Appendix F

Assessments of Significance

F.1 Threatened Species Conservation Act 1995 Assessments of Significance

The following species and communities are assessed below:

- Green and Golden Bell Frog *Litoria aurea*
- Red-crowned Toadlet *Pseudophryne australis*
- Regent Honeyeater *Anthochaera phrygia*
- Gang-gang Cockatoo *Callocephalon fimbriatum*
- Glossy Black-cockatoo *Calyptorhynchus lathami*
- Powerful Owl *Ninox strenua*
- Grey-headed Flying-fox *Pteropus poliocephalus*
- Insectivorous (microchiropteran) bats: Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Large Footed Myotis *Myotis adversus*, Eastern Freetail Bat *Mormopterus norfolkensis* and Large-eared Pied Bat *Chalinolobus dwyeri*
- *Acacia bynoeana*
- Netted Bottle Brush *Callistemon linearifolius*
- *Darwinia biflora*
- *Epacris purpurascens ssp purpurascens*
- Hairy Geebung *Persoonia hirsuta*
- *Pimelea curviflora var. curviflora*
- Glandular Pink-bell *Tetratheca glandulosa*
- Blue Gum High Forest in the Sydney Basin Bioregion

F.1.1 FAUNA

F.1.2 Green and Golden Bell Frog *Litoria aurea*

The Green and Golden Bell Frog (GGBF) was once distributed along the coastal lowlands in NSW from approximately 50 kilometres south of the Queensland border to north-east Victoria. Since the 1970's the species has undergone a decline in its population and distribution.

This species was not recorded during targeted surveys within the M2 corridor.

The Green GGBF is listed as Endangered under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of the Green and Golden Bell Frog?

The proposed works would result in the removal of approximately 3 ha of vegetation for detention basin works and access roads. The detention basins within the M2 corridor contain an artificial assemblage of emergent native aquatic plants which were planted when the detention basins were constructed. Water quality in the basins is likely to be relatively poor due to the influx of pollutants from the road surface. It is unknown whether or not the Amphibian Chytrid Fungus is found in any of these basins but it is possible that it may have been introduced there by colonising frogs and therefore on tnis basis are unlikely to provide suitable breeding habitat for the GGBF. Detention basin works are being designed to favour the GGBF through revegetation works with emergent aquatic plant species. Due to the very small area of impact and the absence of important populations of GGBF in the study area, the M2 Upgrade is not likely to affect the lifecycle of the GGBF.

How is the proposal likely to affect the habitat of the Green and Golden Bell Frog?

Whilst the removal of approximately 3 ha of vegetation would occur for permanent access roads to new and existing detention basins, much of this is currently weedy regrowth from the original construction of the basins. Due to the propensity of the species to utilise recently disturbed habitat and its probable competitive interaction with other frog species, it is unclear whether such disturbance is likely to increase or decrease the area potentially occupied by the species.

Vegetation clearance around detention basins is likely to improve the potential of these areas as GGBF foraging habitat as the initially low, dense regrowth that is likely to result is likely to be more suitable for the species than much of the existing vegetation. Vegetation clearance here is also likely to increase light levels.

These works may alter the area of occupancy of potential breeding, foraging and shelter habitat of the GGBF temporarily due to an alteration to the environmental conditions such as water depth and light levels.

Detention basins would be planted with emergent native aquatic plant species.

The proposed works may result in the removal of vegetation from an area of up to approximately 20 ha of which approximately 3 ha would be subsequently rehabilitated post construction. While some of this area may be potential foraging habitat for this species, most of this area is marginal or unsuitable as habitat due to a lack of suitable vegetation cover, dry surface conditions and distance from potential breeding habitat.

Only the permanent clearing for widening works will permanently modify the potential area of occupancy of the species, but the areas affected are chiefly considered to be marginal as habitat for the species. Modification to other areas as a result of clearing for access may result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating and replanted vegetation begins to mature.

