BELLS LINE OF ROAD CORRIDOR IMPROVEMENT PROGRAM

INFORMATION TO SUPPORT REFERRAL UNDER PART 3 OF *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999* (EPBC 2014/7346)

Biodiversity Assessment Report

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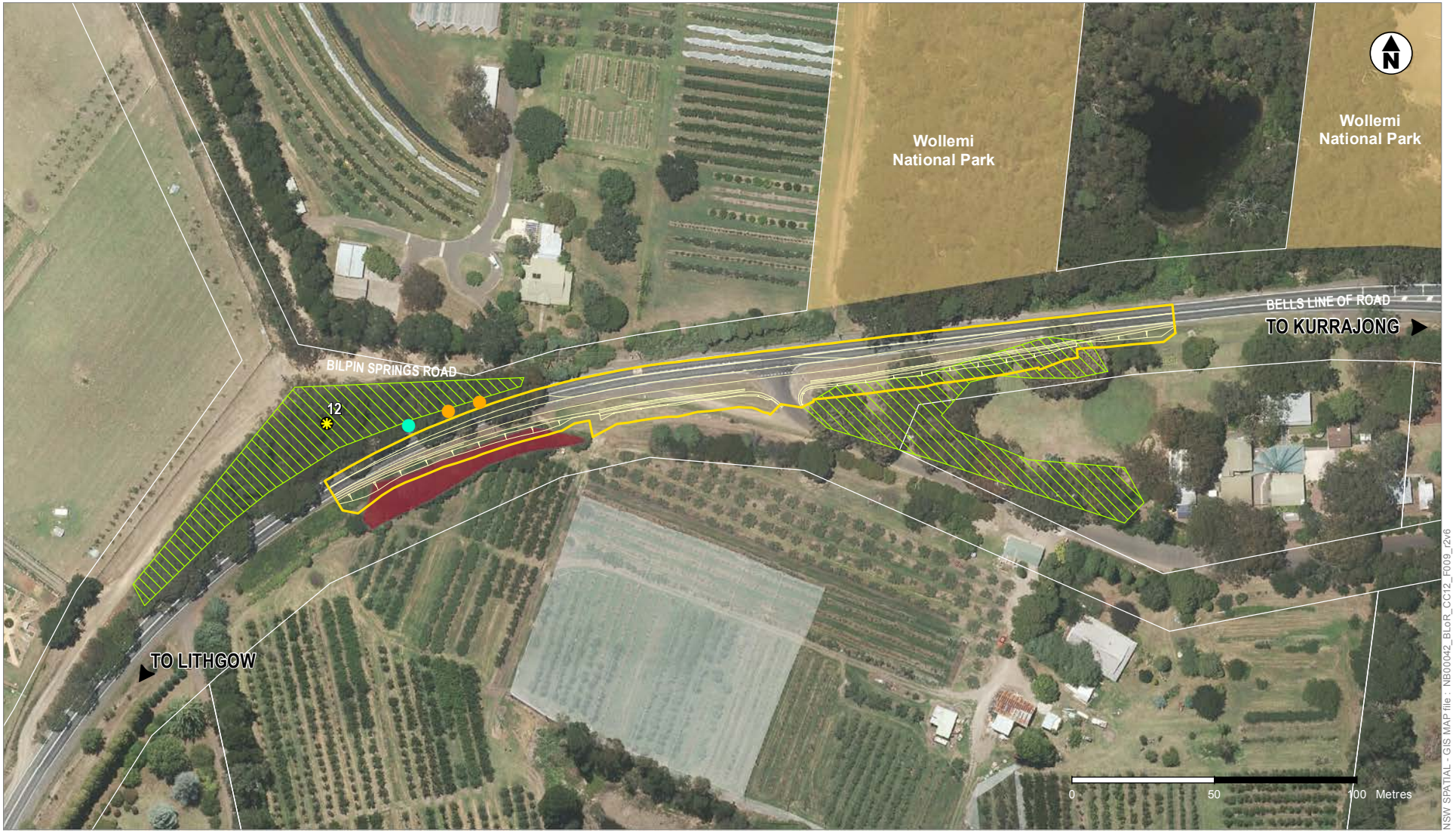


Safety works 12 design

Safety works 12 clearing extents

Vegetation plots

Fauna Habitat Assessment and Koala SAT

Habitat tree

National Park

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Exotic trees and shrubs

Figure 3-5 Biodiversity values (Safety works site 12)

Overtaking lane 6 design

Overtaking lane 6 clearing extents

Proposed powerline relocation

Vegetation plots

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Dam

Exotic trees and shrubs

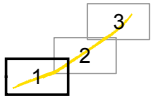


Figure 3-6 Biodiversity values (Site 6) Page 1 of 3

Overtaking lane 6 design

Overtaking lane 6 clearing extents

Proposed powerline relocation

Vegetation plots

Fauna Habitat Assessment and Koala SAT

Habitat tree

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Exotic trees and shrubs

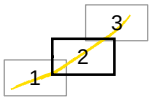


Figure 3-6 Biodiversity values (Site 6) Page 2 of 3

Overtaking lane 6 design

Overtaking lane 6 clearing extents

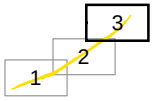
Proposed powerline relocation

Habitat tree

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Exotic trees and shrubs



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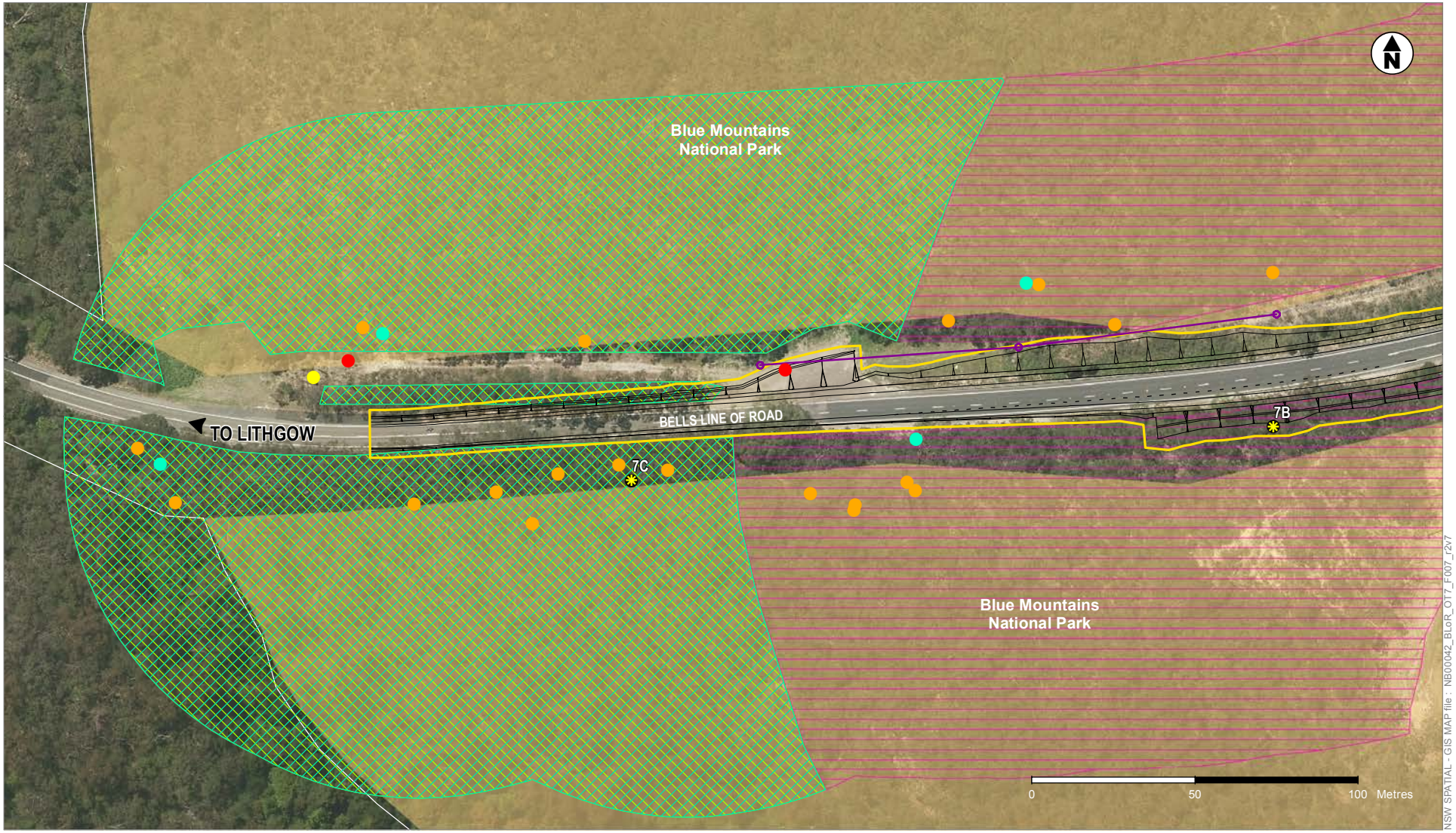


Overtaking lane 7 design

Overtaking lane 7 clearing extents

Proposed powerline relocation

Vegetation plots

Bat Call Device

Fauna Habitat Assessment and Koala SAT

Habitat tree

Owl / Koala Call Playback

National Park

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Map Unit 3: Blue Mountains Sandstone Ridgetop Woodland

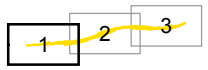


Figure 3-7 Biodiversity values (Site 7) Page 1 of 3

Overtaking lane 7 design

Overtaking lane 7 clearing extents

Proposed powerline relocation

Vegetation plots

Habitat tree

National Park

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Exotic trees and shrubs

Map Unit 3: Blue Mountains Sandstone Ridgetop Woodland

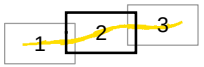
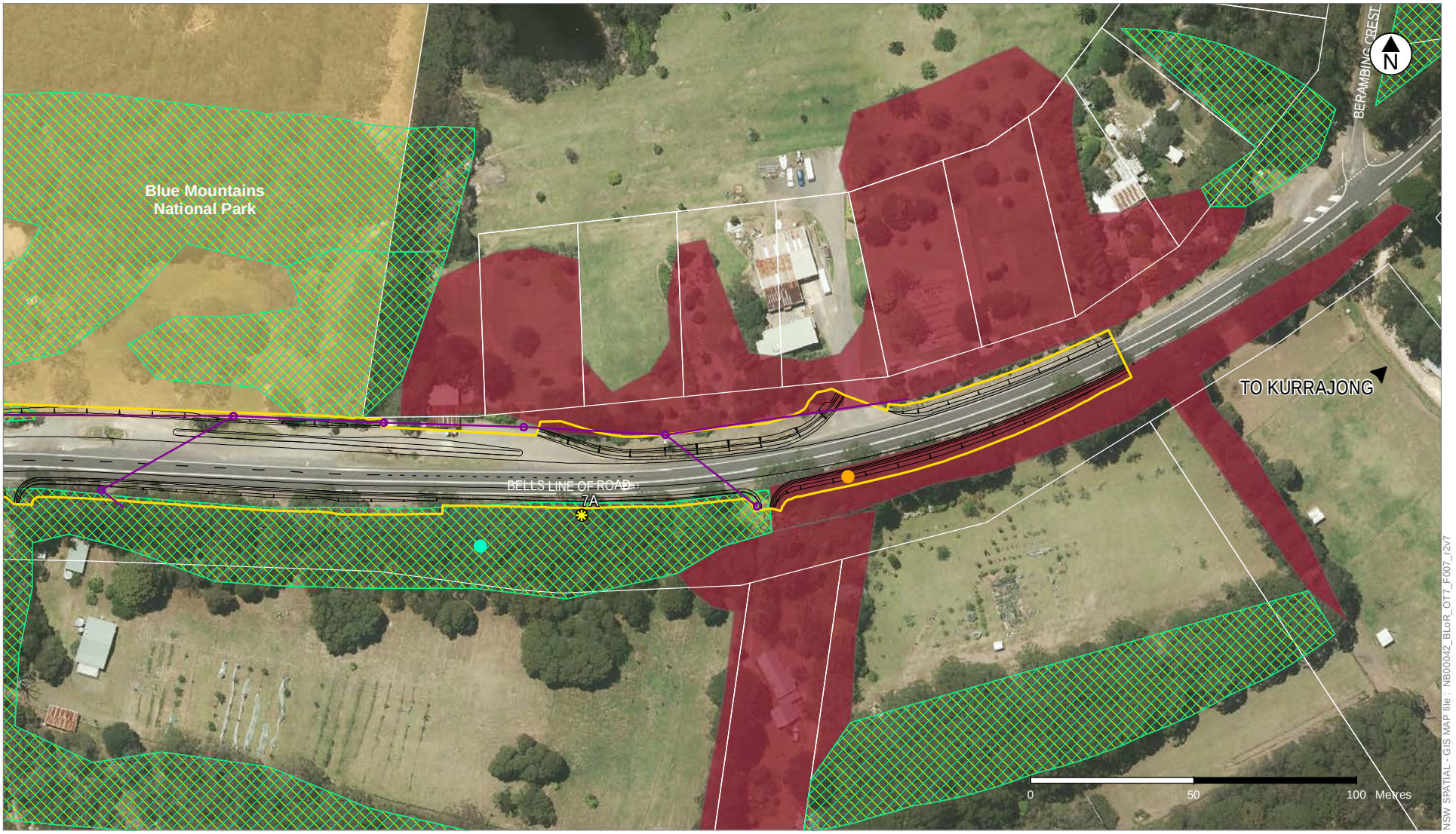


Figure 3-7 Biodiversity values (Site 7) Page 2 of 3



Overtaking lane 7 design

Overtaking lane 7 clearing extents

Proposed powerline relocation

Vegetation plots

Fauna Habitat Assessment and Koala SAT

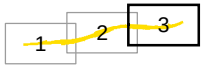
Habitat tree

National Park

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Exotic trees and shrubs



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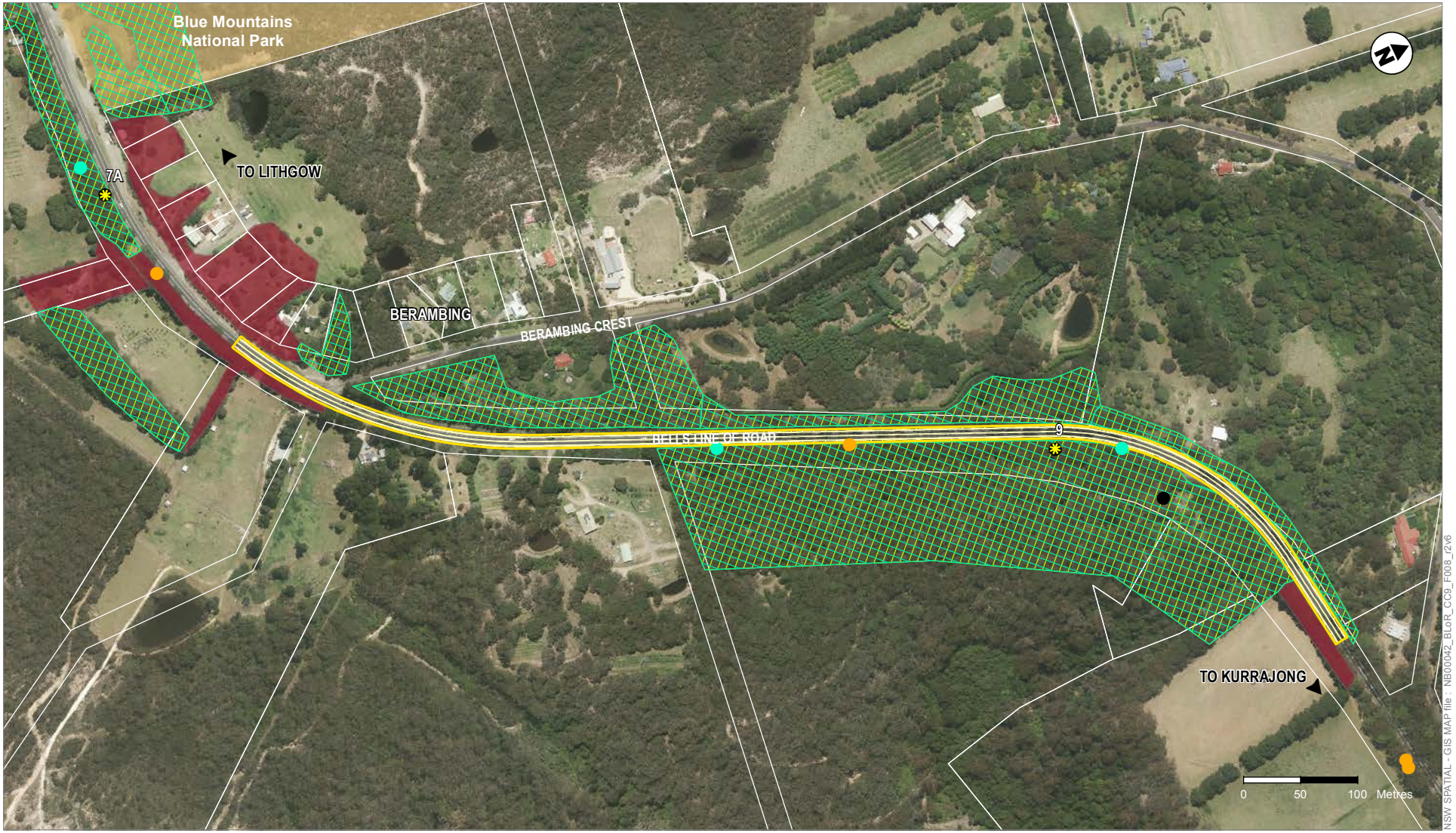


Safety works 9 design

Safety works 9 clearing extents

Vegetation plots

Disused dwellings

Fauna Habitat Assessment and Koala SAT

Habitat tree

National Park

Turpentine Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered, EPBC Act)

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered, TSC Act)

Exotic trees and shrubs

Figure 3-8 Biodiversity values (Safety works site 9)

3.3.2 Vegetation communities at each study site

OT1: The OT1 study area includes areas of Map Unit 1 in various states of condition, as well as areas of exotic trees and shrubs, and several dams on surrounding private properties (refer to Figure 3-1). Vegetation in this area has species positive of both shale and sandstone environments occurring in a transitional area between two soil landscapes. Lower condition areas of Map Unit 1 are present on the southern side of Bells Line of Road at OT1, generally comprising canopy species only with some minor regeneration of mid-storey species in road reserves and on private property mostly with a maintained understorey (refer to Plate 1). Although these areas are contiguous with large patches of vegetation to the south, they have been excluded from the federal listing of this ecological community on the basis of the poor condition and ongoing routine management of these areas (refer to Section 2.3.4) on private property and in the road reserve.

Areas of Map Unit 1 on the north of Bells Line of Road at OT1 include a mix of high condition areas of vegetation, regenerating native vegetation and partially disturbed areas which are directly connected to large areas of vegetation on private property and Wollemi National Park. The majority of the vegetation adjacent to the northern side of the road is within private properties which were not accessible during the surveys, however these areas appear to be largely un-managed. Considering the mix of good and moderate condition vegetation on the northern side of Bells Line of Road that is contiguous with large areas of vegetation, the lack of evidence of routine management (ie slashing) and the restricted access to private properties for field vegetation condition assessments, the majority of this area has been identified as part of the federally listed critically endangered ecological community. Disturbed areas on the northern side of the road consisting of old plantations with regenerating native trees and shrubs and limited/no canopy cover have been excluded from the federal listing.

OT2: The OT2 study area includes larger patches of high condition vegetation (federally listed) on the north and south sides (refer to Plate 2) of the road including private property and Wollemi National Park and the road reserve (refer to Figure 3-2). Vegetation in this area has species positive of both shale and sandstone environments occurring in a transitional area between two soil landscapes. Plot assessments undertaken in this area had the minimum number of positive diagnostic species for two different map units as shown in Table 3-3 (Plot 2B and 2C). Taking precautionary approach vegetation at OT1 and OT2 has been identified as the threatened Turpentine Ironbark Forest based on the presence of diagnostic species and low abundance of flora associated with sandstone landscapes.

Moderate condition areas of Map Unit 1 are present at the eastern end of the study area comprising a strip of vegetation 1-3 trees wide with regenerating midstorey and groundcovers along the southern edge of the road which is connected to larger areas of intact vegetation as well as areas of derived grassland and regenerating trees (refer to Figure 3-2). This moderate condition area was also included as part of the federal listing considering the connectivity to larger intact patches of vegetation, the relatively high resilience with an abundance of regenerating shrubs and trees, the presence of native groundcovers and potential connectivity value for fauna and pollination.

Plate 1: OT1 at eastern end facing east showing disturbed examples of Map Unit 1 on the southern side of the road (right of frame) comprising isolated trees with no understorey

Plate 2: Central area of OT2 facing east showing high condition vegetation on south side of road and isolated trees on north side of road

There are also patches of moderate condition areas of Map Unit 1 at the western end of the study area on the north side of Bells Line of Road which has been previously disturbed comprising an isolated patch less than one hectare in area with a fragmented canopy and regenerating trees and shrubs. Considering the smaller patch size, isolation, fragmentation of the canopy and disturbed nature of this patch it has been excluded from the federal listing.

OT3: The **OT3** study area includes areas of Map Unit 1 at the eastern end and areas of Map Unit 2 at the western end (refer to Figure 3-3). Areas of Map Unit 1 include fragmented patches of high and moderate condition vegetation. Moderate condition vegetation at the eastern end includes a thin strip of under scrubbed vegetation along the southern edge of the road which appears to be regularly maintained/slashed (refer to Plate 3), this area has been excluded from the federal listing due the missing mid-storey/shrub layer, reduced condition and somewhat isolation of the patch. High condition areas of Map Unit 1 (federally listed) include un-maintained and/or disturbed areas of vegetation in the road reserve and on private property (refer to Plate 4).

Areas of Map Unit 2 are present at the western end of the study area include larger intact patches (federally listed) along in the road reserve and on adjacent private property (refer to Plate 5). This community is distinguished from Map Unit 2 in this area by the higher number of positive diagnostic species generally comprising a higher proportion of more mesic flora species such as ferns and herbs and shrub species such as Native Indigo and Veined Mock Olive.

OT5: The study area of **OT5** includes areas of high and moderate condition areas of Map Unit 2 (refer to Figure 3-4). High condition patches (federally listed) have been identified on the northern and southern side of the road at the eastern end of the study area, comprising larger patches generally dominated by Monkey Gum (refer to Plate 6).

Plate 3: Moderate condition Map Unit 1 in Plot 3A at OT3, comprising maintained vegetation where the mid-storey/shrub layer has been removed

Plate 4: High condition Map unit in plot 3B at OT3 with mid-storey/shrub layer intact

Plate 5: Central area of OT3 facing east showing high condition areas of Map Unit 2 on the southern side of the road

Plate 6: Eastern end of OT5 facing west showing high condition areas of Map unit 2 on the northern side of the road (right of frame) and isolated row of trees on southern side of road

Moderate condition areas comprise isolated trees in the road easement and fragmented patches of the community at the western end (refer to Plate 7). These patches have been excluded from the federal listing of the critically endangered ecological community due to the small patch size, and highly modified, isolated and fragmented nature of these patches.

SW12: This site includes disturbed vegetation including remnant trees with a maintained understorey on the south side of the road and a small area of intact vegetation on the northern side of the road (refer to Figure 3-5). Considering the fragmented and/or highly modified condition of the vegetation in the Safety works SW12 study area, these small patches have been excluded from the federal listing of the critically endangered ecological community.

OT6: The **OT6** study area supports areas of Map Unit 2 in high condition including areas of private property and Wollemi National Park (refer to Figure 3-6). There is limited native vegetation in the road reserve and is generally limited to disturbed strips of vegetation (refer to Plate 8) which are connected to larger patches of vegetation surrounding the OT6 study area. There are also areas of exotic trees and shrubs, and several dams on surrounding private properties.

Plate 7: Western end of OT3 facing west showing small remnant on northern side of road

Plate 8: Western end of OT6 facing west showing strip of moderate condition vegetation in road reserve on southern side of road

SW9: The Safety works site 9 study area supports a large patch of Map Unit 2 in relatively good condition (federally listed) on the eastern side of the road (refer to Figure 3-7). There are also disturbed areas of Map Unit 2 on the western side of the road which are fragmented and disturbed including edge effects and underscrubbing in some areas. Although these patches are somewhat isolated, linear in shape and partially disturbed, the total area consists of approximately 2.6 hectares with canopy cover greater than ten per cent and there are some intact areas present and have therefore been included under the federal listing of the community.

OT7: The **OT7** study area supports areas of Map Unit 2 and 3 (refer to Figure 3-8). Map Unit 2 includes areas at the eastern end of the study area and areas of vegetation at the western end have also been identified as Map Unit 2 based on the presence of positive diagnostic species. Sandstone soil landscapes are present at the western end of the study area where Map Unit 3 is present (Plate 9).

Areas of Map Unit 2 at the eastern end of the study area include a strip of relatively intact of vegetation in the southern road reserve which is connected to large areas of vegetation to the south. This area is dominated by White Stringybark, Mountain Mahogany and Sydney Peppermint.

Vegetation at the western end of OT7 has affinities to a number of vegetation communities and has the minimum number of positive diagnostic species for two different map units as shown in Table 3-6 (Plot 7C). Taking a precautionary approach the vegetation at the western end of OT7 has been identified as the threatened Blue Mountains Shale Cap Forest (equivalent to EPBC Act Turpentine Ironbark Forest) based on the presence of diagnostic species and potentially enriched soils being situated between shale landscapes to the east and basalt soil landscapes to the west. This area is also unique in the eight study areas in that it is dominated by Blue Mountains Ash (refer to Plate 10) as well as supporting more typical species such as Sydney Peppermint and Smooth-barked Apple.

Plate 7: Map Unit 3 in road reserve at western end of OT7, south side of road

Plate 8: Map Unit 2 at western end of OT7 dominated by Blue Mountains Ash

3.3.3 Fauna habitat types, distribution and condition

Fauna habitats are described in relation to the broad Bells Line of Road study area followed by a description of the distribution relevant to each overtaking lane. These habitats were identified from a combination of the field surveys and broad-scale mapping of vegetation communities in the region (Tozer *et al.* 2010). The main fauna habitats present within the Bells Line of Road study area include:

- Remnant dry and moist open forest habitats
- Aquatic habitats – ephemeral creeks and farm dams
- Agricultural (pastoral and orchard) land.

Fauna habitats in the study area are mapped at Figure 3-1 to Figure 3-8.

The Bells Line of Road traverses the ridgetop between Kurrajong Heights and Bilpin and crosses a small number of upper gullies at the western end of the study area towards Mount Tomah. The surrounding landscape is dominated by mature dry open forest habitats occupying the slopes and ridges with tall moister forest habitats in gullies and steeper slopes. These habitats are widespread across the landscape with very limited fragmentation and contiguous with the open forests on private lands and Blue Mountains National Park to the south of the study area and Wollemi National Park to the north. Clearing of habitat for settlement and farming has been minimal and relatively small in scale typically along the Bells Line of Road resulting in minimal fragmentation of habitat. Habitats and resources for fauna are abundant and widespread and it is likely that fauna populations comprise a large diversity of resident populations in addition to a range of transient or nomadic species.

Hollow trees in the study area occur in moderate abundance, dominated by a range of small to medium-sized hollows and dead trees 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 are present, although at low density. The total number of habitat trees and tree hollows recorded within 20 metres of the forest edge across the five OT sites is shown in Table 3-3. The highest number was recorded at OT3 and lowest at OT1, and this reflects the size of the design footprint area at each site rather than the density of hollows. It is unlikely that all these habitat trees would be removed, as some are likely to be outside the design footprint. A comparable density of hollow-bearing trees was also observed outside the road reserve and associated with adjoining remnant habitats not impacted by the project.

Table 3-3 Habitat trees and tree hollows recorded within 20 metres of the forest edge

Site	No. trees	DBH (mean)	tree hollows			
			small	medium	large	total
OT1	15	51.0	15	0	0	15
OT2	29	81.9	32	18	6	56
OT3	42	67.2	26	34	7	67
OT5	26	113.6	43	5	4	52
OT6	26	81.1	20	24	10	54
OT7	25	60.8	35	17	3	55
Total	**163**		**171**	**98**	**30**	**299**

Remnant dry and moist open forest

Dry open sclerophyll forest dominates the landscape and is present across all sites, particularly surrounding OT1, OT2, OT3, and OT7 and associated with the Blue Mountains Sandstone Ridgetop Woodland, while moist forest is associated with gullies and occurs in parts of OT5 and 6 and associated with the shale cap forest and Turpentine Ironbark Forest habitats.

The drier forest habitats are dominated by Sydney Peppermint (*Eucalyptus piperita*), Silvertop Ash (*E.sieberi*), Red Bloodwood (*Corymbia gummifera*) and Smooth-barked Apple (*Angophora costata*). These common canopy species in addition to a moderately large diversity of mid-storey plant species particularly *Banksia* spp, *Acacia* spp and *Leptospermum* spp. provide shelter and food resources for a wide range of bird and arboreal mammal species. Common arboreal mammals reported included Common Brushtail Possum (*Trichosorus vulpecula*), Common Ringtail Possum (*Pseudocheirus peregrinus*), and Sugar Glider (*Petaurus breviceps*).

Where the forest habitats graded into moister forest types on higher nutrient shale cap soils at the western end of OT3 and parts of OT5, several additional eucalypt species were present including Grey Gum (*E.punctata*), Monkey Gum (*E.cypellocarpa*), and Large-leaved Mountain Gum (*E.deanei*). These habitat are favoured by Koala (*Phascolarctos cinereus*), and Greater Glider (*Petaurioides volans*).

The range of food resources present for birds and represented by nectar and insects provide habitat for a moderate diversity of bird species across all sites. This includes an assemblage of dry and moist forest species with common species including the Bell Miner, Brown-headed Honeyeater, Eastern Spinebill, and White-throated Treecreeper. The Eastern Spinebill was particularly common at OT7 and this species is known to develop an altitudinal migratory during winter to higher elevation habitats, particularly where *Banksia integrifolia* occurs and this accounts for its abundance at the time of the survey. Flocks of Varied Sitella (vulnerable TSC Act) were observed at OT2 and habitat for this insectivorous species is common and widespread across all sites.

The feed-tree species for the threatened Glossy Black-cockatoo (*Calyptorhynchus lathami*), namely Black She-oak (*Allocasuarina littoralis*) was observed at several locations in the study area with the greatest density and abundance present at OT2, also present at OT3, 5 and 7. The species was not confirmed during the survey either through direct observation or evidence of feeding (i.e. chewed She-oak cones). Suitable habitat was observed to be patchy, but widespread through the study area.

The open forest habitats typically have a high structural and floristic diversity with moderately to high abundance of shelter and food resources for fauna and likely to be important for life-cycle activities for a diversity of species from all fauna groups. 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), Glossy Black-cockatoo (Calyptorhyncus lathami) and Powerful Owl (Ninox strenua) which have been recorded in the locality. Turpentine-Ironbark Forest on shale caps in the Blue Mountains has been identified as a rich habitat for mammals and birds, providing nest hollows

for species such as hollow-dependent fauna including the Powerful Owl and Glossy Black-Cockatoo (NSW Scientific Committee 2000).

The sclerophyll open forests 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.

Aquatic habitat

Considering the absence of permanent aquatic habitats along drainage lines in the study area these areas provide little habitat value for aquatic dependent species. Permanent habitat is present within artificial ponds and dams. There are no dams within the design footprint of the project for any of the overtaking lanes. The most common frog species reported during the survey was *Litoria verreauxii*. This is a common and abundant species in the study area found in small and large aggregations around farm dams and were actively calling at the time of the survey.

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 study area, not within, and typically have some minor areas of emergent 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.

A small area of perched swamp or ‘hanging’ swamp was located at the western end of OT7 on the southern side of the road on top of the road cutting. The swamp has formed from seepage of groundwater from the sandstone slope. This habitat is outside of the area of impact and not expected to be indirectly impacted due to its elevated position. The site was small (less than 100 square metres and formed by seepage of groundwater along the ridgetop. The habitat comprised wet ground layer and dense cover of sedges. The Red-crowned Toadlet (*Pseudophyrne australis*) (vulnerable TSC Act) was reported in this habitat. No other areas of hanging swamp were identified from any of the sites.

Modified habitat

Cleared and semi-cleared farmland and rural residential land occurs along the length of the study area and is present at each of the overtaking lanes, being most prevalent at OT1, parts of OT5 and OT6. The habitat is dominated by cleared and modified pasture land or large residential gardens with vegetation cover restricted to scattered mature paddock trees, small fragments of re-growth forest 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 may include the Spotted-tail Quoll listed as vulnerable on the EPBC Act.

3.3.4 Vegetation condition

Vegetation condition was assessed using the vegetation condition assessment plots as defined under the biobanking methodology (DECC 2009). The results of the plot assessments are summarised for each relevant map unit in Table 3-4 including corresponding biometric vegetation type.

Table 3-4 Vegetation and habitat condition assessment plots

Biometric vegetation type	Site	Plot	Map Unit	Condition score (1-100)	Mean site score
Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin	OT2	2A	1	86	86.6
		2B	1	86	
		2C	1	88	
	OT3	3A	1	65	75.8
		3B	1	77	
Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin		3C	2	78	
		3D	2	83	
	OT5	5A	2	70	71.5
		5B	2	73	
	SW12	12	1	79	79
	OT6	6A	2	89	86.5
		6B	2	84	
	SW9	9	2	62	62
	OT7	7A	2	63	66.5
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin		7B	3	45	
Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin		7C	2	83	
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin		7D	3	75	

3.4 Threatened ecological communities

3.4.1 Literature and database review

Based on the background review a number of other potentially occurring threatened ecological communities are noted for the region as listed Table 3-5. Targeted follow-up survey confirmed the presence or absence of these communities.

Table 3-5 Threatened ecological communities known from the region and recorded in the study area

TSC Act Listed Community	EPBC Act Listed Community	Occurrence in the study area
Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered)	Turpentine –Ironbark Forest in the Sydney Basin Bioregion (Critically Endangered)	Yes, all sites
Blue Mountains Basalt Forest in the Sydney Basin Bioregion (Endangered, Preliminary Determination)	Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (Endangered)	West of study area at Mount Tomah
Blue Mountains Swamps in the Sydney Basin Bioregion (Vulnerable)	Temperate Highland Peat Swamps on Sandstone (Endangered)	West of study area

The known distribution of Blue Mountains Shale Cap Forest (TSC Act) and Turpentine –Ironbark Forest (EPBC Act) in the locality has been mapped in broad scale vegetation mapping projects reported in Tozer *et al.* (2010) and Bell (1998), which together cover the large majority of the locality.

The estimated total extent of the Turpentine-Ironbark Forest ecological community listed under the EPBC Act that remained in 2005 was 2945 ha (Threatened Species Scientific Committee). This included remnants on the Cumberland Plain and in the Blue Mountains. In 1997, only 1183 ha remained on the Cumberland Plain, suggesting around 1312 remains on the shale soils in the Blue Mountains, with a large, although unknown proportion historically cleared for farming.

A total of 1,878 hectares within a ten kilometre radius of the study site has been described as follows:

- Tozer *et al* (2010) describes about 460 hectares of Sydney Turpentine Ironbark Forest (p87) and 535 hectares of Shale-Basalt Sheltered Forest (p168). The Tozer mapping covers the southern portion of the locality.
- Bell (1998) has identified an additional 883 hectares of Remnant Shale Cap Forest (F13) outside of the Tozer *et al*. (2010) study area, but within a 10 km radius of the study area.

In addition to this Bell (1998) has also mapped 613 hectares to the north of the locality in Wollemi National Park which is outside the 10 km radius.

It is likely that a portion of the overall mapped vegetation which is consistent with the endangered ecological community, would fall below the condition threshold described for listing as Critically Endangered Sydney-Turpentine Ironbark Forest under the EPBC Act and that some areas are likely to have been cleared since these projects were undertaken.

3.4.2 Survey results

Based on the detailed field survey and assessment of diagnostic species, three vegetation communities were identified and mapped across the eight study sites, two of which are listed under state and federal legislation these include:

- Turpentine-Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered EPBC Act; Endangered, TSC Act).
- Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (Endangered TSC Act).

These vegetation associations in the study area represent the western most occurrences of the community associated with outlying shale caps on mountain ridges in the Blue Mountains as described and mapped in the EPBC Act listing advice. The study area is in the vicinity of mapped occurrences of the community in EPBC Act listing advice (DEH 2005). Broad scale mapping projects in the study area have identified areas of equivalent vegetation map units in and surrounding the Bells Line of Road including p87 Sydney Turpentine Ironbark Forest (Tozer *et al* 2010) surrounding OT1 and OT2; p168 Shale-Basalt Sheltered Forest (Tozer *et al* 2010) surrounding all sites; and Map Unit 43 Turpentine Ironbark Margin Forest (Tozer 2003) to the east of OT1.

The Turpentine-Ironbark Forest ecological community listed under the EPBC Act includes only remnant patches that meet specific condition criteria, including patch size and canopy cover (refer to Section 2.3.4). The equivalent Blue Mountains Shale Cap Forest listed under the TSC Act includes all remnants characteristic of the community irrespective of the size of a remnant patch or its condition (see NSW Scientific Committee 1998, 2000a). Although some areas of vegetation have affinities to Sydney Turpentine Ironbark Forest listed under the TSC Act, the study area is outside the described distribution in the Final Determination for this endangered community, and considering the landscape position, soil landscapes, final determination information and presence of diagnostic species these areas are more consistent with the definition for Blue Mountains Shale Cap Forest listed under the TSC Act. Turpentine Ironbark Forest in the Sydney Basin Bioregion listed under the EPBC Act is equivalent to both Blue Mountains Shale Cap Forest and Sydney Turpentine Ironbark Forest listed under the TSC Act.

To confirm identification of Turpentine-Ironbark Forest (EPBC Act), areas of vegetation and plot data was analysed in relation to the condition criteria and species composition. All plots were found to contain the minimum condition class in terms of canopy cover with greater than 10 per cent canopy cover recorded. Some patches were less than one hectare and/or in poor condition and so have been excluded from the federally listed areas.

