulpes*)	

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
	proposed bridge structure at Whites Creek and would aim to minimise the potential for predation through providing cover for native fauna, and excluding potential feral predators.
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Considering the small area of habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to this species.

Purple Copper Butterfly (*Paralucia spinifera*)

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

Purple Copper Butterfly is found in association with the larval host-plant Blackthorn (*Bursaria spinosa subsp. lasiophylla*). The butterflies rarely venture far from the host plant and are active on sunny days from August to November, when they can be seen sunning themselves, defending their little territories (energetically and acrobatically chasing each other), feeding from flowers, performing courtship chases, mating and laying eggs on the host plant (Mjadwesch 2012).

Purple Copper Butterfly, as well as many other butterflies in the family Lycaenidae, have a symbiotic relationship with a small ant species (*Anonychomyrma itinerans*), which attend the caterpillars constantly. The ants protect the caterpillars from predators, for which service the ants are “paid” with honeydew, which is excreted from a small gland on the caterpillar (Mjadwesch 2012). When the caterpillars grow larger they become nocturnal, retreating to the ants nest at the base of the plant during the day (Mjadwesch 2012). The pupae subsequently metamorphosis underground.

The Old Bowenfels population to the west of the study area and both of the Forty Bends populations within the study area are considered to be viable (Mjadwesch 2012). The nature of the species, occupying discrete and often small areas of habitat, provides that small populations form parts of a larger intermixing metapopulation. Among the populations examined by Clarke & Grosse (2003) “very little genetic differentiation” among these populations was observed, indicating outbreeding events between populations.

With areas of occupied habitat being avoided, it is unlikely any viable local populations in these locations will be put at risk of extinction. However the proposal will be in close proximity to these areas of occupied habitat and therefore there is potential for indirect impacts during construction and operation.

Existing populations are currently in close proximity (3-4 metres) to the existing Great Western Highway at Forty Bends and therefore the Purple Copper Butterfly is currently at risk from the operation of the highway. Butterflies may fly into the paths of vehicles travelling along the highway or potentially be swirled and buffeted into the highway corridor airspace by passing trucks as has been observed and roadkill fatalities would certainly occur. This will remain unchanged under the proposed works and the realignment will not result in vehicles being closer to known populations, and in fact at the western population the highway will be moved slightly to the south resulting in passing vehicles to be (approximately 15 metres) from areas of occupied habitat.

Given an adequate intensity of survey, targeting the best time of year to detect the species and visiting potential habitat areas twice, the likelihood of an unknown population occurring within these areas is considered to be low. However, it is accepted that unknown populations could exist within the proposal area which would potentially be directly impacted. Pre-clearing checks will provide a final audit of Purple Copper Butterfly distribution (adult flying and juvenile larval seasons between September and November) and new populations (if any) will be provided appropriate protection / mitigation in or directly adjacent to the proposed work area, if detected.

A total area of approximately 0.6 hectares of occupied habitat, 3.6 hectares of high potential habitat and 18.4 hectares of potential habitat has been identified in the study area. Of the these total areas of habitat and potential habitat no areas of occupied habitat will be impacted, 2.01 hectares of high potential and 4.62 hectares of potential habitat will be

removed by the Project. The total area of potential habitat impacted (6.63 hectares) comprises approximately 30 per cent of all areas of potential habitat identified in the study area, and when considering the area of potential habitat in the locality (10 kilometre radius) this potential impact would comprise a small proportion. The loss of these areas coupled with the proposed mitigation measures is considered unlikely to place a viable population of the species at risk of extinction.

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

n/a

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

- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

n/a

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

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and***
- ***the importance of the habitat to be removed, modified fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The proposal has been designed to avoid areas of occupied habitat. Impacts will be limited to a total of 6.63 hectares of potential habitat consisting of 2.01 hectares of high potential impact and 4.62 hectares of potential habitat.

Existing populations are currently in close proximity to the existing Great Western Highway at Forty Bends and therefore the Purple Copper Butterfly is currently subject to edge effects such as weed incursion from the existing roadside environment. Proposed weed treatment and habitat enhancement activities proposed as part of the project would allow habitats to be modified in a positive sense, which would compensate for negative impacts.

Any removal of Blackthorn will potentially contribute to further isolation of populations of the species (loss and fragmentation of habitat has been identified as a key threat to the species (NPWS 2001). In this case the proposal will further consolidate an existing road corridor (increasing isolation). For this reason removal of Blackthorn has been minimised where possible, in particular areas of high potential habitat have been avoided.

Habitat enhancement programs will be implemented as part of the project including weed treatment and planting of the larval host plant Blackthorn. Blackthorn will be incorporated into roadside plantings and rehabilitation areas and canopy species on higher cuttings will be excluded from landscaping providing sunny open aspects suitable for the species.

Blackthorn is a widespread species, and occurs relatively frequently in the study area. However “habitat” for the species is not Blackthorn in isolation, habitat has a range of components, including an ant species which tends caterpillars, and suitable conditions with regard to incident sunlight and structural characteristics of the vegetation (both canopy and groundcover).

Blackthorn plants which will be removed by the proposal are considered to be of low to moderate importance locally. However additional areas of potential habitat could potentially support butterflies under changed or more optimal habitat conditions, for example after a fire.

Whilst having high value as potential habitat, the importance of these unoccupied habitats to the butterfly is currently likely to be minor considering the non-use and lack of occupancy in 2011, a tendency for the species to be dependent on often small and discrete habitat areas and the potential habitat which will be lost is unlikely to be important for the long term survival of the species.

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

Critical habitat has not been declared for this species.

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

Protection of populations of the Purple Copper Butterfly is consistent with the objectives and intent of the PCB Recovery Plan (NPWS 2001). Designing the proposed works to avoid impacts on known populations is consistent with the Recovery Plan for the species (NPWS 2001). Implementing actions such as rehabilitation of habitat including removal of weeds and enhancing habitat values through the use of Blackthorn in roadside and proximate plantings, is consistent with the objectives for recovery of the species. Loss of potential habitat, and clearing of native vegetation, is not consistent with the aims of the Recovery Plan.