Due to the very small area of impact and the absence of important populations of GGBF in the study area, the extent of habitat to be removed or modified by the proposed M2 Upgrade is not likely to have a significant negative impact on the GGBF.

How is the proposal likely to affect habitat connectivity?

The GGBF is a relatively mobile frog species that forages and seeks shelter at distances of up to 1 km or more from breeding sites during favourable weather conditions. In doing so, individuals may move through and forage within highly cleared and fragmented landscapes. Major roads may act as barriers to the movement of the species particularly if walls and culverts limit access to ground-dwelling fauna. The existing M2 Motorway is currently a barrier to wildlife movement and the widening works will not increase the barrier significantly.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for the GGBF.

The following Key Threatening Processes (KTPs) are considered to contribute to the decline of the GGBF (DEC 2005):

- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands,
- Clearing of native vegetation,
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis
- Predation by the European Red Fox, and
- Predation by the Plague Minnow (*Gambusia holbrooki*) (DEC 2005).

The increased road surface as a result of the works could further alter the natural flow regime of the waterways of the study area. The detention basin works proposed are being designed with capacity for the additional stormwater from the motorway.

The proposal would result in vegetation removal however this vegetation is considered to be largely unsuitable or marginal as habitat for the species. The regeneration and revegetation of disturbed areas post-construction are consistent with the aims of the recovery plan for the species.

With the use of equipment in wet environments in several locations within the M2 corridor, there is a risk that Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis* could be spread in wet mud. Chytridiomycosis caused by Amphibian Chytrid Fungus has been implicated in severe population declines and species extinctions of frogs in the past 20 years (DEH 2006). With the implementation of the proposed mitigation measures, this risk of spreading this disease to uninfected water bodies will be low.

The proposal is unlikely to affect the vegetation or otherwise affect habitat such that the European Red Fox would increase in abundance or in its impact on native species.

With the use of equipment in wet environments in several locations within the M2 corridor, there is a risk that juvenile Plague Minnow could be spread in wet mud. With the implementation of the proposed mitigation measures, the spread of this species is however unlikely.

The proposed works are not likely to modify the waterways of the study area in such a way as to encourage the proliferation of the Plague Minnow.

A draft recovery plan for the GGBF has been prepared (DEC 2005) and considers the conservation requirements of the species across its known range. Based on the above, the M2 Upgrade will be consistent with the Recovery Plan for the GGBF (DECC 2005).

Conclusion

Based on this assessment, a significant impact on a local population of the Green and Golden Bell Frog is unlikely.

F.1.3 Red-crowned Toadlet *Pseudophryne australis*

Red-crowned Toadlets are small frogs with a bright reddish-orange 'triangular pattern on top of the head'. Mature specimens are usually around 20-25 mm in length. When mature, female are slightly larger than males (NPWS, 2001).

The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains (DEC, 2005).

The species occurs close to ridge-tops in open forests and inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Principle vegetation community occupied by this species is Sydney Sandstone Ridgetop Woodland (mainly dominated by *Corymbia gummifera* and *Eucalyptus haemostoma*) (NPWS, 2001).

Red-crowned Toadlets usually live in the vicinity of permanently moist soaks or areas of dense ground vegetation or leaf litter along or near head-water stream beds (NPWS, 2001). They prefer the first or second order ephemeral drainage lines and do not usually live along permanent flowing water courses occurring in gullies, instead preferring moist soaks or areas of dense ground vegetation or litter along headwater stream beds (NPWS, 2001).

Outside the breeding period, the frog shelters under sandstone 'bush-rock' and logs and amongst masses of dense vegetation or thick piles of leaf litter (NPWS, 2001). The Red-crowned Toadlet's diet is believed to consist mainly of ants and termites, although they are likely to eat most small invertebrates when encountered.

The Red-crowned Toadlet is listed as Vulnerable under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of the Red-crowned Toadlet?