In total, 15 plots were found to contain species richness greater than required to be 95% confident that vegetation is consistent with the floristics for the critically endangered EPBC Act community (refer to Table 3-5). This 95% confidence limit was achieved for all plots surveyed for OT2, OT3, OT5, OT6, safety work 9 and safety work 12, and two plots at OT7 (refer to Table 3-6). Two plots surveyed in OT7 were consistent with other non-threatened vegetation communities occurring on sandstone (refer to Table 3-6).

Table 3-6 Comparison of diagnostic species from plot survey with regional vegetation community mapping projects and final determinations for state-listed communities

Site	Plot no.	No. native species in plot	Final Determinations (provided under TSC Act)		MU identified as Threatened Ecological Communities				MU (not listed)		
			Turpentine Ironbark Forest - Final determination TSC Act	BM Shale Cap Forest - Final determination TSC Act	Sydney Turpentine Ironbark Forest (p87 Tozer et al. 2010) - 23 sp. = 95% confidence	Turpentine Ironbark Margin Forest (MU43 Tozer 2003) - 11 sp. = 95% confidence	Shale-Basalt Sheltered Forest (p168 Tozer et al. 2010) - 12 sp. = 95% confidence)	Blue Mts Shale Cap Forest (OEH unpub)	Blue Mts Ridge top Forest (p136 Tozer et al. 2010) - 27 sp. = 95% confidence	Hinterland Sandstone Gully Forest (p142 Tozer et al. 2010) 26 sp. = 95% confidence	Lower Blue Mountains Wet Forest (p102 Tozer et al. 2010) 20 sp. = 95% confidence
OT2	2A	43	14	18	18	13	10	13	11	22	11
	2B	47	12	14	16	11	11	13	14	29	16
	2C	44	15	16	19	12	8	14	15	27	15
OT3	3A	29	13	13	19	12	9	12	7	15	9
	3B	33	14	17	19	11	10	14	10	19	11
	3C	45	22	24	27	19	16	18	5	16	15
	3D	46	16	22	24	16	19	15	1	8	15
OT5	5A	31	15	20	19	13	19	12	3	8	12
	5B	37	14	17	23	11	12	9	2	7	14
CC	12	26	14	20	18	12	12	12	3	9	12
OT6	6A	38	16	19	13	12	11	16	14	24	15
	6B	45	17	25	19	16	16	13	3	12	21
CC	9	34	13	18	18	12	16	9	2	7	13
OT7	7A	32	15	17	24	13	14	13	9	15	10
	7B	35	2	6	13	1	4	3	25	21	7
	7C	40	9	17	13	7	17	11	15	23	20
	7D	37	8	11	9	9	9	9	27	27	8

Cleared estimate and landscape position from the Biometric Vegetation Types database (OEH 2012). Shaded cells = minimum number of species present for 95% confidence

3.5 Groundwater dependant ecosystems

The level of water dependence of vegetation communities in the study area have been identified in the Risk Assessment Guidelines for Groundwater Dependant Ecosystems released by the NSW Department of Primary Industries (Kuginis et al. 2012). The level of groundwater dependence identified for ecological communities in the study area is identified in Table 3-7.

Table 3-7 Level of groundwater dependence of vegetation in study area

Map Unit	Level of groundwater dependence (Kuginis *et al.* 2012)
Map Unit 1: Turpentine Ironbark Forest	High
Map Unit 2: Blue Mountains Shale Cap Forest	High
Map Unit 3: Blue Mountains Sandstone Ridgetop Woodland	High

3.6 Threatened flora species

3.6.1 Literature and database review

On the basis of regional records and reports and the presence of suitable habitat, a total of 46 threatened flora species have been previously recorded or listed as having potential to occur in the locality. Of these 46 species, none were recorded in the study area during this survey. All species are considered to have either have a low or unlikely potential to be present. The full list of flora species considered in this assessment is provided in Table 3-8 and the distribution of threatened flora species records in the study area is provided in Figure 3-9.

Table 3-8 Threatened flora potentially occurring in the study area

Species	Status*		Potential likelihood to occur in the study area	No. of records and source#
	TSC Act	EPBC Act		
Acacia baueri subsp. *Aspera*	V	-	Low – outside known distribution and habitat not suitable	2 OEH
*Acacia bynoeana (*Bynoe's Wattle, Tiny Wattle*)*	E	V	Low – limited suitable habitat present, targeted searches undertaken	8 OEH, PMST
Acacia gordonii	E	E	Low – limited suitable habitat present, targeted searches undertaken	19 OEH, PMST
Acacia pubescens (Downy Wattle, Hairy Stemmed Wattle)	V	V	Low – outside of known distribution	11 OEH, PMST
Acrophyllum australe	V	V	Unlikely – suitable habitat absent from study area	8 OEH, PMST
Allocasuarina glareicola	E	E	Low	4 OEH, PMST
Asterolasia elegans	E	E	Low – outside natural distribution, no records in locality	PMST
Boronia deanei (Deane's Boronia)	V	V	Unlikely – suitable habitat absent from study area	PMST
Cryptostylis hunteriana (Leafless Tongue-Orchid)	V	V	Low – suitable habitat limited in study area and no known records from locality	PMST
Cynanchum elegans (White-Flowered Wax Plant)	E	E	Unlikely – suitable habitat absent from study area	2 OEH, PMST
Dillwynia tenuifolia	V	-	Low – outside known distribution of species and habitat suitability marginal	131 OEH

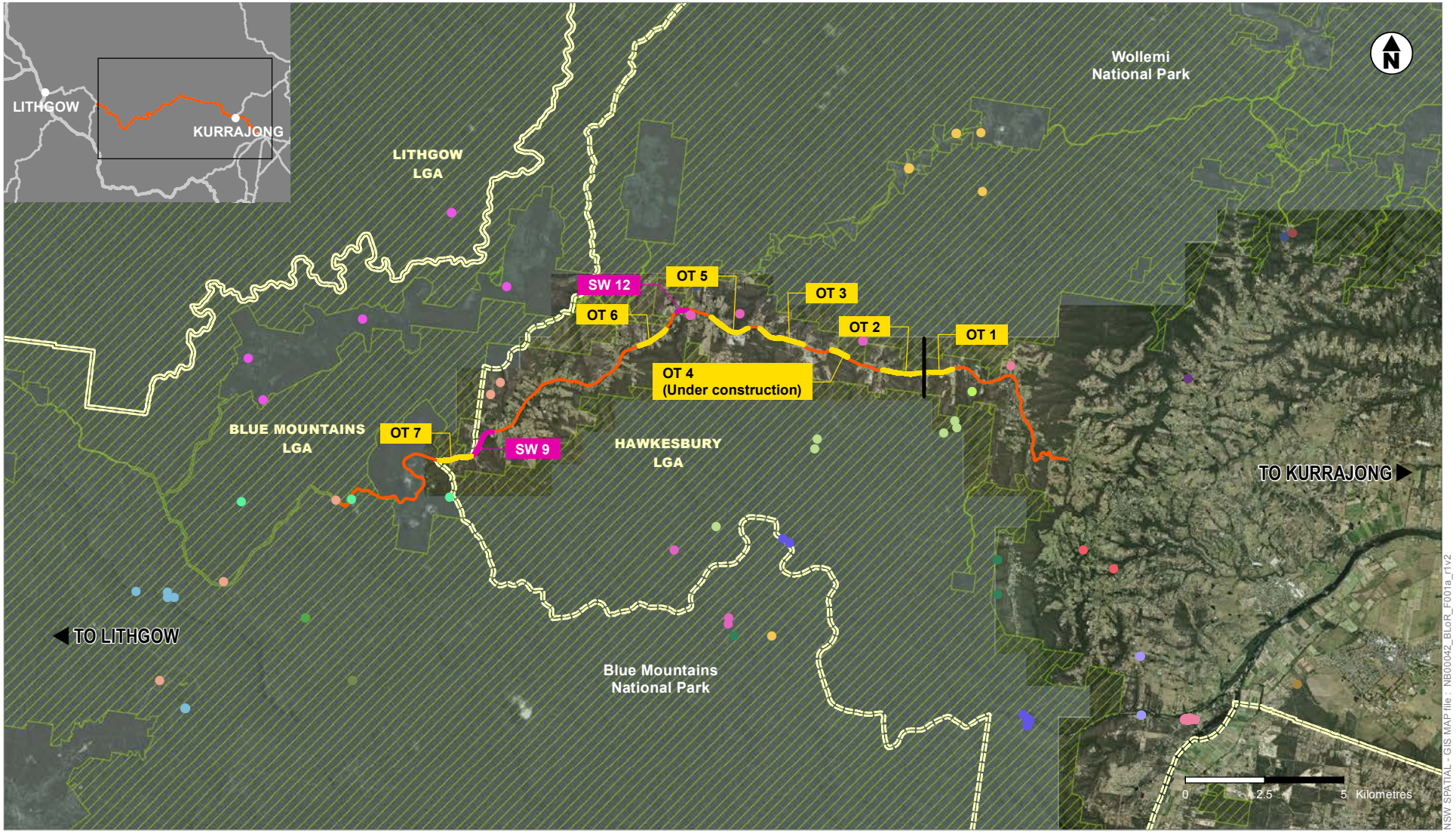
Species	Status*		Potential likelihood to occur in the study area	No. of records and source#
	TSC Act	EPBC Act		
Epacris hamiltonii	E	E	Unlikely – suitable habitat absent from study area	7 OEH
Epacris sparsa (Sparse Heath)	V	V	Unlikely – suitable habitat absent from study area	19 OEH, PMST
Euphrasia arguta	CE	CE	Low – outside known distribution of species	PMST
*Genoplesium baueri (*Bauer's Midge Orchid, Yellow Gnat Orchid*)*	E	E	Low – habitat suitability marginal, and no records from locality	PMST
Grammitis stenophylla (Narrow-Leaf Finger Fern)	E	-	Unlikely – suitable habitat absent from study area	6 OEH
Grevillea juniperina subsp. *juniperina* (Juniper-Leaved Grevillea)	V	-	Low - – habitat suitability marginal, and limited records from locality	1 OEH
Haloragis exalata subsp. *exalata* (Wingless Raspwort, Square Raspwort)	V	V	Unlikely – suitable habitat absent from study area	PMST
Haloragodendron lucasii	E	E	Low – outside known distribution, suitable habitat limited	4 OEH, PMST
Isopogon fletcheri (Fletcher's Drumsticks)	V	V	Low - outside known distribution, targeted searches undertaken in suitable habitat	10 OEH, PMST
Leucopogon fletcheri subsp. *fletcheri*	E	-	Low - outside known distribution, targeted searches undertaken in suitable habitat	1 OEH
Melaleuca deanei (Deane's Paperbark)	V	V	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	1 OEH
Micromyrtus minutiflora	E	V	Low	8 OEH
Olearia cordata	V	V	Unlikely – suitable habitat absent from study area	5 OEH, PMST
Pterostylis saxicola (Sydney Plains Greenhood)	E	E	Unlikely – suitable habitat absent from study area	PMST
Pelargonium sp. Striatellum (G. W. Carr 10345) (Omeo Storksbill)	E	E	Unlikely – suitable habitat absent from study area	PMST
Persoonia acerosa (Needle Geebung)	V	V	Low –suitable habitat limited, targeted searches undertaken	7 OEH, PMST
Persoonia hirsuta (Hairy Geebung)	E	E	Low –suitable habitat limited, targeted searches undertaken	4 OEH, PMST
Persoonia nutans (Nodding Geebung)	E	E	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	16 OEH, PMST
Pimelea curviflora var. *curviflora*	V	V	Low – outside known distribution, targeted searches undertaken	3 OEH, PMST
Pimelea spicata (Spiked Rice-Flower)	E	E	Low – outside known distribution, targeted searches undertaken	PMST
Pomaderris brunnea (Brown Pomaderris, Rufous Pomaderris)	V	V	Unlikely – suitable habitat absent from study area	PMST
Prasophyllum fuscum (Slaty Leek-Orchid, Tawny Leek-Orchid)	CE	V	Unlikely – suitable habitat absent from study area	2 OEH, PMST
Prasophyllum uroglossum (Wingcarribee Leek-Orchid, Dark Leek-Orchid)	CE	E	Unlikely – suitable habitat absent from study area	PMST
Pterostylis gibbosa (Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood)	E	E	Unlikely – suitable habitat absent from study area, and outside known distribution	PMST

Species	Status*		Potential likelihood to occur in the study area	No. of records and source#
	TSC Act	EPBC Act		
Pultenaea glabra (Smooth Bush-Pea, Swamp Bush-Pea)	V	V	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	6 OEH, PMST
Pultenaea parviflora	E	V	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	1 OEH
Pultenaea villifera Sieber ex DC. In the Blue Mountains LGA	EP	-	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	246 OEH
Rhizanthella slateri (Eastern Australian Underground Orchid)	V	E	Low –Suitable habitat such as thick leaf litter in sheltered positions limited in study area	PMST
Streblus pendulinus (Siah's Backbone, Sia's Backbone, Isaac Wood)	-	E	Unlikely – suitable habitat absent from study area, and outside known distribution	PMST
Thelymitra sp. *Kangaloon* (D.L.Jones 18108) *(*Kangaloon Sun-Orchid)	CE	CE	Unlikely – suitable habitat absent from study area, and outside known distribution	PMST
Thesium australe (Austral Toadflax)	V	V	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	PMST
Velleia perfoliata	V	V	Unlikely – suitable habitat absent from study area	3 OEH, PMST
Wollemia nobilis (Wollemi Pine)	E	E	Unlikely – suitable habitat absent from study area	PMST
Zieria involucrata	E	V	Low – limited suitable habitat present, targeted searches undertaken	1 OEH
Zieria murphyi (Velvet Zieria)	V	V	Low – limited suitable habitat present, targeted searches undertaken	3 OEH, PMST

*V=Vulnerable, E=Endangered, CE=Critically Endangered, EP=Endangered population. # OEH = NSW Wildlife Atlas records (Accessed April 2014); PMST = EPBC Act Protected matters Search Tool (Accessed April 2014).

3.6.2 Survey results

No threatened flora species were identified in the study area despite targeted searches. Some species have areas of suitable habitat in the study area, however these species are considered to be non-cryptic and were not identified during targeted searches and therefore are considered to have a low potential to be present in the study area. Several cryptic species have been identified as being potentially present, however suitable habitat is not present for these species in the study area.



Overtaking lane
Safety works
Local Government Area
National Park

Threatened Flora

- Acacia baueri subsp. aspera
- Acacia bynoeana
- Acacia gordonii
- Acacia pubescens
- Acrophyllum australe
- Cynanchum elegans
- Dillwynia tenuifolia
- Epacris sparsa
- Grammitis stenophylla
- Grevillea juniperina subsp. juniperina
- Isopogon fletcheri
- Leucopogon fletcheri subsp. fletcheri
- Persoonia acerosa
- Persoonia hirsuta
- Persoonia nutans
- Pimelea curviflora var. curviflora
- Prasophyllum fuscum
- Pultenaea glabra
- Zieria involucrata
- Zieria murphyi

Data source: OEH, 2014

Figure 3-9 Threatened flora records within a 10 km radius of the study area

3.7 Threatened fauna species

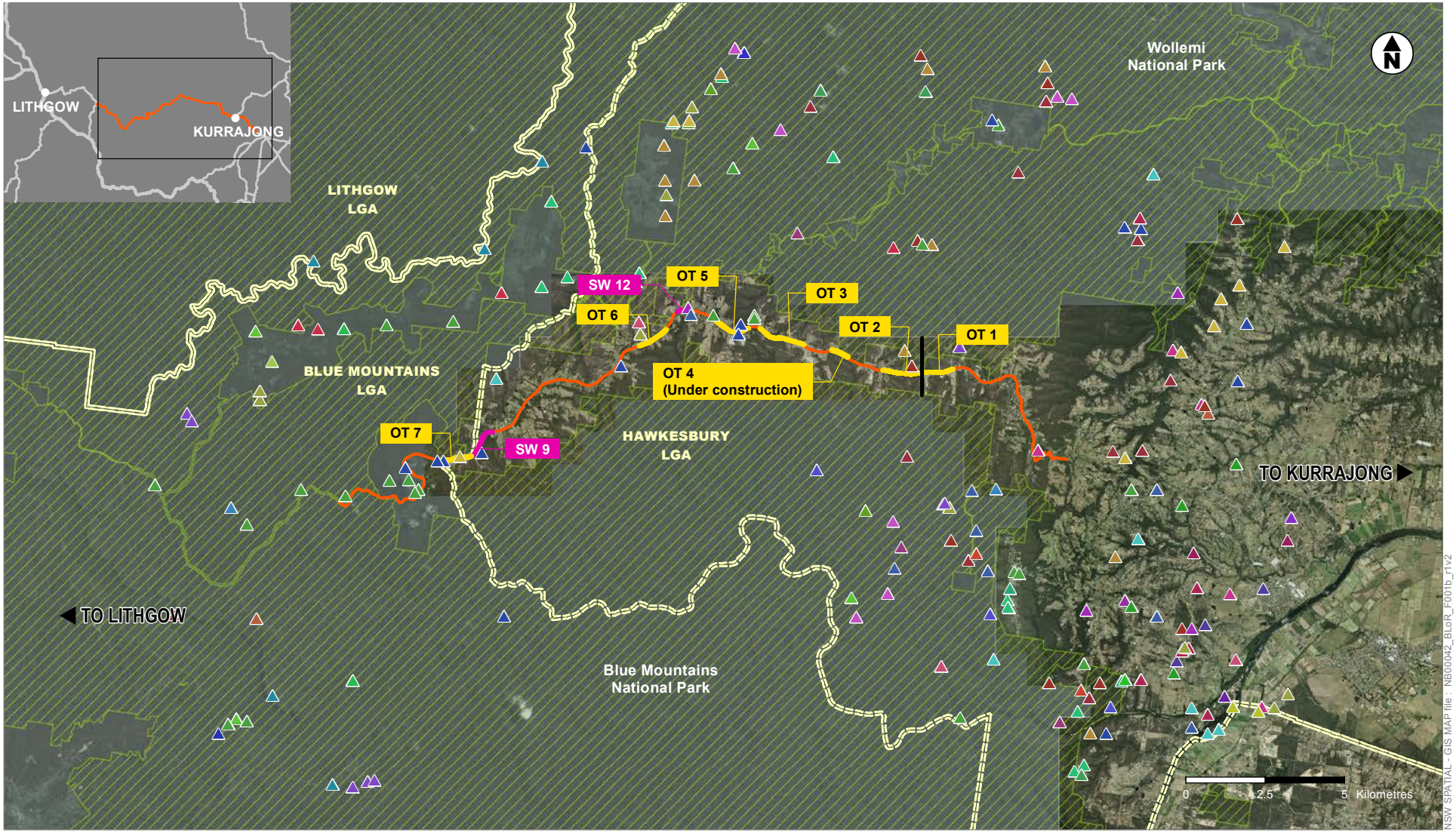
3.7.1 Literature and database review

On the basis of regional records, reports and the presence of suitable habitat, a total of 56 threatened fauna species have been identified from locality, which encompasses a range of terrestrial and aquatic habitats within a 10 kilometre radius of the study area. These species are listed in Appendix A which includes an assessment of their likelihood of occurrence in the study area using the criteria described in Section 2.7.1. Many of these species favour habitats that are not represented in the study area and these were considered unlikely or a low likelihood of occurring (n=43). From the review, 26 species were considered to have a moderate or high chance of occurring and three species were confirmed to be present from the field survey. These species are presented in Table 3-9 and all threatened fauna records within a 10 kilometre radius of the study area are illustrated in Figure 3-10.

Table 3-9 Fauna species with moderate to high likelihood of occurring

Species	Status		Potential likelihood	No. of records and source
	TSC Act	EPBC Act		
BIRDS				
Callocephalon fimbriatum (Gang-Gang Cockatoo)	V	-	High	21 BIONET
Calyptorhynchus lathami (Glossy Black Cockatoo)	V	-	High	18 BIONET
Daphoenositta chrysoptera (Varied Sittella)	V	-	Confirmed	25 BIONET
Glossopsitta pusilla (Little Lorikeet)	V	-	Moderate	7 BIONET
Lophoictinia isura (Square-Tailed Kite)	V	-	Moderate	3 BIONET
Melithreptus gulari gularis (Black-Chinned Honeyeater)	V	-	Moderate	3 BIONET
Ninox strenua (Powerful Owl)	V	-	High	14 BIONET
Petroica boodang (Scarlet Robin)	V	-	Moderate	17 BIONET
Petroica phoenicea (Flame Robin)	V	-	Moderate	5 BIONET
Tyto novaehollandiae (Masked Owl)	V	-	Moderate	3 BIONET
Tyto tenebricosa (Sooty Owl)	V	-	Moderate	7 BIONET
MAMMALS				
Cercartetus nanus (Eastern Pygmy Possum)	V	-	Moderate	1 BIONET
Chalinolobus dwyeri (Large-Eared Pied Bat)	V	V	Moderate	15 BIONET, PMST
Dasyurus maculatus (Spotted-tailed Quoll)	V	E	High	43 BIONET, PMST
Falsistrellus tasmaniensis (Eastern False Pipistrelle)	V	-	High	7 BIONET
Miniopterus schreibersii oceanensis (Eastern Bentwing-Bat)	V	-	High	23 BIONET
Mormopterus norfolkensis (Eastern Freetail-Bat)	V	-	High	20 BIONET
Myotis macropus (Southern Myotis)	V	-	High	8 BIONET
Petaurus australis (Yellow-Bellied Glider)	V	-	Moderate	6 BIONET
Petaurus norfolcensis (Squirrel Glider)	V	-	Moderate	11 BIONET
Phascolarctos cinereus (Koala)	V	V	Confirmed	25 BIONET, PMST
Pteropus poliocephalus (Grey-Headed Flying-Fox)	V	V	High	30 BIONET, PMST
Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)	V	-	High	Roads and Maritime (2012)
Scoteanax rueppellii (Greater Broad-Nosed Bat)	V	-	High	12 BIONET
Vespadelus troughtoni (Eastern Cave Bat)	V	-	Moderate	2 BIONET
AMPHIBIANS				
Pseudophryne australis (Red-crowned Toadlet)	V	-	Confirmed	30 BIONET

V- vulnerable; E – endangered; CE – critically endangered



Overtaking lane
Safety works
Local Government Area
National Park

Threatened Fauna

- Black-chinned Honeyeater (eastern subspecies)
- Broad-headed Snake
- Brown Treecreeper (eastern subspecies)
- Brush-tailed Rock-wallaby
- Cattle Egret
- Common Sandpiper
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Flame Robin
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Giant Dragonfly
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Grey-headed Flying-fox
- Koala
- Large-eared Pied Bat
- Little Bentwing-bat
- Little Eagle
- Little Lorikeet
- Littlejohn's Tree Frog
- Masked Owl
- Painted Honeyeater
- Powerful Owl
- Rainbow Bee-eater
- Red-crowned Toadlet
- Regent Honeyeater
- Scarlet Robin
- Sooty Owl
- Sooty Tern
- Southern Myotis
- Speckled Warbler
- Spotted-tailed Quoll
- Square-tailed Kite
- Squirrel Glider
- Swift Parrot
- Varied Sittella
- White-bellied Sea-Eagle
- White-throated Needletail
- Yellow-bellied Glider

Data source: OEH 2014

Figure 3-10 Threatened fauna records within a 10 km radius of the study area

3.7.2 Survey results

Three threatened fauna species were confirmed from the site surveys, namely:

Koala (Phascolarctos cinereus) – vulnerable species EPBC Act and TSC Act

Varied Sittella (Daphoenositta chrysoptera) – vulnerable species TSC Act

Red-crowned Toadlet (Pseudophryne australis) – vulnerable species TSC Act.

Varied Sittella

The Varied Sittella inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches. 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. The species is sedentary and may inhabit or nest in the same location over successive years. A flock of Varied Sittella were recorded at OT2 and this species may occur widely throughout the study area and associated with any of the study sites.

Red-crowned Toadlet

The Red-crowned Toadlet was recorded in one location at the western extent of OT7 on top of the cutting adjacent to the existing road corridor. A small area of hanging swamp habitat was located in this location. As a result of the survey findings the design of OT7 altered to avoid impacts to the habitat of this species and no longer directly impacts this area. The site at Section 7 is the only area of potential habitat located with an overtaking lane site.

Koala

An adult female Koala was observed in the road reserve at OT5 on the north side of the Bells Line of Road (refer Figure 3-4) and a mix of old and fresh Koala scats were recorded from eight trees all on the northern side of the Bells Line of road at OT5 and two locations at the western end of OT3 in proximity to OT5, although on the southern side of the Bells Line of Road. In addition to this there are 13 historical Koala records from a five kilometre radius of Bilpin and include several sightings along the road and north and south of the Bells Line of Road. The results of the desktop assessment and on-ground surveys suggest the presence of an important Koala population occupying habitat to the north and south of the Bells Line of Road. There are considerably large areas of potential habitat for koalas in this location that is continuous with Wollemi and Blue Mountains National Parks. The extent and distribution of the Koala population is not known, although in relation to the project area the presence of Koalas along the Bells Line of Road was confirmed between Johnson Road in the east and Mountain Lagoon Road to the west (ie. OT3 and OT5) and associated with the presence of Grey Gum (E.punctata) which is patchy in the landscape. There was no evidence that Koalas using other apparent Koala feed tree species Monkey Gum (E.cypellocarpa) or Mountain Gum (E.deanei) in the study area.

The results of the Koala survey and habitat assessment confirmed Koala activity in the study area and Koala habitat based on the presence of important Koala food tree species known from the region (refer Table 3-10). The evidence of Koala presence in the study area was found to be associated with the Blue Mountains Shale Cap Forest and Turpentine Ironbark Forest, although only where Grey Gum (E.punctata) was present and not widespread across these communities. . There was no evidence of Koala activity within the Blue Mountains Ridgetop Woodland dominated by Sydney Peppermint (E.piperita) and Silvertop Ash (E.seiberi). In addition to this, Koalas appear to be associated with forests comprising a higher proportion of shale or basalt soil and this may be associated with higher moisture or nutrient content in the leaves.

Table 3-10 Koala food tree species and relevant vegetation communities comprising potential Koala habitat

Species	Map Unit in study area	Koala recovery plan (DEC 2009) food tree species for central coast and Sydney Basin region	AKF (2012) Recommended tree species for protection (Hawkesbury and Blue Mountains LGA)	SEPP44 Koala Habitat Protection
Grey Gum (Eucalyptus punctata)	1,2	Secondary species	Yes	Yes
Monkey Gum (E.cypellocarpa)	2	Secondary species	Primary	-
Stringybark (*E.notabilis*)	1	Secondary species	-	-
White Stringybark (*E. globoidea*)	1,2	Supplementary species	Yes	-
Sydney Peppermint (*E. piperita*)	1,2,3	-	Yes	-

3.8 Migratory species

A total of 14 migratory fauna species were identified in the EPBC Act Protected Matters Report as potentially occurring in the locality based on the distributional range of the species. These migratory species, along with their preferred habitat requirements and an assessment of their likely presence in the study area are listed in Appendix A. From this review a list of eight migratory species are considered to have a moderate likelihood of occurring in the study area (Table 3-11).

Table 3-11 Migratory species considered to have a moderate likelihood of occurring

Species	EPBC Act	No. of records and source
Apus pacificus (Fork-Tailed Swift)	Migratory (CAMBA, JAMBA, ROKAMBA)	PMST
Ardea ibis (Cattle Egret)	Marine, Migratory (CAMBA, JAMBA)	11 BioNET, PMST
Hirundapus caudacutus (White-throated Needletail)	Marine, Migratory (CAMBA, JAMBA, ROKAMBA)	7 BioNET, PMST
Merops ornatus (Rainbow Bee-Eater)	Migratory (JAMBA)	6 BioNET, PMST
Monarcha melanopsis (Black-faced Monarch)	Migratory (Bonn)	PMST
Monarcha trivirgatus (Spectacled Monarch)	Marine, Migratory (Bonn)	PMST
Myiagra cyanoleuca (Satin Flycatcher)	Migratory (Bonn)	PMST
Rhipidura rufifrons (Rufus Fantail)	Migratory (Bonn)	PMST

Further assessment of the significance of potential impacts on listed migratory species was made through consideration of the significant impact guidelines 1.1 provided in DEWHA (2009). According to the guidelines an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it would:

- Substantially modify (including by fragmenting, altering fire regimes and nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

3.9 General flora and fauna

A complete list of flora and fauna including common and threatened species identified from the field surveys is provided in Appendix C for flora species and Appendix D for fauna species.

Native floral species richness was relatively high within the naturally vegetated portions of the study area. A total of 345 flora species were recorded within the study area. This total comprises 80 exotic species including nine noxious weed species (refer to Table 3-11). There is a total of 265 native flora species that were recorded in the study area. Exotic and non-indigenous native flora represents about 23% of the floral diversity in the study area. Native floral diversity is likely to be higher in the study area considering the late autumn timing of the

survey, with some species likely to be unidentifiable or not present during the time of the survey. The flora species recorded in each plot in each of the eight study areas is provided in Appendix C.

A total of 63 vertebrate fauna species were recorded from this survey across the eight sites, this includes 50 bird species, 9 mammal species including two introduced species, and 4 frog species. The list of fauna species recorded on each site is provided in Appendix D.

3.10 Wildlife connectivity corridors

The Bells Line of Road traverses the ridgetop between Kurrajong Heights and Bilpin and crosses a small number of upper gullies at the western end of the study area towards Mount Tomah. The surrounding landscape is dominated by mature dry open forest habitats occupying the slopes and ridges with tall moister forest habitats in gullies and steeper slopes. These habitats are widespread across the landscape with very limited fragmentation and contiguous with the open forests on private lands and Blue Mountains National Park to the south of the study area and Wollemi National Park to the north. Clearing of habitat for settlement and farming has been minimal and relatively small in scale being generally associated with land along the Bells Line of Road and adjoining roads, resulting in minimal fragmentation of habitat. Given the presence of the large conservation reserves to the north and south of the study area, the corridor along Bells Line of Road is located between these and with the extent of clearing presents some localised fragmentation or interruption to connectivity.

There are a limited number of locations between Kurrajong Heights and Mt Tomah where vegetation has been retained up to the edge of the Bells Line of Road on both sides of the road and therefore connectivity is largely maintained, albeit for the road corridor itself. This scenario was noted at OT2 and OT7. It is assumed the narrow two lane road through these locations would have minimal impact on local connectivity, although the proposed widening of the road in these locations would have some impact on local and regional connectivity. The greatest area of fragmentation is a result of clearing for properties and farming or utilities adjoining the Bells Line of Road, and this was noted in numerous places across each site. This includes parallel clearing for power easements at OT5, OT6 and OT7. Therefore the road widening would have minimal impact at these locations as the footprint would be largely placed within existing cleared easements or wide cleared road verges. Conversely the impact on widening would be most prevalent where there is vegetation alongside the road and this would occur at about 10% of the areas for OT2 and OT7.

3.11 Weeds

Of the total 345 species of flora recorded, 80 introduced species were identified, representing about 23 per cent of the total species. Of these 80 introduced species recorded in the study area, nine species listed as noxious in the Hawkesbury and Blue Mountains control areas were recorded (refer to Table 3-12).

Table 3-12 Noxious weed species listed in the Hawkesbury and Blue Mountains control areas

Species	Prevalence on Site	Noxious Class
Asparagus Fern *Asparagus aethiopicus*	Low abundance. Only recorded at one location near safety work 12	Class 4: The plant must not be sold, propagated or knowingly distributed Weed of national significance
Blackberry *Rubus fruticosus* aggregate species	Moderate to high abundance throughout all study areas. Common and Widespread.	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed
Crofton Weed *Ageratina adenophora*	Moderate abundance. Several infestations recorded around rest area at OT2	Class 3: The plant must be fully and continuously suppressed and destroyed
Honey Locust *Gleditsia triacanthos*	Low abundance. Recorded at safety work 9	Class 3: The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed
Montbretia *Crocosmia x crocosmiiflora*	Moderate abundance. Recorded in roadside areas in all study areas	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold,

Species	Prevalence on Site	Noxious Class
		propagated or knowingly distributed
Montipellier Broom *Genista monspessulana*	Low abundance recorded at one location OT2	Class 3: The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed
Privet species *Ligustrum sinense* and *L. lucidum*	Moderate abundance. Moderate abundance. Recorded in roadside areas in all study areas.	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread
St John's Wort *Hypericum perforatum*	Moderate abundance. Moderate abundance. Recorded in roadside areas throughout all study areas.	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed

4. Potential impacts

4.1 Avoidance measures

Impacts to native vegetation have been avoided where possible and informed by the results of the detailed vegetation surveys, in particular the identification of critically endangered ecological communities and habitat for the Koala and Red-crowned Toadlet.

Design modifications were made following review of biodiversity constraints with the intent of reducing the impacts on identified ecological values, these modifications were most pronounced at OT1, OT6 and OT7.

4.2 Loss of vegetation

4.2.1 Direct clearing per project

The potential loss of vegetation and habitat for fauna associated with each project is summarised in Table 4-1. These impacts are quantified on the basis of clearing footprint including a two metre buffer from the base of batters and four metres from the top of cuts to provide construction access. There is potential for a further 10% impact to this area, given small changes that may occur during the detailed design of the proposal.

The vegetation to be cleared at OT1, OT6 and SW12 is in moderate condition, while the remaining sites contain both moderate and high condition vegetation as determined by the biobanking condition assessment.

Table 4-1 Direct impacts on vegetation and fauna habitat

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

4.2.2 Cumulative vegetation loss

The clearing footprint would impact on up to 3.25 hectares of remnant vegetation consisting of MU1 (1.14 ha), MU2 (2 ha) and MU3 (0.11 ha). Of this total 2.03 ha is high condition and 1.22 is moderate condition. There would be an additional loss of 0.29 ha of exotic vegetation.

4.3 Threatened ecological communities

Impacts to threatened ecological communities (TECs) associated with the eight study sites relate to the:

- Clearing of moderate to high condition Blue Mountain Shale Cap Forest (BMSCF) TSC Act listed and Turpentine Ironbark Forest (TIF) EPBC Act listed
- Direct removal of vegetation to accommodate the design of the overtaking lane and safety works.
- Indirect impacts through potential introduction of invasive weeds and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

- To a lesser degree there is potential for stormwater run-off impacts, although most areas are on low gradients and it unlikely that run-off would be a major issue.

4.3.1 Direct clearing per project

The extent of potential clearing for each project is shown in Table 4-2. There would be 3.14 hectares of TEC cleared over the total proposal study areas. There would be no clearing of TECs at SW9. Overall the extent of clearing at each site is low and would occur along the edges of small or large patches and from the road reserve only. The highest extent of clearing is expected at OT3 (1.38 ha) while lesser clearing is required at OT1 (0.18 ha), OT6 (0.19 ha) and SW12 (0.06 ha). Small areas of regrowth vegetation occur in the road reserve on the northern side of OT1 which may require clearing, although these do not meet the condition threshold for the listed Turpentine Ironbark Forest.

Table 4-2 Estimate of direct removal of threatened ecological communities required

Threatened Ecological Community	Status	Site and Area (ha)							
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12
Blue Mountains Shale Cap Forest of the Sydney Basin Bioregion	Endangered, TSC Act	0.18	0.60	1.38	0.6	0.19	0.13	-	0.06
*Turpentine Ironbark Forest of the Sydney Basin Bioregion**	*Critically Endangered, EPBC Act*	-	*0.60*	*1.14*	*0.15*	*0.16*	*0.07*	-	-
Total clearing (EEC)		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.20**	**-**	**0.06**

*the areas shown in italics, meet the condition threshold for listing under the EPBC Act

The majority of the TIF (EPBC Act) comprises high condition intact areas of remnant vegetation occurring within larger patches (greater than one hectare). These areas have been subject to edge effects from the presence of the existing Bells Line of Road resulting in minor weed invasion and altered vegetation structure and floristics. Disturbed areas include isolated trees, underscrubbed vegetation and smaller fragments that are excluded from the federal listing as they do not meet the condition threshold. The TSC Act listed vegetation includes these higher condition areas included under the EPBC Act, as well as disturbed vegetation with affinities to the TEC and accounts of the total impacts shown in Table 4-2.

4.3.2 Cumulative impact

Clearing for agriculture and suburban and rural settlement are considered a threat to the western outliers of this TIF. In addition to this other threats observed at each site included weed invasion along edge areas, particular the invasion of the native *Pittosporum undulatum*.

The cumulative clearing of threatened ecological communities (TECs) across the eight sites would equate to around 3.14 hectares (TSC Act listed BMSCF) which is of high to moderate condition (Map Units 1 and 2). Of the 3.14 hectares, a total of 2.12 hectares meets the condition threshold for the critically endangered ecological community listed under the EPBC Act (Turpentine-Ironbark Forest). It is likely that edge effects would also occur where impacts would occur to larger intact patches or where new edges would be created. In this instance the total area of impact may be greater than the 3.14 hectares stated and would be associated with weed invasion and changed vegetation structure.

About 0.47 hectares of the critically endangered ecological community was cleared to build an overtaking lane at OT4 (located between OT2 and OT3), and therefore the overall Bells Line of Road Corridor Improvement Program from Kurrajong heights to Mt Tomah would potentially result in a cumulative impact of about 2.59 hectares to the EPBC Act ecological community (TIF) and 3.61 hectares of the state-listed ecological community (BMSCF). There will be no direct clearing of the Turpentine-Ironbark forest at OT1 as the clearing would be limited to small fragments of isolated low condition vegetation in the road reserve, including isolated trees with mown understorey. There is some potential for trimming of trees or removal of regrowth from the road

reserve on the north side in this location although this is considered very minimal and does not meet the condition threshold for the TIF.

The distribution of this community in the locality has been mapped in broad scale vegetation mapping projects by Tozer et al. (2010) and Bell (1998), which together cover the large majority of the locality. A total of 1,878 hectares of equivalent map units have been identified within a ten kilometre radius of the project study sites. The proposal would result in the removal of about 2.59 hectares which represents about 0.14 per cent of the 1,878 hectares. Therefore the cumulative impact would reduce the area of occupancy of the ecological community in the locality by an about 0.14 per cent for the federally listed ecological community and 0.19 per cent for the state listed community.