Field assessment at Forty Bends resulted in two new Purple Copper Butterfly populations being identified in 2011. Far from interfering with the recovery effort, this project has already contributed in a positive way to the recovery of the species, with now 14 sub-populations having been identified, comprising the Lithgow / Hartley Valley complex of populations.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this species that are directly enacted by the proposal are those associated with clearance of habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality and habitat degradation from feral herbivores.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
DIRECT IMPACT	
Clearing of native vegetation	A total area of approximately 0.6 hectares of occupied habitat, 3.6 hectares of high potential habitat and 18.4 hectares of potential habitat has been identified in the study area. Of the these total areas of habitat and potential habitat no areas of occupied habitat will be impacted, 2.01 hectares of high potential impact and 4.62 hectares of potential habitat will be removed by the Project. As this threat pertains to the Purple Copper Butterfly, clearing of native vegetation utilised by the butterfly (i.e. occupied habitat areas) will not occur, and thus the threat will not be enacted for this species in this instance. Clearing of potential habitat will occur, which presents potential for a longer term impact, based on the reduced capacity for the species to utilise presently unsuitable habitat units, if conditions change, and presently non-utilised habitat becomes more optimal.

Threatening Process	Potential impacts, and proposed avoidance and mitigation measures
INDIRECT IMPACT	
Infection of native plants by *Phytophthora cinnamomi*	There is potential for equipment and personnel to introduce pathogens to the area during construction. Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011) and include: ▪ Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site. ▪ The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks. ▪ Construction works would be programmed to move from uninfected areas to any known infected areas. ▪ Restrict vehicles to designated tracks, trails and parking areas. ▪ The above pathogen management measures need to be implemented throughout the entire construction period.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	
Invasion of native plant communities by exotic perennial grasses	Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. A weed management plan would be developed as part of the CEMP. The details of the weed management plan would vary for each site but should include: ▪ Taxa and potential sources of the weed species. ▪ Weed management priorities and objectives. ▪ Sensitive environmental areas within or adjacent to the site. ▪ Location of weed infested areas. ▪ Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance. ▪ Measures to prevent the spread of weeds. ▪ A monitoring program to measure the success of weed management. ▪ Strategic management with adjacent landowners. ▪ Appropriate disposal of weed infested materials and soils to be identified in the CEMP. ▪ Communication strategies to improve contractor awareness of weeds and weed management.
Invasion and establishment of exotic vines and scramblers	
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*), feral deer (Family Cervidae) and feral goats (*Capra hircus*) in the study area over the long-term. Revegetation of disturbed areas particularly formerly vegetated sites would assist in managing populations of these species. A landscape management plan would be developed as part of the CEMP which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.
Competition and habitat degradation by feral goats (*Capra hircus*)	
Herbivory and environmental degradation caused by feral deer	

Conclusion

Avoidance as a mechanism to reduce impacts on threatened species has been the first strategic objective in developing and designing the project, and direct impacts on known populations of the Purple Copper Butterfly are not expected.

Impacts on potential habitat will occur (clearing of Blackthorn plants), and this indirect or future impact could limit the capacity for the Copper to inhabit or re-colonise locations, in the absence of the plant, in the future. Impacts on high value potential habitats have been minimised by avoidance as much as possible. Otherwise programs managing and enhancing known habitat areas are planned including formal reservation (offsetting) of the Old Bowenfels population, inclusion of Blackthorn in landscaping surrounding the proposal and targeted surveys will be undertaken prior to construction.

F.2 EPBC Act Assessments of Significance
Endangered Species

Swift Parrot (*Lathamus discolour*) and Regent Honeyeater (*Anthochaera phrygia*)

Lead to a long-term decrease in the size of a population

Swift Parrot *Lathamus discolour*

The Swift Parrot occurs from Tasmania north to south-eastern Queensland and west to Adelaide. In New South Wales, the Box - Ironbark Open Forests of the inland slopes of the Great Dividing Range are often used. This species breeds in Tasmania and over-winters in south-eastern mainland Australia, occasionally being recorded as far north as Queensland (Garnett 1992). This species has been greatly affected as a result of the clearing of suitable habitat, often to facilitate agriculture. The Swift Parrot inhabits Eucalypt forests, breeding in hollows in mature and senescent trees, particularly Blue Gums (*Eucalyptus globulus*) in Tasmania. On the mainland, forages in forests containing winter flowering Eucalypts such as Red Ironbark (*Eucalyptus sideroxylon*), Spotted Gum (*Corymbia maculata*), Yellow Gum (*Eucalyptus leucoxylon*), White Box (*Eucalyptus albens*) and Swamp Gum (*Eucalyptus ovata*) (Garnett 1992).

This species is generally very gregarious and can occur, at times, in populations of several hundred individuals, feeding on flowering Eucalypts. Swift Parrots will also feed on lerps and the secretions of hemipterans, however the nectar of flowering Eucalypts is preferred (Garnett 1992). All breeding by this species occurs in southern and eastern Tasmania. Following breeding, this species disperses throughout Tasmania, and in late March almost the entire population moves to mainland Australia, although some individuals remain in Tasmania. Most of the population over-winter in Victoria and central and eastern New South Wales, however a few may reach south-eastern Queensland and as far west as Adelaide. The mainland migrants return to Tasmania in September (Garnett 1992). The movements of this species are little understood, although it appears that this species congregates in areas where winter-flowering Eucalypts are blossoming profusely and is therefore tied to areas which contain winter-flowering species of Eucalypt.

Regent Honeyeater (*Anthochaera phrygia*)

Formerly, most breeding of the Regent Honeyeater appears to have occurred in the coastal parts of south-eastern Australia and adjacent inland scarps of the Great Dividing Range, with post-breeding dispersal to the north and west, from the Mount Lofty Ranges in South Australia to about Dalby in Queensland. Sightings now centre on a few sites in north-eastern Victoria, along the western slopes of the Great Dividing Range to Tenterfield, the Warrumbungle Ranges and Parkes in the west, and the central coast of New South Wales. Minor irruptions occasionally occur elsewhere (Garnett 1992; Australian Museum Business Services 1995).

Once considered abundant, and recorded in flocks of 'thousands', this species underwent a drastic decline from the mid 1900's (Australian Museum Business Services 1995). The Regent Honeyeater is currently considered to be Endangered in the national context (Garnett 1992), and has disappeared from some parts of its former range. Though widely dispersed, population estimates suggest that fewer than 1,000 individuals remain and, due to the small population size and widespread movement habits, the species is difficult to conserve. The causal factors involved in the drastic decline of Regent Honeyeater populations is not well understood, but habitat loss, degradation and fragmentation of habitat, would have contributed. Other suggested contributory factors include disease, trapping, egg-collecting, timber-removal and predation by feral cats, but little evidence has been collected (Australian Museum Business Services 1995).

Temperate Eucalypt Woodland and Open Forest including forest edges, woodlands, farmlands and urban areas which contain mature Eucalypts are utilised by this species. Associations of Red Ironbark (*Eucalyptus sideroxylon*), White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*), Yellow Gum (*Eucalyptus leucoxylon*) and Red Box (*Eucalyptus polyanthemos*) appear to be essentially important. In New South Wales, Regent Honeyeaters also use riparian forests of River Oak (*Casuarina cunninghamiana*) and Swamp Mahogany (*Eucalyptus robusta*).