The Red-crowned Toadlet is confined to Hawkesbury Sandstone country of around Sydney and the NSW Central Coast. It has an unusual terrestrial reproductive strategy. Rather than spawn in water, the toadlet mates and spawns on moist leaf litter (NPWS, 2001). Small nests are found within decomposing, accumulated leaf matter and clutch sizes are small, consisting of around 20-24 large eggs (NPWS, 2001).

When not in breeding, Red-crowned Toadlets are thought to disperse over wider areas of its sandstone habitat, (i.e. into non-breeding areas) and many individuals have been observed sheltering under cover that would be unsuitable for egg-laying (NPWS, 2001). However, it is likely that such 'dispersion' is only in the order of tens of metres from suitable breeding areas (NPWS, 2001). Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat (NPWS, 2001).

Much of the area surrounding the M2 is highly urbanised consisting chiefly of residential properties, parkland, weed-infested areas and disturbed riparian vegetation. Although the Red-crowned Toadlet (*Pseudophryne australis*) was not recorded during current surveys within the M2 corridor, this species has been recorded between Wicks Road and Epping Road, North Ryde, adjacent to the M2 corridor (Eco Logical Australia, 2009 and Biosphere, 2007), and also at Nile Close, Marsfield. The North Ryde area is occupied by Transport Infrastructure Development Corporation (TIDC) and is currently proposed as a compound site for the M2 Upgrade. Monitoring of the population of Red-crowned Toadlets at the TIDC site has been recommended to assess the potential changes to persistence of the species during works carried out for the M2 site and was undertaken by Eco Logical Australia in 2009. The mitigation measures proposed for the M2 Upgrade project include targeted searches for this species during pre-clearance surveys for the construction phase to mimise impacts to any Red-crowned Toadlets occurring at this location.

The Red-crowned Toadlet's specialised terrestrial reproductive strategy and reliance on ephemeral water flows mean that the species may be particularly vulnerable to a range of activities that impact on hydrology or water quality. The increased road surface as a result of the works could further alter the natural flow regime of the creeks of the study area however the detention basin works are being designed with capacity for the additional stormwater from the Motorway.

As Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat, impacts to populations of Red-crowned Toadlets would occur if the proposed works are within favoured breeding or refuge sites. Much of the widening works are not are not in close proximity to breeding areas of the Red-crowned Toadlet and are considered to be at best, marginal as habitat for the species. As Red-crowned Toadlets are well represented in National Parks within Sydney it is not considered likely that a significant impact on the lifecycle such that a viable population of the species is likely to be placed at risk of extinction.

How is the proposal likely to affect the habitat of the Red-crowned Toadlet?

Permanent removal of vegetation would occur in areas occupied by the widened motorway.

The proposed works may result in the permanent removal of less than one hectare of marginal potential habitat for this species. This habitat consists of Coastal Sandstone Ridgetop Woodland and Coastal Sandstone Gully Forest located within a few hundred metres of ephemeral drainage lines on gully slopes. Additional areas of marginal potential foraging habitat (approximately 1 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

The proposed works may involve disturbance to such Red-crowned Toadlet habitat as a result of water quality effects and vegetation clearance and bush rock removal during the M2 upgrade works.

The M2 compound site occupied by TIDC has become weed infested (Eco Logical 2009). With the implementation of the mitigation measures proposed for the M2 Upgrade, such as exclusion of weed control measures at known Red-crowned Toadlet occupation sites, impacts to potential habitat for this species is unlikely.

Only the permanent clearing for the widening works is considered to permanently modify the potential area of occupancy of the species however these rocky outcrop areas are not within areas of permanent soaks or drainage lines. Preferred breeding habitat is not considered to be affected by the proposed M2 Upgrade works.

How is the proposal likely to affect habitat connectivity?