The cumulative impact from the loss of TIF at five sites has been assessed as a significant impact according to the Assessment of Significance (EPBC Act). This conclusion is based on a number of factors which include the:

- critically endangered status of this community,
- generally high condition of the vegetation being impacted
- extent of the impact area across multiple sites, and
- additional indirect impacts which could be expected and are unlikely to be mitigated over the long-term.

4.4 Threatened flora species

No threatened flora species have been confirmed from the targeted survey across all sites and there is a low likelihood that threatened plant populations would occur.

4.5 Loss of foraging habitat for fauna

As presented in Table 4-1, the proposal would result in the clearing of about 3.25 hectares of native vegetation over seven locations, thereby resulting in an equivalent loss of habitat for fauna. The loss of habitat is relatively minor on a local site scale and restricted to narrow and linear strips of clearing along the edge of larger contiguous habitats. There will also be impacts to areas of modified habitats and other disturbed areas supporting exotic vegetation with limited value for fauna and comprising 0.29 hectares.

The habitat to be cleared at OT1, OT6 and SW12 is in moderate condition, while the remaining sites contain both moderate and high condition vegetation as determined by the biobanking condition assessment. This potential impact includes approximately 3.14 hectares of potential habitat for Koala (Map Units 1 and 2) as discussed below and scattered low densities of potential foraging habitat (feed-trees) for Glossy Black-cockatoo scattered at densities throughout all vegetation types.

The loss of foraging habitat is at the scale which includes nectar resources for threatened birds (Little Lorikeet) and mammals (gliders, Grey-headed Flying-fox) and foliage for arboreal mammals including the Koala, Common Brushtail Possum, Common Ringtail Possum and Greater Glider all recorded from the surveys.

4.6 Impact to Koala habitat and population

The method for assessing potential impacts of the project on the Koala followed the identification of the distribution of Koala habitat in relation to the proposed activity and the presence of Koala activity. The assessment of significance for this species under the EP&A Act and the EPBC Act is detailed in Appendix B. It is noted that Koala populations are known from the Blue Mountains, Wollemi and Yengo National Parks.

4.6.1 Impact per project

The results from the Koala scat search and habitat assessment at each site is provided in Appendix E. These data show the importance of the habitat for koalas according to three categories as used in the NSW Koala Recovery Plan (DECC 2009) Appendix 2, and include:

- Primary habitat

- Secondary habitat (class A)
- Secondary habitat (class B)
- Secondary habitat (class C)

Table 4-3. Koala habitat categories and percentage of plots identified for each category per site

Koala	OT1 (n=10)	OT2 (n=7)	OT3 (n=10)	OT5 (n=11)	OT6 (n=4)	OT7 (n=8)
Primary habitat	-	-	-	27 %		25 %
Secondary habitat (class A)	-	-	40%	27 %	75 %	
Secondary habitat (class B)	-	-	10%	18 %		12.5 %
Secondary habitat (class C)	60%	-	10%	18 %	25 %	25 %
Koala scats confirmed	-	-	Yes	Yes	-	-

An adult female Koala was observed in the road reserve at OT5 on the north side of the Bells Line of Road and a mix of old and fresh Koala scats were also recorded from six trees all on the northern side of the Bells Line of Road at OT5. Scats were recorded at two trees at the western end of OT3 in proximity to OT5, although in the southern side of the Bells Line of Road. In addition to this there are 13 historical Koala records from a five kilometre radius of Bilpin and include several sightings along the road and north and south of the Bells Line of Road.

Habitat of importance for koalas appears to be located at the western end of OT3; through to OT5, OT6 and the eastern end of OT7, however evidence of koalas was only reported at OT3 and OT5. In the locations where important Koala habitat was identified this occurs to the north and south of the road, however potential movements by Koalas across the road in these locations is limited by the extent of clearing and fenced residential properties and the high proportion of domestic dogs. Opportunities for koalas to cross the road corridor are poor at the locations where Koala habitat was identified and while the project would add to the cumulative barrier effect, it is not expected to significantly impact on Koala movements in these locations, which already represent poor crossing locations. The location of Koala crossing points along the Bells Line of Road is not known and may not be present at these overtaking lane sites.

4.6.2 Cumulative impact

Consideration was also given to the Koala habitat assessment tool from the Draft Koala Referral Guidelines (Commonwealth Department of the Environment 2013). The document guides issues for consideration in assessing the impacts of an action on Koala and the need to refer the action. This includes determining whether the proposed site contains critical Koala habitat, whether the proposed action would threaten the viability of such habitat and whether the proposal is consistent with the interim recovery objectives of the species.

In summary, the assessment used the following approach:

- Reviewing the Atlas of Living Australia, NSW BioNet, the Australian Koala Foundation Koala map, Commonwealth Protected Matters Search Database, and consulting with residents, to establish the occurrence of a Koala population in the study area.
- Collation of information on the vegetation composition in the study area and analysis in relation to Koala habitat. This involved a review of Tozer et al (2003), followed by a Koala survey and habitat assessment, including an assessment of vegetation condition and structure.
- SAT surveying for Koala to provide an indication of the extent and frequency of habitat use and identify the relative importance of the habitat for Koala. This was supported by walking transect searches and spotlighting.
- Determining the landscape context of the Koala habitat in the study area in terms of habitat connectivity.
- Identifying existing threats to survival of koalas in the study area.

- Identifying the recovery value of the habitat in the study area in accordance with the interim recovery objectives for genetically diverse, disease-free, breeding Koala populations on the coast.

The conclusions drawn from the above approach are that an important Koala population is present in the Bilpin area and that this is likely a low-density and widespread population given the large expanses of habitat to the north and south of the study area and associated with the National Parks estates. Potential habitat is likely to be widespread beyond the clearing footprint areas. With the study area potential Koala habitat was found to be associated with Map unit 1 (Sydney Turpentine-Ironbark Forest) and Map Unit 2 (Blue Mountains Shale Cap Forest). There was no evidence of Koala activity associated with Map Unit 3 (Blue Mountains Ridgetop Sandstone Woodland). However, within these habitats and specifically in the study area close to the Bells Line of Road, Koala activity was reported in a relatively small area of associated with a higher prevalence of shale and basalt soil influence located between Johns Road and Mount Lagoon Road, east of Bilpin. This habitat type was observed to extend north and south into the adjoining private properties and was not limited to the study area. The presence of koalas appeared to be associated with the presence of Grey Gum (Eucalyptus punctata) and the higher soil moisture levels in these sheltered locations.

The extent and distribution of the Koala population near Bilpin is not known, although in relation to the project area the presence of Koalas along the Bells Line of Road was confirmed between Johnson Road in the east and Mountain Lagoon Road to the west (ie. OT3 and OT5) and associated with the presence of Grey Gum (E.punctata) which is patchy in the landscape. There was no evidence that Koalas were using other apparent Koala feed tree species Monkey Gum (E.cypellocarpa) or Mountain Gum (E.deanei) in the study area. Therefore the evidence of Koala presence in the study area was found to be associated with the Blue Mountains Shale Cap Forest and Turpentine Ironbark Forest, although only where Grey Gum (E.punctata) was present and not widespread across these communities which may reflect the low density of the population. There was no evidence of Koala activity within the Blue Mountains Ridgetop Woodland dominated by Sydney Peppermint (E.piperita) and Silvertop Ash (E.seiberi). In addition to this, Koalas appear to be associated with forests comprising a higher proportion of shale or basalt soil and this may be associated with higher moisture or nutrient content in the leaves.

In assessing the impact of the proposal on habitat critical to the survival of the Koala, consideration was given to the referral guidelines (DoE 2013), and the results of the assessment are shown in Table 4-4. It is concluded the impacts are unlikely to be adverse for the following reasons:

- The cumulative impacts of the proposed activity would clear around 3.14 ha of vegetation considered to be critical to the survival of koalas, mostly from OT3 (1.39 ha). Comparable Koala habitat associated with MU1 and MU2 is extensive to the north and south of the Bells Line of Road and well conserved within Wollemi and Blue Mountains National Park and as stated, koalas do not appear to be using all habitats associated with these communities and therefore the loss of vegetation is likely overstating the actual loss of Koala habitat.
- The habitat assessment tool has reported a high score of 8 (refer Table 4-4), confirming the presence of habitat critical to the survival of koalas, although the population is considered a low-density population (<0.01 koalas / ha).
- The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements.
- The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening.

The presence of Koala habitat in the study area was identified as strongly influenced by the presence of Grey Gum (Eucalyptus punctata) which occurs patchily throughout map units 1 and 2. The area of clearing is likely to be an overestimate of the resource available to and potential foraging habitat used by the local Koala population.

Table 4-4 Inputs to the Koala habitat assessment tool

Action: Minor road upgrades in Hawkesbury LGA (Bells Line of Road).
Context: Coastal.
Associated infrastructure: Road widening for overtaking lanes.
Primary impacts: Habitat clearing, potential increase barrier to dispersal, potential vehicle strike. Impact area size: 3.14 ha across 6 sites.

Attribute	Score	Example habitat appraisal	
Koala occurrence	**+2** (evidence of koalas confirmed)	Desktop	– EPBC PMST report identified the Koala as 'known to occur' in the study area. – The NSW BioNET map identifies 13 records within 5 km of the proposed activity (undated). – The Atlas of living Australia has 8 records within 5 km of the impact area (undated). – The AKF Koala Map identifies 1 record 2 km to the south of the impact area.
		On-ground	– Due to the linear nature of the impact area, transects were walked and scat surveys and spotlighting observations were conducted in areas of Koala habitat. – Survey effort totalled 5 km of linear transects and 50 scat search plots, both adjacent to the road and in adjoining properties. – The density of feed trees (Primary and Secondary) was calculated to determine the categories of Koala habitat present, according to the NSW Koala Recovery Plan (Appendix 2). See table below for results. – One Koala was identified from the transect walks and 10 trees containing Koala scats were identified from searches (sites were OT3 and OT5). No other Koala evidence at the remaining sites. – Primary habitat was identified at OT3 and OT5 in addition to Secondary habitat (class A and class B) at these locations. Secondary habitat class C was identified at OT1 and OT2 – The Blue Mountains Shale cap Forest (MU2) and Turpentine Ironbark forest (MU1) were identified adjoining the road reserve in all sites and these vegetation communities are known to contain three Koala feed trees in varying density according to topography and the presence of shale. These habitats are therefore considered potential Koala habitat. – The evidence supports at least 2 koalas resident near OT3 and OT5 at the time of the survey. The density of koalas is considered low and approximately <0.3 per hectare based on searches over 7-8 ha for the six sites assessed.
Vegetation structure and composition	**+2** (2 or more Koala feed tree species are present)	Desktop	– A review of vegetation from Tozer (2003) indicates that *Eucalyptus punctata, E. cypellocarpa and E.notabilis* occur in vegetation surrounding the study area (MU1 and MU2 mapped in this project). – Aerial imagery for the site shows that the vegetation is a forest with an open canopy structure.
		On-ground	– Habitat ground-truthing was carried out during the on-ground surveys. The Koala habitat within the impact area was found to be open sclerophyll forest, with *E. punctata* occurring in the canopy, along with *E.cypellocarpa* and *E.notabilis*. The middle storey is diverse and primarily *Acacia, Pittosporum, Banksia*, *Allocasuarina* and *Melaleuca spp.* The shrub layer is a relatively diverse and open layer. – The relevant Koala food tree table provided by NSW OEH indicates that three of the dominant/canopy tree species are 'secondary' Koala food trees (*E. punctata, E.cypellocarpa; and E.notabilis*). In addition, the scats identified during on-ground surveys were associated with *E. punctata and E.cypellocarpa)*. – A review of the AKF (2012) recommended tree species for protection in the Hawkesbury and Blue mountains LGA's suggests that Grey Gum (E.punctata) is a primary feed trees species. Therefore the assessment of the importance of the habitat has considered this species as primary and not secondary. – Primary habitat was identified at OT3 and OT5 in addition to Secondary habitat (class A and class B) at these locations. Secondary habitat class C was identified at OT1 and OT2
Habitat connectivity	**+2** (area is part of a contiguous landscape > 500 ha)	– The Koala habitat is part of a contiguous landscape > 1000 ha extending into Wollemi National Park to the north and south of the Bells Line of Road into the Blue Mountains National Park. There is clearing along the ridge lines and adjacent to the Bells Line of Road and local roads such as Mountain Lagoon Road and Pup Road associated with residential and agricultural development. – Minor clearing would occur along the edge of larger habitats extending to the north and south of the road – Primary and secondary (class A) habitat, and evidence of koalas were reported at OT3 and OT5. In these locations the current connectivity across the Bells Line of Road is very poor and hindered by fenced residential properties (and abundance of domestic dogs), and cleared and fenced orchards along the length of the project footprint. Small scale clearing for the project will contribute to this poor situation although in itself will not cause fragmentation of habitat as the clearing will be minor and occur along an existing road corridor that is predominantly cleared already, no fragmentation of habitat and no increased traffic numbers will result. – Widening of the road in OT2 will impact on secondary habitat class C and in effect cause small-scale increased fragmentation of the habitat, north and south of the road. – Widening of the road at OT1 will impact small areas of secondary habitat class C located in the road reserve. These exist as isolated small patches of trees with a mown understorey, and the works would in effect be located within an existing cleared corridor, and adjoin fenced residential estates.	

Attribute	Score	Example habitat appraisal	
Key existing threats	+1 (evidence of infrequent mortality)	Desktop	The AKF Koala Map identifies two road kill records within 2 km.
		On-ground	– Evidence of infrequent or irregular Koala mortality from vehicle strike, however the status of dog populations and level of predation is not known. – Recent Koala road kills have been reported in Bilpin and Kurrajong Heights
Recovery value	+1	– Due to the large size of the contiguous landscape, vegetation composition and level of threats present the habitat is considered likely to be important for the recovery of the Koala, however, the degree to which the habitat that would be impacted is considered to effectively contribute to those areas is not known. The habitat to be removed is located along the road edge and is small in scale compared with the extent of Koala habitat available throughout the two nearby National Parks, suggesting road reserve would have lower importance. – The status of disease in the population is not known. The individual sighted appeared disease free.	
Total score	**8**	**Habitat in the impact area is critical to the survival of koalas**	

4.7 Loss of hollow-bearing trees

The loss of hollow-bearing trees is listed as a key threatening process under the TSC Act. 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.

4.7.1 Impact per project

The total number of habitat trees and tree hollows recorded within 20 metres of the forest edge across the five OT sites is shown in Table 4-5. The highest number was recorded at OT3 and lowest at OT1, and this reflects the size of the design footprint area at each site rather than the density of hollows. It is unlikely that all these habitat trees would be removed, as some are likely to be outside the design footprint. A comparable density of hollow-bearing trees was also observed outside the road reserve and associated with adjoining remnant habitats not impacted by the project.

Table 4-5 Habitat trees and tree hollows recorded within 20 metres of the forest edge

Site	No. trees	DBH (mean)	Tree hollows			
			small	medium	large	total
OT1	15	51.0	15	0	0	15
OT2	29	81.9	32	18	6	56
OT3	42	67.2	26	34	7	67
OT5	26	113.6	43	5	4	52
OT6	26	81.1	20	24	10	54
OT7	25	60.8	35	17	3	55
Total	**163**		**171**	**98**	**30**	**299**

The loss of 15 trees at OT 1 is associated with a group of pine trees that are located along the fence line of the road reserve and were planted in a row. The trees have all died due to fire and contain some cracks in the bark and decorticating bark. No other hollow trees were noted in the works area.

4.7.2 Cumulative impact

Hollow trees in the study area occur in moderate abundance, dominated by a range of small to medium-sized hollows and dead trees 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 are present, although at low density. A comparable density of hollow-bearing trees was also observed outside the road reserve and associated with adjoining remnant habitats not impacted by the project.

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 4-6).

Table 4-6 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
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	
Eastern Freetail-bat	*Mormopterus norfolkensis*	V	
Southern Myotis	*Myotis macropus*	V	
Yellow-bellied Glider	*Petaurus australis*	V	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	

4.8 Wildlife connectivity and habitat fragmentation

The proposed activity will impact on habitat connectivity through an increase in the width of the Bells Line of Road at the five proposed locations. This would result from the widening of the road surface and associated verge by up to seven metres and result in an increase in the gap or distance required for fauna to traverse north to south across the road to access habitats and resources. For some species and individuals this may be an interruption to daily movement as part of their home range, or more generally for some fauna populations, an impact on dispersal opportunities important for genetic exchange and population viability.

4.8.1 Impact per project

There are only a limited number of locations between Kurrajong Heights and Mt Tomah where vegetation has been retained up to the edge of the Bells Line of Road, this is because the majority of land along the road has been cleared or fragmented. The presence of vegetation continuing up to the road may present important opportunities for fauna to traverse the road by retaining habitat connectivity north and south in the context of the extent of clearing and development along this road.

These ‘local’ corridors were considered in the context of the proposed activities. Vegetation retention on both the north and south sides of the road is only present at a portion of OT2 and OT7, while the remaining sites comprise fenced residential and agricultural properties on either one side or both sides, which would hinder the movements of fauna.

The proposed widening of the road at OT2 and OT7 may have potentially a greater impact then the general widening locations for the remainder of the sites assessed and may lead to reduced connectivity and increased risk of road kill at a portion of the study site. Targeted mitigation measures are required at these locations and are discussed in Chapter 5.

For the remainder of the sites assessed (OT1, OT3, OT5 and OT6), there are currently no optimum locations for fauna to cross the road due to the presence of cleared areas of residential development, farmland or existing power easements which run parallel to the road and already create a wider barrier to movements. Further to this most residential properties are fenced and there appears to be a high density of domestic dogs which would further hinder fauna movements across the road.

In relation to the distribution of the Koala population, the evidence from the field surveys suggests that important habitat exists near OT3 and OT5. Opportunities for koalas to cross the road at these sites are currently limited, for the reasons stated previously, in addition to the high density of domestic dogs at these sites. There is no north-south connectivity at the western end of OT5 and at the eastern end, koalas would need to negotiate fences and farmland to successfully cross the road and these features present an existing barrier. The impact of the widening of the road here would contribute to the existing barrier effect, but would not appear to create a barrier. At OT3 there are large expanses of suitable habitat to the north and south of the Bells Line of Road, however very limited opportunity for koalas to cross, again due to the presence of fencing and cleared land. The better opportunities for movements are east-west and parallel to the road. The overtaking lane would contribute to this existing barrier, although unlikely to result in increased road strike for koalas.

The widening of the road at OT2 would widen the gap in the tree canopy which may be expected to impact on the movements of arboreal mammals accessing habitat to the north and south of the road. In particular the Sugar Glider which was found to be present at OT2 and other species may include Greater Glider, Common Ringtail and Common Brush tail Possum. The impacts on connectivity may affect fauna movements from the Blue Mountains NP to the south and the Wollemi NP to the north at OT2.

An example of the extent of reduced connectivity that the clearing of the road may impose is shown in Plate 1. Plate 1 shows the recently cleared Site 4, located between OT3 and OT5. The width extent of clearing was relatively small in scale and allowed the retention of tall trees adjacent to the road and a relatively narrow gap in the tree canopy to remain. Glider species would still be expected to traverse this gap. Measures to protect individual or tall trees adjacent to the road would help to further retain trees and protect opportunities for gliders to cross the gap.

Plate 1. Photo looking west along recently cleared overtaking lane Site 4 showing narrow road corridor and relatively narrow gap in tree canopy

4.8.2 Cumulative impact

The average length of the overtaking lane widening is around 935 m and ranges from 700 – 1220 m. There will also be a small number of cuttings required which may increase the barrier effect for terrestrial fauna movements across the road. The main fauna species potentially impacted from the increased width of the road will be small terrestrial mammals and reptiles and arboreal species such as Koala, and Sugar Glider. This includes the Spotted-tailed Quoll. More mobile threatened species such as large forest owls, diurnal birds and microchiropteran bats are expected to be less affected by the widening. This is because of the small scale of the widening and the presence of large areas of suitable habitat north and south of the road.

There is potential for minor increase in road kill at the overtaking lane sites, although the impact of the widening on population viability for a range of threatened fauna predicted to occur is likely to be relatively minor on a landscape scale. This is considered in the context of the large expanses of habitat available in this locality and the low traffic volumes, as well as the fact that the project would not result in an increase in traffic volume. However increased speed at overtaking lanes would be expected.

It is acknowledged that road kill is likely an issue on the Bells Line of Road between Kurrajong and Mt Tomah and that this issue may increase in the future due to the increased traffic to the area in general. These series of projects would not result in increased traffic although would contribute to the cumulative impact expected over time. In the context of providing fauna crossing mitigation measures, a broader strategic assessment may be required focused on the entire length of the Bells Line of Road to identify optimum locations to provide targeted measures. Such measures would need to consider the land tenure and future development expectations along the road in addition to the location of the reserves. Of the locations assessed in this study there may be future opportunities at OT2 and OT7 although these should be assessed in the context of a wider targeted study.

4.9 Injury and mortality of fauna

The widening of the Bells Line of Road for additional overtaking lanes and the subsequent likely increase in vehicle speeds at these locations has potential to increase the risk of road kill in key areas. The highest potential for this to occur was noted where remnant vegetation has been retained near the road as opposed to the large expanses of cleared land and fenced residential dwellings which are common feature of each of the sites assessed. The central parts of OT2 are mostly likely to be affected and mitigation measures are recommended here to reduce the chance of road kill. The risk of increased fauna road kill appears lower at the remaining sites.

Plate 2. Superb Fairy Wren at OT2, likely road kill

4.10 Potential weed invasion

Weed diversity and abundance was reported as relatively low. Of the total 345 species of flora recorded across the combined projects, 80 (23 per cent) of these were introduced species. Of these 80 introduced species, nine are listed as noxious in the Hawkesbury and Blue Mountains control areas (refer to Table 3-12).

There are currently five key threatening processes listed under the TSC Act and EPBC Act that relate to the invasion and establishment of weeds into native vegetation indicating the importance of this situation. Each of these KTP has potential to be exacerbated by construction and operation of the project, and includes the following:

- 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*).

During construction there is potential to disperse weed seeds and plant material into adjoining remnant vegetation. 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.

Some weed invasion in edge areas was already noted in the study area as a result of the existing Bells Line of Road suggesting further weed invasion could be expected from additional clearing associated with this project. The scale and magnitude of edge effects are likely to be relatively minor given the extent of cleared land already adjoining the Bells Line of Road and likely to be limited to existing vegetated edges and therefore be most prevalent at OT2 and OT3.

In addition to this there is a risk weeds being spread into lands occupied by the National Park where the boundary of the works lies adjacent to the park boundary. This scenario occurs at OT2, OT6 and OT7. A mitigation strategy is required in these locations and should follow in accordance with the measures outlined in Roads and Maritime Biodiversity Guidelines (RTA 2011) (refer section 5.2.5). Given the location of the national park boundaries, in this instance a targeted weed management strategy is required considering the long-term suppression of weeds during the operation of the lanes.

4.11 Pests and pathogens

4.11.1 Pests

There are currently five key threatening processes listed under the TSC Act and three under the EPBC Act that relate to the invasion and establishment of pests. Each of these has potential to be exacerbated by construction and operation of the project, which includes:

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

The clearing of vegetation is unlikely to significantly 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 open habitats, any increase in the population of this pest species is more likely to impact on native fauna tolerant of modified habitats. After construction of the project, revegetation of redundant sections would assist in reducing potential habitat for rabbits in the project area.

Feral honeybees are introduced bees which originally escaped from hives and have subsequently established in the wild. While the project would not directly increase bee numbers, the removal of hollow-bearing trees would indirectly increase competition for hollows with native fauna. Where tree hollows are occupied by feral honeybees, this would reduce 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-roosting microbats, and several bird, reptile and frog species. The project is unlikely to contribute to increased levels of predation on native fauna from foxes and cats.

4.11.2 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 project. 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).

While these pathogens were not observed or tested in the study area the potential for pathogens to occur should be treated as a risk during construction. The risk is especially high in construction areas affecting waterways (Table 4-4).

Table 4-4 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 (eg 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.
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.

4.12 Changed hydrology

Areas to be cleared are along existing edges of the road corridor and mostly on flatter ground with limited surface water runoff expected into adjoining habitats. Potential impacts would be mitigated during construction and long-term impacts associated with introducing nutrients are not expected to be exacerbated. There is some potential for run-off impacts to occur at the western end of OT7 and OT3 given the steepness of the slope adjoining the road and the opportunity for alteration of surface water drainage. It may be possible to mitigate this impact and this is recommended.

4.12.1 Drainage

The existing corridor has minimal drainage infrastructure to capture and control stormwater runoff from the road. Runoff from the road in the study area is not treated and currently drains to grassed areas within the verge area. In addition, there is no spill containment infrastructure within the road corridor. Cross drainage culverts are

located in a few locations providing road drainage at a low point in the topography; these are not a natural drainage line and the road does not cross any waterways within the study area.

4.12.2 Operational

Once operational, the proposal would result in some minor changes to the local hydrology. As the road would be widened, a minor increase in the flow and rate of stormwater runoff would be experienced due to the increased impervious catchment area. Existing drainage patterns along the road corridor would generally be improved as part of the proposal through the construction of SO gutters and improvements to existing table drains adjacent to the road. These SO gutters will diffusely drain to the adjacent grassed areas. The existing culverts would be extended beneath the new overtaking lane and outlet at the toe of the batter on the opposite side. In some areas rock mattressing would be installed to arrest the flow of water within the drainage line and ensure no localised erosion occurs. These rock mattress areas would drain into the grassed verge.

The proposal is not considered sufficient in size to result in more than a minimal change to the local hydrology. There would be minor change to stormwater discharge in receiving drainage lines and no increased flood risk will be expected to the receiving environment on localised erosion or scouring of drainage lines.

Similarly, given the small scale and nature of the proposed work and the proposals location along a ridgeline, the proposal is not expected to be impacted by flooding from nearby waterways.

In terms of water quality, operational impacts would be associated with the discharge of additional road runoff, the constituents of which commonly include gross pollutants, sediment, toxic organics, nutrients, heavy metals and hydrocarbons. However, the proposal would result in only a minor change to the existing road catchment. The existing road does not include any water quality treatment measures and no permanent water quality treatment measures have been included in the proposal.

4.13 Groundwater-dependent ecosystems

The remnant vegetation communities in the study area are considered to have a high level of potential groundwater dependence. All areas of remnant vegetation potentially have a high-level of groundwater dependence as identified by Kuginis et al. (2012). The remaining planted and exotic vegetation are considered unlikely to be dependent on groundwater.

Hydrological regimes including groundwater levels and flooding regimes would not be altered from the project. Proposed excavations are relatively minor and are unlikely to include intersection of the groundwater table and no substantial dewatering or depletion of ground water levels is expected. It is considered unlikely that there would be any groundwater drawdown as a result of the project. Considering groundwater levels are unlikely to be altered as a result of the project, potential groundwater-dependant ecosystems are considered unlikely to be impacted.

4.14 Aquatic impacts

The Bells Line of Road study area crosses the ridgetop and upper slopes from Kurrajong Heights to Mt Tomah. Any aquatic habitats in this location are represented by the upper reaches of ephemeral creeks and numerous artificial farm dams. The project would not impact on significant aquatic habitats.

4.15 Noise, vibration and light

Considering the existing levels of noise, vibration and light from the Bells Line of Road it is unlikely there would be a significant increase in these impacting factors resulting in any increased impacts to flora and fauna species. There is potential for impacts to locally common fauna from noise and vibration during construction, which may result in fauna temporarily avoiding habitats adjacent to the project. No lighting is proposed as part of the upgrades.

4.16 Key threatening processes

Key threatening processes identified as being a result of the project would comprise those associated with habitat degradation including vegetation clearing and removal of hollow-bearing trees. Mitigation measures would be implemented to minimise the extent of vegetation clearing and habitat disturbance (refer section 5.2). There is also potential for other key threatening processes to be further increased from their current condition (eg weed invasion, introduction of pests and diseases), however, mitigation measures would be implemented to minimise their effect. Further details regarding likely key threatening processes and a link to proposed mitigation measures is shown in Table 4-7.

Table 4-7 Assessment of key threatening processes associated with the project

Threatening process	Relevant legislation	Associated with the project?	Proposed mitigation
Habitat Degradation			
Bushrock removal	TSC Act	Unlikely	section 5.2
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	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	Potential	
Feral Invertebrate Fauna			
Competition from feral honey bees (Apis mellifera)	TSC Act	Potential	
Feral Vertebrate Fauna			
Predation by feral cats / Predation by the feral cat (*Felis catus*)	EPBC Act, TSC Act	Unlikely	section 5.2
Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs / Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	EPBC Act, TSC Act	Unlikely	
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	EPBC Act, TSC Act	Potential	
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	TSC Act	Unlikely	
Herbivory and environmental degradation caused by feral deer	TSC Act	Unlikely	
Predation by European red fox / Predation by the European red fox (*Vulpes vulpes*)	EPBC Act, TSC Act	Unlikely	
Hydrology and Riparian Zones			
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act	No	section 5.2
The degradation of native riparian vegetation along NSW water courses	FM Act	No	
Removal of large woody debris from NSW rivers and streams	FM Act	No	
Installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams	FM Act	No	
Pathogens			
Infection of amphibians with chytrid fungus resulting in chytridiomycosis/Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	EPBC Act, TSC Act	Unlikely	section 5.2
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi*	EPBC Act, TSC Act	Potential	

Threatening process	Relevant legislation	Associated with the project?	Proposed mitigation
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
Weeds			
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act	Potential	section 5.2
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive (Olea europaea L. subsp. cuspidata)	TSC Act	Unlikely	
Invasion, establishment and spread of Lantana camara	TSC Act	Unlikely	
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

4.17 Bell Miner Associated Dieback (BMAD)

Dieback is a condition in which trees progressively die, from the top downward. The condition spreads through the leaves and branches and often the whole plant will eventually die. Eucalypt dieback associated with a high density of Bell Miners appears to be present at OT5 in the central parts of the site on both the north and south. Indeed Bell Miners were observed to be abundant in a number of the locations, associated with the moister forest gullies, and were also present at OT6.

This type of dieback is strongly associated with sap-feeding insects called psyllids and psyllids are strongly associated with the Bell Miner. There is a likelihood of BMAD spread associated with the project, where the spread of weeds occurs, in particularly Lantana, which provides dense understorey favoured by the Bell Miners. An appropriate mitigation strategy would be associated with effective prevention of the spread of weeds during construction and the suppression of weeds in key areas. This is discussed further in Section 5.2.5.

4.18 Impacts to conservation reserves

Wollemi National Park occurs to the north of Bells Line of Road and Blue Mountains National Park largely to the south, with some sections also on the north and intersected by the road. The boundaries of these reserves adjoin the proposed upgrade areas at the following locations:

- OT2 has Wollemi National Park on the north side of the road for about 600 metres
- OT7 has Blue Mountains National Park on the north side of the road for about 800 metres and Blue Mountains National Park to the south of the road for 350 metres. The western end of OT7 adjoins the Blue Mountains world Heritage Area, although there will be no direct impacts on the ecological values in this location.
- SW12 has Wollemi National Park adjacent to the northern side opposite the works.

The proposed works have no direct impact to either the Wollemi National Park or the Blue Mountains National Park World Heritage Areas.

There are currently minor indications of the existing road corridor impacting on vegetation in these locations, typically through increased weed abundance at this edge. In general across all study areas, weeds were found to be more abundant in edge areas along the road, particularly Lantana camara. This suggests that there is a reasonable chance of increased weed invasion adjacent to the completed road widening works and that appropriate mitigation measures would be required to minimise the impacts. Where appropriate the mitigation

strategy should also consider the potential impact of stormwater run-off into the reserve at the locations identified above.

According to the SIG1.1 under the EPBC Act, an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or probability that it will cause:

- one or more of the World Heritage values to be lost
- one or more of the World Heritage values to be degraded or damaged, or
- one or more of the World Heritage values to be notably altered, modified, obscured or diminished.

The proposed overtaking lane at Site 7 will be developed though widening of the existing road in this location and largely occur over an existing cleared power easement which lies adjacent to the road and provides a buffer between the road and the park boundary. There will be no increased fragmentation or isolation of habitat and no expected substantial run-off of surface water from the road surface. There is some potential for increased weed invasion in adjacent and downslope areas of the park and this should be managed over the long-term. However in the context of the extent of this World Heritage Area, the project is unlikely to result in the loss of or substantial impacts to one or more of the World Heritage values in proximity to OT7.

4.19 Summary of impacts

A summary of the potential impacts to flora and fauna from developed of the overtaking lanes and safety works project is provided in Table 4-8.

Table 4-8 Summary of predicted impacts to flora and fauna at each study site

Site	Vegetation / habitat condition	Habitat removal (ha)	Loss of CEEE (EPBC Act)	Loss of EEC (TSC Act)	Potential for weed invasion in adjoining remnant	Potential loss of habitat trees	Potential loss of Koala habitat (MU1 / MU2)	Importance of habitat to be removed for Koala	Contribute pressure to BMAD	Potential impacts to fauna movement
OT1	Moderate	0.18	-	0.18	Low, footprint in cleared area and adjoins already edge affected habitat	15	0.18	Secondary habitat (class C)	Not expected	Low
OT2	Moderate-high	0.60	0.60	0.60	High, will create a new edge	32	0.60	-	Not expected	Moderate
OT3	Moderate-high	1.38	1.14	1.38	High, will create a new edge	26	1.38	Secondary habitat (class A, B, and C)	Potential	None
OT5	Moderate-high	0.60	0.15	0.60	Low, footprint in cleared areas and adjoins already edge affected habitat, or impacts fragmented bushland	43	0.60	Primary habitat and Secondary habitat (class A, B, and C)	Likely	None
OT6	Moderate	0.19	0.16	0.19	Low, footprint in cleared areas and adjoins already edge affected habitat, or impacts fragmented bushland	20	0.19	Secondary habitat (class A and C)	Not expected	None
OT7	Moderate-high	0.24	0.07	0.13	Moderate, footprint mostly in cleared areas or along existing edge, some new edge will be created	35	0.13	Primary habitat and Secondary habitat (class B and C)	Not expected	Moderate
SW9	Moderate	-	-	-	None	-	-	-	Not expected	None
SW12	Moderate	0.06	-	0.06	Very low, existing edge affected habitat	-	0.06	-	Not expected	None
TOTAL		**3.25**	**2.12**	**3.14**		**163**	**3.14**			

5. Mitigation measures

In managing biodiversity, the project aims to:

- Avoid and minimise impacts first.
- Mitigate impacts where avoidance is not possible.
- Offset where residual impacts cannot be avoided.

5.1 Avoid and minimise

Impacts to native vegetation have been avoided where possible, with modifications made to the design following review of biodiversity constraints. The proposed improvement works have been designed to be restricted to the existing road corridor and avoid areas of high condition vegetation where possible.

Vegetation impacts have been calculated based on construction clearing allowances from the base of batters and top of cuts. The placement of proposed construction compounds has been selected to avoid impacts to native vegetation.

5.2 Recommended construction mitigation measures

It is recommended that the following mitigation measures as outlined in the Roads and Maritime Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects (RTA 2011) are implemented.

5.2.1 Pre-clearing

- A construction environmental management plan (CEMP) should include details on pre-clearing surveys, including pre-clearing requirements and a clearing procedure.
- The clearing footprint described in this report should be identified and marked before construction and exclusion zones established in all retained areas of vegetation.
- The CEMP should identify nearby habitats along the proposal suitable for the release of fauna, should they be encountered any time during construction, including pre-clearing and clearing process.

5.2.2 Management of unexpected species finds

Pre-clearing surveys should be undertaken by an experienced ecologist to identify any nesting/roosting animals present in the project area. In particular it would be important to conduct a pre-clearing inspection for any artificial structures such as culverts which are proposed to be physically demolished or upgraded. The inspection would identify if threatened bat species are present and are using the structure for roosting and/or breeding habitat. The inspection would be conducted during the day and would ensure that all cracks, fissures, lifting holes, etc, within concrete structures are inspected for microbats prior to any works commencing.

As no large structures are proposed to be demolished, it is unlikely that works would have impact on any microbats roosting in adjacent structures. However, if bats are found, an appropriately qualified ecologist would provide advice on work methods and timing to minimise impacts on the bats. If exclusions are required, these would be done in accordance with a Bat Management Plan prepared by an appropriately qualified ecologist.

5.2.3 Exclusion zones

The location of exclusion zones should be established to avoid damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Delineation of areas with barrier tape or flagging tape is to be used to indicate the limits of clearing. The CEMP would identify these areas on plans and the function and importance of the exclusion zones communicated to construction personnel.

5.2.4 Minimising fauna injury and mortality

Considering the relatively large number of hollow trees and areas of fallen timber in the study area, there is likely to be a range of fauna species sheltering in the clearing footprint. To prevent injury and mortality of fauna during the clearing of vegetation an experienced and licensed wildlife carer and/or ecologist should 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 Roads and Maritime Biodiversity Guidelines (RTA 2011). The following should 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 Roads and Maritime 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 any native fauna, including snakes, as all native species are protected under the *National Parks and Wildlife Act 1974*.
- Keep records of fauna captured and relocated.
- Report any injury to or death of a threatened species to Roads and Maritime Services environmental staff.

5.2.5 Habitat replanting

Given the proposed loss of potential habitat for Koala in roadside edges, including known home range trees, supplementary planting of Grey Gum (*Eucalyptus punctata*) should occur post construction.

5.2.6 Weed management

A weed management plan should be developed as part of the CEMP given the potential for weed invasion into national park areas. The plan should focus on weed management in the park areas.

The Roads and Maritime 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 clearing footprint with particular emphasis on noxious weed species. A weed management plan should also be consistent with other plans of management for the area.

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 would 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.

5.2.7 Pest and disease management

No pests and diseases are currently known from the clearing footprint but could potentially be present. Root Rot (*Phytophthora cinnamomi*) is known to be impacting vegetation in the Greater Blue Mountains World Heritage Area, and could potentially be present in the study area. 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 project.