One study, comparing occupied sites to nearby unoccupied sites, found that areas occupied appear to have noticeably larger trees, a greater percentage of trees in flower, and a taller shrub layer than surrounding unoccupied sites. Webster & Menkhorst (1992) found that structure appeared to be more important than floristics, and the density of the shrub layer of habitats varied from luxuriant but scattered to almost non-existent, and did not appear to be a critical factor. The birds did appear to seek large, mature, copiously flowering eucalypts, with an abundant nectar flow.

Both species are regarded as winter-visitors to this region, and their presence would depend predominantly on the key winter-flowering eucalypt species to provide food resources. None of the tree species in the project footprint have been identified as being winter-flowering species important for Swift Parrot or Regent Honeyeater, and therefore habitat is considered only marginal for both the Swift Parrot and Regent Honeyeater. Potential impacts constitute approximately 7.40 hectares of non-breeding habitat for a proportion of the population of both species. There are extensive areas of potential habitat in the locality which may provide more favourable foraging opportunities. Considering the above the proposal is unlikely to lead to a long-term decrease in the size of the populations of Swift Parrot and Regent Honeyeater.

Reduce the area of occupancy of the species

Both species are wide ranging and highly mobile, semi-nomadic species with patchy and sporadic distribution across coastal NSW. Their presence in the study area is seasonally dependent and influenced by drought and rain periods affecting the flowering of preferred tree species. Therefore there is no defined area of occupancy in the study area. The Proposal would have minor impacts on a relatively small area of potential foraging habitat for these species.

Fragment an existing population into two or more populations

Potential habitat in the project footprint is currently fragmented by existing roads and cleared land. Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated.

Furthermore, both species are highly mobile and semi-nomadic, capable of accessing patchy food resources. There are no defined areas of habitat in the study area that are exclusively occupied by these species and the Proposal would not fragment a population of the Swift Parrot and Regent Honeyeater.

Adversely affect habitat critical to the survival of the species

None of the tree species in the project footprint have been identified as being winter-flowering species important for Swift Parrot or Regent Honeyeater, and therefore habitat is considered only marginal for both the Swift Parrot and Regent Honeyeater. The study area is unlikely to constitute a critical area of habitat for the Swift Parrot and Regent Honeyeater.

Disrupt the breeding cycle of a population

The study area would constitute non-breeding habitat for a proportion of the population of both species

Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline

The area of vegetation potentially removed as a result of the proposal is not considered substantially large or of a high quality to lead to the decline of these species. The Proposal would impact on 7.40 hectares of marginal habitat. This is minimal in relation to the extent of higher quality foraging habitat in the locality and wider region.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species habitat

Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks, which could potentially modify the habitat suitability for the species. A weed management plan would be developed as part of the Construction Environment Management Plan (CEMP). The details of the weed management plan would vary for each site but should include: taxa and potential sources of the weed species; weed management priorities and objectives; location of weed infested areas; mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance; measures to prevent the spread of weeds; a monitoring program to measure the success of weed management; strategic management with adjacent landowners; appropriate disposal of weed infested materials and soils; communication strategies to improve contractor awareness of weeds and weed management.

Introduce disease that may cause the species to decline

Disease has not been identified as a direct threat to the species. There is potential for indirect impacts from introduction of disease (such as *Phytophthora cinnamomi* and exotic rust fungi) to alter habitat attributes for the species and potentially cause the species to decline.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011). These include: vehicle and boot wash down facilities and ensuring vehicles and footwear is free of soil before entering or exiting the site: raising awareness about the risk of spreading pathogens and the mitigation measures required on site through regular communication to staff and contractors during inductions and toolbox talks; construction works would be programmed to move from uninfected areas to any known infected areas; restrict vehicles to designated tracks, trails and parking areas; and implementation of these pathogen management measures throughout the entire construction period.

Interfere with the recovery of the species

The project \ would not conflict with the recovery plans for these species. The upgrade would avoid recognised critical areas for these species including breeding, and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the project boundary.

Conclusion

It is unlikely there would be significant impacts to any local populations, considering the lack of important feed tree species and small amount of marginal foraging habitat to be removed within by the proposal.

Spotted-tail Quoll (*Dasyurus maculatus*)

Lead to a long-term decrease in the size of a population

The current distribution of this species is the coast and ranges of eastern Australia from southern Queensland to the Victorian/ South Australian border and Tasmania. The mainland range of this species has been fragmented and significantly reduced and is now disjunct over much of its former distribution. Spotted-tail Quolls have been reported inhabiting a wide range of habitats including rainforest, wet and dry sclerophyll forest, woodland, coastal heathland and inland riparian forest. Occasionally, the species has been recorded in rock outcrops or other treeless areas (Edgar & Belcher 1995). The species requires extensive home ranges, and is generally so confined to localities which contain extensive and continuous tree cover.

Populations of the Spotted-tail Quoll have been much reduced through habitat loss, and the species is currently sparsely distributed and rare. Land clearance for agricultural and urban development, as well as disease (possibly a form of toxoplasmosis - which is caused by a protozoan parasite prevalent in feral cats) and persecution have significantly reduced populations of this species, and the distribution of the Spotted-tail Quoll is heavily fragmented as a result. Spotted-tail Quolls compete for resources and shelter with Foxes, Feral Dogs and Feral Cats, and competition with these species may have an adverse impact on populations (Edgar & Belcher 1995). Spotted-tail Quolls are also susceptible to baits laid for wild dogs.

A solitary, generally nocturnal (although some foraging, and sun-basking takes place during the day) and semi-arboreal species, the Spotted-tail Quoll preys on a variety of species, ranging in size from small wallabies to reptiles and insects, as well as plants. Medium-sized terrestrial and arboreal mammals, such as Brushtail Possums, Rats, small macropods and Rabbits, comprise about two-thirds of the diet in south-east Australia, with birds (and their young) and carrion also being important dietary components. The species has been persecuted as a result of attacks on domestic poultry. Much of the foraging of this species is undertaken on the ground, but some foraging in trees is undertaken, and trees are also used as vantage points to detect prey and pounce on prey. Spotted-tail Quolls, as opportunistic predators, utilise extensive home ranges which are estimated to be between 500 - 1 000 hectares (Australian Museum Business Services 1995). Movements of up to several kilometres in a single night have been recorded.

Both males and females mature when about one year old and mating occurs between April and July. The average litter size is five and young are fully independent at 18 weeks. Den and nest sites have been recorded in caves, rock crevices, tree hollows and hollow logs (Edgar & Belcher 1995).