Although vegetation and some areas of bush rock would be removed during construction, abundant rock outcrops closer to potential breeding habitat is not considered likely to be affected. As the widening is alongside the existing motorway, vegetation fragmentation is not likely to be significantly increased.

How is the proposal likely to affect critical habitat?

No Critical habitat has been declared for the Red-crowned Toadlet.

The following Key Threatening Processes are considered to contribute to the decline of the Red-crowned Toadlet:

- Alteration to the natural flow regimes of watercourses
- Bush rock removal
- Clearing of habitat
- Increase of fires

The increased road surface as a result of the works could further alter the natural flow regime of the waterways of the study area however the proposed works proposed are being designed with capacity for the additional stormwater from the motorway.

Some areas of bushrock would be removed during construction however these areas are not likely to contain suitable breeding for the Red-crowned Toadlet due to their distance from permanent moist soaks and drainage lines.

The proposal would result in vegetation removal however this vegetation is considered to be largely unsuitable or marginal as habitat for the species. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating species and replanted vegetation begins to mature. With the implementation of the mitigation measures proposed for the M2 Upgrade such as establishment of habitat boundaries and erosion and sedimentation control works, impacts to Red-crowned Toadlet habitat at the TIDC compound site is unlikely.

The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 corridor.

With the use of equipment in wet environments in several locations within the M2 Corridor, there is a risk that Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis* could be spread in wet mud. Chytridiomycosis caused by Amphibian Chytrid Fungus has been implicated in severe population declines and species extinctions of frogs in the past 20 years (DEH 2006). With the implementation of the proposed mitigation measures, this risk of spreading this disease to uninfected water bodies is considered to be low.

A recovery plan has not been prepared for the Red-crowned Toadlet.

Conclusion

Based on the above investigation, it is considered a significant impact on the Red-crowned Toadlet is unlikely.

F.1.4 Swift Parrot *Lathamus discolor*

The Swift Parrot breeds in Tasmania during spring and summer and migrates to eastern Australia in autumn and winter. The breeding population has declined from in excess of 10,000 pairs to less than 1,000 with only a fraction of this number occurring in NSW (DECC 2009).

On the mainland, Swift Parrots occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations (DECC 2009). Favoured feed trees include Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens* (DECC 2009). Commonly used lerp trees are Grey Box *E. microcarpa*, Grey Box *E. moluccana* and blackbutt *E. pilularis* (DECC 2009). Swift Parrots show little site fidelity between years (Mac Nally & Horrocks, 2000) and this is probably due to the random variation in lerp infestation and flowering of their feed trees.

How is the proposal likely to affect the lifecycle of the Swift Parrot?

As a wide-ranging, nomadic and migratory species that breeds in a localized area in Tasmania, all Swift Parrots are likely to comprise a single population with high levels of genetic mixing.

The Swift Parrot does not breed on mainland Australia. Therefore, the M2 Upgrade will not disrupt the breeding cycle of the Swift Parrot.

Given its wide range and lack of site fidelity, the localised works will not disrupt the migration patterns of the Swift Parrot.

How is the proposal likely to affect the habitat of the Swift Parrot?

Potential winter foraging habitat for the Swift Parrot consists of stands of trees containing winter-flowering eucalypt species and lerp-infested trees.

Eucalypt species usually have regular flowering seasons, though many also show a degree of variability in flowering patterns as a result of the age of plants, local environmental conditions and variation in rainfall and other environmental conditions between years (DEC 2004).

None of the dominant tree species within the bushland areas of the M2 corridor are primarily winter-flowering. One of the dominant or sub-dominant species throughout much of the bushland is Red Bloodwood *Corymbia gummifera* which chiefly flowers in February and March but also sporadically in late autumn and winter.

The original native vegetation at the western end of the M2 corridor may have contained winter-flowering eucalypts. None of this original vegetation remains here however revegetation along the edges of the M2 has involved the planting of some individuals of these species.

How is the proposal likely to affect habitat connectivity?