Measures to confirm the presence of pathogens/disease causing agents such as bacteria and fungi may be undertaken before construction. This includes a background search of government-maintained websites for the most recent known locations of contamination and for the most up-to-date hygiene protocols for each pathogen. If risks are identified in the vicinity of the project, 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/disease causing agents are found to be present, measures to prevent the introduction and/or spread of these pathogens/disease causing agents are to be incorporated into the CEMP for the project. If pathogens are identified exclusion zones with fencing and signage to restrict access into contaminated areas would be required. The pest and disease management plan should be developed in accordance with Guide 7 Pathogen Management of the Roads and Maritime Biodiversity Guidelines (RTA 2011), including:

Providing vehicle and boot wash down facilities and ensuring vehicles and footwear are free of soil before entering or exiting the site.

- Regular communication to staff and contractors during inductions and toolbox talks, of the risk of spreading pathogens and the mitigation measures required on site.
- Programming construction works to move from uninfected areas to any known infected areas.
- Restricting vehicles to designated tracks, trails and parking areas.

5.3 Wildlife connectivity and road kill

There is potential for an increase in wildlife road kill at OT2 associated with the long-term operation of the overtaking lane, particularly in the central parts of the site. The introduction of wildlife road signage in this location may assist to reduce the road kill and is recommended. The use of fencing is not recommended, as there are few opportunities for fauna to cross the road and this site is potentially important for local movements.

Concrete barriers are likely to be used during construction to separate traffic from the worksite and provide safety to travelling public and to construction workers whilst works are undertaken. The placement of concrete 'jersey kerb' barriers in a continuous line along one side of the construction zone has the potential to create additional barriers to fauna including Koalas attempting to cross the road and may increase the risk of car strike. Where continuous lines of jersey kerbs are to be installed during construction, consideration should be given to alternative arrangements that allow the escape of trapped animals from within the construction zone or from the travel lanes of the road. Any proposed measures should consider the effectiveness and feasibility, whilst taking account of the traffic safety requirements.

5.4 Offsetting

The Roads and Maritime (2011) Guideline for Biodiversity Offset was considered to determine whether the proposal would trigger offset requirements under the guideline. The guideline identifies works where offsets should be considered, including specific definitions of impacts to habitats and vegetation. The relevant trigger for the consideration of offsets for this project is any clearing of native vegetation that is of very high conservation value which is defined in the guidelines as a vegetation type that is more than 90 per cent cleared in NSW where the patch size of the impacted vegetation is greater than four hectares.

The proposed clearing includes highly cleared vegetation types of very high conservation value identified as being federally critically endangered and is considered to be a highly cleared vegetation type. Considering the relatively high connectivity between roadside vegetation and surrounding extensive areas of habitat/vegetation, there are numerous patches greater than 4 hectares in area being impacted by the project. Therefore the project would require consideration of biodiversity offsets for the proposed cumulative impacts from the Bells Line of Road improvement program, including impacts to the critically endangered ecological community and including impacts from OT4.

6. Significance assessments

Significance assessments have been conducted for threatened biodiversity that have been positively identified or that have a moderate or high likelihood of occurring in the study area.

6.1 NSW Environmental Planning and Assessment Act, 1979

For threatened species and ecological communities listed under the NSW TSC Act, this section details the threatened species assessment as listed under Section 5a of the EP&A Act in assessing the significance of the impacts.

Species with similar taxonomy or ecological requirements have been assessed together, for example tree-roosting microchiropteran bats. Full details of assessment of significance under the EP&A Act are presented in Appendix B. The conclusions of the EP&A Act / TSC Act assessments of significance are provided in Table 6-1, which indicates that a significant impact is **not** considered likely on any biota listed under the TSC Act.

Table 6-1 Summary of EP&A Act assessments of significance

Species	Status (TSC Act)	Sect 5A EP&A Act							Likely significant impact	Potential to occur in the clearing footprint
		a	b	c	d	e	f	g		
Threatened Ecological Communities										
Blue Mountains Shale Cap Forest	CE	X	X	N	Y	X	N	Y	No	Confirmed in the study area
Threatened Fauna										
Callocephalon fimbriatum (Gang-Gang Cockatoo)	V	N	N	N	N	N	N	N	No	High
Calyptorhynchus lathami (Glossy Black Cockatoo)	V	N	N	N	N	N	N	N	No	High
Daphoenositta chrysoptera (Varied Sittella)	V	N	N	N	N	N	N	N	No	Confirmed
Glossopsitta pusilla (Little Lorikeet)	V	N	N	N	N	N	N	N	No	Moderate
Lophoictinia isura (Square-Tailed Kite)	V	N	N	N	N	N	N	N	No	Moderate
Melithreptus gulari gularis (Black-chinned Honeyeater)	V	N	N	N	N	N	N	N	No	Moderate
Petroica boodang (Scarlet Robin)	V	N	N	N	N	N	N	N	No	Moderate
Petroica phoenicea (Flame Robin)	V	N	N	N	N	N	N	N	No	Moderate
Cercartetus nanus (Eastern Pygmy Possum)	V	N	N	N	N	N	N	N	No	Moderate
Dasyurus maculatus (Spotted-tailed Quoll)	V	N	N	N	N	N	N	N	No	High
Petaurus australis (Yellow-Bellied Glider)	V	N	N	N	N	N	N	N	No	Moderate
Petaurus norfolcensis (Squirrel Glider)	V	N	N	N	N	N	N	N	No	Moderate
Phascolarctos cinereus (Koala)	V	N	N	N	N	N	N	N	No	Confirmed
Pteropus poliocephalus (Grey-Headed Flying-Fox)	V	N	N	N	N	N	N	N	No	High
Cave-roosting bats										
Myotis macropus (Southern Myotis)	V	N	N	N	N	N	N	N	No	High
Chalinolobus dwyeri (Large-Eared Pied Bat)	V	N	N	N	N	N	N	N	No	Moderate

Species	Status (TSC Act)	Sect 5A EP&A Act							Likely significant impact	Potential to occur in the clearing footprint
		a	b	c	d	e	f	g		
Miniopterus schreibersii oceanensis (Eastern Bentwing-Bat)	V	N	N	N	N	N	N	N	No	High
Tree-roosting bats										
Scoteanax rueppellii (Greater Broad-Nosed Bat)	V	N	N	N	N	N	N	N	No	High
Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)	V	N	N	N	N	N	N	N	No	High
Falsistrellus tasmaniensis (Eastern False Pipistrelle)	V	N	N	N	N	N	N	N	No	High
Mormopterus norfolkensis (Eastern Freetail-Bat)	V	N	N	N	N	N	N	N	No	High
Large Forest Owls										
Ninox strenua (Powerful Owl)	V	N	N	N	N	N	N	N	No	High
Tyto novaehollandiae (Masked Owl)	V	N	N	N	N	N	N	N	No	Moderate
Tyto tenebricosa (Sooty Owl)	V	N	N	N	N	N	N	N	No	Moderate
AMPHIBIANS										
Pseudophryne australis (Red-crowned Toadlet)	V	N	N	N	N	N	N	N	No	Confirmed

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

Significance Assessment Questions (heads of consideration) as detailed in S.5a of the EP&A Act

- 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.

6.2 Commonwealth EPBC Act, 1999

6.2.1 Turpentine Ironbark Forest of the Sydney Basin Bioregion

Details of the assessment of significance for the critically endangered ecological community Turpentine Ironbark Forest of the Sydney Basin Bioregion listed under the EPBC Act are presented in Appendix B. The conclusions of the EPBC Act assessment of significance are provided in Table 6-2 which indicates that the project **would have a significant impact** on the critically endangered Turpentine Ironbark Forest of the Sydney Basin Bioregion.

This conclusion is based on removal of around 2.12 hectares of high condition Turpentine Ironbark Forest listed as critically endangered under the EPBC Act, combined with 0.47 hectares cleared for overtaking lane 4 approved as a separate project (total cumulative impact 2.59 hectares). The cumulative direct and indirect impacts would be considered significant in the context of the critically endangered status and considering the high condition of the vegetation and the spatial extent of the impact.

Table 6-2 Summary of Commonwealth EPBC Act assessment for Turpentine Ironbark Forest of the Sydney Basin Bioregion

Species/Ecological Community	*Assessment of significance questions (EPBC Act)							Likely Significant Impact
	1	2	3	4	5	6	7	
Turpentine Ironbark Forest of the Sydney Basin Bioregion	Y	N	Y	N	N	N	N	Yes

* Assessment of significance questions

1) Reduce the area of occupancy of an ecological community;
2) Fragment or increase fragmentation of an ecological community;
3) Adversely affect habitat critical to the survival of an ecological community;
4) Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival;
5) Cause a substantial change in the species composition of an occurrence of an ecological community;
6) Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community;
7) Interfere with the recovery of the species.

6.2.2 Threatened species

Details of the assessment of significance for threatened species under the EPBC Act are presented in Appendix B. The conclusions of the EPBC Act assessment of significance are provided in Table 6-3 which indicates that a significant impact is **not** considered likely on any threatened fauna species listed under the EPBC Act.

Table 6-3 Summary of Commonwealth EPBC Act assessments of significance for threatened fauna species

Species/Ecological Community	*Assessment of significance questions (EPBC Act)									Likely Significant Impact	Important Population +
	1	2	3	4	5	6	7	8	9		
Critically endangered and endangered fauna											
Spotted-tailed Quoll (*Dasyurus maculatus*)	N	N	N	N	N	N	N	N	N	No	Potential
* 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.											
Vulnerable fauna											
Grey-headed Flying-fox (*Pteropus poliocephalus*)	N	N	N	N	N	N	N	N	N	No	No
Large-eared Pied Bat (*Chalinolobus dwyeri*)	N	N	N	N	N	N	N	N	N	No	No
Koala (*Phascolarctos cinereus*)	N	Y	N	Y	N	N	N	N	N	No	Yes
* Assessment of significance questions for vulnerable species 1) lead to a long-term decrease in the size of an important population of a species 2) reduce the area of occupancy of an important population 3) fragment an existing important population into two or more populations 4) adversely affect habitat critical to the survival of a species 5) disrupt the breeding cycle of an important population 6) modify, destroy, remove or 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 vulnerable species becoming established in the vulnerable species' habitat 8) introduce disease that may cause the species to decline, or 9) interfere substantially 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 * Y= Yes (negative impact), N = No (no or positive impact), X = not applicable											

6.2.3 Migratory species

Full details of the assessment of significance under the EPBC Act are presented in Appendix B. The conclusions of the assessments of significance on migratory species are provided in Table 6-4 and indicate that a significant impact is **not** considered likely on migratory species listed under the EPBC Act.

Table 6-4 Summary of Commonwealth significance assessment for migratory species

Migratory species	EPBC Act status	Important population* in project area	Likely significant impact
Black-faced Monarch (*Monarcha melanopsis*)	Marine; Migratory (BONN)	No	No
Cattle Egret (*Ardea ibis*)	Marine; Migratory (CAMBA, JAMBA)	No	No
Fork-tailed Swift (*Apus pacificus*)	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
Great Egret (*Egretta alba*)	Marine; Migratory (CAMBA, JAMBA)	No	No
Latham's Snipe (*Galliago hardwickii*)	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
Eastern Osprey (*Pandion haliaetus*)	Marine; Migratory (BONN)	No	No
Rainbow Bee-eater(*Merops ornatus*)	Marine; Migratory (JAMBA)	No	No
Rufous Fantail (*Rhipidura rufifrons*)	Marine; Migratory (BONN)	No	No
Satin Flycatcher (*Myiagra cyanoleuca*)	Marine; Migratory (BONN)	No	No
Swift Parrot (*Lathamus discolour*)	Marine	No	No
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Marine; Migratory (CAMBA)	No	No
White Throated Needletail (*Hirundapus caudacutus*)	Marine; Migratory(CAMBA, JAMBA, ROKAMBA)	No	No

* Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:

a is likely to be key source populations either for breeding or dispersal

b is likely to be necessary for maintaining genetic diversity

c is at or near the limit of the species range.

7. Conclusions

The biodiversity assessment identifies the following key factors associated with the project:

The removal of around 2.12 hectares of high condition Turpentine Ironbark Forest listed as critically endangered under the EPBC Act, plus an additional 0.47 hectares recently removed for Site 4, resulting in cumulative impact of around 2.59 hectares for the overall proposal. The impact would be considered significant in the context of the status and condition of the community and extent of the community impacted by the proposal.

The cumulative impact of 3.12 hectares of Blue Mountains Shale Cap Forest listed under the TSC Act, increasing to 3.61 hectares where Site 4 clearing is also taken into account.

Impacts to habitat for threatened fauna species, in particular the loss of about 3.14 hectares of critical habitat for the Koala according to the EPBC Act. The loss of habitat for the Koala was not considered a significant impact, given the large expanses of higher quality habitat for this species and the small degree of fragmentation expected by this proposal.

The project is unlikely to substantially contribute to further fragmentation of habitats and impacts to wildlife connectivity considering the existing high levels of clearing along the existing Bells Line of Road and the presence of cleared farmland and fenced residential development. Potential impacts to ‘local’ corridors have been identified in addition to recommended mitigation measures.

Key mitigation measures to minimise and avoid biodiversity impacts include but are not limited to:

- Avoidance and minimisation of vegetation removal where possible.
- Pre-clearing surveys.
- Staged habitat removal.
- Management of invasive species, pests and diseases.

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Appendix A. Threatened subject species assessment

The following assessment identifies the list of threatened flora and fauna species recorded from a 10 km radius of the project and compares the preferred habitat of these species with the habitats identified in the project area to make an assessment of the likelihood of the species being present in the project study area (ie. subject species). The criteria used in the assessment are detailed below.

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

Table A-1 Known or potentially occurring threatened flora species

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Acacia baueri subsp. *aspera*	V	-	Restricted to the Sydney region, occurring on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mount Keira district and at Wedderburn. May also occur on the escarpment/Woronora Plateau in the Flat Rock Junction and Stanwell Tops area of the Illawarra. Occurs in low, damp heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this species have been made following fire, suggesting the species prefers early successional habitats.	Low – outside known distribution and habitat not suitable	2 OEH
*Acacia bynoeana (*Bynoe's Wattle, Tiny Wattle*)*	E	V	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 – limited suitable habitat present, targeted searches undertaken	8 OEH, PMST
Acacia gordonii	E	E	Restricted to the north-west of Sydney. Has a disjunct distribution, occurring in the lower Blue Mountains in the west, and in the South Maroota/Glenorie area in the east. Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops.	Low – limited suitable habitat present, targeted searches undertaken	19 OEH, PMST
Acacia pubescens (Downy Wattle, Hairy Stemmed Wattle)	V	V	Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone.	Low – outside of known distribution	11 OEH, PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Acrophyllum australe	V	V	Restricted, from Faulconbridge to Lawson, South of Bilpin and near Kings Tableland, in the Blue Mountains area and is currently known from 27 sites. Grows in sheltered gullies beneath waterfalls and drip zones of rock overhangs and cliff faces, usually with a south-east to south-west aspect. Typically found in areas where there is a generally a constant supply of water. Usually grows in shale interbeds at the base of small cliffs, in crevices on the sandstone rock face or on talus slopes. The rock overhangs are of Hawkesbury or Narrabeen Sandstone. Associated species commonly include *Callicoma serratifolia, Dracophyllum secundum, Todea barbata, Allania endlicheri and Blechnum ambiguum*. Found adjacent to open forest of *Eucalyptus piperita and Angophora costata* and closed forest of *Doryphora sassafras and Ceratopetalum apetalum*. Frequently growing on very thick layers of moss	Unlikely – suitable habitat absent from study area	8 OEH, PMST
Allocasuarina glareicola	E	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil. Found in open woodland with *Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri, Eucalyptus sclerophylla and Melaleuca decora.* Common associated understorey species include *Melaleuca nodosa, Hakea dactyloides, Hakea sericea, Dillwynia tenuifolia, Micromyrtus minutiflora, Acacia elongata, Acacia brownei, Themeda australis and Xanthorrhoea minor.*	Low	4 OEH, PMST
Asterolasia elegans	E	E	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 – outside natural distribution, no records in locality	PMST
Boronia deanei (Deane's Boronia)	V	V	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 – suitable habitat absent from study area	PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Cryptostylis hunteriana (Leafless Tongue-Orchid)	V	V	Recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra although it is uncommon at all sites. Also recorded at Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, Ben Boyd National Park. Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black She-oak (*Allocasuarina littoralis*). Seems to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*).	Low – suitable habitat limited in study area and no known records from locality	PMST
Cynanchum elegans (White-Flowered Wax Plant)	E	E	Occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree (*Leptospermum laevigatum*) – Coastal Banksia (*Banksia integrifolia subsp. integrifolia*) coastal scrub; Forest Red Gum (*Eucalyptus tereticornis*) aligned open forest and woodland; Spotted Gum (*Corymbia maculata*) aligned open forest and woodland; and Bracelet Honeymyrtle (*Melaleuca armillaris*) scrub to open scrub.	Unlikely – suitable habitat absent from study area	2 OEH, PMST
Dillwynia tenuifolia	V	-	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in Western Sydney are recorded from Voyger Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include the Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains. In western Sydney, it may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	Low – outside known distribution of species and habitat suitability marginal	131 OEH

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Epacris hamiltonii	E	E	Occurs in the Blue Mountains, west of Sydney. Found at 72 sites within three creek catchments. The creeks occur in an altitude range of 810 - 940 metres elevation and are all located on the northern side of the escarpment and flow into the Grose Valley. All known sites occur within a radius of about five kilometres. Has a very specific habitat, being found on or adjacent to Narrabeen sandstone cliffs alongside perennial creeks, often below plateau hanging swamps. The soil generally has a spongy/peat-like consistency, with very high moisture content. Sites are found at the sheltered base of cliffs adjacent to wet gully or swamp vegetation, usually where a perennial or virtually perennial source of water, such as cliff seepages, is present. Associated species include King Fern (*Todea barbara*), Rough Tree Fern (*Cyathea australis*) and Coral Fern (*Gleichenia rupestris*). Sundews (*Drosera binata*) are also common on the cliff face. Occasionally occurs beside small creek lines which are vegetated with moist gully forest species (*Callicoma serratifolia, Doryphora sassafras and Ceratopetalum apetalum*).	Unlikely – suitable habitat absent from study area	7 OEH
Epacris sparsa (Sparse Heath)	V	V	Restricted to the lower Grose River, within the Hawkesbury and Blue Mountains LGAs. Grows in Riparian Sandstone Scrub, where it is found on the base of cliffs or rock faces, on rock ledges or among rocks in the riparian flood zone. Grows in small pockets of damp clay soil, chiefly on south-west facing slopes. In rocky sites the scrub vegetation is dominated by *Tristaniopsis laurina, Leptospermum trinervium, Allocasuarina littoralis, Acacia longifolia, Grevillea sericea and Lomandra fluviatilis.* In wetter, more sheltered sites typical species include *Callicoma serratifolia, Backhousia myrtifolia, Austromyrtus tenuifolia, Leucopogon lanceolatus, Lomandra montana, Todea barbara, Sticherus flabellatus and Dracophyllum secundum.*	Unlikely – suitable habitat absent from study area	19 OEH, PMST
Euphrasia arguta	CE	CE	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 – outside known distribution of species	PMST
*Genoplesium baueri (*Bauer's Midge Orchid, Yellow Gnat Orchid*)*	E	E	Recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. The species has been recorded at locations now likely to be within the several conservation reserves including Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Found in sparse sclerophyll forest and moss gardens over sandstone	Low – habitat suitability marginal, and no records from locality	PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Grammitis stenophylla (Narrow-Leaf Finger Fern)	E	-	In NSW it has been found on the south, central and north coasts and as far west as Mount Kaputar National Park near Narrabrai. Inhabits moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest.	Unlikely – suitable habitat absent from study area	6 OEH
Grevillea juniperina subsp. *juniperina* (Juniper-Leaved Grevillea)	V	-	Endemic to Western Sydney, centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium often with a shale influence, typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest. Associated canopy species within Cumberland Plain Woodland and Shale/Gravel Transition Forest include *Eucalyptus tereticornis, E. moluccana, E. crebra, E. fibrosa and E. eugenioides.* Understorey species include *Bursaria spinosa, Dillwynia sieberi, Ozothamnus diosmifolius, Daviesia ulicifolia, Acacia falcata, Acacia parramattensis, Themeda australis, Aristida ramosa, Cymbopogon refractus, Eragrostis brownii, Cheilanthes sieberi, Dianella revoluta and Goodenia hederacea. In Castlereagh* Woodland on more sandy soils the dominant canopy species are *Eucalyptus fibrosa, E. sclerophylla, Angophora bakeri and Melaleuca decora. Understorey species include Melaleuca nodosa, Hakea sericea, Cryptandra spinescens, Acacia elongata, Gonocarpus teucrioides, Lomandra longifolia and the threatened species Dillwynia tenuifolia, Pultenaea parviflora, Micromyrtus minutiflora and Allocasuarina glareicola.*	Low - – habitat suitability marginal, and limited records from locality	1 OEH
Haloragis exalata subsp. *exalata* (Wingless Raspwort, Square Raspwort)	V	V	Square Raspwort is known from a few scattered locations in south-eastern NSW including the Nepean River, Lake Illawarra, the Wallaga Lake - Tilba area and the Geehi Valley in Kosciuszko National Park. There are isolated records from northern NSW in Mt Kaputar National Park and Tuggolo State Forest. Square Raspwort occurs in damp places near watercourses.	Unlikely – suitable habitat absent from study area	PMST
Haloragodendron lucasii	E	E	The known locations of this species are confined to a very narrow distribution on the north shore of Sydney. Associated with dry sclerophyll forest. Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland.	Low – outside known distribution, suitable habitat limited	PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Isopogon fletcheri (Fletcher's Drumsticks)	V	V	Restricted to a very small area in the Blackheath district of the Blue Mountains on the Central Tablelands. The entire known population occurs within Blue Mountains National Park. Restricted to moist sheltered cliffs within the spray zone of a waterfall. Grows in dry sclerophyll forest and heath on sandstone and is confined to sheltered moist positions.	Low - outside known distribution, targeted searches undertaken in suitable habitat	10 OEH, PMST
Leucopogon fletcheri subsp. *fletcheri*	E	-	Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the LGAs of Hawkesbury, Baulkham Hills and Blue Mountains. Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs.	Low - outside known distribution, targeted searches undertaken in suitable habitat	1 OEH
Melaleuca deanei (Deane's Paperbark)	V	V	Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai, Berowra, Holsworthy and Wedderburn areas. There are also more isolated occurrences at Springwood, Wollemi National Park, Yalwal and the Central Coast areas. The species grows in heath on sandstone	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	1 OEH
Micromyrtus minutiflora	E	V	Restricted to the general area between Richmond and Penrith in Western Sydney. Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments.	Low	8 OEH
Olearia cordata	V	V	The *Olearia cordata* is known or predicted to occur in the following sub-regions of the Hawkesbury-Nepean Catchment Management Region. In this region the *Olearia cordata* - Hawkesbury-Nepean is known to be associated with the Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion.	Unlikely – suitable habitat absent from study area	5 OEH, PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Pterostylis saxicola (Sydney Plains Greenhood)	E	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where Pterostylis saxicola occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	Unlikely – suitable habitat absent from study area	PMST
Pelargonium sp. Striatellum (G. W. Carr 10345) (Omeo Storksbill)	E	E	Known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. A population at a fourth known site on the Monaro has not been seen in recent years. The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang, Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Unlikely – suitable habitat absent from study area	PMST
Persoonia acerosa (Needle Geebung)	V	V	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 –suitable habitat limited, targeted searches undertaken	7 OEH, PMST
Persoonia hirsuta (Hairy Geebung)	E	E	The Hairy Geebung has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	Low –suitable habitat limited, targeted searches undertaken	4 OEH, PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Persoonia nutans (Nodding Geebung)	E	E	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith, and to a lesser extent, Hawkesbury LGAs, with isolated and relatively small populations also occurring in the Liverpool, Campbelltown, Bankstown and Blacktown LGAs. Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	16 OEH, PMST
Pimelea curviflora var. *curviflora*	V	V	Confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	Low – outside known distribution, targeted searches undertaken	3 OEH, PMST
Pimelea spicata (Spiked Rice-Flower)	E	E	Once widespread on the Cumberland Plain, Spiked Rice-flower occurs in two disjunct areas, the Cumberland Plain and the Illawarra, where its is found on well-structured clay soils. On the inland Cumberland Plain sites it is associated with Grey Box and Ironbark. In the coastal Illawarra it occurs commonly in Coastal Banksia open woodland with a more well developed shrub and grass understorey.	Low – outside known distribution, targeted searches undertaken	PMST
Pomaderris brunnea (Brown Pomaderris, Rufous Pomaderris)	V	V	Found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. It also occurs at Walcha on the New England tablelands and in far eastern Gippsland in Victoria. Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	Unlikely – suitable habitat absent from study area	PMST
Prasophyllum fuscum (Slaty Leek-Orchid, Tawny Leek-Orchid)	CE	V	The type specimen is from "moist meadows towards the Georges River" in the Sydney area. The species is likely to be extinct from this area. Harden (1993) states that it is confined to the Blue Mountains area. However, some authorities believe Prasophyllum species from this area are not Prasophyllum fuscum, but an un-described species. In addition, some authorities believe it is identical to *Prasophyllum uroglossum* which occurs in the Wingecarribee area. Grows in moist heath, often along seepage lines.	Unlikely – suitable habitat absent from study area	2 OEH, PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Prasophyllum uroglossum (Wingcarribee Leek-Orchid, Dark Leek-Orchid)	CE	E	Wingecarribee Leek Orchid is known only from Wingecarribee Swamp in the Southern Highlands. Grows in boggy heath dominated by tea-tree (*Leptospermum* spp.) and rushes.	Unlikely – suitable habitat absent from study area	PMST
Pterostylis gibbosa (Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood)	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Forest Red Gum (*Eucalyptus tereticornis*) and Black Cypress Pine (*Callitris endlicheri*).	Unlikely – suitable habitat absent from study area, and outside known distribution	PMST
Pultenaea glabra (Smooth Bush-Pea, Swamp Bush-Pea)	V	V	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 – outside known distribution, suitable habitat limited, targeted searches undertaken	6 OEH, PMST
Pultenaea parviflora	E	V	Endemic to the Cumberland Plain the core distribution is from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. May be locally abundant, particularly within scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. *Eucalyptus fibrosa* is usually the dominant canopy species. *Eucalyptus globoidea, E. longifolia, E. parramattensis, E. sclerophylla* and *E. sideroxylon* may also be present or co-dominant, with *Melaleuca decora* frequently forming a secondary canopy layer. Associated species may include *Allocasuarina littoralis, Angophora bakeri, Aristida* spp. *Banksia spinulosa*, *Cryptandra* spp*., Daviesia ulicifolia*, *Entolasia stricta, Hakea sericea, Lissanthe strigosa, Melaleuca nodosa, Ozothamnus diosmifolius* and *Themeda australis*.	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	1 OEH

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Pultenaea villifera Sieber ex DC. In the Blue Mountains LGA	EP	-	Has a patchy distribution within NSW, occurring within the South and Central Coasts and Southern Tablelands. The population of P. villifera in the Blue Mountains Local Government Area is disjunct from other known populations and occurs only at a few small sites in the Springwood-Woodford Area. One of these populations occurs within Blue Mountains National Park. Grows in dry sclerophyll forest and woodlands on sandy soil and appears to favour sheltered spots.	Low – outside known distribution, suitable habitat limited, targeted searches undertaken	246 OEH
Rhizanthella slateri (Eastern Australian Underground Orchid)	V	E	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 –Suitable habitat such as thick leaf litter in sheltered positions limited in study area	PMST
Streblus pendulinus (Siah's Backbone, Sia's Backbone, Isaac Wood)	-	E	In warmer rainforest, chiefly along watercourses, north from Milton.	Unlikely – suitable habitat absent from study area, and outside known distribution	PMST
Thelymitra sp. *Kangaloon* (D.L.Jones 18108) (Kangaloon Sun-Orchid)	CE	CE	Thelymitra kangaloonica (Thelymitra sp. Kangaloon) is only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. It is found in swamps in sedgelands over grey silty grey loam soils.	Unlikely – suitable habitat absent from study area, and outside known distribution	PMST

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Thesium australe (Austral Toadflax)	V	V	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 – outside known distribution, suitable habitat limited, targeted searches undertaken	PMST
Velleia perfoliata	V	V	Only known from the Hawkesbury district and upper Hunter Valley. Found in shallow depressions on Hawkesbury sandstone shelves or under cliffs. Occurs on fairly shallow soils of sandy loam texture. Generally found growing on moss mats formed on the rock shelf.	Unlikely – suitable habitat absent from study area	3 OEH, PMST
Wollemia nobilis (Wollemi Pine)	E	E	Restricted to remote canyons in the Wollemi National Park, north-west of Sydney. Occurs in warm temperate rainforest and rain forest margins in remote sandstone canyons.	Unlikely – suitable habitat absent from study area	PMST
Zieria involucrata	E	V	Has a disjunct distribution north and west of Sydney, in the Baulkham Hills, Hawkesbury, Hornsby and Blue Mountains LGAs. Recent records for the species come from 22 populations in the catchments of the Macdonald, Colo and Hawkesbury Rivers—between Melon Creek and Mogo Creek in the north to Little Cattai Creek and Wheeny Creek in the south, and from a single population in the upper Blue Mountains north of Katoomba. Occurs primarily on Hawkesbury sandstone. Also occurs on Narrabeen Group sandstone and on Quaternary alluvium. Found primarily in sheltered forests on mid- to lower slopes and valleys, such as in or adjacent to gullies which support sheltered forest, however some populations extend upslope into drier vegetation. Also known from at least two atypical ridgetop locations. The canopy typically includes *Syncarpia glomulifera subsp. glomulifera, Angophora costata, Eucalyptus agglomerata* and *Allocasuarina torulosa*.	Low – limited suitable habitat present, targeted searches undertaken	1 OEH

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
Zieria murphyi (Velvet Zieria)	V	V	Velvet Zieria is found in the Blue Mountains at Mount Tomah and on the southern tablelands where it has been recorded in Morton National Park in the Bundanoon area. The Velvet Zieria is found in gullies in dry sclerophyll forest with sandy soil.	Low – limited suitable habitat present, targeted searches undertaken	3 OEH, PMST

*V=Vulnerable, E=Endangered, CE=Critically Endangered, EP=Endangered population.

Table A-2 Known or potentially occurring threatened fauna species

Species	Status		Distribution and habitat requirements	Potential likelihood to occur in the study area	No. of records and source
	TSC Act	EPBC Act			
BIRDS					
Anthochaera phrygia (Regent Honeyeater)	CE	E	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box (Eucalyptus melliodora) and Red Ironbark (Eucalyptus sideroxylon).	Unlikely	4 OEH, PMST
Botaurus poiciloptilus (Australasian Bittern)	E	E	They are widespread but uncommon over south-eastern Australia. It extends mainly along the coasts of eastern Australia and is found all over NSW except for the far north west. It inhabits freshwater wetlands with tall dense vegetation where it feeds in shallow waters.	Unlikely	PMST
Callocephalon fimbriatum (Gang-Gang Cockatoo)	V	-	Occurs within a variety of forest and woodland types. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes.	High	21 OEH
Calyptorhynchus lathami (Glossy Black Cockatoo)	V	-	Open forest habitats with She-oak species (Allocasuarina spp.) required for food.	High	18 OEH
Chthonicola sagittata (Speckled Warbler)	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 re-growth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	Low	3 OEH
Climacteris picumnus victoriae (Brown Treecreeper)	V	-	Open grassy woodlands	Low	2 OEH
Daphoenositta chrysoptera (Varied Sittella)	V	-	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and acacia woodland.	Confirmed	25 OEH

Dasyornis brachypterus (Eastern Bristlebird)	E	E	Habitat is characterised by dense, low vegetation including heath and open woodland with a heathy understorey; in northern NSW occurs in open forest with tussocky grass understorey; all of these vegetation types are fire prone	Unlikely	PMST
Falco subniger (Black Falcon)	V	-	Wide range of forest and woodland, and open habitats, generally west of the divide	Low	1 OEH
Glossopsitta pusilla (Little Lorikeet)	V	-	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in apples (angophora sp.), paperbarks (melaleuca sp.) and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country (e.g. paddocks, roadside remnants) and urban trees also help sustain viable populations of the species.	Moderate	7 OEH
Grantiella picta (Painted Honeyeater)	V	-	Drier open woodlands	Low	1 OEH
Hieraaetus morphnoides (Little Eagle)	V	-	Open forests, partiucularly coastal or near coastal	Moderate	1 OEH
Lathamus discolor (Swift Parrot)	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 maculate), Red Bloodwood (C. Gummifera), Red Ironbark (E. sideroxylon), and White Box (E. albens).	Low	2 OEH, PMST
Lophoictinia isura (Square-Tailed Kite)	V	-	It is widely distributed to the coastal and sub-coastal area of Australia. Migrates to NSW in September for breeding. Occurs in dry woodlands and open forests, and timbered watercourses.	Moderate	3 OEH
Melithreptus gulari gularis (Black-Chinned Honeyeater)	V	-	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	Moderate	3 OEH
Neophema pulchella (Turquoise Parrot)	V	-	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	Low	1 OEH
Ninox connivens (Barking Owl)	V	-	Forest and woodland habitats, particularly drier western slopes and riverine areas, hunts for birds and small mammals.	Low	2 OEH
Ninox strenua (Powerful Owl)	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	High	14 OEH
Onychoprion fuscata (Sooty Tern)	V	-	Oceanic, marine and estuarine	Unlikely	1 OEH

Petroica boodang (Scarlet Robin)	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 re-growth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.	Moderate	17 OEH
Petroica phoenicea (Flame Robin)	V	-	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with an open understorey.	Moderate	5 OEH
Tyto novaehollandiae (Masked Owl)	V	-	Dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting	Moderate	3 OEH
Tyto tenebricosa (Sooty Owl)	V	-	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	Moderate	7 OEH
Rostratula australis (Australian Painted Snipe)	E	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Unlikely	PMST
MAMMALS					
Cercartetus nanus (Eastern Pygmy Possum)	V	-	Found in a broad range of habitats from rainforest through to wet and dry sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred.	Moderate	1 OEH
Chalinolobus dwyeri (Large-Eared Pied Bat)	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.	High	15 OEH, PMST
Dasyurus maculatus (Spotted-Tailed Quoll)	V	E	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated with large expansive areas of habitat to sustain territory size. Requires hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	High	43 OEH, PMST
Falsistrellus tasmaniensis (Eastern False Pipistrelle)	V	-	Occurs in a variety of open forest and woodland habitats with hollow-bearing trees. Requires hollows for roosting. May forage in re-growth and modified environments.	High	7 OEH
Isoodon obesulus obesulus (Southern Brown Bandicoot)	E	E	Typically associated with coastal heaths or open forest habitats with a heathy understorey on sandy soils.	Low	2 PMST
Miniopterus australis (Little Bentwing-Bat)	V	-	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest	Low	1 OEH

Miniopterus schreibersii oceanensis (Eastern Bentwing-Bat)	V	-	Occurs on east and north west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	High	23 OEH
Mormopterus norfolkensis (Eastern Freetail-Bat)	V	-	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but would also roost under bark or in human-made structures.	High	20 OEH
Myotis macropus (Southern Myotis)	V	-	Generally roost in groups close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools catching insects and small fish.	Moderate	8 OEH
Petaurus australis (Yellow-Bellied Glider)	V	-	Tall open forest habitats, favours mature wet sclerophyll forest and dense gullies.	Moderate	6 OEH
Petaurus norfolcensis (Squirrel Glider)	V	-	Forest and woodland habitats, particularly areas with a diversity of eucalypt species in the canopy and other suitable food resources (shrubs and small trees). Requires tree hollows for denning.	Moderate	11 OEH
Petrogale penicillata (Brush-Tailed Rock Wallaby)	E	V	Open forest habitats on steep terrain with exposed rocks, rock overhangs and platforms.	Low	8 OEH, PMST
Phascolarctos cinereus (Koala)	V	V	Open forests and woodlands with favoured food tree species.	Confirmed	25 OEH, PMST
Potorous tridactylus tridactylusI (Long-Nosed Potoroo)	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.	Low	PMST
Pseudomys fumeus (Smoky Mouse)	CE	E	Heathland and dense coastal forests	Low	PMST
Pseudomys novaehollandiae (New Holland Mouse)	-	V	Distribution is fragmented across all eastern states of Australia, where it inhabits open heath lands, open woodlands with heath understorey and vegetated sand dunes.	Low	PMST
Pteropus poliocephalus (Grey-Headed Flying-Fox)	V	V	Forages on nectar and pollen in sclerophyll forests and on rainforest fruits and vines, orchards, gardens.	Moderate	30 OEH, PMST
Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)	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.	High	Roads and Maritime (2012)

Scoteanax rueppellii (Greater Broad-Nosed Bat)	V	-	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.	High	12 OEH
Vespadelus troughtoni (Eastern Cave Bat)	V	-	Drier open forests and woodand on the western slopes	Low	2 OEH
AMPHIBIANS					
Heleioporus australiacus (Giant Burrowing Frog)	V	V	Found in heath, woodland and open forest with sandy soils.	Low	8 OEH, PMST
Litoria aurea (Green and Golden Bell Frog)	E	V	Ephemeral and permanent freshwater wetlands, ponds, dams with an open aspect and fringed by Typha and other aquatics, free from predatory fish.	Low	PMST
Litoria booroolongensis (Booroolong Frog)	E	E	Sedge swamps, wallum and sandy soils	Low	PMST
Litoria littlejohni (Littlejohn's Tree Frog)	V	V	It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops.	Low	1 OEH, PMST
Mixophyes balbus (Stuttering Frog)	E	V	Permanent streams in moist and wet sclerophyll forests.	Low	PMST
Pseudophryne australis (Red-crowned Toadlet)	V	-	It has restricted distribution from Pokolbin to Nowra and west to Mt Victoria. Occurs in open forests and wet drainage lines below sandstone ridges that often have shale lenses or cappings in the Hawkesbury and Narrabeen Sandstones.	Confirmed	30 OEH
REPTILES					
Eulamprus leuraensis (Blue Mountains Water Skink)	E	E	Hanging swamps, densely vegetated swamps and ponds in the blue Mountains area	Unlikely	17 PMST
Hoplocephalus bungaroides (Broad-headed Snake)	E	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 m of escarpments in summer.	Low	12 OEH, PMST
FISH					
Macquaria australasica (Macquarie Perch)	E	E	Macquarie Perch has been recorded within the upper Reaches of the Hawkesbury –Nepean System.	Unlikely	PMST
Prototroctes maraena (Australian Grayling)	-	V	The Australian Grayling has been recorded within the upper reaches of the Hawkesbury-Nepean River Catchment. It inhabits clear, flowing waters.	Unlikely	PMST

INVERTEBRATES					
Petalura gigantea (Giant Dragonfly)	E	-	Sedge swamps, freshwater wetlands and peat bogs.	Unlikely	28 OEH
Meridolum corneovirens (Cumberland Plain Land Snail)	E	-	Primarily inhabits Cumberland Plain Woodland (an endangered ecological community). This community is grassy, open woodland with occasional dense patches of shrubs. Lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish.	Unlikely	9 OEH

Table A-3 Migratory species potentially occurring in the study area

Species	EPBC Act	No. of records and source
Actitis hypoleucos (Common Sandpiper)	Marine, Migratory (Bonn, CAMBA, JAMBA, ROKAMBA)	4 OEH
Apus pacificus (Fork-Tailed Swift)	Migratory (CAMBA, JAMBA, ROKAMBA)	PMST
Ardea alba or *Ardea modesta* (Great Egret)	Marine, Migratory (CAMBA, JAMBA)	PMST
Ardea ibis (Cattle Egret)	Marine, Migratory (CAMBA, JAMBA)	11 OEH, PMST
Gallinago hardwickii (Latham's Snipe, Japanese Snipe)	Marine, Migratory (Bonn, CAMBA, JAMBA, ROKAMBA)	1 OEH, PMST
Haliaeetus leucogaster (White-Bellied Sea Eagle)	Migratory (CAMBA)	5 OEH, PMST
Hirundapus caudacutus (White-throated Needletail)	Marine, Migratory (CAMBA, JAMBA, ROKAMBA)	7 OEH, PMST
Merops ornatus (Rainbow Bee-Eater)	Migratory (JAMBA)	6 OEH, PMST
Monarcha melanopsis (Black-faced Monarch)	Migratory (Bonn)	PMST
Monarcha trivirgatus (Spectacled Monarch)	Marine, Migratory (Bonn)	PMST
Myiagra cyanoleuca (Satin Flycatcher)	Migratory (Bonn)	PMST
Pandion haliaetus or *Pandion cristatus* (Osprey)	Marine, Migratory (Bonn)	PMST
Rhipidura rufifrons (Rufus Fantail)	Migratory (Bonn)	PMST
Rostratula benghalensis (sensu lato) (Painted Snipe)	TSC Act, Marine, Migratory (CAMBA)	PMST

Appendix B. Assessment of significance

Significance assessments have been conducted for species and ecological communities that were identified as present or as having a moderate to high likelihood of occurring in the study area, and hence may be impacted by the propose activities. These species are listed in Table 6-1 for TSC Act listed species, Table 6-2 for EPBC Act listed species and Table 6-3 for EPBC Act listed migratory species.