Potential threats to the spotted-tail quoll associated with this proposal include the clearing of habitat features, such as hollow bearing trees, and logs and mortality vehicle strike. Potential denning opportunities were noted in steeper escarpment areas over 200 metres to the north of the highway. These are listed in the significant impact guidelines for the Spotted-tailed Quoll (DEWHA 2009) among other known threats such as baiting with 1080 which is not relevant to this proposal.

Suitable habitat is well represented in the locality within the larger fragments of forest such as Newnes State Forest and Crown Lands, as well as vegetation on private properties including the edges of open farmland. The species was not recorded during this study however is expected to occur. The Project would remove potential habitat for the species and its prey, leading to further fragmentation of habitat, a known threat to the species. Measures to improve connectivity for terrestrial fauna have been incorporated into the proposal including the provision of a bridge over Whites Creek and two 2.4 x 2.4 metre culvert underpasses.

The proposal would remove approximately 7.40 hectares of potential habitat for prey species and potentially sheltering or denning habitat, however large hollow logs are very scarce in the habitats to be removed and no cave sites occur. The habitat to be removed constitutes a small proportion of the available habitat for the species in the locality. Considering the small proportion of habitat being impacted, and the proposed improved habitat connectivity the proposal is unlikely to lead to a long-term decrease to the local population.

Reduce the area of occupancy of the species

The species typically has a large home range and occupies a diversity of habitat types. It is therefore difficult to identify the area of occupancy. The Spotted-tail Quoll could potentially occur in any of the habitats of the study area, including the edges of cleared agricultural areas, however the preferred habitat includes dry and moist sclerophyll forests. The Proposal would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat within the locality.

Fragment an existing population into two or more populations

Potential habitat in the project footprint is currently fragmented by existing roads and cleared land. Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. Furthermore, wildlife connectivity across this section of the Great Western Highway would be improved by the inclusion of several underpasses along the length of the project.

Adversely affect habitat critical to the survival of the species

While habitats in the study area are suitable for populations of Spotted-tail Quoll, they are unlikely to constitute an area of habitat critical for the survival of the species. Critical habitat for populations of this species would include habitat that supports known breeding populations, such as denning/breeding sites or a known population. Or the habitat is located with a critical movement corridor for quolls. The habitat to be removed for the project provides potential resources for prey species for the quoll, however sheltering and denning resources are scarce. Furthermore, the position of the habitat adjacent to the existing highway would suggest that it is not critical to the survival of a local population.

Disrupt the breeding cycle of a population

Given the large home ranges of this species, the habitat within the proposal area may only constitute a small portion of the large area occupied by quoll populations in the region. The habitat may be important for prey species and therefore the foraging range of a small number of individuals. There is potential that movements across the road corridor occur in this location as suitable habitats occur on both sides of the road. While there is very limited shelter and breeding hollows noted, there is potential for the habitat to be used for this purpose. Any impacts to breeding would only be expected for a short duration (one season) for one breeding pair, and not have an overall significant long-term impact on the population as a whole.

Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline

Suitable habitat is well represented in the larger fragments of forest in the study area, particularly to the north of the project corridor and adjoining private properties including the edges of open farmland. Given the large home range of this species, potentially only a small number of individuals may be present in the lands surrounding the study area.

The project would remove potential habitat for this small number of individuals, leading to further fragmentation of habitat. The impacts are not likely to cause the species to decline in the region. Measures to facilitate the movement opportunities for this species across the project have been included through the provision of dedicated and combined fauna underpass structures.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species habitat

Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks, which could potentially modify the habitat suitability for the species. A weed management plan would be developed as part of the Construction

Environment Management Plan (CEMP). The details of the weed management plan would vary for each site but should include: taxa and potential sources of the weed species; weed management priorities and objectives; location of weed infested areas; mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance; measures to prevent the spread of weeds; a monitoring program to measure the success of weed management; strategic management with adjacent landowners; appropriate disposal of weed infested materials and soils; communication strategies to improve contractor awareness of weeds and weed management.

Introduce disease that may cause the species to decline

Disease has not been identified as a direct threat to the species. There is potential for indirect impacts from introduction of disease (such as *Phytophthora cinnamomi* and exotic rust fungi) to alter habitat attributes for the species and potentially cause the species to decline.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011). These include: vehicle and boot wash down facilities and ensuring vehicles and footwear is free of soil before entering or exiting the site: raising awareness about the risk of spreading pathogens and the mitigation measures required on site through regular communication to staff and contractors during inductions and toolbox talks; construction works would be programmed to move from uninfected areas to any known infected areas; restrict vehicles to designated tracks, trails and parking areas; and implementation of these pathogen management measures throughout the entire construction period.

Interfere with the recovery of the species

A draft national recovery plan for the Spotted-tailed Quoll is currently being prepared. In NSW, the Threatened Species Priorities Action Statement lists recovery actions for all threatened species. A total of 33 recovery actions are listed for the Spotted-tailed Quoll. These actions focus on addressing current knowledge gaps and managing the threats to quoll populations as identified through scientific research. Mortality from collisions with vehicles is a known threat to this species and has been considered in this project the provision of dedicated underpass structures targeting this species. The current proposed project is consistent with the objectives of the draft recovery plan.

Conclusion

While habitats in the study area are suitable for populations of Spotted-tail Quoll, they are unlikely to constitute an area of habitat critical for the survival of the species. Critical habitat for populations of this species would include habitat that supports known breeding populations, such as denning/breeding sites or a known population. Or the habitat is located with a critical movement corridor for quolls. The habitat to be removed for the project provides potential resources for prey species for the quoll, however sheltering and denning resources are scarce. Furthermore, the position of the habitat adjacent to the existing highway would suggest that it is not critical to the survival of a local population. Therefore the proposal is unlikely to constitute a significant impact to this species.

Vulnerable Species

Grey-headed Flying-fox (*Pteropus poliocephalus*)

Lead to a long-term decrease in the size of an important population

The Grey-headed Flying-fox is Australia's only endemic flying-fox and occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (Tidemann 1998). However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years. At a local scale, the species is generally present intermittently and irregularly (Eby & Lunney 2002). At a regional scale, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration (Eby & Lunney 2002).

The species is widespread throughout its range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW associated with flowering Spotted Gum (*Corymbia maculata*) and on the northwest slopes generally associated with flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*Eucalyptus sideroxylon*) (NSW DECCW 2010a).