Significance assessments have been divided into:

- State listed species (under the *Threatened Species Conservation Act 1995* (refer to Appendix B.1)
- Commonwealth listed species (under the *Environmental Protection and Biodiversity Assessment Act 1999*) (refer to Appendix B.2).

For threatened biodiversity listed under the TSC Act, the assessment considers threatened species assessment detailed in the Department of Environment and Climate Change (2007) *Threatened species assessment guidelines: The assessment of* significance. The guidelines present methods to consider the impacts on biodiversity of projects assessed under Section 5a of the EP&A Act.

For threatened biodiversity listed under the EPBC Act significance assessment have been completed in accordance with the matters of National Environmental Significance Significant Impact Guidelines 1.1 (SIG 1.1) (Department of the Environment, Water, Heritage and the Arts 2009).

Each question within the respective Assessments of Significance addresses the impacts on individual projects individually before providing a cumulative impact. Species with similar taxonomy or ecological requirements have been assessed together, for example tree-roosting microchiropteran bats and cave-roosting microchiropteran bats.

B.1 Environmental Planning & Assessment Act, 1979

Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion

Direct and indirect impacts

Impacts to BMSCF associated with the eight study sites relate to the:

- direct removal of vegetation to accommodate the design of the overtaking lane and safety works.
- indirect impacts through potential introduction of invasive weeds and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).
- to a lesser degree there is potential for run-off impacts, although most areas are on low gradients and it unlikely that run-off would be a major issue.

The cumulative removal of vegetation for the eight projects equates to around 3.14 hectares of moderate to high condition BMSCF. This is in addition to 0.4 hectares cleared for overtaking lane 4 (total cumulative impact 3.61 hectares). The loss of vegetation for each site is shown below.

Threatened Ecological Community	Status	Site and Area (ha)								Total loss
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
Blue Mountains Shale Cap Forest of the Sydney Basin Bioregion	Endangered, TSC Act	0.18	0.60	1.38	0.6	0.19	0.13	-	0.06	**3.14**

Assessment of Significance (EP&A Act)

(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.*

Assessment per project

OT1: A potential direct impact on 0.18 ha mostly on isolated fragments in the road reserve that comprise a removed and mown understorey. An additional small area of clearing would occur at the western end of OT1 and equating to around 80-100 square metres, this area exists as a 4 metre wide road reserve, flanked by a cleared firebreak along the fence line and the road clearing on the other side. There is a high diversity of weeds in the understorey. This community is widespread through the locality and the project would not result in an adverse effect on the extent of the community in the local context and would not substantially modify the structure or composition of existing or adjoining vegetation given the presence of cleared land either side of the road reserve. Areas to be cleared are along existing edge of the road corridor are on flat ground with limited surface water runoff expected into adjoining habitats. Potential impacts can be mitigated during construction and long-term impacts associated with introducing nutrients are not expected to be exacerbated to a significant extent.

OT2: A potential direct impact on 0.60 ha has a long linear impact along the southern side of the Bells Line of Road. The clearing would occur along the edge of a much larger area of similar habitat that extents to the south and the clearing would therefore not result in an adverse impact on the extent of the community in the locality. The clearing would result in a new edge along the remnant in this location and there is potential for a change in floristic composition along the edge affected areas for a distance of around 500 metres. There is an existing cleared utility easement running parallel to the road in this location and current altered composition of the forest associated with recovery following fire. The change in composition would likely be restricted to edge areas potentially up to 20-30 metres. Areas to be cleared are mostly on flatter ground with limited surface water runoff expected into adjoining habitats. Potential impacts can be mitigated during construction and long-term impacts associated with introducing nutrients are not expected to be exacerbated to a significant extent.

OT3: A potential direct impact on 1.38 ha would occur along the length of the southern side of the road and affecting the edge of a much larger remnant which extends to the south eventually linking with the Blue Mountains NP. The clearing would no significantly reduce the extent of the community in the locality. There is an existing easement / track running parallel to the road along the length of the project footprint and the clearing would affect vegetation positioned between the road and the cleared easement, so the impacts from edge effects are unlikely to result. There is some potential for run-off impacts to occur at the western end of OT3 given the steepness of the slope adjoining the road and the opportunity for alteration of surface water drainage. Potential impacts can be mitigated during construction and long-term impacts associated with introducing nutrients are not expected to be exacerbated to a significant extent.

OT5: A potential direct impact on 0.6 ha mostly on isolated fragments in the road reserve and along an existing edge on the north side. The vegetation on the north side extents significantly away from the road and contiguous with habitats to the north in Wollemi NP and the loss of vegetation would not significantly affect the extent of this community in the locality. Edge effects are evident in all areas of vegetation to be impacted on OT5 and the project will not create a new edge, thereby here is unlikely to be a substantial change in the composition of the retained habitat. There is potential for runoff to exist the road pavement to the north into the adjoining remnant which may assist weed invasion, however there is not waterway adjoining the road.

Areas to be cleared are along existing edges of the road corridor and mostly on flatter ground with limited surface water runoff expected into adjoining habitats. Potential impacts can be mitigated during construction and long-term impacts associated with introducing nutrients are not expected to be exacerbated to a significant extent

OT6: A potential direct impact on 0.19 ha. All areas impacted are fragmented woodland represented along the road reserve. There is an existing cleared power easement running along the north side of the road and separates the road edge from the adjoining forest. The widening would affect vegetation present between the easement and the road and would not create a new edge or substantially change the composition of the adjoining vegetation. The loss of vegetation is minimal and would not negatively affect the extent of the community in the locality.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and along associate with narrow linear strips of road reserve vegetation. The loss of vegetation would not significantly impact on the extent of the communi9ty in the locality. Given the widening would take up the cleared power easement the likelihood of a substantial change in the composition of the adjoining habitat is low.

There is some potential for run-off impacts to occur at the western end of OT7 given the steepness of the slope adjoining the road and the opportunity for alteration of surface water drainage. This will need to be managed to reduce potential impacts to downslope receiving environments.

SW9 and SW12: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve. This is a minor direct impact and would not significantly impact on the extent of the community in the neither locality nor change the structure of the isolated road reserve remnants adjoining the site, which are already of low condition.

Cumulative impact

The combined eight projects would result in the removal of around 3.0 hectares of the community, which comprise of linear strips of vegetation retained along the edges of Bells Line of Road, impacted through widening the road. In all cases the clearing of vegetation is along the edge of larger remnants and will remove a number of isolated fragments of vegetation with low condition that occur along the edge of the existing road.

This community has been extensively cleared in the locality previously for agricultural and residential purposes. About 0.47 hectares of the community has been recently cleared to accommodate the Site 4 overtaking lane, and therefore the overall Bells Line of Road improvement program would potentially result in a cumulative impact of about 3.5 hectares as a direct loss of vegetation.

The local occurrence of this community has been mapped in broad scale vegetation mapping projects by Tozer *et al.* (2010) and Bell (1998), which together cover the large majority of the locality. A total of 1,878 hectares of equivalent map units have been identified by these authors within a ten kilometre radius of the proposed activity. This total includes about 460 hectares of Sydney Turpentine Ironbark Forest (p87) and 535 hectares of Shale-Basalt Sheltered Forest (p168) which are equivalent map units as described by Tozer *et. al* 2010 which cover the southern portion of the locality. Bell (1998) has identified 883 hectares of Remnant Shale Cap Forest (F13) outside of the Tozer *et al.* (2010) study area. Additionally 613 hectares have been mapped by Bell (1998) to the north of the locality in Wollemi National Park. It is likely that some of these areas identified as the ecological community in the locality are degraded and some areas are likely to have been cleared since these

projects were undertaken. The proposal would result in the removal of about 3.5 hectares which represents about 0.19 per cent of the 1,878 hectares of the community within 10 kilometres of the proposal. The proposed clearing of the community is relatively small in this context and not expected to have an adverse effect on the extent of the ecological community placing the remainder at risk of extinction.

Some weed invasion in edge areas was noted in the study area along the existing Bells Line of Road suggesting that further weed invasion could be expected from additional clearing proposed for each project. However the scale and magnitude of these edge effects are likely to be relatively minor in the landscape and limited to areas where vegetation has been retained in large fragments adjacent to the road. It should be noted that the majority of the proposed overtaking lanes would occur adjacent to the cleared land for farming or residential development or electricity easements.

Considering the limited potential for substantial modification from edge effects, and existing levels of modification within the community, the local occurrence is unlikely to be placed at risk of extinction by the proposal.

(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.*

Assessment per project

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is not considered important for this community given its low condition and the extent of the community in the region.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for this community given its low condition and the extent of the community in the region.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for this community given its low condition and the extent of the community in the region.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is not considered important for this community given its low condition and the extent of the community in the region.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for this community given its low condition and the extent of the community in the region.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat along the road edge is not considered important for this community given its low condition and the extent of the community in the region.

SW9 and SW12: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important in the long term for this EEC.

Cumulative impact

The proposal would result in the removal of about 3 hectares of habitat which represents about 0.19 per cent of the 1,878 hectares of the community within 10 kilometres of the proposal. The extent of clearing for each study site is relatively minor in scale and restricted to edge areas and removal of isolated fragments of roadside vegetation.

Threatened Ecological Community	Status	Site and Area (ha)								Total loss
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
Blue Mountains Shale Cap Forest of the Sydney Basin Bioregion	Endangered, TSC Act	0.18	0.60	1.38	0.6	0.19	0.13	-	0.06	**3.14**

The project would involve clearing along the edge of an existing road resulting in a wider corridor; however the increased corridor width is not expected to result in substantial fragmentation of the community resulting patches becoming isolated from other areas of connected habitat. Existing ecological processes such as pollination and seed dispersal are likely to be maintained across the widened road corridor.

About one third of the vegetation to cleared for the overall program is in a relatively poor condition, comprising isolated trees and disturbed examples of the community. Considering the relatively restricted distribution of habitat for the ecological community all areas of occupied habitat could be regarded as being important to the survival of the community, particularly higher condition areas.

(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 community.

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

Each project (action) involves a small area of clearing along the road edge to widen the road and allow construction of the overtaking lane. This assessment considers the combined actions across the eight sites which would result in a combined loss of this EEC of around 3 ha.

There is no recovery plan for this ecological community however recovery strategies that have been identified for Blue Mountains Shale Cap Forest and those that are relevant to the project include the following objectives:

- Protect remnants from further clearing.
- Prevent incursion of weeds into the community.
- Retain old trees as a source of hollows.

The impacts expected will include clearing of vegetation at each site and removal of hollow-bearing trees and these actions are not consistent with the recovery actions. However considering the impacts would focus on the edge of larger expanses of vegetation, the combined projects are considered unlikely to substantially interfere with the recovery of the EEC.

(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.

Each project (action) involves a small area of clearing along the road edge to widen the road and allow construction of the overtaking lane. This assessment considers the combined actions across the eight sites which would result in a combined loss of this EEC of around 3 ha.

Key threatening processes that are relevant to this community and the project study sites 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 proposed upgrade. The main key threatening processes relevant to this community that are associated with the eight projects are associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant site	Associated with the proposal	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation. At all sites the clearing would occur along the edge of larger remnants and the condition of this vegetation varies from moderate to high depending on the extent of disturbance and weed invasion.	OT1	0.18 ha	Section 5.2
	OT2	0.60 ha	
	OT3	1.38 ha	
	OT5	0.6 ha	
	OT6	0.19 ha	
	OT7	0.13 ha	
	SW12	0.05 ha	
Pathogens			
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi*	EPBC Act, TSC Act	Potential	Section 5.2

Koala (Phascolarctos cinereus)

Direct and indirect impacts

The extent and distribution of the Koala population near Bilpin is not known, although in relation to the project area the presence of Koalas along the Bells Line of Road was confirmed between Johnson Road in the east and Mountain Lagoon Road to the west (ie. OT3 and OT5) and associated with the presence of Grey Gum (*E.punctata*) which is patchy in the landscape. There was no evidence that Koalas were using other apparent Koala feed tree species Monkey Gum (*E.cypellocarpa)* or Mountain Gum (*E.deanei)* which were common at OT6 and OT7. The species may however occur at OT1 and OT2.

Therefore the evidence of Koala presence in the study area was found to be associated with the Blue Mountains Shale Cap Forest and Turpentine Ironbark Forest, although only where Grey Gum (*E.punctata*) was present and not widespread across these communities which may reflect the low density of the population. There was no evidence of Koala activity within the Blue Mountains Ridgetop Woodland dominated by Sydney Peppermint (*E.piperita*) and Silvertop Ash (*E.seiberi*) (OT6 and OT7). In addition to this, Koalas appear to be associated with forests comprising a higher proportion of shale or basalt soil and this may be associated with higher moisture or nutrient content in the leaves. Despite the low density and patchy occurrence of the Koala population and habitat resources for the species, the subject population would be considered an important population.

In assessing the impact of the proposal on habitat critical to the survival of the Koala, consideration was given to the referral guidelines (DoE 2013). It is concluded the impacts are unlikely to be adverse for the following reasons:

- The cumulative impacts of the proposed activity would clear around 3.14 ha of vegetation considered to be critical to the survival of koalas, mostly from OT3 (1.39 ha). The breakdown in potential loss of Koala habitat is based on the presence of Map Units 1 and 2 and not the distribution of the Koala population which is not known. The impact is therefore a worst case scenario and is as follows: OT1 (0.18 ha), OT2 (0.60), OT3 (1.38), OT5 (0.60 ha), OT6 (0.19), OT7 (0.13) and SW12 (0.06)

- Comparable Koala habitat associated with MU1 and MU2 is extensive to the north and south of the Bells Line of Road and well conserved within Wollemi and Blue Mountains National Park and as stated, koalas do not appear to be using all habitats associated with these communities and therefore the loss of vegetation is likely overstating the actual loss of Koala habitat.

- The habitat assessment tool has reported a high score of 8, confirming the presence of habitat critical to the survival of koalas, although the population is considered a low-density population (<0.03 koalas / ha).

- The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements. Of all the study sites, it is only OT2 that is considered to have some potential minor impacts to Koala movements, due to the presence of contiguous vegetation north and south of the road.

- The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening.

Assessment of Significance (EP&A Act)

(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 Koala is adversely affected by habitat loss and fragmentation, wild fire, predation and disease. In fragmented habitats, road kills 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).

Assessment per project

OT1: impact on around 0.18 ha of potential habitat which was identified as secondary habitat (class 6) based on the low density of Mountain Mahogany (E.notabilis). There are no primary feed trees at this site, and the vegetation to be impacted exists along as isolated trees and small patches in the road reserve. The site is not considered important for life-cycle of the local population.

OT2: impact on around 0.60 ha, no Koala feed tree species were identified at OT2 or evidence of koalas and the site is not expected to be important for life-cycle of the local population.

OT3: impact on around 1.38 ha, no primary Koala feed trees (ie Monkey Gum) however a moderately high density of the secondary feed tree Grey Gum and evidence of Koalas reported on the south side of the road in this location, with habitat that is outside the impact areas. It is likely that the habitat off site, which continues to the south into very large areas of habitat for koalas, is important for the life-cycle of the local population. There may be a short-term impact to the movements of the Koala during the breeding season, however the impacts to the foraging life-cycle is minor.

OT5: impact to around 0.6 ha of potential habitat, this includes primary and secondary habitat, associated with the presence of two feed tree species, Monkey Gum (primary) and Grey Gum (secondary) and evidence of Koalas at this site. It is likely that the habitat is important for the life-cycle of the local population. There may be a short-term impact to the movements of the Koala during the breeding season, however the impacts to the foraging life-cycle is minor given the extensive areas of habitat north and south of the road.

OT6: impact to around 0.19 ha containing secondary habitat for koalas as determined by low densities of the secondary feed tree Mountain Mahogany (E.notabilis) and very low density of Grey Gum. The areas to be cleared are fragments of vegetation adjacent to the road and are not expected to be important for koalas

OT7: impacts to around 0.13 ha of primary and secondary habitat. Monkey Gum is only present at the eastern end of the site (primary habitat) and the remainder and majority of the habitat is secondary habitat or not

classified as habitat for koalas. There was no evidence of koalas feeding in the road reserve habitats at OT7 and the habitat at OT7 is not expected to be important for life-cycles of the local population.

Cumulative impact

A low-density and widespread population is expected to be present in the locality and potentially occupy large expanses of habitat to the north and south of the study area and associated with the National Parks estates. Potential habitat is likely to be widespread beyond the clearing footprint areas. With the study area potential Koala habitat was found to be associated with Map unit 1 (Sydney Turpentine-Ironbark Forest) and Map Unit 2 (Blue Mountains Shale Cap Forest). There was no evidence of Koala activity associated with Map Unit 3 (Blue Mountains Ridgetop Sandstone Woodland). However, within these habitats and specifically in the study area close to the Bells Line of Road, Koala activity was reported in a relatively small area associated with a higher prevalence of shale and basalt soil influence located between Johns Road and Mount Lagoon Road, east of Bilpin. This habitat type was observed to extend north and south into the adjoining private properties and was not limited to the study area. The presence of koalas appeared to be associated with the presence of Grey Gum (*Eucalyptus punctata*) and the higher soil moisture levels in these sheltered locations.

There was no evidence that Koalas were using other apparent Koala feed tree species Monkey Gum (*E.cypellocarpa)* or Mountain Gum (*E.deanei)* in the study area. Therefore the evidence of Koala presence in the study area was found to be associated with the Blue Mountains Shale Cap Forest and Turpentine Ironbark Forest, although only where Grey Gum (*E.punctata*) was present and not widespread across these communities which may reflect the low density of the population. There was no evidence of Koala activity within the Blue Mountains Ridgetop Woodland dominated by Sydney Peppermint (*E.piperita*) and Silvertop Ash (*E.seiberi*).

The cumulative impacts of the proposed activity would clear around 3.08 ha of vegetation considered to be potential Koala habitat, mostly from OT3 (1.39 ha). The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements.

The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening. The project would impact on the home range and foraging resources of at least one Koala reported at OT5 and possibly a second individual to the east within OT3. Considering the widespread and extensive areas of similar habitat outside the road edge, 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,*

Assessment per project

The results from the Koala scat search and habitat assessment at each site is provided in Appendix E. These data are summarised below. The extent to which habitat is removed for each project is also shown and this relates to the loss of MU1 and MU2, this is a conservative estimate considering that both vegetation types are known to contain Koala feed tree species, however the presence and density and the relative importance of each site for koalas varies as shown below.

Koala	OT1 (n=10)	OT2 (n=7)	OT3 (n=10)	OT5 (n=11)	OT6 (n=4)	OT7 (n=8)
Primary habitat	-	-	-	27 %		25 %
Secondary habitat (class A)	-	-	40%	27 %	75 %	
Secondary habitat (class B)	-	-	10%	18 %		12.5 %
Secondary habitat (class C)	60%	-	10%	18 %	25 %	25 %
Koala scats confirmed	-	-	Yes	Yes	-	-
Total loss (MU1 / MU2)	0.18 ha	0.60 ha	1.38 ha	0.60 ha	0.19 ha	0.13 ha
Fragmentation of habitat	No	Minor	No	No	No	Minor

OT3 and OT5: Important habitat is likely to be present at OT3 and OT5 given the high density of primary and secondary feed tree species and the known presence of koalas. However considerable large areas of potential habitat occur to the north and south of these sites and are contiguous with the areas being impacted. The clearing of habitat will occur along the edge of very large patches and is not expected to be a significant loss of feed trees for the local population.

OT1, OT2, OT6, and OT7: a mix of secondary and primary habitat, where impacts are minima and would largely affect fragmented vegetation in the road reserve. These sites are not likely to be important areas of habitat.

Cumulative impact

The cumulative impacts of the proposed activity would clear around 3.14 ha of vegetation considered to be potential Koala habitat, mostly from OT3 (1.39 ha). The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements.

The breakdown in potential loss of Koala habitat is based on the presence of Map Units 1 and 2 and not the distribution of the Koala population which is not known. The impact is therefore a worst case scenario and is as follows: OT1 (0.18 ha), OT2 (0.60), OT3 (1.38), OT5 (0.60 ha), OT6 (0.19), OT7 (0.13) and SW12 (0.06)

The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening.

(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 under the TSC Act.

(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.
Objective 2: To rehabilitate and restore Koala habitat and populations.	Koala feed trees (*Eucalyptus punctata*) 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 3 hectares of native vegetation supporting primary and secondary feed tree species. Proposed avoidance and mitigation measures include: ▪ The proposed activity has been designed to minimise vegetation clearing where possible and minimise potential impacts to Koala habitat. ▪ Landscaping will include the primary feed tree species Grey Gum (*Eucalyptus punctata*) in addition to other secondary feed tree species.
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.

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	▪ 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 exotic vines and scramblers	

Woodland birds

Direct and indirect impacts

The following woodland bird species are assessed:

Species	Status	Occurrence
Black-chinned Honeyeater (*Melithreptus gularis gularis*)	Vulnerable	Potential all sites
Varied Sittella (*Daphoenositta chrysoptera*)	Vulnerable	Present OT2, potential all sites
Scarlet Robin (*Petroica boodang*)	Vulnerable	Potential all sites
Flame Robin (*Petroica phoenicea*)	Vulnerable	Potential all sites

The potential loss of habitat for woodland birds associated with each study site is summarised below. The total loss is around **3.25 hectares** of remnant vegetation in various states of condition combined across all of the sites within this proposal.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Impacts to woodland birds associated with the eight study sites relate to the:

- direct removal of potential foraging, shelter and breeding habitat.
- indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Black-chinned Honeyeater

The Black-chinned Honeyeater occurs mostly in upper levels of drier open forests /woodlands dominated by box and ironbark eucalypts, or less commonly smooth-barked gums, stringybarks and tea-trees. It tends to occur within largest woodland patches in the landscape. Nests are made high in the canopy. The Black-chinned Honeyeater was not recorded from the targeted surveys however may forage and breed in woodland throughout much of the study area.

Varied Sittella

The Varied Sittella's nest is a deep open cup of bark and spider web, decorated on the outside with long pieces of bark to look like the fork or branch where it is placed. This species usually breeds cooperatively, with the breeding pair having several helpers. They will sometimes also breed in single pairs. Only the breeding female incubates the eggs and broods the young (Higgins and Peter 2002).

The Varied Sittella inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches. 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. The species is sedentary and may inhabit or nest in the same location over successive years.

The Varied Sittella was recorded from the targeted surveys and would forage and breed in woodland throughout much of the study area.

Scarlet Robin

In NSW, the Scarlet Robin occurs in open forests and woodlands from the coast to the inland slopes. It breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. The Scarlet Robin was not recorded from the targeted surveys however the species may forage and breed in woodland throughout much of the study area.

The Scarlet Robin was not recorded during current surveys. The species may forage and breed in woodland throughout much of the study area.

Flame Robin

The Flame Robin is found in a broad coastal band from Queensland border to Tasmania and South Australia. In NSW, it breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. In winter many individuals migrate to more open lowland habitats on the inland slopes and plains. Individuals forage from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. The open cup nest of plant fibres and cobweb is built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank (OEH 2013b).

The Flame Robin was not recorded during current surveys. The species may forage and breed in woodland throughout much of the study area.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

It is likely that the impacts of construction and operation of the project would be confined to loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is not considered important for the life-cycle of these woodland birds.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for the life-cycle of these woodland birds. A flock of Varied Sittella were observed at this site, although only briefly and dispersed to other adjoining areas outside the impact area.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for the life-cycle of these woodland birds.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is not considered important for the life-cycle of these woodland birds.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for the life-cycle of these woodland birds.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat along the road edge is not considered important for the life-cycle of these woodland birds.

SW9 and SW12: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of these woodland birds.

Cumulative impact

The Black-chinned Honeyeater is also likely to utilise nectar resources and also forage insects in the study area. There is potential foraging and breeding habitat for the Scarlet Robin and Flame Robin associated with the woodlands and lower slopes. Impacts to woodland and open forest habitats associated with the proposal relate to 3.25 hectares and within existing fragmented landscapes. The surveys did not identified an existing species' population in these areas, however if a population occurs the narrow clearing through the edge of the road is not expected to lead to local extinction of negatively affect the life-cycle of the species'.

There is potential for the proposal to disrupt feeding behaviours and remove foraging habitat. However it is not likely that the life cycle of the species would be threatened and placed at a risk of extinction, considering that the study area is part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north).

(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.*

Assessment per project

The extent of habitat removal across the eight project sites is shown below. This is considered very minor in the context of the habitat available to these species throughout the locality.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment existing habitat		No	Minor	No	No	No	Minor	No	No	

All sites contain large remnant eucalypt species which are considered important in providing food resources, shelter and potential breeding habitat. The project would further increase the width of the Bells Line of Road; however all bird species are highly mobile and can still move across forest clearings such as roads to access foraging and breeding habitat and are unlikely to be significantly impacted by the barrier effect of the road. The extent of habitat to be removed is likely to reduce the availability of foraging resources. However considering the large area of protected foraging and nesting habitats for some bird species in adjoining vegetation, the project is unlikely to significantly impact the long term survival of the species.

Cumulative impact

The Black-chinned Honeyeater is likely to utilise nectar resources and also forage insects in the study area. There is potential foraging and breeding habitat for the Scarlet Robin and Flame Robin associated with the woodlands and lower slopes. Impacts to woodland and open forest habitats associated with the proposal relate to 3.25 hectares and within existing fragmented landscapes. The surveys did not identified an existing species' population in these areas, however if a population occurs the narrow clearing through the edge of the road is not expected to lead to local extinction of negatively affect the life-cycle of the species'.

A flock of Varied Sittella were recorded at OT2 and this species may occur widely throughout the study area and associated with any of the study sites as a viable local population. There is potential for the proposal to disrupt feeding behaviours and remove foraging habitat. However it is not likely that the life cycle of the species would be threatened and placed at a risk of extinction, considering that the study area is part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north).

The project would further increase the width of the Bells Line of Road; however the all bird species are highly mobile and can still move across forest clearings such as roads to access foraging and breeding habitat and are unlikely to be significantly impacted by the barrier effect of the road. The extent of habitat to be removed is likely to reduce the availability of foraging resources. However considering the large area of protected foraging and nesting habitats for some bird species in adjoining vegetation, the project is unlikely to significantly impact the long term survival of the species.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

Recommendations are considered for the exclusion of timber extraction and other developments from areas identified as regularly used sites. The study area is not considered an important site for the Regent Honeyeater. There are no recovery plans for other 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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 proposed upgrade. The main key threatening processes relevant to this community that are directly enacted by the proposed upgrade are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	Potential	
Pathogens			
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi*	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
Weeds			
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act	Potential	
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Gang Gang Cockatoo Callocephalon fimbriatum and Glossy Black Cockatoo Calyptorhynchus lathami

Direct and indirect impacts

The feed-tree species for the threatened Glossy Black-cockatoo (*Calyptorhynchus lathami*), namely Black She-oak (*Allocasuarina littoralis*) was observed at several locations in the study area with the greatest density and abundance present at OT2, also present at OT3, OT5 and OT7. The species was not confirmed during the survey either through direct observation or evidence of feeding (i.e. chewed She-oak cones). Suitable habitat was observed to be patchy, but widespread throughout the adjoining forested habitats adjoining the study area.

The open forest habitats typically have a high structural and floristic diversity with moderately to high abundance of shelter and food resources for these two species and likely to be important for life-cycle activities including feeding, breeding and seasonal movements. Turpentine-Ironbark Forest on shale caps in the Blue Mountains has been identified as a rich habitat for hollow-dependent fauna including the Glossy Black-Cockatoo and Gang Gang Cockatoo (NSW Scientific Committee 2000).

The potential loss of habitat for these birds associated with each study site is summarised below. The total loss is around **3.25 hectares** of remnant vegetation in various states of condition combined across all of the sites within this proposal.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Impacts to both species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging, shelter and breeding habitat.
- the indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Gang Gang Cockatoo

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).

Glossy Black Cockatoo

Glossy Black-cockatoos require suitable hollows in large, old eucalypt trees (living or dead) for nesting. Glossy Black-cockatoos are highly specialised, feeding almost exclusively on the seeds extracted from the cones of species of *Allocasuarina*. The cockatoos are highly selective with respect to both the trees and the cones on which they choose to forage, often showing fidelity to particular trees. Glossy Black-cockatoos prefer trees carrying a large number of cones (Pepper et al. 2000), in part because they appear to select feeding trees primarily on the basis of optimizing kernel intake (Crowley and Garnett, 2006).

Assessment of Significance (EP&A Act)

(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.

Assessment per project

It is likely that the impacts of construction and operation of the project would be confined to loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is not considered important for the life-cycle of these birds, due to a lack of feed trees and suitable hollows.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat has some value for these species due to a low density of feed trees and hollows however these features are common throughout the landscape in adjoining forested areas.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat has some value for these species due to a low density of feed trees and hollows however these features are common throughout the landscape in adjoining forested areas.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation The habitat has some value for these species due to a low density of feed trees and hollows however these features are common throughout the landscape in adjoining forested areas.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for the life-cycle of these birds.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat has some value for these species due to a low density of feed trees and hollows however these features are common throughout the landscape in adjoining forested areas.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of these birds.

Cumulative impacts

The proposal would result in the removal of about 3.25 hectares of foraging habitat, although there are 163 hollow bearing trees (small to medium in size) recorded in the study area. Low densities of medium sized hollows may provide suitable attributes for nesting individuals. Potential habitats in the locality are extensive particularly throughout the National Parks to the north and south. There is a low potential for the life-cycle of the species to be impacted given the few suitable tree hollows in the study area and the widespread occurrence of suitable foraging habitat.

The feed-tree species for the threatened Glossy Black-cockatoo, namely Black She-oak (*Allocasuarina littoralis*) was observed at several locations in the study area with the greatest density and abundance present at OT2, also present at OT3, 5 and 7. The species was not confirmed during the survey either through direct observation or evidence of feeding (i.e. chewed She-oak cones). Suitable habitat was observed to be patchy, but widespread through the study area.

Hollow-bearing trees are in moderate abundance throughout the study area, but hollows are small to medium in size. Trees supporting larger trunk hollows suitable for this species are present, although at low density. Shelter and food resources in the study area are likely to be important for the life cycle of this species, however there is a low potential that the proposal would adversely affect the life-cycle of the species to be impacted given the widespread occurrence of suitable foraging habitat.

(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.*

Assessment per project

The extent to which the habitat will be removed from each project is outlined in the following table. The density of feed trees was not quantified at each site due to the low densities, and occur sparsely throughout the clearing habitats. These resources are widespread throughout the surrounding habitats.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Feed trees present in footprint		No	Yes	Yes	Yes	No	Yes	No	No	

The proposal would remove foraging habitat containing *Allocasuarina littoralis* (foraging habitat for Glossy Black-cockatoo), at OT2, OT3, 5 and 7. The proposal would also remove a range of Eucalypt and Acacia species (potential foraging habitat for Gang-gang Cockatoo). Large areas of foraging habitat are present within the locality. Given the high mobility of these species and the proximity of large areas of native vegetation in the locality (eg Blue Mountains National Park (to the south) and Wollemi National Park (to the north)), the removal of a small area of foraging habitat would be very unlikely to have a significant effect on the long-term survival of a local population of these species.

Cumulative impact

According to the impact calculations, up to 163 hollow-bearing trees occur within the areas to be cleared. Low densities of medium sized hollows may provide nesting habitat for the Gang Gang Cockatoo. Trees supporting larger trunk hollows suitable for Glossy Black Cockatoo are present, although at low density. Hollow-bearing trees are present throughout vegetation within the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). Those that would be lost are a very minor proportion of hollow-bearing trees available in the locality.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

There is no recovery plan for these 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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

Threats to the survival of the species include:

- The depletion of food resources as a result of clearing of moist and dry forests thus reducing survival and reproduction. Small scale clearing, such as during roadwork and fence construction, continues to destroy habitat and it would be decades before revegetated areas supply adequate forage sites.
- The loss of old hollow bearing trees has reduced nest sites, and increased competition with other native and exotic species that need large hollows with small entrances to avoid predation. Felling of hollow trees for firewood collection or other human demands increases this competition.
- The Gang-gang Cockatoo is susceptible to *Psittacine cirovirus* disease (PCD) (McDonald 2004). This disease is known to have increased near Bowral in the southern highlands of New South Wales over the past decade (McDonald 2004). It is spread through contaminated nest chambers and constitutes a further threat to the species

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 proposed upgrade. The main key threatening processes relevant to this community that are directly enacted by the proposed upgrade are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	Potential	
Pathogens			
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi*	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Large Forest Owls

Direct and indirect impacts

The following species have been assessed:

Species	Status	
Powerful Owl (*Ninox strenua*)	Vulnerable	Potential to occur across all sites
Masked Owl (*Tyto novaehollandiae*)	Vulnerable	Potential to occur across all sites
Sooty Owl (*Tyto tenebricosa*)	Vulnerable	Habitat restricted, may occur at OT5 and OT7

The open forest habitats typically have a high structural and floristic diversity with moderately to high abundance of shelter and prey resources for the Powerful Owl and Masked Owl and likely to be important for life-cycle activities including hunting and breeding. Turpentine-Ironbark Forest on shale caps in the Blue Mountains has been identified as a rich habitat for hollow-dependent fauna including the Powerful Owl (NSW Scientific Committee 2000). The Sooty Owl is known from the Blue Mountains area where it is associated with moist forest habitats is steeper gorges, similar to the habitat found at the western end of OT7 to the north and south of the site.

Impacts to these species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging, shelter and breeding habitat (large hollows).
- the indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality. Large tree hollows used for roosting and breeding were found to be very scarce.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is not considered important for the life-cycle of these birds, due to a lack of suitable nesting hollows.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat has some value for these species due to a lack of nesting hollows.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat has some value for these species due to a lack of nesting hollows.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat has limited value for these species due to a lack of nesting hollows.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is not considered important for the life-cycle of these birds due to a lack of nesting hollows.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat has very limited value for these species due to a lack of nesting hollows.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of these birds.

Cumulative impact

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.

Whilst Powerful Owl are known to roost by day in dense thickets of vegetation or foliage, the *Tyto* spp. (Sooty and Masked Owl) are more specialised hollow roosting species. The nesting requirements for all three species are also specialised being totally dependent on suitably large tree-hollows generally found in the trunks of tall and mature trees. Their dependence on this specific habitat feature restricts the 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 and sooty owl ranging from swamp forest to wet and dry sclerophyll, preferably in wet gullies for roosting and the masked owl favouring the more open forest and woodland types for foraging, particularly on the edge of open lands such as agricultural lands.

The proposal will result in the removal of about 3.25 hectares of potential foraging habitat for these species, supporting prey species such as possums and gliders, particularly for the Powerful Owl. Trees supporting larger trunk hollows suitable for large forest owls are present, although at low density. Suitable hollow trees are likely to be a common feature of the surrounding landscape in National Parks.

There is limited potential for mortality of owls from vehicle strike. Potential habitats in the locality are extensive within the National Parks and the small loss of potential foraging habitat associated with clearing of roadside vegetation 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.*

Assessment per project

The potential loss of habitat for Powerful Owl and Masked Owl associated with each study site is summarised below. The impacts for each site are equivalent and relate to the loss of potential habitat for prey species. There were no tree hollows observed in the footprint that would be suitable for nesting by large forest owls.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Cumulative impact

The proposal will result in the removal of about 3.25 hectares of foraging habitat for these species. Tree hollows potentially suitable as nesting habitat for large forest owls were present in low densities, although tree hollows would be present in the surrounding habitats, including tree hollows suitable for prey species are present and common in the surrounding landscape and are important to maintain prey populations, particularly for present Sugar Glider and Greater Glider.

Vegetation clearing for the proposal would be limited to vegetation on the roadside, these highly mobile species are adapted to moving across fragmented landscapes and the proposal would not isolated important habitat or result in a barrier to forest owls. Habitats in the study area 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. Therefore the habitat impacted by the proposal is considered unlikely to be highly important to these species.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

Threats to the survival of the species include:

- The loss of suitable foraging habitat as a result of clearing of moist and dry forests thus reducing survival and reproduction. Small scale clearing, such as during roadwork and fence construction, continues to destroy habitat and it would be decades before revegetated areas supply adequate forage sites.

- The loss of old hollow bearing trees has reduced nest sites, and increased competition with other native and exotic species that need large hollows with small entrances to avoid predation. Felling of hollow trees for firewood collection or other human demands increases this competition.

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 proposed upgrade. The main key threatening processes relevant to this community that are directly enacted by the proposed upgrade are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	Potential	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Little Lorikeet (Glossopsitta pusilla)

Direct and indirect impacts

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 will return to the nest area for short periods if there is some tree-flowering in the vicinity.

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, during May to September, raising clutches of three to five eggs (DECC 2008). They likely commence breeding at one year, and live for around 10 years in the wild.

Major threats to little lorikeets are loss of breeding sites and food resources from ongoing land clearing. Loss of nest trees from road-side verges, often associated with road works, remains an ongoing threat (DECC 2008).

The study area would constitute foraging and potentially breeding habitat as suitable hollows are present. The loss of feed trees would directly affect the species opportunity to feed and breed in the area, however the impact area is not considered a critical 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 habitat is expected to remain after completion of the project such that foraging, movement and other life-cycle attributes would not be impacted.

The project would remove up to 3.25 hectares including a mix of nectar-producing native shrubs and trees which provide potential foraging habitat. The habitat ranges from low to high and is distributed across each of the study sites assessed. The large majority of this potentially impacted foraging habitat comprises planted vegetation and potential impacts will be avoided where possible during construction.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

It is likely that the impacts of construction and operation of the project would include the loss of potential feeding habitat and breeding hollows caused by 1) direct clearing or damage to native vegetation during the construction phase and 2) edge effects during operation related to degradation of foraging habitat from increased light and noise/traffic disturbance.

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area to be impacted is not considered important for the life-cycle of the species in the locality.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species.

Cumulative impact

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, OEH 2011). 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 (OEH 2011). 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.

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 would also feed in other species such as melaleucas and mistletoes. The species breeds in tree hollows in living trees, during May to September, raising clutches of three to five eggs (OEH 2011). They likely commence breeding at one year, and live for around 10 years in the wild.

Major threats to little lorikeets are loss of breeding sites and food resources from ongoing land clearing. Loss of nest trees from road-side verges, often associated with road works, remains an ongoing threat (OEH 2011).

The study area would constitute as potential breeding habitat for the species as there are a moderate abundance of trees supporting suitable hollows in associated remnant habitats. Hollow bearing trees in the study area range from small to medium sized hollows and up to 163 hollow trees throughout the study area. The loss of feed trees such as flowering *Eucalyptus* and *Corymbia* species would directly affect the species opportunity to feed and breed in the area. Although there are only four recorded sightings of Little Lorikeet in the study locality, the study area has suitable habitat features to be considered as a critical area for the Little Lorikeet. The current potential for the species to occur based on the presence foraging and potential breeding habitat is expected to remain after completion of the project such that foraging, movement and other life-cycle attributes would not be impacted.

The project would remove up to 3.25 hectares including a mix of nectar-producing native shrubs and trees which provide potential foraging habitat, including a loss of up to 163 hollow bearing trees of which some provide suitable breeding habitat. The large majority of this potentially impacted foraging/breeding habitat comprises remnant native vegetation with abundant and widespread fauna habitat resources and impacts would be avoided and mitigated where possible during construction. The life cycle of the Little Lorikeet is unlikely to be adversely impacted by the project. Although a viable local population of Little Lorikeet has not been confirmed in the study area, it is likely that a large number of individuals would rely on foraging and breeding habitat in different times of the year. The loss of this habitat would not place this species at risk.

(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.*

In considering the potential habitat for the Little Lorikeet, it is likely that moist and dry forests consisting of *Eucalyptus* and *Corymbia* tree species would provide opportunities for foraging. A moderate abundance of hollow bearing trees provide potential breeding habitat in the study area. The extent of clearing for each site is shown below. These totals are very small in the context of the large expanses of habitat present throughout the locality and the wide ranging habits of the species.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for this species		**no**	**no**	**no**	**no**	**no**	**no**	**no**	**no**	

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road; however the Little Lorikeet is a highly mobile species adapted to

moving across forest clearings such as roads to access foraging and breeding habitat and are unlikely to be significantly impacted by the barrier effect of the road. The extent of habitat to be removed is likely to reduce the availability of flowering tree resources and number of suitable nesting hollows. However considering the large area of protected foraging and breeding habitat for Little Lorikeet in adjoining vegetation, the project is unlikely to significantly impact 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).

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

There are no recovery plan actions or threat abatement plans associated with the protection of the Little Lorikeet.

(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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

Threats to the survival of the species include:

- The depletion of food resources as a result of clearing of moist and dry forests thus reducing survival and reproduction. Small scale clearing, such as during roadwork and fence construction, continues to destroy habitat and it would be decades before revegetated areas supply adequate forage sites.

- The loss of old hollow bearing trees has reduced nest sites, and increased competition with other native and exotic species that need large hollows with small entrances to avoid predation. Felling of hollow trees for firewood collection or other human demands increases this competition.

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 proposed upgrade. The main key threatening processes relevant to this community that are directly enacted by the proposed upgrade are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	Potential	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Square-Tailed Kite Lophoictinia isura

Direct and indirect impacts

This species occurs across most of NSW and covers a broad area of the coastal and sub-coastal region, frequented open forest and woodlands on fertile soils with abundant prey species (Debus et al. 1993; Marchant and Higgins 1993). On the coast, the species appears to prefer the drier forest types on the foothills and coastal plains. Records appear to be associated with the extensive dry sclerophyll forest habitats on low hills.

No nest sites were located within the study area. There are no published accounts of nesting by these species in the vicinity of the project. The project is unlikely to have a significant impact on breeding activities of local populations, however the clearing of vegetation could impact on the habitat of prey species and roosting habitat. Similar and suitable habitats for prey species are common and widespread in the region and the impacts on this life-cycle activity are expected to be minimal.

Impacts to the species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging, and roosting habitat.
- the indirect impacts through potential introduction of invasive weeds into the adjoining habutat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat is widespread beyond the edges of the road.

Assessment of Significance

(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.

Assessment per project

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality. No nests present.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area to be impacted is not considered important for the life-cycle of the species in the locality. No nests present.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No nests present.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No nests present.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality. No nests present.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would

occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality. No nests present.

SW9 and **SW12:** A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species. No nests present.

Cumulative impact

This species occurs across most of NSW and cover a broad area of the coastal and sub-coastal region, frequented open forest and woodlands on fertile soils with abundant prey species (Debus et al. 1993; Marchant and Higgins 1993). On the coast, these species appear to prefer the drier forest types on the foothills and coastal plains. Records appear to be associated with the extensive dry sclerophyll forest habitats on low hills.

No nest sites were located within the study area. There are no published accounts of nesting by these species in the vicinity of the project. Further surveys are recommended prior to construction. The project is unlikely to have a significant impact on breeding activities of local populations, however the clearing of vegetation could impact on the habitat of prey species and roosting habitat. Similar and suitable habitats for prey species are common and widespread in the region and the impacts on this life-cycle activity are expected to be minimal.

(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.*

Assessment per project

The Square-tailed Kite is known to occur in a variety of dry woodland and open forest habitats, it has a particular preference for timbered watercourses. This species is considered to have a large hunting range of greater than 100 kilometres squared. Therefore the very minor losses of vegetation associated with each project are small in relation to the extent of habitat and not considered important.

Habitats are widespread throughout the region particularly in the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road; however this bird of prey is wide-ranging, highly mobile species adapted to moving across forest clearings such

as roads to access foraging and breeding habitat and are unlikely to be significantly impacted by the barrier effect of the road.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for this species		**no**	**no**	**no**	**no**	**no**	**no**	**no**	**no**	

Cumulative impact

The extent of habitat to be removed is likely to reduce the availability of foraging resources. However considering the large area of protected foraging and nesting habitat in adjoining vegetation, the project is unlikely to significantly impact 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).

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

There is no recovery plan for these species. However there are a few activities to assist this species listed below:

- Protect known habitat from fires of a frequency greater than that recommended for the retention of biodiversity.
- Retain and protect nesting and foraging habitat, particularly along watercourses.
- Report suspected illegal bird shooting and egg-collecting to OEH

(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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 would increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Spotted-tailed Quoll Dasyurus maculatus

Direct and indirect impacts

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 large forest reserves in the locality (ie National Parks north and south of study area). The project would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat.

Construction of the proposal would result in the loss of about 3.25 hectares of potential habitat. The study area also contains some small areas of rock outcrops to the west in ridgetop woodland. The proposal may displace or disturb a small number of individuals but would only be a temporary and short duration impact that is unlikely to impact local populations.

Impacts to the species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging, shelter and breeding habitat.
- the indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality. No potential den sites present.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area to be impacted is not considered important for the life-cycle of the species in the locality. No potential den sites present.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No potential den sites present.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No potential den sites present.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality. No potential den sites present.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality. No potential den sites present.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species. No potential den sites present.

Cumulative impact

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 large forest reserves in the locality (ie National Parks north and south of study area). The project would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat.

Construction of the proposal would result in the loss of about 3.25 hectares of potential habitat. The proposal would potentially impact up to 163 hollow-bearing trees, mainly from near edges of woodland and open forest. The study area also contains some small areas of rock outcrops to the west in ridgetop woodland. The proposal may displace or disturb a small number of individuals but would only be a temporary and short duration impact that is unlikely to impact local populations.

(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.*

Impact per project

The proposal would not create new gaps or further fragment habitat for these species to the degree that any areas become isolated. Given the large area of habitat present in the locality the proposal is unlikely disrupt the breeding cycle of any local populations of this species. The impact of each project is equivalent is regards to the small loss of potential habitat for prey species and potential impacts on movements across the road. Details of the area cleared and fragmentation effect are described below. None of the sites is considered important habitat for the species given the location adjacent to the road and the lack of potential den sites.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for the species		**no**	**minor**	**no**	**no**	**no**	**minor**	**no**	**no**	

Cumulative impact

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road which may result in an increase in the number of vehicle strike, particularly if concrete road barriers provide no means of escape for animals on the road. However the species would not be significantly impacted by the barrier effect of the road.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 would need to be considered in this project with the provision of dedicated underpass structures targeting 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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 proposed upgrade. The main key threatening processes relevant to this community that are directly enacted by the proposed upgrade are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Grey-headed Flying-fox (Pteropus poliocephalus)

Direct and indirect impacts

There have been no roost camps identified in the project boundary to date and the project would not directly impact on any known breeding / maternity site.

Therefore it is likely that the impacts of construction and operation of the project would be confined to loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where possible. Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. A number of tree species identified in the project boundary are significant food plants for the blossom diet of the Grey-headed Flying-fox and include *Syncarpia glomulifera*, *Corymbia gummifera* and *Eucalyptus deanei* (Eby and Law 2008). Potential habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. A known roost camp is located at Yarramundi about 15 kilometres east of the study area. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and known roost camps in the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). Given the relative widespread nature of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to significantly affect the life cycle of the species.

Impacts to this species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging habitat.
- the indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Assessment of Significance

(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.

Assessment per project

It is likely that the impacts of construction and operation of the project would include the loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality. No roost camps identified.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area

to be impacted is not considered important for the life-cycle of the species in the locality. No roost camps identified.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No roost camps identified.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No roost camps identified.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality. No roost camps identified.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality. No roost camps identified.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species. No roost camps identified.

Cumulative impacts

There have been no roost camps identified in the project boundary to date and the project would not directly impact on any known breeding / maternity site.

Therefore it is likely that the impacts of construction and operation of the project would be confined to loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where possible. Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. A number of tree species identified in the project boundary are significant food plants for the blossom diet of the Grey-headed Flying-fox and include *Syncarpia glomulifera*, *Corymbia gummifera* and *Eucalyptus deanei* (Eby and Law 2008). Potential habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. A known roost camp is located at Yarramundi about 15 kilometres east of the study area. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and known roost camps in the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). Given the relative widespread nature of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to significantly affect the life cycle of the 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.*

Assessment per project

In considering the potential habitat for the Grey-headed Flying-fox in this locality, it is likely that moist and dry forests consisting of Eucalyptus and Corymbia tree species would provide opportunities for foraging. In addition to fruit orchards, which will not be impacted.

The extent of clearing for each site is shown below. These totals are very small in the context of the large expanses of habitat present throughout the locality and the wide ranging habits of the species. None of the areas to be cleared represent important habitat.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for this species		**no**	**no**	**no**	**no**	**no**	**no**	**no**	**no**	

Cumulative impact

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. A number of tree species identified in the project boundary are significant food plants for the blossom diet of the Grey-headed Flying-fox and include *Syncarpia glomulifera*, *Corymbia gummifera* and *Eucalyptus deanei* (Eby and Law 2008). These food plants occur in Map Unit 1 and 2 consisting of 3.14 hectares of proposed habitat removal. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and roost camps within the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). Given the relative widespread nature of higher quality foraging habitat within the

feeding range of regional populations, the project is not expected to significantly affect the life cycle of the species.

The species occurs from Bundaberg in Queensland to Melbourne in Victoria and is not at the limit of its distribution in the study area.

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road; however the Grey-headed Flying-fox is a highly mobile species adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the road.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

Any impacts from change of habitat condition associated with altering disturbance regimes in proximity to the road may be offset by their ability to move widely throughout the landscape and access disturbed and fragmented habitats. The habitat to be removed 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).

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

(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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 proposed upgrade. The main key threatening processes relevant to this community that are directly enacted by the proposed upgrade are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	Potential	
Weeds			
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act	Potential	
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Tree-roosting microbats

Direct and indirect impacts

The following species are assessed:

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

Impacts to tree roosting bats associated with the eight study sites relate to the direct removal of potential foraging, shelter and breeding habitat. Up to 163 habitat trees may be impacted.

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

Impacts to tree roosting bats associated with the eight study sites are equivalent and relate to the direct removal of potential foraging, shelter and breeding habitat including the expected clearing of hollow-bearing trees. The extent of removal of vegetation varies at each site and may impact on the density and abundance of insect prey. Aquatic habitats which may assist in insect breeding will not be impacted.

The potential loss of habitat for tree-roosting bats associated with each study site is summarised below, and the number of hollow-bearing trees recorded in 20 metres of the road edge which may be impacted. The highest number of hollow-bearing trees was reported in OT3 and associated with a narrow strip of vegetation in the road reserve where underscrubbing is conducted.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
No. of hollow-bearing trees		**15**	**29**	**42**	**26**	**26**	**25**	**-**	**-**	**163**

Cumulative impacts

Vegetation in the study area provides suitable foraging and roosting habitat for the assessed species. These bat species frequently use a variety of habitat types including disturbed habitats, forests and woodlands and would occur widely throughout the locality

Important life-cycle activities include roosting and breeding and both are typically associated with tree hollows as well as foraging for insect prey which occurs in a variety of habitat types. Breeding habitat for insect prey includes a very diverse range of wetlands, swamps and open modified and artificial landscapes. These habitats would not be impacted by the proposed activities.

The size of local populations is not known, however they are likely to be in high abundance considering the presence moderate-high condition habitat adjoining large areas of protected remnant native vegetation. Hollow bearing trees in the study area range from small to medium sized hollows in moderate abundance (163 hollow trees) and decorticating bark was observed in several trees in the study area.

Potential impacts to the life-cycle activities of these bat species mainly relates to disruption of breeding activities and shelter or dormancy activities and removal of roosting habitats leading to increased local competition for hollows. These potential roosting habitats are considered to have high habitat value.

The project would remove up to 3.25 hectares of suitable foraging and roosting habitat, including a loss of up to 163 hollow bearing trees which provide suitable roosting habitat. Although viable local populations of tree roosting bat species have not been confirmed in the study area, it is likely that a large number of individuals would rely on foraging and roosting habitat at different times of the year.

Roost sites are often used seasonally and require assessments over a number of seasons to determine roost site importance. Retaining suitable roost sites including surrounding vegetation is important for protecting bat species (DECC 2007). The potential loss of 163 hollow bearing trees would not place these species' at risk of extinction but would disrupt the breeding life cycle of any existing local populations. This is due to the density of hollow-bearing trees which occurs throughout the adjoining landscape.

With a moderate abundance of preferred roosting habitat attributes mitigation measures are necessary and include avoiding clearance of potential roosting habitats, pre-clearance surveys and staged habitat removal. With mitigation measures in place, there is still likely to be a loss of potential roost sites and may result in a negative impact to the life cycle of local populations. However as a large majority of the locality comprises of remnant native vegetation with widespread foraging and roosting habitat, impacts to the life cycle of tree roosting bats are unlikely to be significant.

(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.*

Assessment per project

Impacts to tree roosting bats associated with the eight study sites are equivalent and relate to the direct removal of potential foraging, shelter and breeding habitat including the expected clearing of hollow-bearing trees. The extent of removal of vegetation varies at each site and may impact on the density and abundance of insect prey. Aquatic habitats which may assist in insect breeding will not be impacted.

The potential loss of habitat for tree-roosting bats associated with each study site is summarised below, and the number of hollow-bearing trees recorded in 20 metres of the road edge which may be impacted. The highest number of hollow-bearing trees was reported in OT3 and associated with a narrow strip of vegetation in the road reserve where underscrubbing is conducted.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
No. of hollow-bearing trees		**15**	**29**	**42**	**26**	**26**	**25**	**-**	**-**	**163**

Each project would involve widening of the road corridor, although this activity is not expected to fragment habitat for these highly mobile species. The habitat to be removed does exhibit important values for tree-roosting bats as it is likely to contribute to the availability of foraging and roosting habitats for local populations. Given the small scale clearing at each site, and the position of the habitat in the road edge, in addition to the wide distribution of suitable habitat in the surrounding landscape, it is likely that local population are very widespread. In this regard the narrow road reserve impacted is unlikely to constitute important habitat in the broader context.

Cumulative impact

Removal of potential foraging habitat includes 3.25 hectares of moist and dry forest and up to 163 hollow bearing trees of suitable roosting habitat. None of these tree roosting threatened bat species are at the limit of their distribution in the project study area. Habitats are widespread throughout the region particularly in the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road; however the insectivorous bats are wide-ranging, highly mobile species adapted to moving across forest clearings such as roads to access foraging and breeding habitat and are unlikely to be significantly impacted by the barrier effect of the road. The extent of habitat to be removed is likely to reduce the availability of foraging resources and number of suitable nesting hollows. However considering the large area of protected foraging and roosting habitat for insectivorous bats in adjoining vegetation, the project is unlikely to significantly impact the long term survival of the species.

The range of disturbance regimes that currently exists in the study area, and the evolutionary adaption of species to these disturbances, has been influenced by the historical and current land-uses. For example

processes such as seasonal weed invasions, interruption to surface and groundwater flow, nutrient inputs into aquatic systems can result in the creation of habitat for insect prey species creating potential foraging habitat resources for microbat species. The project has potential to affect these current disturbance regimes, however existing high condition vegetation in the locality reduces the risk of weed invasion and increases recovery rates compared to low condition vegetation. The proposal is unlikely to substantially exacerbate these disturbance regimes.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 minimise ecological impacts, such as minimising the size of fill batters where appropriate, avoiding hollow tree removal where possible during construction, the re-establishment of native vegetation and provision of nest boxes and re-use of hollows, 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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 would increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Cave-roosting microbats

Direct and indirect impacts

The following cave-roosting bat species are assessed:

Species	Status – TSC Act
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	V
Southern Myotis (*Myotis macropus*)	V
Eastern Cave Bat (*Vespadelus troughtoni*)	V

The potential loss of habitat for cave-roosting bats associated with each study site is summarised below. The total loss is around 3.25 hectares of remnant vegetation in various states of condition combined across all of the sites within this proposal.

Impacts to cave-roosting bats associated with the eight study sites relate to the:

- direct removal of potential foraging habitat, as there are no cave roosting opportunities in the project area
- indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

Impacts to cave-roosting bats associated with the eight study sites are equivalent and relate to the direct removal of potential foraging habitat as there are no cave-roosting opportunities in the project areas. The extent of removal of vegetation varies at each site and may impact on the density and abundance of insect prey. Aquatic habitats which may assist in insect breeding will not be impacted.

The potential loss of habitat for cave-roosting bats associated with each study site is summarised below. The small loss of habitat at each site is associated with the road reserve or fragmented areas and the loss is not expected to have a significant impact on the foraging life-cycle activities of these species, particularly in the context of the widespread extent of similar habitats throughout the locality.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Cumulative impact

Vegetation in the study area provides potential foraging habitat for the assessed species only, no cave-roosting habitats have been identified. Inspection of culverts beneath the road revealed no roosting bats. These bat species frequently use a variety of habitat types including disturbed habitats, forests and woodlands. Important life-cycle activities include roosting and breeding and both are typically associated with caves and artificial structures as well as foraging for insect prey which occurs in a variety of habitat types. Breeding habitat for insect prey includes a very diverse range of wetlands, swamps and open modified and artificial landscapes.

The size of local populations is not known, although expected to be considerably large considering the high quality of surrounding vegetation and habitats in the locality. Impacts to these habitats would impact on the potential breeding habitat for prey species (invertebrates), however any potential overall reductions to the abundance of prey species is likely to be minimal, considering the widespread nature of these habitats in the locality and minimal impacts associate with the proposal.

The project would impact on up to 3.25 hectares of foraging habitat comprising a combination of all identified map units. This includes indirect impacts from increased light and removal of vegetation where required, however foraging attributes are unlikely to be substantially modified. These habitats are widespread and very common throughout the wider region and the project would have minimal impact on foraging life-cycles.

Potential impacts to the life-cycle activities of these bat species mainly relates to disruption of breeding activities and shelter or dormancy activities and removal of roosting habitats. Potential roost sites may include cavities in the existing bridge structures, culverts, buildings, and other structures. Impacts to these potential roosting habitats are not expected and any potential impacts from construction would be identified during the pre-clearance surveys.

Mitigation measures will include avoiding disturbance of potential roosting habitats, pre-clearance surveys and staged habitat removal. Considering the limited potential impact to preferred roosting habitats and the proposed mitigation measures the proposal is unlikely to result in a negative impact to the life cycle of these 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.*

Assessment per project

Impacts to cave-roosting bats associated with the eight study sites are equivalent and relate to the direct removal of potential foraging habitat. The extent of removal of vegetation varies at each site and may impact on the density and abundance of insect prey. Aquatic habitats which may assist in insect breeding will not be impacted. The loss of habitat per project and the condition of the habitat is described below.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Each project would involve widening of the road corridor, although this activity is not expected to fragment habitat for these highly mobile species. The habitat to be removed does exhibit important values for cave-roosting bats as it is likely to contribute to the availability of foraging habitat for local populations. Given the small scale clearing at each site, and the position of the habitat in the road edge, in addition to the wide distribution of suitable habitat in the surrounding landscape, it is likely that local populations are very widespread. In this regard the narrow road reserve impacted is unlikely to constitute important habitat in the broader context.

Cumulative impact

The project would impact on up to 3.25 hectares of foraging habitat comprising a combination of all identified map units. This includes indirect impacts from increased light and removal of vegetation where required, however foraging attributes are unlikely to be substantially modified. These habitats are widespread and very common throughout the wider region and the project would have minimal impact on foraging life-cycles.

The range of disturbance regimes that currently exists in the study area, and the evolutionary adaption of species to these disturbances, has been influenced by the historical and current land-uses. For example processes such as seasonal weed invasions, interruption to surface and groundwater flow, nutrient inputs into aquatic systems can result in the creation of habitat for insect prey species creating potential foraging habitat resources for microbat species. The project has potential to affect these current disturbance regimes, however existing high condition vegetation in the locality reduces the risk of weed invasion and increases recovery rates compared to low condition vegetation. The proposal is unlikely to substantially exacerbate these disturbance regimes.

None of these threatened bat species are at the limit of their distribution in the project study area. Habitats are widespread throughout the region particularly further south and north of the study area throughout the wider region.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 would increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Arboreal mammals

Direct and indirect impacts

The following species are assessed:

Species	Status – TSC Act
Yellow-Bellied Glider (*Petaurus australis*)	V
Squirrel Glider (*Petaurus norfolcensis*)	V
Eastern Pygmy Possum (*Cercartetus nanus*)	V

The potential loss of habitat associated with each study site is summarised below. The total loss is around **3.25 hectares** of remnant vegetation in various states of condition combined across all of the sites within this proposal. Impacts to these mammals associated with the eight study sites relate to the:

- direct removal of potential foraging, shelter and breeding habitat. Up to 163 hollow-bearing trees may be impacted and a portion of these provide potential den sites.
- indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Yellow-bellied Glider

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 proposal would involve the removal of about 3.25 hectares of potential foraging including a loss of up to 163 hollow bearing trees which provide potential nesting habitat. Tree hollows occur in moderate densities throughout the surrounding landscapes, and habitat for this species is particularly well represented within the adjoining National Parks. The potential impact to habitat represents a low proportion of habitat within the surrounding landscape and would be significantly less when considering the extent of potential habitats in the wider region.

Potential habitat occurs in the study area, and is widespread and common. The removal of remnant vegetation and existing edge areas is not expected to significantly impact on the life-cycle of local populations.

Squirrel Glider

The Squirrel Glider requires abundant tree hollows for refuge and nest sites, with family groups utilising a number of hollows within their home range (DEC 2005). Hollows used by Squirrel Gliders are small (about 5 cm diameter). The Squirrel Glider requires a mix of eucalypts, banksias and acacias for foraging (DEC 2005). Its diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein (DEC 2005).

Potential foraging and nesting habitat throughout the study area and is widespread and common. The removal of remnant vegetation and existing edge areas is not expected to significantly impact on the life-cycle of local populations.

Eastern Pygmy Possum

The Eastern Pygmy Possum occurs in a range of habitats from rainforest through sclerophyll forests and woodlands to heath, though heath and woodland habitats are preferred through most of its range. It feeds on nectar and pollen from eucalypts, banksias and bottlebrushes and occasionally on insects (DEC 2005). It is known to nest in hollows in trees but its small size also allows it to nest in a variety of places, including under the bark of eucalypts, forks of tea-trees, and in abandoned bird nests (Turner and Ward 1995). It shelters during the day in tree hollows, rotten stumps, and holes in the ground, abandoned bird nests, possum dreys or thickets of vegetation, including the bases of grasstrees or waratahs. Males have non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares.

Shrubby woodland habitats at the site contain potential habitat for this species, however there are no records within the locality. Habitats at the site would represent only a minor proportion of the habitat available to any individuals resident in the locality. Potential habitat occurs as intact dry sclerophyll forest where there is a mid-storey nectar resource. Potential foraging and nesting habitat throughout the study area and is widespread and common. The removal of remnant vegetation and existing edge areas is not expected to significantly impact on the life-cycle of local populations.

Mitigation measures will include avoiding disturbance of potential habitats, pre-clearance surveys and staged habitat removal.

Assessment of Significance (EP&A Act)

(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.

Assessment per project

It is likely that the impacts of construction and operation of the project would include the loss of potential feeding habitat and potentially shelter/breeding hollows (dens) caused by 1) direct clearing or damage to native vegetation during the construction phase and 2) edge effects during operation related to degradation of foraging habitat from increased light and noise/traffic disturbance.

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality. Up to 15 habitat trees were identified, however these were planted pine trees along the boundary fence of OT1 that were killed in a fire. The hollows in these trees are mostly small and associated with cracks and loose bark which have limited value for arboreal mammals.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area to be impacted is not considered important for the life-cycle of the species in the locality. The clearing may also remove up to 29 habitat trees comprising a range of small to large hollows, with a high probability of use by arboreal mammals, particularly the Sugar Glider which was recorded at this site.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. The clearing may also remove up to 42 habitat trees, which contain a diversity small, to large hollows, with a high probability of use by arboreal mammals.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. The clearing may remove up to 26 hollow-bearing trees, which contain a high proportion of small hollows.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality. The clearing may remove up to 26 hollow-bearing trees, which contain a diversity of small to large hollows.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality. The clearing may remove up to 25 hollow-bearing trees which are dominated by medium and small hollows suited to the Squirrel Glider and Eastern Pygmy Possum.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species.

Cumulative impact

It is evident that potential habitat for these arboreal mammals occurs in the study area, and that comparable habitats are very widespread and common. The removal of remnant vegetation from the existing edge areas of these larger patches is not expected to significantly impact on the life-cycle of local populations.

(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.*

Assessment per project

Impacts to arboreal mammals associated with the eight study sites are likely to be similar and relate to the direct removal of potential foraging, shelter and breeding habitat including the expected clearing of hollow-bearing trees. The extent of removal of vegetation varies at each site as does the condition of the vegetation, and impacts may be more evident at OT2, OT3, OT5 and OT7 than at OT1 and OT6, this is due to the extent of habitat removal and the degree of connectivity with habitat outside the project corridor.

The loss of habitat will occur along the edge of larger fragments of vegetation or impact on isolated road reserve remnants, and is not expected to cause fragmentation of habitat for these species. The potential loss of habitat for these arboreal mammals associated with each study site is summarised below, and the number of hollow-bearing trees recorded in 20 metres of the road edge which may be impacted. The highest number of hollow-bearing trees was reported in OT3 and associated with a narrow strip of vegetation in the road reserve where underscrubbing is conducted, and this location is not considered of high quality for Yellow-bellied Glider, due to the very small size of the hollows.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
No. of hollow-bearing trees		**15**	**29**	**42**	**26**	**26**	**25**	**-**	**-**	**163**

Each project would involve widening of the road corridor, although this activity is not expected to fragment habitat for these species. The habitat to be removed does exhibit important values for arboreal mammals as it is likely to contribute to the availability of foraging and denning habitat for local populations. Given the small scale clearing at each site, and the position of the habitat in the road edge, in addition to the wide distribution of suitable habitat in the surrounding landscape, it is likely that local population are widespread. In this regard the narrow road reserve impacted is unlikely to constitute important habitat in the broader context.

Cumulative impact

Yellow-bellied Glider

Habitats within the study area may be important for any potential local population of Yellow-bellied Glider. Considering the small proportion of habitat being removed relative to available habitats in the locality, it is unlikely that the proposal would lead to a long term decline in the species.

Movement and dispersal across canopy gaps such as roads are important for this species to forage habitats. The proposal would increase the width of road and may have a negative effect on movement if the distance exceeds gliding mammal ability glide across canopy gap.

Squirrel Glider

Habitats within the study area may be important for any potential local population of Squirrel Glider. Considering the small proportion of habitat being removed relative to available habitats in the locality, it is unlikely that the proposal would lead to a long term decline in the species.

Movement and dispersal across canopy gaps such as roads are important for this species to forage habitats. The proposal would increase the width of road and may have a negative effect on movement if the distance exceeds gliding mammal ability glide across canopy gap.

Eastern Pygmy Possum

Shrubby woodland habitats at the site contain potential habitat for this species, however there are no records within the locality. Habitats at the site would represent only a minor proportion of the habitat available to any individuals resident in the locality. Potential habitat occurs as intact dry sclerophyll forest where there is a mid-storey nectar resource. Potential foraging and nesting habitat throughout the study area and is widespread and common. Although a viable local population of this species has not been confirmed in the study area, if a population did occur along the roadside the road widening would impede species movement. However considering the small area of home ranges for this species it is unlikely that any local population would affect the long term survival of this species.

Mitigation measures will include avoiding disturbance of potential habitats, pre-clearance surveys and staged habitat removal.

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

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

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 would increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Red-crowned Toadlet *Pseudophryne australis*

Direct and indirect impacts

A small area of perched swamp or 'hanging' swamp was located at the western end of OT7 on the southern side of the road on top of the road cutting. The swamp has formed from seepage of groundwater from the sandstone slope. This habitat is outside of the area of impact and not expected to be indirectly impacted due to its elevated position. The site was small (less than 100 square metres and formed by seepage of groundwater along the ridgetop. The habitat comprised wet ground layer and dense cover of sedges. The Red-crowned Toadlet (*Pseudophyrne australis*) (vulnerable TSC Act) was reported in this habitat. No other areas of hanging swamp were identified from any of the sites.

Assessment of Significance

(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.

Assessment per project

The species and potential habitat was only identified at OT7.

A habitat specialist occurring only on sandstone formations of the Sydney Basin, generally within 100m of ridge tops. The species prefers ephemeral 'feeder creeks', permanently moist soaks and seepage zones. When not breeding, individuals are still largely restricted to the vicinity of breeding areas, dispersing only in the order of tens of metres. Breeding may occur year-round depending on weather conditions. Eggs are laid in nests of decomposing leaf matter and are flushed by rainfall events into transient pools where tadpoles complete their development (National Parks and Wildlife Service 2001). Water quality is particularly important for this species.

Confirmed habitat for this species was located on steep rocky outcrops in ridgetop woodland at the western extent of the study area. This habitat occurs where water seepage has created of small moist areas of isolated swamps on the top of sandstone. The proposal has avoided works in within and around these habitats and

would not affect their quality or ability to function. Therefore disruption to the life cycle of this species is unlikely and would not 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.*

Confirmed habitat and identified species was located on steep rocky outcrops in ridgetop woodland at the western extent of the study area. This habitat occurs where water seepage has created small moist areas of isolated swamps on the top of sandstone. The proposal has avoided works in within and around these habitats and would not affect their quality or ability to function. Therefore, no habitat vital to this species would be removed or fragmented as part of the proposal. The identified habitat is highly important for the survival of the viable local population, but the proposal would not impact on 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).

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW.

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

The assessment of impacts to recovery of the species is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

There is no recovery plans for these species however there are 15 priority action statements for each of species related to scientific research, community awareness and protection of these species. Considering the zero impact to habitat for these species and the proposed avoidance 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.

The assessment of key threatening processes is considered in the context of the cumulative impacts for all 8 projects, as each project will have identical impacts in this regard.

Key threatening processes that are relevant to these species are listed below.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Removal of dead wood and dead trees	TSC Act	Yes	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

B.2 Environment Protection and Biodiversity Conservation Act, 1999

Turpentine-Ironbark Forest in the Sydney Basin Bioregion (Critically Endangered)

Direct and indirect impacts

Impacts to TIF associated with the eight study sites relate to the:

- direct removal of vegetation to accommodate the design of the overtaking lane and safety works.
- indirect impacts through potential introduction of invasive weeds and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).
- to a lesser degree there is potential for run-off impacts, although most areas are on low gradients and it unlikely that run-off would be a major issue.

The cumulative removal of vegetation for the eight projects equates to around 3.14 hectares of moderate to high condition BMSCF. This is in addition to 0.47 hectares cleared for overtaking lane 4 (total cumulative impact 3.61 hectares). The loss of vegetation for each site is shown below.

Threatened Ecological Community	Status	Site and Area (ha)								Total loss
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
Turpentine Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered, EPBC Act	-	0.60	1.14	0.15	0.16	0.07	-	-	**2.12 ha**

Assessment of Significance

Reduce the area of occupancy of the community

Assessment per project

The majority of the TIF ecological community comprises higher condition intact areas of remnant vegetation occurring within larger patches (greater than one hectare). These areas have been subject to edge effects from the presence of the existing Bells Line of Road resulting in minor weed invasion and altered vegetation structure and floristics that are common along all edge areas. Disturbed areas including isolated trees, underscrubbed vegetation and smaller fragments have been excluded from the federal listing.

The project will reduce the area of occupancy of the community. The community is widespread in proximal areas to the Bells Line of Road and the extent of clearing for each site identified below represents a small proportion of the community in the locality.

Threatened Ecological Community	Status	Site and Area (ha)								Total loss
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
Turpentine Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered, EPBC Act	-	0.60	1.14	0.15	0.16	0.07	-	-	**2.12 ha**

Cumulative impact

The proposal would result in the removal of about two hectares of the community, comprising linear strips of vegetation along the edges of Bells Line of Road to accommodate the proposed upgrades. Measures to avoid and minimise clearing were adopted resulting in revised designs and reduction in vegetation loss.

Areas of this community have been extensively cleared in the locality for agricultural and residential purposes. About 0.47 hectares of the community has been recently cleared to accommodate the Site 4 overtaking lane, and therefore the overall Bells Line of Road upgrade program would potentially result in a cumulative impact of about 2.6 hectares to the ecological community.

The distribution of this community in the locality has been mapped in broad scale vegetation mapping projects by Tozer *et al.* (2010) and Bell (1998), which together cover the large majority of the locality. A total of 1,878 hectares of equivalent map units have been identified within a ten kilometre radius of the clearing footprint for the project. This total includes about 460 hectares of Sydney Turpentine Ironbark Forest (p87) and 535 hectares of Shale-Basalt Sheltered Forest (p168) which are equivalent map units as described by Tozer *et. al* 2010 which cover the southern portion of the locality. Bell (1998) has identified 883 hectares of Remnant Shale Cap Forest (F13) outside of the Tozer *et al.* (2010) study area. Additionally 613 hectares have been mapped by Bell (1998) to the north of the locality in Wollemi National Park. It is likely that some of these areas identified as the ecological community in the locality are degraded and would not be within the condition thresholds for the ecological community. Some areas are likely to have been cleared since these projects were undertaken.

The combined projects would reduce the area of occupancy of the community by about 2.6 hectares which represents about 0.14 per cent of the 1,878 hectares of the community within 10 kilometres of the proposal. Therefore based on the above estimates of the location distribution, the proposal would reduce the area of occupancy of the ecological community in the locality by an about 0.14 per cent. However considering that some of these areas identified as the ecological community in the locality are degraded and would not be within the condition thresholds for the ecological community this proportion of impact may be as high as 0.5 per cent assuming only 25 per cent of estimated local occurrence meets the federal definition for the critically endangered ecological community.