The national population of the Grey-headed Flying-fox is spatially structured into colonies (Parry-Jones & Wardle 2004). However, there are no separate or distinct populations due to the constant genetic exchange and movement between camps throughout the species' entire geographic range. This indicates that there is one single interbreeding population (Webb & Tidemann 1995; DSE 2005).

The Grey-headed Flying-fox is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits (Eby 1998). None of the vegetation communities used by the Grey-headed Flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources (Eby 1996, 1998; Nelson 1965).

Flying foxes roost communally in open canopy vegetation and the location of day roosts or camps is generally stable through time (Eby 2002). Flying fox camps serve a number of functions for the animals including resting habitat within suitable commuting distance of feeding areas which is typically within 20 kilometres but as far as 50 kilometres (Eby 1996), they are sites of behaviours associated with reproduction and maternal care and they provide refuge at night for flightless young who remain in camps for many weeks while adults feed during the night (Nelson 1965).

Foraging resources for the Grey-headed Flying-fox occur throughout all naturally vegetated areas of the study area and it is likely that the vegetation to be cleared provides a portion of the foraging range of local populations of Grey-headed Flying-foxes. The projected removal of 7.40 hectares is considered a sustainable loss of potential foraging habitat in the context of available habitat in the surrounding region, including several state forests and conservation reserves. Life-cycle characteristics of the species at threat from habitat clearing relate to the loss of critical foraging habitat within a 50 kilometre radius of known camps (DECCW 2009). This is the expected maximum foraging distance of the species from a roost site (Eby 1996).

There are no known roost camps within 50 kilometres of the proposal area. The closest known roost camps are to the east of the proposal in the Penrith and Hawkesbury LGAs. There are also no records (OEH 2012) of Grey-headed Flying-fox in the locality (10 kilometre radius).

Given the absence of a roost camp in the proposal study area, the impacts of the proposal relate to loss of feeding habitat caused by direct clearing and/or damage to native vegetation during the construction phase.

The affected area of foraging habitat would represent a small percentage of the total extent of these vegetation types within a 50 kilometre radius of the proposal area. Similarly, vegetation types containing known diet species as dominants or subdominants are widespread in the study area and the overall impact of loss of these species will be ameliorated by their prevalence in a broad range of vegetation types such that this proposal is unlikely to lead to a long-term decrease in the size of the population.

Considering the small proportion of potential foraging habitat for this species being removed and the lack of evidence for the occurrence of the species in the locality the proposal is unlikely to lead to a decrease to the size of any Grey-headed Flying-Fox populations. The lack of evidence for the species in the study area suggests that an important population is not present.

Reduce the area of occupancy of an important population

The project would involve the removal of approximately 7.40 hectares of potential foraging habitat for the Grey-headed Flying-fox. There are over 780 hectares of potential foraging habitat for this species within 1.5 kilometres of the project footprint (Tozer *et al*. 2010).

The project is not expected to significantly impact on food resources available for local populations of the Grey-headed Flying-fox. This species is wide ranging a capable of exploiting seasonally available and wide spread food resources. Furthermore there are no known roost camps within 50 kilometres of the proposal area.

Fragment an existing important population into two or more populations

Potential habitat in the project footprint is currently fragmented by existing roads and cleared land. Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. Furthermore, this species is nomadic, highly mobile and capable of accessing patchy food resources.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of a species refers to areas that are necessary:

- *For activities such as foraging, breeding, roosting, or dispersal.*
- *For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.*
- *To maintain genetic diversity and long-term evolutionary development.*
- *For the reintroduction of populations or recovery of the species.*

Habitat in the study area is not considered critical to the survival of this species.

Disrupt the breeding cycle of an important population

No evidence of a roosting colony of the Grey-headed Flying-fox occurs in proximity to the study area and the proposal would not impact on breeding cycles.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

There would be a decrease in the availability of foraging habitat in the region however this decrease represents a very small percentage (<1 per cent) of the potential foraging habitat for the species in the locality.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks, which could potentially modify the habitat suitability for the species. A weed management plan would be developed as part of the Construction Environment Management Plan (CEMP). The details of the weed management plan would vary for each site but should include: taxa and potential sources of the weed species; weed management priorities and objectives; location of weed infested areas; mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance; measures to prevent the spread of weeds; a monitoring program to measure the success of weed management; strategic management with adjacent landowners; appropriate disposal of weed infested materials and soils; communication strategies to improve contractor awareness of weeds and weed management.

Introduce disease that may cause the species to decline

Disease has not been identified as a direct threat to the species. There is potential for indirect impacts from introduction of disease (such as *Phytophthora cinnamomi* and exotic rust fungi) to alter habitat attributes for the species and potentially cause the species to decline.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011). These include: vehicle and boot wash down facilities and ensuring vehicles and footwear is free of soil before entering or exiting the site: raising awareness about the risk of spreading pathogens and the mitigation measures required on site through regular communication to staff and contractors during inductions and toolbox talks; construction works would be programmed to move from uninfected areas to any known infected areas; restrict vehicles to designated tracks, trails and parking areas; and implementation of these pathogen management measures throughout the entire construction period.

Interfere with the recovery of the species

The proposal would not conflict with the recovery of Grey-headed Flying-fox.

Conclusion

Considering there are no known records of this species (OEH 2012) or roost camps within the locality, and the extensive areas of habitat surrounding the project footprint, the habitats potentially impacted by the project footprint are unlikely to constitute a significant impact for this species.

Koala (*Phascolarctos cinereus*)

Lead to a long-term decrease in the size of an important population

Distributed from about Townsville, Queensland to the Victorian/ South Australian border, from the coast to the western slopes and plains (within River Red Gum Forest) in New South Wales, this species is rare in the north and south of its range and nowhere can it be considered abundant. The Koala is a foliovore, feeding on a select range of Eucalypt species, and the presence of suitable Eucalypt forests influences the distribution of Koala populations. The Koala is found in a variety of habitats where suitable food trees occur and is often sighted in younger trees, which may have leaves of a higher palatability and nutrient value. The more abundant populations have been associated with vegetation communities growing on high nutrient soils, but Koalas also occur in forests of the poorer coastal soils (Martin & Handasyde 1995).

The Koala is adversely affected by habitat loss and fragmentation, wild fire, predation and disease. Hunting for pelts and shooting for sport is likely to have caused the local extinction of some populations (i.e. Wallalong area - as suggested in Callaghan et al 1994). In fragmented habitats, roadkills and dog attacks are significant problems. Genetic introgression can be a serious threat to high density populations in isolated habitats. Habitat preservation and linking of isolates with habitat corridors is essential for the long term survival of Koala populations (Martin & Handasyde 1995). Clearing of the forests from the high nutrient soils of valleys for agriculture probably removed prime habitat areas for Koalas, and forced individuals into areas of sub-optimal habitat.