Fragment or increase fragmentation of an ecological community

Assessment per project

The clearing of TIF will occur along the edge of existing large patches and widen the road by several metres at each site. These activities will not cause substantial fragmentation at each site.

Cumulative assessment

The project would involve clearing along the edge of an existing road resulting in a wider corridor, however the increased corridor width is not expected to result in substantial fragmentation of the community resulting patches becoming isolated from other areas of connected habitat. Existing ecological processes such as pollination and seed dispersal are likely to be maintained across the widened road corridor.

Adversely affect habitat critical to the survival of an ecological community

There is no critical habitat listed under the EPBC Act or state legislation for this ecological community. Considering the critically endangered status of the ecological community and the highly restricted distribution of higher condition remnants, all areas that are consistent with the critically endangered ecological community could be considered critical to the survival. The proposal would impact about 2.6 hectares (including Site 4) of habitat critical to the survival of the community.

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

Assessment per project

On a site specific scale, the impacts to this community are minimal and involve linear clearing along the edge of larger patches, and all areas exhibit some edge effects. Additional edge effects could be expected, and associated with a potential change in the soil nutrient levels immediately adjacent to the road, associated with minor run-off from the road. There will be no significant changes to the surface hydrology or groundwater levels at these locations.

There is some potential for run-off impacts to occur at the western end of OT7 and OT3 given the steepness of the slope adjoining the road and the opportunity for alteration of surface water drainage. It may be possible to mitigate this impact and this is recommended.

Cumulative impact

From a cumulative impacts perspective, the loss is greater at 2.6 hectares (this includes Site 4) of the ecological community, however substantial indirect impacts due to modification of abiotic factors is not expected. Areas to be cleared are along existing edges of the road corridor and mostly on a flat gradient with limited surface water runoff expected into adjoining habitats. There will be an edge effect where surface water runs off the road and the extent of the impact is not known but may extend several metres where sloping ground occurs. Potential impacts would be mitigated during construction however long-term impacts associated with introducing nutrients are not expected to be mitigated.

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

Assessment per project

There is potential for a change in species composition associated with a new edge adjacent to the linear clearing. The extent of this disturbance will vary at each site, and is influenced by the presence of other clearings such as tracks and easements which are evident at all sites. Some minor edge effects could be expected at all sites and would be associated with invasion of weeds and native weeds such as *Pittosporum undulatum.* The change would not be substantial, being limited in scale, although would be long-term as mitigation is unlikely.

Cumulative impact

The cumulative direct Impacts will be a loss of 2.6 hectares (including Site 4) of the ecological community. There will be an additional indirect impact associated with a change a potential change to species composition along cleared edges and up to several metres from the edge of the road. The scale of this impact is larger at the cumulative impact scale as it would occur over several kilometres of the Bells Line of Road rather than one discrete area.

Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

-- assisting invasive species, that are harmful to the listed ecological community, to become established, or

-- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.

Assessment per project

There is potential for weed invasion associated with new edges adjacent to the linear clearing for each project. The extent of this disturbance will vary at each site, and is influenced by the presence of other clearings such as tracks and easements which are evident at all sites. Some minor edge effects could be expected at all sites and would be associated with invasion of weeds and native weeds such as *Pittosporum undulatum.* The change would not be substantial at the site scale, being limited in scale, although would be long-term as mitigation is unlikely.

Cumulative impact

The cumulative impact of all projects combined would be 2.6 hectares (including Site 4). At this scale the likely invasion of weeds into edge areas is more substantial. The scale of this impact is larger at the cumulative impact scale as it would occur over several kilometres of the Bells Line of Road rather than one discrete area.

There may be some frequent use of herbicides during routine vegetation maintenance and this would contribute to a cumulative impact on the condition of the vegetation in edge areas.

Interfere with the recovery of an ecological community.

No recovery plans specific to the ecological community in the locality have been produced. The Cumberland Plain Recovery Plan addresses recovery of the Cumberland Plain component only of the EPBC listed community. Priority actions identified for the equivalent state-listed community Blue Mountains Shale Cap Forest that are relevant to the project include:

- Protect remnants from further clearing.
- Prevent incursion of weeds into the community.
- Retain old trees as a source of hollows.

Considering the low potential for substantial indirect impacts such as weed invasion, the avoidance measures that have been undertaken to protect vegetation and hollow trees where possible and the proposed mitigation measures the proposal is considered unlikely to substantially interfere with the recovery of the ecological community.

Endangered fauna

Spotted-tailed Quoll

Direct and indirect impacts

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 large forest reserves in the locality (ie National Parks north and south of study area). The project would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat.

Construction of the proposal would result in the loss of about 3.25 hectares of potential habitat. The study area also contains some small areas of rock outcrops to the west in ridgetop woodland. The proposal may displace or disturb a small number of individuals but would only be a temporary and short duration impact that is unlikely to impact local populations.

Impacts to the species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging habitat.
- the indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road. No potential den sites were observed in the habitats to be removed.

Assessment of Significance (EP&A Act)

Lead to a long-term decrease in the size of a population

Assessment per project

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality. No potential den sites present.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area to be impacted is not considered important for the life-cycle of the species in the locality. No potential den sites present.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No potential den sites present.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No potential den sites present.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality. No potential den sites present.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality. No potential den sites present.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species. No potential den sites present.

Cumulative impact

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 large forest reserves in the locality (ie National Parks north and south of study area). The project would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat.

Construction of the proposal would result in the loss of about 3.25 hectares of potential foraging habitat. The study area also contains some small areas of rock outcrops to the west in ridgetop woodland. The proposal may displace or disturb a small number of individuals but would only be a temporary and short duration impact that is unlikely to impact local populations or result in a decrease in the size of a population.

Reduce the area of occupancy of the species

Impact per project

The proposal would not create new gaps or further fragment habitat for these species to the degree that any areas become isolated. Given the large area of habitat present in the locality the proposal is unlikely disrupt the breeding cycle of any local populations of this species. The impact of each project is equivalent is regards to the small loss of potential habitat for prey species and potential impacts on movements across the road. Details of the area cleared and fragmentation effect are described below. None of the sites is considered important habitat for the species given the location adjacent to the road and the lack of potential den sites.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for the species		**no**	**minor**	**no**	**no**	**no**	**minor**	**no**	**no**	

Cumulative impact

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road which may result in an increase in the number of vehicle strike, particularly if concrete road barriers provide no means of escape for animals on the road. However the species would not be significantly impacted by the barrier effect of the road.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

Fragment an existing population into two or more populations

Impact per project

The proposal would not create new gaps or further fragment habitat for these species to the degree that any areas become isolated. The impact of each project is equivalent is regards to the small loss of potential habitat for prey species and potential impacts on movements across the road. Details of the area cleared and fragmentation effect are described below.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for the species		**no**	**minor**	**no**	**no**	**no**	**minor**	**no**	**no**	

Cumulative impact

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road which may result in an increase in the number of vehicle strike, particularly if concrete road barriers provide no means of escape for animals on the road.

Adversely affect habitat critical to the survival of a species

Assessment per project

This impact is discussed below in the context of the cumulative impact, as each project will remove small linear areas of habitat along the edge of larger habitats, or small isolated patches in the road reserve.

Cumulative impact

While the habitats to be cleared that are adjoining the road may be suitable for occasional use by Spotted-tail Quoll, they are unlikely to constitute an area of habitat critical for the survival of the species. This is the case for each of the eight study sites.

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 but is unlikely to be used for breeding or denning. The impacts to vegetation in these areas would be along the edges of the exiting corridor, while potential habitat is very widespread through the surrounding area that may be considered critical for the species.

Disrupt the breeding cycle of a population

Assessment per project

This impact is discussed below in the context of the cumulative impact, as each project will remove small linear areas of habitat along the edge of larger habitats, or small isolated patches in the road reserve.

Cumulative impact

The proposed area of disturbance represents a very small fraction of the potential habitat for the species and any impacts to breeding individuals would be limited to a very small proportion of the population given the extensive areas of potential habitat in this location.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Highly unlikely, potential habitat is widespread and common surrounding the project corridor, and conserved within the nearby national parks.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

There are no recognised invasive species that are harmful to the assessed species. The potential for weed invasion into habitat of the species is considered possible with a project of this nature and appropriate controls are required during construction and operation to reduce this threat. The management of invasive species would be managed during the construction.

Introduce disease that may cause the species to decline

There are no currently no diseases affecting this species. Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the project has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat near the project. This can be mitigated through the development and implementation of suitable control measures.

Interfere with the recovery of the species.

The project \ would not conflict with the recovery plans for this species. The proposal involves minimal vegetation and habitat removal and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the project boundary.

Vulnerable Fauna

Koala (*Phascolarctos cinereus*)

Direct and indirect impacts

The extent and distribution of the Koala population near Bilpin is not known, although in relation to the project area the presence of Koalas along the Bells Line of Road was confirmed between Johnson Road in the east and Mountain Lagoon Road to the west (ie. OT3 and OT5) and associated with the presence of Grey Gum (*E.punctata*) which is patchy in the landscape. There was no evidence that Koalas were using other apparent Koala feed tree species Monkey Gum (*E.cypellocarpa)* or Mountain Gum (*E.deanei)* which were common at OT6 and OT7. The species may however occur at OT1 and OT2.

Therefore the evidence of Koala presence in the study area was found to be associated with the Blue Mountains Shale Cap Forest and Turpentine Ironbark Forest, although only where Grey Gum (*E.punctata*) was present and not widespread across these communities which may reflect the low density of the population. There was no evidence of Koala activity within the Blue Mountains Ridgetop Woodland dominated by Sydney Peppermint (*E.piperita*) and Silvertop Ash (*E.seiberi*) (OT6 and OT7). In addition to this, Koalas appear to be associated with forests comprising a higher proportion of shale or basalt soil and this may be associated with higher moisture or nutrient content in the leaves. Despite the low density and patchy occurrence of the Koala population and habitat resources for the species, the subject population would be considered an important population.

In assessing the impact of the proposal on habitat critical to the survival of the Koala, consideration was given to the referral guidelines (DoE 2013). It is concluded the impacts are unlikely to be adverse for the following reasons:

- The cumulative impacts of the proposed activity would clear around 3.14 ha of vegetation considered to be critical to the survival of koalas, mostly from OT3 (1.39 ha). The breakdown in potential loss of Koala habitat is based on the presence of Map Units 1 and 2 and not the distribution of the Koala population which is not known. The impact is therefore a worst case scenario and is as follows: OT1 (0.18 ha), OT2 (0.60), OT3 (1.38), OT5 (0.60 ha), OT6 (0.19), OT7 (0.13) and SW12 (0.06)

- Comparable Koala habitat associated with MU1 and MU2 is extensive to the north and south of the Bells Line of Road and well conserved within Wollemi and Blue Mountains National Park and as stated, koalas do not appear to be using all habitats associated with these communities and therefore the loss of vegetation is likely overstating the actual loss of Koala habitat.

- The habitat assessment tool has reported a high score of 8, confirming the presence of habitat critical to the survival of koalas, although the population is considered a low-density population (<0.01 koalas / ha).

- The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements. Of all the study sites, it is only OT2 that is considered to have some potential minor impacts to Koala movements, due to the presence of contiguous vegetation north and south of the road.

- The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening.

Assessment of Significance (EP&A Act)

Lead to a long-term decrease in the size of an important population

Assessment per project

OT1: impact on around 0.18 ha of potential habitat which was identified as secondary habitat (class 6) based on the low density of Mountain Mahogany (E.notabilis). There are no primary feed trees at this site, and the vegetation to be impacted exists along as isolated trees and small patches in the road reserve. The site is not considered important for life-cycle of the local population.

OT2: impact on around 0.60 ha, no Koala feed tree species were identified at OT2 or evidence of koalas and the site is not expected to be important for life-cycle of the local population.

OT3: impact on around 1.38 ha, no primary Koala feed trees (ie Monkey Gum) however a moderately high density of the secondary feed tree Grey Gum and evidence of Koalas reported on the south side of the road in this location, with habitat that is outside the impact areas. It is likely that the habitat off site, which continues to the south into very large areas of habitat for koalas, is important for the life-cycle of the local population. There may be a short-term impact to the movements of the Koala during the breeding season, however the impacts to the foraging life-cycle is minor.

OT5: impact to around 0.6 ha of potential habitat, this includes primary and secondary habitat, associated with the presence of two feed tree species, Monkey Gum (primary) and Grey Gum (secondary) and evidence of Koalas at this site. It is likely that the habitat is important for the life-cycle of the local population. There may be a short-term impact to the movements of the Koala during the breeding season, however the impacts to the foraging life-cycle is minor given the extensive areas of habitat north and south of the road.

OT6: impact to around 0.19 ha containing secondary habitat for koalas as determined by low densities of the secondary feed tree Mountain Mahogany (E.notabilis) and very low density of Grey Gum. The areas to be cleared are fragments of vegetation adjacent to the road and are not expected to be important for koalas

OT7: impacts to around 0.13 ha of primary and secondary habitat. Monkey Gum is only present at the eastern end of the site (primary habitat) and the remainder and majority of the habitat is secondary habitat or not classified as habitat for koalas. There was no evidence of koalas feeding in the road reserve habitats at OT7 and the habitat at OT7 is not expected to be important for life-cycles of the local population.

Cumulative impact

A low-density and widespread population is expected to be present in the locality and potentially occupy large expanses of habitat to the north and south of the study area and associated with the National Parks estates. Potential habitat is likely to be widespread beyond the clearing footprint areas. With the study area potential Koala habitat was found to be associated with Map unit 1 (Sydney Turpentine-Ironbark Forest) and Map Unit 2 (Blue Mountains Shale Cap Forest). There was no evidence of Koala activity associated with Map Unit 3 (Blue Mountains Ridgetop Sandstone Woodland). However, within these habitats and specifically in the study area close to the Bells Line of Road, Koala activity was reported in a relatively small area associated with a higher prevalence of shale and basalt soil influence located between Johns Road and Mount Lagoon Road, east of Bilpin. This habitat type was observed to extend north and south into the adjoining private properties and was not limited to the study area. The presence of koalas appeared to be associated with the presence of Grey Gum (*Eucalyptus punctata*) and the higher soil moisture levels in these sheltered locations.

There was no evidence that Koalas were using other apparent Koala feed tree species Monkey Gum (*E.cypellocarpa)* or Mountain Gum (*E.deanei)* in the study area. Therefore the evidence of Koala presence in the study area was found to be associated with the Blue Mountains Shale Cap Forest and Turpentine Ironbark Forest, although only where Grey Gum (*E.punctata*) was present and not widespread across these communities which may reflect the low density of the population. There was no evidence of Koala activity within the Blue Mountains Ridgetop Woodland dominated by Sydney Peppermint (*E.piperita*) and Silvertop Ash (*E.seiberi*).

The cumulative impacts of the proposed activity would clear around 3.08 ha of vegetation considered to be potential Koala habitat, mostly from OT3 (1.39 ha). The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements.

The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening. The project would impact on the home range and foraging resources of at least one Koala reported at OT5 and possibly a second individual to the east within OT3. However considering the widespread and extensive areas of similar habitat outside the road edge, the proposal is unlikely to result in a long-term decrease in the size of a local population.

Reduce the area of occupancy of an important population

Assessment per project

The results from the Koala scat search and habitat assessment at each site is provided in Appendix E. These data are summarised below. The extent to which habitat is removed for each project is also shown and this relates to the loss of MU1 and MU2, this is a conservative estimate considering that both vegetation types are known to contain Koala feed tree species, however the presence and density and the relative importance of each site for koalas varies as shown below.

Koala	OT1 (n=10)	OT2 (n=7)	OT3 (n=10)	OT5 (n=11)	OT6 (n=4)	OT7 (n=8)
Primary habitat	-	-	-	27 %		25 %
Secondary habitat (class A)	-	-	40%	27 %	75 %	
Secondary habitat (class B)	-	-	10%	18 %		12.5 %
Secondary habitat (class C)	60%	-	10%	18 %	25 %	25 %
Koala scats confirmed	-	-	Yes	Yes	-	-
Total loss (MU1 / MU2)	0.18 ha	0.60 ha	1.38 ha	0.60 ha	0.19 ha	0.13 ha
Fragmentation of habitat	No	Minor	No	No	No	Minor

OT3 and OT5: Important habitat is likely to be present at OT3 and OT5 given the high density of primary and secondary feed tree species and the known presence of koalas. However considerable large areas of potential habitat occur to the north and south of these sites and are contiguous with the areas being impacted. The clearing of habitat will occur along the edge of very large patches and is not expected to be a significant loss of feed trees for the local population.

OT1, OT2, OT6, and OT7: a mix of secondary and primary habitat, where impacts are minima and would largely affect fragmented vegetation in the road reserve. These sites are not likely to be important areas of habitat.

Cumulative impact

The cumulative impacts of the proposed activity would clear around 3.14 ha of vegetation considered to be potential Koala habitat, mostly from OT3 (1.39 ha). The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements.

The cumulative impacts of the proposed activity would clear around 3.14 ha of vegetation considered to be critical to the survival of koalas, mostly from OT3 (1.39 ha). The breakdown in potential loss of Koala habitat is based on the presence of Map Units 1 and 2 and not the distribution of the Koala population which is not known. The impact is therefore a worst case scenario and is as follows: OT1 (0.18 ha), OT2 (0.60), OT3 (1.38), OT5 (0.60 ha), OT6 (0.19), OT7 (0.13) and SW12 (0.06)

The clearing would remove a relatively small number of Koala feed tree species and these species are widespread in adjacent areas that are of similar density to the impact area and would not be impacted by the road widening.

Fragment an existing important population into two or more populations

The widening of the road would contribute to the barrier effect of the existing road. However the clearing would take place of the edge of the existing cleared road corridor in most areas surrounded by fenced residential properties and cleared farmland and would cause minimal fragmentation of the habitat beyond the current scenario and minimal risk of increased road kill of impacts of Koala movements.

Adversely affect habitat critical to the survival of the species

The cumulative impacts of the proposed activity would clear around 3.08 ha of vegetation considered to be critical to the survival of koalas, mostly from OT3 (1.39 ha). Comparable Koala habitat associated with MU1 and MU2 is extensive to the north and south of the Bells Line of Road and well conserved within Wollemi and Blue Mountains National Park and as stated, koalas do not appear to be using all habitats associated with these communities and therefore the loss of vegetation is likely overstating the actual loss of Koala habitat.

The habitat assessment tool has reported a high score of 8, confirming the presence of habitat critical to the survival of koalas, although the population is considered a low-density population (<0.03 koalas / ha).

Potential Koala habitat is present throughout much of the locality, and very widespread to the north and south of the Bells Line of Road. Given the large areas of surrounding habitat, and the existing fragmentation of the area, the proposal is unlikely to adversely affect habitat critical to the survival of the species.

Disrupt the breeding cycle of an important population

The proposed area of disturbance represents a very small fraction of the potential habitat for the species and any impacts to breeding individuals would be limited to a very small proportion of the population given the extensive areas of potential habitat in this location.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Highly unlikely, potential habitat is widespread and common surrounding the project corridor, and conserved within the Blue Mountains and Wollemi National Park that support populations.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

There are no recognised invasive species that are harmful to the assessed species. The potential for weed invasion into habitat of the species is considered possible with a project of this nature and appropriate controls are required during construction and operation to reduce this threat. The management of invasive species would be managed during the construction.

Introduce disease that may cause the species to decline

The Proposal is unlikely to introduce diseases affecting koalas, such as Chlamydia. Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation

clearance and subsequent construction for the project has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat near the project. This can be mitigated through the development and implementation of suitable control measures.

Interferes substantially with the recovery of the species

The project \ would not conflict with the recovery plans for this species. The proposal involves minimal vegetation and habitat removal and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the project boundary.

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

Direct and indirect impacts

There have been no roost camps identified in the project boundary to date and the project would not directly impact on any known breeding / maternity site.

Therefore it is likely that the impacts of construction and operation of the project would be confined to loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where possible. Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. A number of tree species identified in the project boundary are significant food plants for the blossom diet of the Grey-headed Flying-fox and include *Syncarpia glomulifera*, *Corymbia gummifera* and *Eucalyptus deanei* (Eby and Law 2008). Potential habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. A known roost camp is located at Yarramundi about 15 kilometres east of the study area. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and known roost camps in the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). Given the relative widespread nature of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to significantly affect the life cycle of the species.

Impacts to this species associated with the loss of habitat from the eight study sites would include:

- the direct removal of potential foraging habitat.
- the indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Lead to a long-term decrease in the size of an important population

Assessment per project

It is likely that the impacts of construction and operation of the project would include the loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

OT1: A potential direct impact on 0.18 ha will occur to fragmented vegetation and along the edge of larger habitats. There will be no further fragmentation of habitat. The habitat is very widespread and the area to be impacted is not considered important for the life-cycle of this species in the locality. No roost camps identified.

OT2: A potential direct impact on 0.60 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and the area to be impacted is not considered important for the life-cycle of the species in the locality. No roost camps identified.

OT3: A potential direct impact on 1.38 ha will occur as a long linear impact along the edge of fragmented and intact vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No roost camps identified.

OT5: A potential direct impact on 0.6 ha will occur to fragmented vegetation and a long linear impact along the edge of intact vegetation on the north side and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of the species in the locality. No roost camps identified.

OT6: A potential direct impact on 0.19 ha will occur to fragmented vegetation and will not further fragment or isolate the vegetation. The habitat is widespread and is not considered important for the life-cycle of this species in the locality. No roost camps identified.

OT7: A potential direct impact on 0.13 ha, this is a minor direct impact and occurs along the edge of much extensive areas of better quality habitat extending north and south of the road. The impacts to vegetation would occur between the road and an adjoining power easement and would not further fragment the vegetation. The habitat is widespread and the area to be impacted along the road edge is not considered important for the life-cycle of the species in the locality. No roost camps identified.

SW9 and **SW12**: A potential direct impact on 0.06 ha mostly on isolated fragments in the road reserve and would not further fragment the vegetation. This is a minor direct impact on disturbed remnants that are not considered important for the life-cycle of the species. No roost camps identified.

Cumulative impacts

There have been no roost camps identified in the project boundary to date and the project would not directly impact on any known breeding / maternity site.

Therefore it is likely that the impacts of construction and operation of the project would be confined to loss of potential 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 foraging habitat from increased light and noise/traffic disturbance.

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where possible. Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. A number of tree species identified in the project boundary are significant food plants for the blossom diet of the Grey-headed Flying-fox and include *Syncarpia glomulifera*, *Corymbia gummifera* and *Eucalyptus deanei* (Eby and Law 2008). Potential habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. A known roost camp is located at Yarramundi about 15 kilometres east of the study area. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and known roost camps in the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). Given the relative widespread nature of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to significantly affect the life cycle of the species.

Reduce the area of occupancy of an important population

Assessment per project

In considering the potential habitat for the Grey-headed Flying-fox in this locality, it is likely that moist and dry forests consisting of Eucalyptus and Corymbia tree species would provide opportunities for foraging. In addition to fruit orchards, which will not be impacted.

The extent of clearing for each site is shown below. These totals are very small in the context of the large expanses of habitat present throughout the locality and the wide ranging habits of the species. None of the areas to be cleared represent important habitat.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**
Fragment habitat for this species		**no**	**no**	**no**	**no**	**no**	**no**	**no**	**no**	

Cumulative impact

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. A number of tree species identified in the project boundary are significant food plants for the blossom diet of the Grey-headed Flying-fox and include *Syncarpia glomulifera*, *Corymbia gummifera* and *Eucalyptus deanei* (Eby and Law 2008). These food plants occur in Map Unit 1 and 2 consisting of 3.14 hectares of proposed habitat removal. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and roost camps within the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). Given the relative widespread nature of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to significantly affect the life cycle of the species.

The species occurs from Bundaberg in Queensland to Melbourne in Victoria and is not at the limit of its distribution in the study area.

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road; however the Grey-headed Flying-fox is a highly mobile species adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the road.

The main disturbance regimes affecting foraging habitats in the study area are potential weed invasion, and edge effects (ie increased light and noise) and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes and the current high condition of native vegetation in the locality reduces the risk of weed invasion and increases ecosystem recovery rates compared to low condition vegetation.

Any impacts from change of habitat condition associated with altering disturbance regimes in proximity to the road may be offset by their ability to move widely throughout the landscape and access disturbed and fragmented habitats. The habitat to be removed is unlikely to be important for the long term survival of the species.

Fragment an existing important population into two or more populations

The existing habitats in the study area are part of a larger native vegetation landscape, extensive across the Blue Mountains National Park (to the south) and Wollemi National Park (to the north). The project would further increase the width of the Bells Line of Road; however the Grey-headed Flying-fox is a highly mobile species

adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the road.

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 habitat loss represents a small percentage of the potential foraging habitat for the Grey-headed Flying-fox within a 50 kilometre radius of the project boundary and know roost camps in the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). No evidence of a camp site has been identified from the footprint of the upgrade.

The draft recovery plan for the Grey-headed Flying-fox (DECCW 2009) identifies critical foraging habitat for this species as:

- Productive during winter and spring, when food bottlenecks have been identified
- Known to support populations of >30,000 individuals, within an area of 50 kilometre radius
- Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (Sept-May)
- Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes
- Known to be continuously occupied as a camp site.

The project would directly remove up to 3.25 hectares of foraging habitat however vegetation clearing would be avoided where possible. Foraging habitat mainly comprises nectar resources from remnant native trees and shrubs. Potential habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the project boundary and known roost camps in the region. Given the relative widespread nature of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to adversely affect habitat critical to the survival of the species.

Disrupt the breeding cycle of an important population

As stated above there would be a minor impact on critical habitat identified as important during the breeding cycle of the species. The upgrade would not directly impact on a known roost camp / breeding or maternity site.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No evidence of a roost camp has been identified from the footprint of the upgrade. Further there would be a relatively minor impact (up to 3.25 hectares) on critical foraging habitat associated with the upgrade and

contained with a 50 kilometre radius of known camp sites. This impact is not expected to lead to a decline in the species in this region.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

During construction there is potential to disperse weed seeds and plant material into adjoining areas and foraging habitat 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. Some weed invasion in edge areas was noted in the study area and minor weed invasion is expected from further clearing along the edges associated with this project.

Appropriate controls are required during construction and operation of the road to reduce this threat. The management of invasive species would be managed under the construction environmental management plan and during operation of the highway using best practice methods as outlined in RTA (2011).

Introduce disease that may cause the species to decline

There are no known disease issues affecting this species in relation to the project. The project would be unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the project has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat near the road. This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. It is the intention to use current best practice hygiene protocols as detailed in RTA (2011) on this project as part of the CEMP to prevent the introduction or spread of pathogens.

Interferes substantially with the recovery of the species

Given the relative widespread nature of high quality foraging habitat within the feeding range of regional populations, the project is not expected to interfere substantially with the recovery of the species.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

Direct and indirect impacts

Impacts to the species associated with the eight study sites relate to the:

- direct removal of potential foraging, and shelter habitat.
- indirect impacts through potential introduction of invasive weeds into the adjoining habitat and altering of the structure of the community in edge areas leading to reduced condition (floristic and structural).

The loss of habitat is very small in scale compared to the extent of similar and better condition habitats within this locality, and the use of the habitat to be removed is likely to be low-level foraging activity, as habitat for breeding is widespread beyond the edges of the road.

Lead to a long-term decrease in the size of an important population

Assessment per project

Impacts to cave-roosting bats associated with the eight study sites are equivalent and relate to the direct removal of potential foraging habitat as there are no cave-roosting opportunities in the project areas. The extent of removal of vegetation varies at each site and may impact on the density and abundance of insect prey. Aquatic habitats which may assist in insect breeding will not be impacted.

The potential loss of habitat for the species associated with each study site is summarised below. The small loss of habitat at each site is associated with the road reserve or fragmented areas and the loss is not expected to have a significant impact on the foraging life-cycle activities of this species, particularly in the context of the widespread extent of similar habitats throughout the locality.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Cumulative impact

This species uses frequent a variety of habitat types including disturbed habitats, forests and woodlands. Important life-cycle activities include roosting and breeding and both are typically associated with caves, as well as foraging for insect prey which occurs in a variety of habitat types. Breeding habitat for insect prey includes a very diverse range of wetlands, swamps and open modified and artificial landscapes.

The size of local population is not known, although expected to be potentially large. Potential foraging habitat in the study area is generally widespread including natural habitats such as remnant woodlands, as well as planted vegetation and exotic dominated vegetation. Impacts to these habitats would impact on the potential breeding habitat for prey species (invertebrates), however any potential overall reductions to the abundance of prey species is likely to be minimal, considering the widespread nature of these habitats in the locality.

The project would have some level of impact to up to 3 hectares of foraging habitat comprising a combination of all identified map units. Potential impacts to the life-cycle activities of this species mainly relates to disruption of foraging activities.

Mitigation measures would include avoiding disturbance of potential roosting habitats, pre-clearance surveys and staged habitat removal. Considering the limited potential impact to preferred roosting habitats and the proposed mitigation measures the proposal is unlikely to lead to a long-term decrease in the size of an important population.

Reduce the area of occupancy of an important population

Assessment per project

Impacts to cave-roosting bats associated with the eight study sites are equivalent and relate to the direct removal of potential foraging habitat. The extent of removal of vegetation varies at each site and may impact on the density and abundance of insect prey. Aquatic habitats which may assist in insect breeding will not be impacted. The loss of habitat per project and the condition of the habitat is described below.

Map Unit	Condition	Area (ha)								Total (ha)
		OT1	OT2	OT3	OT5	OT6	OT7	SW9	SW12	
1	High	-	0.58	0.15	-	-	-	-	-	**0.73**
1	Moderate	0.18	0.02	0.21	-	-	-	-	-	**0.41**
2	High	-	-	1.02	0.15	-	0.02	-	-	**1.19**
2	Moderate	-	-	-	0.45	0.19	0.11	-	0.06	**0.81**
3	High	-	-	-	-	-	0.11	-	-	**0.11**
TOTAL		**0.18**	**0.60**	**1.38**	**0.60**	**0.19**	**0.24**	**0.00**	**0.06**	**3.25**

Each project would involve widening of the road corridor, although this activity is not expected to fragment habitat for these highly mobile species. The habitat to be removed does exhibit important values for cave-roosting bats as it is likely to contribute to the availability of foraging habitat for local populations. Given the small scale clearing at each site, and the position of the habitat in the road edge, in addition to the wide distribution of suitable habitat in the surrounding landscape, it is likely that local populations are very widespread. In this regard the narrow road reserve impacted is unlikely to constitute important habitat in the broader context.

Cumulative impact

The project would impact on up to 3.25 hectares of foraging habitat comprising a combination of all identified map units. This includes indirect impacts from increased light and removal of vegetation where required, however foraging attributes are unlikely to be substantially modified. These habitats are widespread and very common throughout the wider region and the project would have minimal impact on foraging life-cycles.

The range of disturbance regimes that currently exists in the study area, and the evolutionary adaption of species to these disturbances, has been influenced by the historical and current land-uses. For example processes such as seasonal weed invasions, interruption to surface and groundwater flow, nutrient inputs into aquatic systems can result in the creation of habitat for insect prey species creating potential foraging habitat resources for microbat species. The project has potential to affect these current disturbance regimes, however existing high condition vegetation in the locality reduces the risk of weed invasion and increases recovery rates compared to low condition vegetation. The proposal is unlikely to substantially exacerbate these disturbance regimes.

None of these threatened bat species are at the limit of their distribution in the project study area. Habitats are widespread throughout the region particularly further south and north of the study area throughout the wider region.

Fragment an existing important population into two or more populations

Highly mobile species such as bats are expected to be less impacted by fragmentation. The project would not fragment an important population of this species.

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 project would have some level of impact to up to 3 hectares of foraging habitat comprising a combination of all identified map units. The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the Large-eared Pied-bat. Impacts to areas of roosting habitat are not anticipated. The proposal is unlikely to impact habitat critical to the survival of the species.

Disrupt the breeding cycle of an important population

The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the Large-eared Pied-bat. The upgrade would not directly impact on a known roost or maternity site and such as unlikely to disrupt the breeding cycle of this species.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The project would have some level of impact to up to 3 hectares of foraging habitat comprising a combination of all identified map units. This includes indirect impacts from shading and removal of vegetation where required, however foraging attributes are unlikely to be substantial modified throughout much of this 3 hectare area. The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the Large-eared Pied-bat, and it is considered unlikely the species would decline a result of the proposal.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

The potential for weed invasion was considered possible with a project of this nature and appropriate controls are required during construction and operation of the road to reduce this threat. The management of invasive species would be managed under the construction environmental management plan and during operation of the highway using best practice methods as outlined in RTA (2011).

Introduce disease that may cause the species to decline

There are no known disease issues affecting this species in relation to the project. The project would be unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Interferes substantially with the recovery of the species

Given the relative widespread nature of similar planted vegetation in the locality and abundance of higher quality foraging habitat in the region and locality, the project is not expected to interfere substantially with the recovery of the species.

Migratory species

An area of 'important habitat' for a migratory species is:

- habitat used 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 used by a migratory species which is at the limit of the species range, and/or
- habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species. Some factors that would be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates). These factors have been considered in the following assessment.

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

There is no evidence to suggest that an ecologically significant proportion of the population of any identified migratory species exists within the proposal boundary.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species

The potential for weed invasion has been considered highly likely with a proposal of this nature and appropriate controls have been provided during the construction and operation of the road to reduce this threat as it may have long term implications for the habitat of threatened and migratory species. The management of invasive species would be managed under the construction environmental management plan.

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

As discussed there is no evidence to suggest that an ecologically significant proportion of the population of a migratory species exists within the proposal boundary.

Appendix C. Flora species

Abbreviations
i = introduced (i.e. not indigenous to Australia)
ix = Noxious species listed under the *Noxious Weeds Act 1993*.
n = native Australian species not considered to be indigenous to the site
t = threatened species

Notes

A sample flora assemblage obtained from a short term survey, such as the present one, cannot be considered to be comprehensive, but rather indicative of the actual flora assemblage. It can take many years of flora surveys to record all of the plant species occurring within any area, especially species that are only apparent in some seasons. Not all species can be accurately identified in a 'snapshot' survey due to absence of flowering or fruiting material, etc.

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
LYCOPODIACEAE	*Lycopodium deuterodensum*	Bushy Clubmoss																	1	
SELAGINELLACEAE	*Selaginella uliginosa*	Selaginella																		
CUPRESSACEAE	*Thuja* spp.	Cedar	i																	
PINACEAE	*Pinus radiata*	Monterey Pine	i												1	1	1			
ADIANTACEAE	*Adiantum aethiopicum*	Maidenhair Fern								1										
ADIANTACEAE	*Cheilanthes sieberi* subsp. *sieberi*	Slender Cloak-fern																		
ADIANTACEAE	*Pellaea falcata* var. *falcata*	Sickle Fern								1										
ADIANTACEAE	*Pellaea paradoxa*																			
BLECHNACEAE	*Blechnum cartilagineum*	Gristle Fern											1		1				1	
BLECHNACEAE	*Blechnum nudum*	Fishbone Water-fern																		
BLECHNACEAE	*Doodia aspera*	Prickly Rasp-fern														1				
CYATHEACEAE	*Cyathea australis*	Rough Tree-fern													1	1			1	
DAVALLIACEAE	*Nephrolepis cordifolia*	Fishbone Fern	i																	
DENNSTAEDTIACEAE	*Calochlaena dubia*	False Bracken								1						1			1	
DENNSTAEDTIACEAE	*Hypolepis muelleri*	Harsh Ground-fern																		

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
DENNSTAEDTIACEAE	*Pteridium esculentum*	Bracken			1	1					1			1	1				1	
GLEICHENIACEAE	*Gleichenia dicarpa*	Pouched Coral-fern																		
GLEICHENIACEAE	*Gleichenia microphylla*	Scrambling Coral-fern																		
LINDSAEACEAE	*Lindsaea linearis*	Screw Fern								1										1
LINDSAEACEAE	*Lindsaea microphylla*	Lacy Wedge-fern		1	1	1	1	1				1		1			1			
POLYPODIACEAE	*Pyrrosia rupestris*	Rock Felt-fern										1	1			1				
ACANTHACEAE	*Brunoniella australis*	Blue Trumpet		1		1														
ACANTHACEAE	*Brunoniella pumilio*	Dwarf Blue Trumpet					1	1												
ACANTHACEAE	*Pseuderanthemum variable*	Pseuderanthemum										1								
APIACEAE	*Centella asiatica*																			
APIACEAE	*Foeniculum vulgare*	Fennell	i																	
APIACEAE	*Hydrocotyle peduncularis*	Hairy Pennywort			1	1				1	1	1	1		1	1	1		1	
APIACEAE	*Hydrocotyle tripartita*	Tre-foil Pennywort																		
APIACEAE	*Platysace lanceolata*	Narrow-leaf Platysace																		
APIACEAE	*Platysace linearifolia*			1	1	1												1		1
APIACEAE	*Trachymene incisa* subsp. *incisa*	Native Carrot												1						
APIACEAE	*Xanthosia pilosa*	Hairy Xanthosia				1												1		1
APIACEAE	*Xanthosia tridentata*	Three-tooth Xanthosia																		
APOCYNACEAE	*Parsonsia straminea*	Common Silkypod																		
APOCYNACEAE	*Tylophora barbata*	Bearded Tylophora								1	1	1	1		1	1				
ARALIACEAE	*Astrotricha floccosa*																		1	
ARALIACEAE	*Polyscias sambucifolia*	Elderberry Panax		1			1	1	1	1			1	1	1	1	1		1	1
ASTERACEAE	*Ageratina adenophora*	Crofton Weed	i																	
ASTERACEAE	*Bidens pilosa*	Cobblers Peg	i												1					
ASTERACEAE	*Cassinia longifolia*														1			1	1	
ASTERACEAE	*Cassinia trinerva*											1								

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
ASTERACEAE	*Cirsium vulgare*	*Spear Thistle*	i												1					
ASTERACEAE	*Conyza spp.*	Fleabane	i																	
ASTERACEAE	*Conyza sumatrensis*	Tall Fleabane	i																	
ASTERACEAE	*Coreopsis lanceolata*	Coreopsis	i																	
ASTERACEAE	*Coronidium scorpioides*	Button Everlasting																	1	
ASTERACEAE	*Euchiton involucratus*	Satr Cudweed																		
ASTERACEAE	*Gazania rigens*	Gazania	i																	
ASTERACEAE	*Hypochaeris radicata*	Catsear	i	1			1	1				1		1			1			
ASTERACEAE	*Lagenophora stipitata*	Bottle-daisy		1	1				1											
ASTERACEAE	*Microseris lanceolata*	Yam Daisy																		
ASTERACEAE	*Olearia tomentosa*	Hairy Daisy-bush							1											
ASTERACEAE	*Ozothamnus diosmifolius*	Tall Paperdaisy					1	1	1			1		1						
ASTERACEAE	*Senecio bipinnatisectus*																			
ASTERACEAE	*Senecio diaschides*																			
ASTERACEAE	*Senecio linearifolius*	Fireweed Grounsel																		
ASTERACEAE	*Senecio madagascariensis*	Fireweed	i																	
ASTERACEAE	*Sigesbeckia orientalis*	Indian Weed								1										
ASTERACEAE	*Sonchus asper*	Toothed Sow-thistle	i																	
ASTERACEAE	*Sonchus oleraceus*	Common Sow-thistle	i																	
ASTERACEAE	*Tagetes minuta*	Stinking Roger	i																	
ASTERACEAE	*Taraxacum officinale*	Dandelion	i																	
ASTERACEAE	*Vernonia cinerea* var. *cinerea*	Vernonia				1			1											
ASTERACEAE	*Xerochrysum bracteatum*	Golden Everlasting																		
BIGNONIACEAE	*Pandorea pandorana*	Wonga Vine		1						1					1	1				
CAMPANULACEAE	*Wahlenbergia gracilis*	Sprawling Bluebell																		
CAPRIFOLIACEAE	*Lonicera japonica*	Honeysuckle	i										1			1				

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
CARYOPHYLLACEAE	*Stellaria flaccida*	Forest Starwort								1					1					
CARYOPHYLLACEAE	*Stellaria media*	Common Chickweed	i																	
CASUARINACEAE	*Allocasuarina littoralis*	Black She-oak			1			1												
CLUSIACEAE	*Hypericum japonicum*	Matted St. Johns Wort																		
CLUSIACEAE	*Hypericum perforatum*	St. Johns Wort	i																	
CONVOLVULACEAE	*Dichondra repens*	Kidney Weed								1	1		1			1				
CUNONIACEAE	*Callicoma serratifolia*	Black Wattle																	1	
CUNONIACEAE	*Ceratopetalum apetalum*	Coachwood																		
DILLENIACEAE	*Hibbertia aspera*	Rough Guinea-flower		1	1		1	1	1		1			1	1	1				1
DILLENIACEAE	*Hibbertia bracteata*			1																
DILLENIACEAE	*Hibbertia dentata*	Twining Guinea-flower																		
DILLENIACEAE	*Hibbertia diffusa*	Wedge Guinea-flower																		
DILLENIACEAE	*Hibbertia saligna*														1				1	
DILLENIACEAE	*Hibbertia scandens*	Climbing Guinea-flower													1					
DROSERACEAE	*Drosera peltata*	Rosette Sundew			1															
ELAEOCARPACEAE	*Elaeocarpus reticulatus*	Blueberry Ash												1	1	1	1			
ELAEOCARPACEAE	*Tetratheca thymifolia*	Thyme-leaf Black-eyed Susan		1	1	1								1	1				1	1
ERICACEAE	*Acrotriche divaricata*	Ground Berry			1						1	1		1	1					
ERICACEAE	*Epacris microphylla*	Small-leaf Heath																		
ERICACEAE	*Epacris obtusifolia*	Swamp Heath																		
ERICACEAE	*Epacris pulchella*	Coral Heath			1													1	1	1
ERICACEAE	*Erica lusitanica*		i																	
ERICACEAE	*Leucopogon juniperinus*	Juniper Beard-heath																		
ERICACEAE	*Leucopogon lanceolatus var. lanceolatus*	Lance-leaf Beard-heath		1	1	1	1	1	1					1			1			1
ERICACEAE	*Leucopogon setiger*							1												
ERICACEAE	*Monotoca scoparia*	Prickly Broom-heath																		

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
ERICACEAE	*Styphelia tubiflora*	Red Five-corners																		
EUPHORBIACEAE	*Amperea xiphoclada*	Broom Spurge																	1	
EUPHORBIACEAE	*Chamaesyce prostrata*	Red Caustic Weed	i																	
EUPHORBIACEAE	*Euphorbia peplus*	Petty Spurge	i																	
EUPHORBIACEAE	*Homalanthus populifolius*	Bleeding Heart																		
EUPHORBIACEAE	*Phyllanthus hirtellus*	Thyme Spurge		1	1	1	1	1	1					1			1	1	1	1
EUPHORBIACEAE	*Poranthera microphylla*	Small Poranthera																		
FABACEAE-CAESALPINIOIDEAE	*Senna pendula* var. *glabrata*	Cassia	i																	
FABACEAE-FABOIDEAE	*Bossiaea heterophylla*	Variable Bossiaea																		
FABACEAE-FABOIDEAE	*Bossiaea lenticularis*																			
FABACEAE-FABOIDEAE	*Bossiaea obcordata*	Spiny Bossiaea		1	1	1												1		
FABACEAE-FABOIDEAE	*Daviesia mimosoides subsp. mimosoides*																			
FABACEAE-FABOIDEAE	*Daviesia ulicifolia*	Gorse Bitter-pea									1			1			1			
FABACEAE-FABOIDEAE	*Desmodium rhytidophyllum*	Rusty Tick-trefoil																		
FABACEAE-FABOIDEAE	*Desmodium varians*	Slender Tick-trefoil									1									
FABACEAE-FABOIDEAE	*Dillwynia retorta*	Prickly Parrot-pea																1		1
FABACEAE-FABOIDEAE	*Erythrina* x *sykesii*	Coral Tree	i																	
FABACEAE-FABOIDEAE	*Glycine clandestina* agg.	Twining Glycine		1							1					1				
FABACEAE-FABOIDEAE	*Glycine microphylla*	Small-leaf Glycine							1						1					
FABACEAE-	*Glycine tabacina* agg.									1					1					

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
FABOIDEAE																				
FABACEAE-FABOIDEAE	*Gompholobium glabratum*																	1		
FABACEAE-FABOIDEAE	*Gompholobium grandiflorum*	Large Wedge Pea																		
FABACEAE-FABOIDEAE	*Gompholobium latifolium*	Broad-leaf Wedge-pea			1															
FABACEAE-FABOIDEAE	*Hardenbergia violacea*	Purple Twining-pea		1					1					1						
FABACEAE-FABOIDEAE	*Indigofera australis*	Native Indigo							1	1	1				1					
FABACEAE-FABOIDEAE	*Kennedia rubicunda*	Dusky Coral Pea							1								1			
FABACEAE-FABOIDEAE	*Lachnagrostis filiformis*																			
FABACEAE-FABOIDEAE	*Melilotus indicus*	Hexham Scent	i																	
FABACEAE-FABOIDEAE	*Mirbelia rubiifolia*	Mirbelia																1		1
FABACEAE-FABOIDEAE	*Podolobium ilicifolium*	Prickly Shaggy-pea							1	1										
FABACEAE-FABOIDEAE	*Pultenaea blakelyi*	Blakelys Bush-Pea															1			
FABACEAE-FABOIDEAE	*Pultenaea flexilis*				1		1	1	1					1						
FABACEAE-FABOIDEAE	*Pultenaea scabra*	Rough Bush-pea		1	1	1	1	1						1			1		1	1
FABACEAE-FABOIDEAE	*Pultenaea tuberculata*	Wreath Bush-pea																1		
FABACEAE-FABOIDEAE	*Trifolium campestre*	Hop Clover																		
FABACEAE-FABOIDEAE	*Trifolium repens*	White Clover	i																	

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
FABACEAE-FABOIDEAE	*Vicia sativa* subsp. *sativa*	Common Vetch	i																	
FABACEAE-MIMOSOIDEAE	*Acacia elata*	Cedar Wattle																		
FABACEAE-MIMOSOIDEAE	*Acacia falcata*	Sickle Wattle																		
FABACEAE-MIMOSOIDEAE	*Acacia linifolia*	Flax-leaf Wattle			1	1	1													
FABACEAE-MIMOSOIDEAE	*Acacia longifolia*	Sydney Golden Wattle							1					1			1			
FABACEAE-MIMOSOIDEAE	*Acacia melanoxylon*	Blackwood																		
FABACEAE-MIMOSOIDEAE	*Acacia myrtifolia*	Myrtle Wattle																		
FABACEAE-MIMOSOIDEAE	*Acacia obtusifolia*																	1	1	1
FABACEAE-MIMOSOIDEAE	*Acacia parramattensis*	Sydney Green Wattle				1	1		1	1		1	1		1	1	1			
FABACEAE-MIMOSOIDEAE	*Acacia suaveolens*	Sweet Wattle					1		1											1
FABACEAE-MIMOSOIDEAE	*Acacia terminalis*	Sunshine Wattle												1				1	1	1
FABACEAE-MIMOSOIDEAE	*Acacia ulicifolia*	Prickly Moses			1															1
FAGACEAE	*Quercus sp.*	Oak	i																	
FUMARIACEAE	*Fumaria muralis* subsp. *muralis*	Wall Fumitory	i																	
GERANIACEAE	*Geranium solanderi* var. *solanderi*	Native Cranesbill													1	1				
GOODENIACEAE	*Dampiera purpurea*	Purple Dampiera						1						1			1	1		
GOODENIACEAE	*Dampiera stricta*	Blue Dampiera				1												1		1
GOODENIACEAE	*Goodenia hederacea*	Forest Goodenia																		

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
GOODENIACEAE	*Goodenia heterophylla*	Variable-leaf Goodenia						1												
GOODENIACEAE	*Goodenia ovata*	Ovate Goodenia																		
HALORAGACEAE	*Gonocarpus tetragynus*	Poverty Raspwort				1				1										1
HALORAGACEAE	*Gonocarpus teucrioides*	Raspwort						1								1			1	
LAMIACEAE	*Plectranthus parviflorus*	Cockspur Flower								1										
LAMIACEAE	*Prostanthera lasianthos*	Victorian Christmas Bush																		
LAMIACEAE	*Prunella vulgaris*	Self-heal	i																	
LAURACEAE	*Cassytha glabella*	Devils Twine																		
LAURACEAE	*Cassytha pubescens*					1														
LAURACEAE	*Cinnamomum oliveri*	Oliver's Sassafras																		
LOBELIACEAE	*Pratia purpurascens*	White Root		1	1				1	1	1	1			1	1	1		1	
LOGANIACEAE	*Mitrasacme polymorpha*	Mitre Weed																1		
LORANTHACEAE	*Amyema miquelii*	Drooping Mistletoe				1	1													
LYTHRACEAE	*Lythrum hyssopifolia*	Hyssop Loosestrife																		
MALACEAE	*Cotoneaster glaucophyllus*	Cotoneaster	i													1	1			
MALACEAE	*Eriobotrya japonica*	Loquat	i																	
MALACEAE	*Malus* x *domestica*	Apple	i																	
MALACEAE	*Pyracantha angustifolia*	Fire-thorn	i																	
MALVACEAE	*Modiola caroliniana*	Red-flowered Mallow	i																	
MALVACEAE	*Sida rhombifolia*	Paddys Lucerene	i																	
MENISPERMACEAE	*Sarcopetalum harveyanum*	Pearl Vine																		
MENISPERMACEAE	*Stephania japonica*	Snake Vine																		
MONIMIACEAE	*Hedycarya angustifolia*	Native Mulberry														1				
MYRSINACEAE	*Anagallis arvensis*	Pimpernell	i																	
MYRSINACEAE	*Myrsine howittiana*	Brush Muttonwood													1					
MYRTACEAE	*Acmena smithii*	Lilly Pilly										1								
MYRTACEAE	*Angophora costata*	Smooth-barked Apple		1	1	1	1	1	1				1	1	1			1	1	1

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
MYRTACEAE	*Angophora floribunda*	Rough-barked Apple																		
MYRTACEAE	*Callistemon citrinus*	Crimson Bottlebrush																		
MYRTACEAE	*Corymbia gummifera*	Red Bloodwood		1	1	1	1	1						1						
MYRTACEAE	*Eucalyptus blaxlandii*	Blaxlands Stringybark														1				
MYRTACEAE	*Eucalyptus crebra*	Narrow-leaf Ironbark											1							
MYRTACEAE	*Eucalyptus cypellocarpa*	Monkey Gum									1	1			1	1				
MYRTACEAE	*Eucalyptus deanei*	Mountain Blue Gum								1		1								
MYRTACEAE	*Eucalyptus fastigiata*	Brown Barrel																		
MYRTACEAE	*Eucalyptus globoidea*	White Stringybark		1	1	1	1	1	1	1	1		1	1	1		1			1
MYRTACEAE	*Eucalyptus notabilis*	Mountain Mahogany		1				1	1								1			
MYRTACEAE	*Eucalyptus oreades*	Blue Mountains Ash																	1	
MYRTACEAE	*Eucalyptus pilularis*	Blackbutt																		
MYRTACEAE	*Eucalyptus piperita*	Sydney Peppermint				1								1			1	1	1	1
MYRTACEAE	*Eucalyptus punctata*	Common Grey Gum						1	1	1	1	1	1							
MYRTACEAE	*Eucalyptus sieberi*	Silvertop Ash																1		1
MYRTACEAE	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark				1											1			
MYRTACEAE	*Leptospermum grandifolium*	Wooly Tea-tree																		
MYRTACEAE	*Leptospermum juniperinum*	Prickly Teatree																		
MYRTACEAE	*Leptospermum polygalifolium*	Yellow Tea-tree																1	1	1
MYRTACEAE	*Leptospermum trinervium*	Flaky-bark Tea-tree																1		1
MYRTACEAE	*Syncarpia glomulifera*	Turpentine		1	1	1		1	1	1	1		1	1	1					
OLEACEAE	*Jasminum polyanthum*	White Jasmine	i																	
OLEACEAE	*Ligustrum lucidum*	Large-leaf Privet	i																	
OLEACEAE	*Ligustrum sinense*	Small-leaf Privet	i							1		1			1					
OLEACEAE	*Notelaea longifolia*	Large Mock Olive				1				1					1					

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
OLEACEAE	*Notelaea venosa*	Smooth Mock Olive								1	1	1	1							
OXALIDACEAE	*Oxalis exilis*	Yellow Oxalis			1				1	1	1	1				1				
PASSIFLORACEAE	*Passiflora caerulea*	Blue Passion-flower	i													1				
PASSIFLORACEAE	*Passiflora edulis*	Passion-fruit	i							1					1					
PASSIFLORACEAE	*Passiflora tarminiana*	Banana Passionfruit	i																	
PHYTOLASWACEAE	*Phytolacca octandra*	Inkweed	i																	
PITTOSPORACEAE	*Billardiera scandens*	Apple-berry		1	1	1	1	1	1					1					1	1
PITTOSPORACEAE	*Bursaria spinosa*	Blackthorn				1			1			1	1							
PITTOSPORACEAE	*Pittosporum revolutum*	Yellow Pittosporum									1		1		1					
PITTOSPORACEAE	*Pittosporum undulatum*	Native Daphne					1	1	1	1	1	1	1	1	1	1	1			
PITTOSPORACEAE	*Rhytidosporum procumbens*	Marianthus																1		
PLANTAGINACEAE	*Plantago lanceolata*	Plantain	i																	
POLYGONACEAE	*Acetosa sagittata*	Rambling Dock	i																	
PROTEACEAE	*Banksia ericifolia*	Heath-leaved Banksia		1																
PROTEACEAE	*Banksia serrata*	Saw Banksia			1													1		1
PROTEACEAE	*Banksia spinulosa* var. *spinulosa*				1	1													1	1
PROTEACEAE	*Grevillea buxifolia* subsp. *buxifolia*	Grey Spider-flower																		
PROTEACEAE	*Grevillea sericea subsp. sericea*	Pink Spider-flower		1	1	1								1						
PROTEACEAE	*Grevillea sphacelata*	Grey Spider-flower																		
PROTEACEAE	*Hakea dactyloides*	Broad-leaved Hakea												1				1		1
PROTEACEAE	*Hakea salicifolia*	Willow Hakea							1											
PROTEACEAE	*Hakea teretifolia*	Needle Hakea																		
PROTEACEAE	*Isopogon anemonifolius*	Broad-leaf Drumsticks				1														1
PROTEACEAE	*Lambertia formosa*	Mountain Devil																	1	1

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
PROTEACEAE	*Lomatia silaifolia*	Crinkle Bush		1	1	1							1	1	1				1	1
PROTEACEAE	*Persoonia levis*	Broad-leaf Geebung		1	1	1												1		1
PROTEACEAE	*Persoonia linearis*	Narrow-leaf Geebung				1														
PROTEACEAE	*Persoonia mollis subsp. mollis*				1									1			1	1	1	
PROTEACEAE	*Persoonia pinifolia*	Mambara		1	1	1														
PROTEACEAE	*Petrophile pulchella*	Conesticks																		
RANUNCULACEAE	*Clematis aristata*	Toothed Clematis							1	1		#			1					
RANUNCULACEAE	*Clematis glycinoides*	Entire-leaf Clematis														1				
RHAMNACEAE	*Pomaderris andromedifolia*	Pomaderris																		
RHAMNACEAE	*Pomaderris betulina subsp. betulina*	Birch Pomaderris								1										
RHAMNACEAE	*Pomaderris prunifolia var. prunifolia*	Plum-leaf Pomaderris																		
ROSACEAE	*Acaena ovina*																			
ROSACEAE	*Photinia glabra*	Japanese Photinia	i																	
ROSACEAE	*Rosa bracteata*	Macartney Rose	i																	
ROSACEAE	*Rosa rubiginosa*	Sweet Briar	i																	
ROSACEAE	*Rubus fruticosus* agg.	Blackberry	i												1	1		1		
ROSACEAE	*Rubus moluccanus var. trilobus*	Braod-leaf Bramble																		
ROSACEAE	*Rubus rosifolius*	Rose-leaf Bramble																		
ROUSSEACEAE	*Abrophyllum ornans*	Native Hydrangea																		
RUBIACEAE	*Coprosma quadrifida*	Prickly Currant Bush														1				
RUBIACEAE	*Galium binifolium*									1	1								1	
RUBIACEAE	*Morinda jasminoides*	Morinda									1	1	1			1				
RUBIACEAE	*Opercularia diphylla*	Stinkweed		1	1			1	1											
RUBIACEAE	*Pomax umbellata*	Pomax							1											

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
RUTACEAE	*Zieria smithii*	Sandfly Zieria										1								
SANTALACEAE	*Exocarpos strictus*	Pale Ballart							1		1	1								
SANTALACEAE	*Leptomeria acida*	Native Current		1	1	1														
SAPINDACEAE	*Dodonaea triquetra*	Hop Bush				1														
SCROPHULARIACEAE	*Veronica pleblia*	Trailing Speedwell								1	1									
SOLANACEAE	*Solanum mauritianum*	Wild Tobacco	i																	
SOLANACEAE	*Solanum nigrum*	Black Nightshade	i																	
SOLANACEAE	*Solanum prinophyllum*	Forest Nightshade								1					1					
STYLIDIACEAE	*Stylidium graminifolium*	Grass-leaf Trigger Plant			1															
THEACEAE	*Camellia japonica*	Camellia	i																	
THEACEAE	*Camellia sasanqua*	Sasanqua Camellia	i																	
THYMELEACEAE	*Pimelea linifolia* subsp. *Linifolia*	Slender Rice Flower																1		1
VERBENACEAE	*Verbena bonariensis*	Purple Top	i																	
VIOLACEAE	*Melicytus dentatus*	Tree Violet														1				
VIOLACEAE	*Viola hederacea*	Ivy-leaf Violet			1		1	1	1	1		1				1		1		
VISCACEAE	*Notothixos subaureus*	Golden Mistletoe																		
VITACEAE	*Cissus hypoglauca*	Five-leaf Water Vine													1	1			1	
ALLIACEAE	*Agapanthus spp.*	Agapanthus	i																	
ARACEAE	*Arum italicum*	Italian Arum Lily	i																	
ARACEAE	*Gymnostachys anceps*	Caterpiller Flower													1					
ARACEAE	*Zantedeschia aethiopica*	Arum Lily	i																	
ASPARAGACEAE	*Protasparagus aethiopicus*	Asparagus Fern	i																	
ASTELIACEAE	*Cordyline stricta*	Narrow-leaf Palm-lily																		
CYPERACEAE	*Carex appressa*	Tussock Tassel-sedge								1					1	1				
CYPERACEAE	*Caustis flexuosa*	Curved Caustis																1		
CYPERACEAE	*Cyperus eragrostis*	Umbrella Sedge	i																	

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
CYPERACEAE	*Eleocharis sphacelata*	Tall Spike-rush																		
CYPERACEAE	*Gahnia sieberiana*	Red-fruited Saw-sedge																1		
CYPERACEAE	*Lepidosperma laterale*	Variable Sword-sedge				1									1			1		
CYPERACEAE	*Schoenoplectus mucronatus*	Angled Club-rush																		
CYPERACEAE	*Schoenus melanostachys*	Black Bog-rush																		
IRIDACEAE	*Crocosmia* x *crocosmiiflora*	Montbretia	i													1				
IRIDACEAE	*Patersonia sericea* var. *sericea*	Basal-leaf Purple-flag																1		1
JUNCACEAE	*Juncus usitatus*	Common Rush													1					
LILIACEAE	*Lilium formosum*	Formosa Lily	i			1		1									1			
LOMANDRACEAE	*Lomandra glauca* subsp. *glauca*	Glaucous Mat-rush																1		1
LOMANDRACEAE	*Lomandra longifolia* subsp. *longifolia*	Spiny Mat-rush		1	1	1	1	1	1	1	1		1	1	1	1	1		1	1
LOMANDRACEAE	*Lomandra multiflora* subsp. *multiflora*	Many-flowered Mat-rush					1	1						1			1			1
LOMANDRACEAE	*Lomandra obliqua*	Twisted Mat-rush		1		1												1		1
LOMANDRACEAE	*Lomandra sp.*	Mat-rush		1			1													
LUZURIAGACEAE	*Eustrephus latifolius*	Wombat Berry							1	1	1	1	1		1	1	1		1	
LUZURIAGACEAE	*Geitonoplesium cymosum*	Scrambling Lily											1							
ORCHIDACEAE	*Acianthus exsertus*	Gnat Orchid																		
ORCHIDACEAE	*Caladenia catenata*	White Fingers		1	1	1								1						
ORCHIDACEAE	*Chiloglottis* sp.	Ant Orchid							1											
ORCHIDACEAE	*Corybas aconitiflorus*	Spurred Helmet-orchid		1	1	1														
ORCHIDACEAE	*Cryptostylis* spp.			1																
ORCHIDACEAE	*Cymbidium suave*	Snake Flower						1												
ORCHIDACEAE	*Pterostylis grandiflora*	Superb Greenhood		1								1					1			
ORCHIDACEAE	*Pterostylis longifolia*	Tall Greenhood		1	1															

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
ORCHIDACEAE	*Pterostylis nutans*	Nodding Greenhood												1						
ORCHIDACEAE	*Pterostylis* sp.	Greenhood			1									1					1	
PHORMIACEAE	*Dianella caerulea* var. *caerulea*	Leafy Blue Flax Lily		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
PHORMIACEAE	*Dianella caerulea* var. *producta*	Stemmed Blue Flax Lily																		
POACEAE	*Aristida personata*	Purple Wire-grass							1											
POACEAE	*Aristida ramosa*	Three-awned Spear Grass																		
POACEAE	*Arundo donax*	Giant Reed	i																	
POACEAE	*Austrodanthonia* spp	Wallaby Grass																		
POACEAE	*Austrostipa pubescens*	Tall Spear Grass																		
POACEAE	*Austrostipa rudis*	Spear Grass			1		1	1	1					1			1			1
POACEAE	*Austrostipa sp.*	Spear Grass							1											
POACEAE	*Austrostipa verticilliata*	Slender Bamboo Spear Grass																		
POACEAE	*Axonopus fissifolius*	Narrow-leaved Carpet Grass	i																	
POACEAE	*Bothriochloa macra*	Red-leg Grass																		
POACEAE	*Bromus catharticus*	Prarie Grass	i																	
POACEAE	*Cynodon dactylon*	Common Couch	i																	
POACEAE	*Dactylis glomerata*	Cocksfoot														1	1			
POACEAE	*Dichelachne inaequiglumis*					1	1		1								1			
POACEAE	*Digitaria diffusa*	Open Summer-grass		1						1		1								
POACEAE	*Echinochloa crus-galli*	Barnyard Grass	i																	
POACEAE	*Echinopogon caespitosus*	Hedgehog Grass				1	1		1								1			
POACEAE	*Echinopogon ovatus*	Hedgehog Grass										1								
POACEAE	*Ehrharta erecta*	Panic Veldtgrass	i																	
POACEAE	*Eleusine indica*	Crowsfoot Grass	i																	

FAMILY	Scientific Name	Common Name		2A	2B	2C	3A	3B	3C	3D	5A	5B	12	6A	6B	9	7A	7B	7C	7D
POACEAE	*Eleusine tristachya*	Crab Grass	i																	
POACEAE	*Entolasia marginata*	Margined Panic							1		1	1	1		1		1			
POACEAE	*Entolasia stricta*	Wiry Panic		1	1	1	1	1	1		1	1	1	1			1	1	1	1
POACEAE	*Eragrostis brownii*	Brown's Lovegrass																1		
POACEAE	*Eragrostis curvula*	African Lovegrass	i																	
POACEAE	*Eragrostis leptostachya*	Paddock Lovegrass																		
POACEAE	*Holcus lanatus*	Yorkshire Fog	i																	
POACEAE	*Imperata cylindrica*	Blady Grass		1	1	1				1					1					
POACEAE	*Microlaena stipoides* var. *stipoides*	Weeping Grass		1			1	1	1	1	1	1				1	1		1	
POACEAE	*Oplismenus imbecillis*	Narrow-leaf Beard-grass		1						1	1	1	1			1				
POACEAE	*Panicum simlie*	Two-colour panic			1	1		1												
POACEAE	*Paspalidium aversum*	Paspalidium										1								
POACEAE	*Paspalum dilatatum*	Paspalum	i																	
POACEAE	*Paspalum urvillei*	Vasey Grass	i																	
POACEAE	*Pennisetum clandestinum*	Kikuyu	i																	
POACEAE	*Phalaris aquatica*	Canary Grass																		
POACEAE	*Phyllostachys aurea*	Fishpole Bamboo	i																	
POACEAE	*Poa affinis*					1	1		1	1		1					1			
POACEAE	*Setaria gracilis*	Slender Pigeon Grass	i																	
POACEAE	*Sporobolus africanus*	Parramatta Grass	i																	
POACEAE	*Themeda australis*	Kangaroo Grass																		
RESTIONACEAE	*Lepyrodia scariosa*	Chaffy Scale-rush																		
SMILACACEAE	*Smilax australis*	Lawyer Vine								1	1	1	1		1	1			1	
SMILACACEAE	*Smilax glyciphylla*	Sweet Sarsaparilla						1						1	1				1	
ZINGIBERACEAE	*Hedychium gardnerianum*	Ginger Lily	i							1						1				

Appendix D. Fauna species

NOTES ON SYMBOLS USED IN THE TABLE
Nomenclature follows Stanger et al (1997)
V = Vulnerable species
* = Introduced species
OT4* - list of species for site OT4 determined from review of RMS (2013) for previous survey

Family / Scientific name	Common name	EPBC Act	TSC Act	OT 1	OT 2	OT 3	OT 5	OT 6	OT 7	OT 4 (*)
Columbidae										
Columba leucomela	White-headed Pigeon						X	X		
Macropygia amboinensis	Brown Cuckoo-Dove							X		
Phaps chalcoptera	Common Bronzewing									
Ocyphaps lophotes	Crested Pigeon						X			
Cacatuidae										
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo						X			
Cacatua galerita	Sulphur-crested Cockatoo				X					
Cacatua sanguinea	Little Corella				X					
Psittacidae										
Trichoglossus haematodus	Rainbow Lorikeet					X				
Alisterus scapularis	Australian King-Parrot								X	
Platycercus elegans	Crimson Rosella				X		X	X	X	
Cuculidae										
Cacomantis flabelliformis	Fan-tailed Cuckoo								X	
Chalcites lucidus	Shining Bronze-Cuckoo							X		
Centropodidae										
Centropus phasianinus	Pheasant Coucal					X				
Strigidae										
Ninox boobook	Southern Boobook					X				
Podargidae										
Podargus strigoides	Tawny Frogmouth								X	
Aegothelidae										
Aegotheles cristatus	Australian Owlet-nightjar					X				
Alcedinidae										
Dacelo novaeguineae	Laughing Kookaburra				X	X		X	X	
Todiramphus sanctus	Sacred Kingfisher					X				
Climacteridae										
Cormobates leucophaea	White-throated Treecreeper				X	X		X	X	
Maluridae										
Malurus cyaneus	Superb Fairy-wren			X					X	
Pardalotidae										
Pardalotus striatus	Striated Pardalote				X			X		
Acanthizidae										
Acanthiza lineata	Striated Thornbill				X	X		X	X	
Acanthiza nana	Yellow Thornbill				X			X		

Family / Scientific name	Common name	EPBC Act	TSC Act	OT 1	OT 2	OT 3	OT 5	OT 6	OT 7	OT 4 (*)
Acanthiza pusilla	Brown Thornbill			X						
Sericornis frontalis	White-browed Scrubwren							X	X	
Meliphagidae										
Melithreptus brevirostris	Brown-headed Honeyeater							X	X	
Acanthorhynchus tenuirostris	Eastern Spinebill				X			X	X	
Meliphaga lewinii	Lewin's Honeyeater				X	X		X	X	
Lichenostomus chrysops	Yellow-faced Honeyeater			X	X	X		X	X	
Manorina melanophrys	Bell Miner					X	X	X	X	
Anthochaera carunculata	Red Wattlebird				X	X			X	
Philemon corniculatus	Noisy Friarbird			X						
Petroicidae										
Eopsaltria australis	Eastern Yellow Robin				X			X	X	
Eupetidae										
Psophodes olivaceus	Eastern Whipbird						X	X		
Neosittidae										
Daphoenositta chrysoptera	Varied Sittella		V		X					
Pachycephalidae										
Pachycephala pectoralis	Golden Whistler									
Pachycephala rufiventris	Rufous Whistler				X			X	X	
Colluricincla harmonica	Grey Shrike-thrush							X		
Dicruridae										
Rhipidura albiscapa	Grey Fantail			X	X				X	
Rhipidura leucophrys	Willie Wagtail				X					
Grallina cyanoleuca	Magpie-lark							X		
Campephagidae										
Coracina novaehollandiae	Black-faced Cuckoo-shrike							X		
Oriolidae										
Oriolus sagittatus	Olive-backed Oriole					X				
Artamidae										
Strepera graculina	Pied Currawong				X	X		X	X	
Cracticus torquatus	Grey Butcherbird				X					
Gymnorhina tibicen	Australian Magpie			X	X			X	X	
Corvidae										
Corvus coronoides	Australian Raven			X						
Ptilonorhynchidae										
Ptilonorhynchus violaceus	Satin Bowerbird								X	
Dicaeidae										
Dicaeum hirundinaceum	Mistletoebird							X		
Pycnonotidae										
Pycnonotus jocosus	Red-whiskered Bulbul *				X			X		
Peramelidae										
Perameles nasuta	Long-nosed Bandicoot				X		X			
Phascolarctidae										
Phascolarctos cinereus	Koala	V	V							
Petauridae										

Family / Scientific name	Common name	EPBC Act	TSC Act	OT 1	OT 2	OT 3	OT 5	OT 6	OT 7	OT 4 (*)
Petaurus breviceps	Sugar Glider				X					
Pseudocheiridae										
Pseudocheirus peregrinus	Common Ringtail Possum			X						
Petauroides volans	Greater Glider					X				
Phalangeridae										
Trichosurus vulpecula	Common Brushtail Possum				X	X			X	
Macropodidae										
Macropus giganteus	Eastern Grey Kangaroo				X					
Canidae										
Canis lupus	Dog *					X				
Leporidae										
Oryctolagus cuniculus	Rabbit *			X	X	X	X			
Myobatrachidae										
Pseudophryne australis	Red-crowned Toadlet		V						X	
Pseudophryne bibronii	Bibron's Toadlet				X					
Crinia signifera	Common Eastern Froglet				X					
Litoria verreauxii	Verreuaxii's Tree Frog				X		X	X		

Appendix E. Classification of Koala habitat at each site

Table 1. Density of primary, secondary and supplementary Koala feed trees at each SAT site (n = 50 plots)

Species	OT1										OT2							OT3										OT5											OT6				OT7							
	1A	1B	1C	1D	1E	1F	1G	1H	1I	1J	2A	2B	2C	2D	2E	2F	2G	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J	5A	5B	5C	5D	5E	5F	5G	5H	5I	5J	5K	6A	6B	6C	6D	7A	7B	7C	7D	7E	7F	7G	7H
Grey Gum (E.punctata)																				5	6	10	60	60	80	10	9	10	8	6	1	60	11		8	7	3		10						2					
Monkey Gum (E.cypellocarpa)																												8		15	9		1	20									15	28						
Large-leaved Mountain Gum (E.deanei)																									20			2	1				17		7															
Turpentine (S.glomulifera)	4	4	6	1		6	7	5			10	4	3	9	13	2	6	4	4	3	8	2				2	10								6	3	2			3	2								
Red Bloodwood (C.gummifera)		1		2	8	6					4	3	5	3			5	2	2	1																				10	3								
White Stringybark (E.globoidea)	7	5	14	16	9	5	6	3	5	15	6	6	8	8	10	8	7	12	12	7	15	16				15	20	8		7	1		11		4	7							2		15	1				
Smooth-barked Apple (A.costata)	1		4	2		4		11	3	1	1	1	2	2	1	2	3	16	16	2	3		10	10		4	3					10			7	8	9	10							2	8		2	2
Sydney Peppermint (E.piperita)		3					2	4	2		5		3	5									30	30								30			5	6	12		7	7	3			3	1	1	2	11	10
Mountain Mahogany (E.notabilis)				4	1	4	4	3	4	3																													10	8	5	15	2		12				1	2
Mountain Ash (E.seiberiana)																																														15	5	25	14	15

Species	OT1										OT2							OT3										OT5											OT6				OT7							
	1A	1B	1C	1D	1E	1F	1G	1H	1I	1J	2A	2B	2C	2D	2E	2F	2G	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J	5A	5B	5C	5D	5E	5F	5G	5H	5I	5J	5K	6A	6B	6C	6D	7A	7B	7C	7D	7E	7F	7G	7H
Rough-barked Apple (A.floribunda)																																									3	3			2					
Blue Mountains Ash (E.oreades)																																															5			
Grey Ironbark (E.paniculata)																																							6											
Total trees	12	13	24	25	18	25	19	28	14	19	26	14	21	27	24	12	21	34	34	18	32	28	100	100	100	31	42	28	9	28	11	100	40	20	19	32	20	23	36	15	28	26	19	28	34	19	19	27	28	29
Primary feed trees (% canopy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	53	81	0	3	100	0	0	0	0	0	0	0	0	79	100	0	0	0	0	0	0
Primary / Secondary (% canopy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	19	36	60	60	80	32	21	64	89	75	91	60	30	100	42	22	15	0	0	0	0	58	90	100	0	0	0	0	0	0
Secondary (% canopy)	0	0	0	16	5	16	21	10	28	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	2	100	0	0	0	0	56	53	18	58	10	0	41	0	0	0	4	7
Koala scats confirmed																							Y	Y					Y		Y						Y													

Species	Map Unit in study area	Koala recovery plan (DEC 2009) food tree species for central coast and Sydney Basin region	AKF (2012) Recommended tree species for protection (Hawkesbury and Blue Mountains LGA)	SEPP44 Koala Habitat Protection	Status in the study area (determined from combined sources and field data)
Monkey Gum (*E.cypellocarpa*)	2	Secondary species	Yes, primary species	-	Primary
Grey Gum (*Eucalyptus punctata*)	1,2	Secondary species	Yes	Yes	Secondary
Mountain Mahogany (*E.notabilis*)	1	Secondary species	-	-	Secondary
White Stringybark (*E. globoidea*)	1,2	Supplementary species	Yes	-	Supplementary
Sydney Peppermint (*E. piperita*)	1,2,3	-	Yes	-	Supplementary

Koala Recovery Plan (Koala habitat categories from Callaghan (unpublished): Appendix 2 (DECC 2009)

- **Primary habitat**: Areas of forest or woodland where primary Koala food tree species comprise at least 50% of the overstorey trees. Capable of supporting high-density Koala populations.
- **Secondary habitat (class A)** Areas of forest or woodland where primary Koala food tree species comprise less than 50% but at least 30% of the overstorey trees; or Areas of forest or woodland where primary Koala food tree species comprise less than 30% of the overstorey trees, but together with secondary food tree species comprise at least 50% of the overstorey trees; or Areas of forest or woodland where secondary food tree species alone comprise at least 50% of the overstorey trees (primary Koala food tree species absent). Capable of supporting high to medium-density Koala populations.
- **Secondary habitat (class B):** Areas of forest or woodland where primary Koala food tree species comprise less than 30% of the overstorey trees; or Areas of forest or woodland where primary Koala food tree species together with secondary food tree species comprise at least 30% (but less than 50%) of the overstorey trees; or Areas of forest or woodland where secondary food tree species alone comprise at least 30% (but less than 50%) of the overstorey trees (primary Koala food tree species absent). Capable of supporting medium to low-density Koala populations.
- **Secondary habitat (class C)** – areas of forest or woodland where Koala habitat is comprised of secondary and supplementary food tree species (primary Koala food tree species absent), where secondary food tree species comprise less than 30% of the overstorey trees. Capable of supporting low-density Koala populations.