Koalas are generally solitary except during the mating season and have a home range of about 3 hectares (although the size of this area is influenced by the distribution, abundance and quality of feeding resources). In dense populations, home ranges may overlap but appear to be discrete at lower densities (Martin & Handasyde 1995). Long movements in search of a mate or new food source are sometimes undertaken, signifying the importance of dispersal corridors in secure Koala habitat (Phillips 1990). The breeding season begins about September, when males commence calling and searching for reproductive females, and ends about April. Mating depends on the weaning of the previous years cub. Females

can produce one young per year, but this has been jeopardized in some populations by Chlamydia which causes ovarian cysts, reducing fertility. Young leave the pouch permanently at about 8 - 9 months and are independent at 12 months although still remain in the vicinity of the mother (Lee & Martin 1988). Males leave the natal range at about 2 to 3 years old with the females often remaining and breeding nearby. There is some mortality associated with the dispersal of young males, especially in fragmented habitats. Longevity is around 18 years of age for females and probably a few years less for males (Martin & Handasyde 1995).

The interim referral guidelines for this species (SEWPaC 2012) require an assessment to identify whether the population in the study area is an important population or whether critical habitat would be removed. An important population is defined as a key source population either for breeding or dispersal, populations that are necessary for genetic diversity or populations that are near the limit of the species range. The status of the Koala population in the study area is not known. There are three historical records of Koalas in the locality (Atlas of NSW Wildlife OEH 2012), and suitable feed species are present in the study area. There is a small area of forest dominated by Ribbon Gum (*Eucalyptus viminalis*), a known feed tree listed under SEPP 44 and the recovery plan (DECC 2008b). There are more extensive areas of marginal habitat which may provide some foraging opportunities, as the dominant tree species in the majority of vegetation in the study area are Monkey Gum (*Eucalyptus cypellocarpa*) a secondary food tree in other Koala Management Areas (Central Coast; Northern Tablelands; South Coast), and Blaxland's Stringybark (*Eucalyptus blaxlandii*) a supplementary species in the Central Coast Koala Management Area (DECC 2008b). Secondary food tree species listed for the Koala Management Areas of the locality (Central and Southern Tablelands; Western Slopes and Plains) occurring in the proposal area in low abundance comprise Mountain Gum (*Eucalyptus dalrympleana*) and several planted Argyle Apple (*Eucalyptus cinerea*).

No evidence of a Koala population was observed in the study area or the wider locality (including larger patches of Ribbon Gum dominated woodland in the Hartley Valley area). Any Koala population in the study area is likely to be widely dispersed over a large area which would extent to the north, east and south of the proposal. The lack of evidence for the presence of a local breeding population suggests that the population in the study area is not likely to constitute an important population.

The proposal would remove approximately 0.05 hectares of forest dominated by Ribbon Gum (*Eucalyptus viminalis*) a primary feed tree, and an additional 7.40 hectares of marginal habitat which may provide some foraging opportunities as Monkey Gum (*Eucalyptus cypellocarpa*) and Blaxland's Stringybark (*Eucalyptus blaxlandii*) are identified as providing secondary/supplementary food sources (DECC 2008b). There are relatively extensive areas of optimal habitat (Ribbon Gum Grassy Woodland) in the locality including

approximately 100 hectares within 1.5 kilometres of the project footprint in addition to over 680 hectares of marginal habitat (Tozer *et al*. 2010).

Considering the small area of potential habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to lead to a long-term decrease to an important population.

Reduce the area of occupancy of an important population

The species typically has a large home range and occupies a diversity of habitat types. It is therefore difficult to identify the area of occupancy. The Koala has the potential to occur in any of the forested habitats of the study area. The Proposal would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat within the locality.

Fragment an existing important population into two or more populations

Potential habitat in the project footprint is currently fragmented by existing roads and cleared land. Vegetation clearing for the proposal would be limited to edge effected habitats currently surrounding the existing Great Western Highway which although would result in greater distance between habitats on either side of the highway no new-edges would be created and no areas of habitat would become isolated. Furthermore, wildlife connectivity across this section of the Great Western Highway would be improved for Koala through the construction of a bridge over Whites Creek and two 2.4 x 2.4 metre culverts with fauna fencing to guide animals into underpasses.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of the koala is currently considered to be areas of forest or woodland where: Habitat critical to the survival of a species refers to areas that are necessary:

- *Primary koala food tree species comprise at least 30 per cent of the overstorey trees,*
- *Primary koala food tree species comprise less than 30 per cent of the overstorey trees, but together with secondary food tree species comprise at least 50 per cent of the overstorey trees,*
- *Primary food tree species are absent but secondary food tree species alone comprise at least 50 per cent of the overstorey trees*
- *The above qualities may be absent in a forest or woodland but other essential habitat features are present and adjacent to areas exhibiting the above qualities (e.g. koalas in the Pilliga are known to escape the heat of the day by taking refuge in white cypress pines, which are not food trees), or*

- *A relatively high density of koalas is supported, regardless of the presence of food tree species. Koala population densities vary across their range and regional data should be used to judge relative density.*

Habitat in the study area would be considered to be critical for this species based on the above criteria for the *Interim koala referral advice for proponents* (DSEWPaC 2012). The majority of potential habitats in the study area comprise greater than 50 per cent secondary food species with no primary food species. There is also a small patch of Ribbon Gum to be removed (0.05 hectares) which is a primary food source.

Considering the small area of critical habitat that would be removed relative to the large extent of similar habitats in the locality the proposal is unlikely to adversely affect a large proportion of these habitat types.

Disrupt the breeding cycle of an important population

The population in the study area is not considered an important population, considering the lack of evidence for the presence of a local breeding population. It is unlikely there would be any impacts to the breeding cycle of any local Koala populations, the populations in the study area are small and widely dispersed. Potential habitat is widespread in the region and there is no evidence that the proposal would directly impact on the home range of a Koala.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

There would be a decrease in the availability of habitat in the region however this decrease represents a very small percentage of the potential foraging habitat for the species in the locality. It would be unlikely to cause the species to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks. Weed invasion could potentially modify the habitat suitability for the species. A weed management plan would be developed as part of the Construction Environment Management Plan (CEMP). The details of the weed management plan would vary for each site but should include: taxa and potential sources of the weed species; weed management priorities and objectives; location of weed infested areas; mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance; measures to prevent the spread of weeds; a monitoring program to measure the success of weed management; strategic management with adjacent landowners; appropriate disposal of weed infested

materials and soils; communication strategies to improve contractor awareness of weeds and weed management.

Introduce disease that may cause the species to decline

Disease has not been identified as a direct threat to the species. There is potential for indirect impacts from introduction of disease (such as *Phytophthora cinnamomi* and exotic rust fungi) to alter habitat attributes for the species and potentially cause the species to decline.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011). These include: vehicle and boot wash down facilities and ensuring vehicles and footwear is free of soil before entering or exiting the site: raising awareness about the risk of spreading pathogens and the mitigation measures required on site through regular communication to staff and contractors during inductions and toolbox talks; construction works would be programmed to move from uninfected areas to any known infected areas; restrict vehicles to designated tracks, trails and parking areas; and implementation of these pathogen management measures throughout the entire construction period.

Interfere with the recovery of the species

The proposal would not conflict with the recovery of Koala.

Conclusion

Considering the small area of potential habitat that would be removed relative to the extent of similar habitats in the locality, the limited number of records, lack of core habitat or the presence of a local breeding population, the proposal is unlikely to constitute a significant impact to this species.

Large-eared Pied-bat (*Chalinolobus dwyeri*)

Lead to a long-term decrease in the size of an important population

Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes (OEH 2012).

Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*) (OEH 2012). Large-eared Pied Bats frequent low to mid-elevation dry open forest and woodland, and well-timbered areas containing gullies close to roosts. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.

The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. This species is likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring (OEH 2012).

The proposal would remove about 7.40 hectares of vegetation comprising dry open forest habitats which could potentially be used by this species for foraging. The species roosts in caves or underground mineshafts. There are no caves on the site and the site does not appear to provide potential roosting habitat. Therefore the potential impact is represented by a loss of potential foraging habitat only and the site is not considered to represent habitat for an important population. The proposed removal of vegetation is considered a sustainable loss of potential foraging habitat in the context of available habitat in the surrounding region. The proposed action would not result in a decrease in the size of an important population and would not impact on known or potential roost sites, considering the lack of evidence to indicate that an important population is resident in the locality.

Reduce the area of occupancy of an important population

The proposal would remove about 7.40 hectares of vegetation comprising dry open forest habitats potentially used by this species for foraging. This is a small percentage of the foraging habitat available throughout the distributional range of the species and there is currently no evidence to indicate that an important population is resident in the locality. The proposal is not expected to substantially impact on food resources available for local populations and would not impact on potential roosting habitat.

Fragment an existing important population into two or more populations

Highly mobile species such as bats are expected to be less impacted by fragmentation, compared with less mobile species such as terrestrial mammals and reptiles. The proposal would not fragment an important population of the Large-eared Pied Bat.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of a species refers to areas that are necessary:

- *For activities such as foraging, breeding, roosting, or dispersal.*
- *For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.*
- *To maintain genetic diversity and long-term evolutionary development.*
- *For the reintroduction of populations or recovery of the species.*

The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the large-eared pied bat. As the species is a cave-roosting bat and there are no caves in the study area, there would be no impact on potential roosting habitat.

Disrupt the breeding cycle of an important population

No evidence of a roosting colony of the large-eared pied bat occurs in proximity to the study area and the proposal would not impact on breeding cycles or potential breeding habitat.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

There would be a decrease in the availability of habitat in the region however this decrease represents a very small fraction of the potential foraging habitat for the species in the locality.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks, which could potentially modify the habitat suitability for the species. A weed management plan would be developed as part of the Construction Environment Management Plan (CEMP). The details of the weed management plan would vary for each site but should include: taxa and potential sources of the weed species; weed management priorities and objectives; location of weed infested areas; mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance; measures to prevent the spread of weeds; a monitoring program to measure the success of weed management; strategic management with adjacent landowners; appropriate disposal of weed infested materials and soils; communication strategies to improve contractor awareness of weeds and weed management.

Introduce disease that may cause the species to decline

Disease has not been identified as a direct threat to the species. There is potential for indirect impacts from introduction of disease (such as *Phytophthora cinnamomi* and exotic rust fungi) to alter habitat attributes for the species and potentially cause the species to decline.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011). These include: vehicle and boot wash down facilities and ensuring vehicles and footwear is free of soil before entering or exiting the site: raising awareness about the risk of spreading pathogens and the mitigation measures required on site through regular communication to staff and contractors during inductions and toolbox talks; construction works would be programmed to move from uninfected areas to any known infected areas; restrict vehicles to designated tracks, trails and parking areas; and implementation of these pathogen management measures throughout the entire construction period.

Interfere with the recovery of the species

The proposal would not conflict with the recovery of Large-eared Pied Bat.

Conclusion

Considering the small area of foraging habitat that would be removed relative to the extent of similar habitats in the locality the proposal is unlikely to constitute a significant impact to this species.

Purple Copper Butterfly (*Paralucia spinifera*)

Lead to a long-term decrease in the size of an important population

Several population groupings or clusters have been identified for the species which are considered to be important for the conservation of the species (PAS2 OEH workshop). These include the Winburndale / Yetholme populations, the Mount Walker / Lidsdale complex, the Lithgow / Hartley Valley populations (of which the populations subject to this study form part), the Hampton cluster, and the Mount David outlier. As well as being identified in recovery planning for Purple Copper Butterfly, the population in the study area is also considered important due to it being towards the limit of the natural distribution of the species and these populations potentially provide ‘stepping stones’ for outbreeding and maintaining genetic diversity throughout the wider population.

Proposed works would not affect the Purple Copper Butterfly as known utilised habitat is outside of the proposal area. Pre-clearing surveys would provide a final audit of Purple Copper Butterfly distribution (adult flying and juvenile larval seasons between September and November). If detected, any new populations would be provided appropriate protection / mitigation in or directly adjacent to the proposed work area.

With impact avoidance being the primary mechanism by which Purple Copper Butterfly would be protected in the work corridor, it follows that the Lithgow / Hartley Valley population of the Purple Copper Butterfly (an important population) would not experience a long-term decrease in the size of an important population as a consequence of carrying out the activity.

Incorporating mitigation and management measures for Purple Copper Butterfly into the project, with landscaping to be designed to provide suitable habitat for Purple Copper Butterfly through planting the larvae-feed species Blackthorn (*Bursaria spinosa* subsp*. lasiophylla*), and creating and maintaining open sunny habitats, which could contribute to a population increase in the longer term.

Reduce the area of occupancy of an important population

The area of occupancy of a species is defined as that area actually occupied by the species. In this case, areas of occupied habitat have been identified and avoided by the proposal. The area of occupancy of the local important population will not be reduced by the proposal.

A total area of approximately 0.6 hectares of occupied habitat, 3.6 hectares of high potential habitat and 18.4 hectares of potential habitat has been identified in the study area. Of the these total areas of habitat and potential habitat no areas of occupied habitat will be impacted, 2.01 hectares of high potential and 4.62 hectares of potential habitat will be removed by the Project. The total area of potential habitat impacted (6.63 hectares) comprises approximately 30 per cent of all areas of potential habitat identified in the study area, and when considering the area of potential habitat in the locality (10 kilometre radius) this potential impact would comprise a very small proportion. The loss of these areas coupled with the proposed mitigation measures is considered unlikely to place a result in a decline in the population.

Fragment an existing important population into two or more populations

The Lithgow / Hartley Valley population of the butterfly (an important population, discussed above) already exists as a fragmented population; in fact the species distribution is characterised as being comprised of numerous small and scattered sub-populations (metapopulation).

Any removal of Blackthorn will potentially contribute to further isolation of populations of the species (loss and fragmentation of habitat has been identified as a key threat to the species (NPWS 2001). In this case the proposal will further consolidate an existing road corridor (increasing isolation). For this reason removal of Blackthorn has been minimised where possible, in particular areas of high potential habitat have been avoided.

The proposal has been designed to avoid areas of occupied habitat. Impacts will be limited to a total of 6.63 hectares of potential habitat consisting of 2.01 hectares of high potential impact and 4.62 hectares of potential habitat. The proposal will not fragment an important population.

Furthermore, there is potential for the landscaping for the project to be designed to provide additional habitat for Purple Copper Butterfly, by incorporating the larvae-feed species Blackthorn (*Bursaria spinosa subsp. lasiophylla*) into plantings, and creating and maintaining open sunny habitats.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of a species refers to areas that are necessary:

- *For activities such as foraging, breeding, roosting, or dispersal.*
- *For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.*
- *To maintain genetic diversity and long-term evolutionary development.*
- *For the reintroduction of populations or recovery of the species.*

Unoccupied habitat could potentially be utilised by the butterfly under more optimal conditions (for example post-fire) in the future. There are indications that population numbers go through “boom and bust” cycles, with populations during the “bust” part of the cycle contracting to core optimal areas of habitat. This may be the current situation at Forty Bends, thus occupied areas are considered to be potentially critical for the species survival locally. This habitat will not be directly impacted by the activity.

Potential habitat which will be impacted by the proposal (unoccupied habitat), or habitat that may be occupied under different seasonal / climatic or successional stages, while potentially periodically contributing to population maximums, is unlikely to be habitat which is critical for the survival of the species.

Disrupt the breeding cycle of an important population

The breeding cycle of Purple Copper Butterfly is reliant on several factors including the presence of the larval food plant, the presence of the attendant ant species, an open sunny aspect and suitable habitat structure. These habitat features are present in occupied areas of habitat and somewhat within the high potential habitat (although potentially marginal), The areas of potential habitat supporting the larval food plant but one or more of the other habitat factors being absent, however following disturbance some of these areas may become suitable for the species.

A total area of approximately 0.6 hectares of occupied habitat, 3.6 hectares of high potential habitat and 18.4 hectares of potential habitat has been identified in the study area. Of the these total areas of habitat and potential habitat no areas of occupied habitat will be impacted, 2.01 hectares of high potential and 4.62 hectares of potential habitat will be removed by the Project.

Proposed works would not affect the Purple Copper Butterfly as known utilised habitat is outside of the proposal area. Pre-clearing surveys would provide a final audit of Purple Copper Butterfly distribution (adult flying and juvenile larval seasons between September and November). If detected, any new populations would be provided appropriate protection / mitigation in or directly adjacent to the proposed work area.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A total area of approximately 0.6 hectares of occupied habitat, 3.6 hectares of high potential habitat and 18.4 hectares of potential habitat has been identified in the study area. Of the these total areas of habitat and potential habitat no areas of occupied habitat will be impacted, 2.01 hectares of high potential and 4.62 hectares of potential habitat will be removed by the Project. The total area of potential habitat impacted (6.63 hectares) comprises approximately 30 per cent of all areas of potential habitat identified in the study area, and when considering the area of potential habitat in the locality (10 kilometre radius) this potential impact would comprise a very small proportion. The loss of these areas coupled with the proposed mitigation measures is considered unlikely to place a result in a decline in the population.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Weed species are prevalent in disturbed habitats of the study area including roadside environments and cleared paddocks, which could potentially modify the habitat suitability for the Purple Copper Butterfly. A weed management plan would be developed as part of the Construction Environment Management Plan (CEMP). The details of the weed management plan would vary for each site but should include: taxa and potential sources of the weed species; weed management priorities and objectives; location of weed infested areas; mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance; measures to prevent the spread of weeds; a monitoring program to measure the success of weed management; strategic management with adjacent landowners; appropriate disposal of weed infested materials and soils; communication strategies to improve contractor awareness of weeds and weed management.

Introduce disease that may cause the species to decline

Disease has not been identified as a threat to the species; no particular butterfly pathogens are known or managed in wild butterfly populations. There is potential for indirect impacts from introduction of disease (such as *Phytophthora cinnamomi* and exotic rust fungi) to alter habitat attributes for the species and cause the species to decline.

Detailed prevention methods are provided in the RMS Biodiversity Guidelines – Guide 7 Pathogen Management (RTA 2011). These include: vehicle and boot wash down facilities and ensuring vehicles and footwear is free of soil before entering or exiting the site: raising awareness about the risk of spreading pathogens and the mitigation measures required on site through regular communication to staff and contractors during inductions and toolbox talks; construction works would be programmed to move from uninfected areas to any known infected areas; restrict vehicles to designated tracks, trails and parking areas; and implementation of these pathogen management measures throughout the entire construction period.

Interfere with the recovery of the species

Field assessment of the proposal area at Forty Bends resulted in two new Purple Copper Butterfly populations being identified in 2011. Far from interfering with the recovery effort, this project has already contributed in a positive way to the recovery of the species, with now 14 sub-populations having been identified, comprising the Lithgow / Hartley Valley complex of populations.

While some areas of potential habitat will be lost under development, treatment of weeds and active management of the site, including utilising Blackthorn (larval host plant) in landscaping and enhancement of habitat for this species, the project would also contribute to improved habitat condition and connectivity in some areas. The activity does not interfere with the recovery of the Purple Copper Butterfly.

Conclusion

It is unlikely there would be significant impacts to any local populations, considering occupied areas would be avoided. Additional pre-clearing surveys would be undertaken to ensure any new populations in the project footprint are not impacted. Blackthorn (larval host plant) would be utilised in landscaping and enhancement of habitat for this species, the project would also contribute to improved habitat condition and connectivity in some areas.