The Swift Parrot is a highly mobile, wide-ranging migratory species that forages within coastal and inland areas of eastern Australia. In doing so, individuals move through and forage within highly cleared and fragmented landscapes.

The relatively small amount of clearing proposed is not considered likely to significantly affect the species in the study area. As the widening is alongside the existing motorway, vegetation fragmentation and barrier effects are not likely to be significantly increased.

How is the proposal likely to affect critical habitat?

No Critical habitat has been declared for the Swift Parrot.

Threats to the Swift Parrot include:

- Clearing of habitat/habitat modification
- Collision with wire netting fences and cars during the breeding season

The proposal would result in vegetation removal however this vegetation is considered to be largely unsuitable or marginal as habitat for the species. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating species and replanted vegetation begins to mature. The extent of habitat to be removed or modified by the proposed M2 Upgrade is not considered significant in relation to areas of less-disturbed habitat in the locality. The proposed installation of nest boxes of a variety of designs would also provide habitat for hollow-dependant fauna such as the Swift Parrot.

A number of invasive fauna species exist within the study area. Of these, only the Noisy Miner *Manorina melanocephala* is considered to potentially affect the Swift Parrot. The Noisy Miner is an aggressive colonial native honeyeater that has increased in urban areas most likely as a result of alteration to vegetation structure and excludes many other bird species from potential foraging resources. The proposed works are not likely to modify habitats in the of the study area in a way that would lead to an increase in the Noisy Miner.

The proposed works are not considered likely to modify the habitats of the study area in such a way as to encourage the establishment of any additional invasive fauna species that may compete with, parasitise or prey upon the Swift Parrot.

The proposed works do have some potential to result in the introduction to the locality of invasive exotic plant species and plant diseases that may be detrimental to potential habitat for the Swift Parrot. With the implementation of the proposed measures to minimise the likelihood of spreading weeds and plant diseases the likelihood of introducing these species is considered to be low.

The proposed works are not likely to further increase the risk of collision with cars as the existing M2 Motorway is not considered to be adjacent to suitable foraging habitat.

A recovery plan has been prepared for the Swift Parrot (DPI, 2001). The mitigation measures proposed are consistent with the actions in the recovery plan.

Conclusion

Based on the above investigation, it is unlikely to have a significant impact on the Swift Parrot.

F.1.5 Regent Honeyeater *Anthochaera phrygia*

The Regent Honeyeater is a generalist forager on the nectar of eucalypts and mistletoes (DECCW, 2009). Key eucalypt species include Mugga Ironbark (*Eucalyptus sideroxylon*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*), White Box (*E. albens*) and Swamp Mahogany (*E. robusta*) but the Regent Honeyeater also utilises *E. microcarpa, E. punctata, E. polyanthemos, E. moluccana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata, E.mckieana, E. macrorhyncha, E. laevopinea*, and *Angophora floribunda* (DECCW, 2009). Nectar and fruit from the Mistletoes (*Amyema miquelii, A. pendula and A. cambagei*) are also eaten during the breeding season (DECCW, 2009). When nectar is scarce, lerp and honeydew comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. A shrubby understorey is an important source of insects and nesting material (DECCW, 2009).

The Regent Honeyeater generally inhabits dry, temperate woodlands and open forests of the inland slopes of south-eastern Australia (DECCW, 2009). There are only three known major breeding locations and two of these occur in NSW. In NSW the distribution is very patchy and largely confined to Capertee Valley and in the Bundarro-Barraba region and surrounding fragmented woodlands (DECCW, 2009).

Regent Honeyeaters sometimes occur in coastal forest, especially in stands dominated by Swamp Mahogany and Spotted Gum, but also on sandstone ranges with banksias (*Banksia* spp.) in the understorey (DEWHA 2009a). The species is occasionally observed in a variety of other vegetation types including low open forest on coastal scrub or heathland dominated by Banksia and Leptospermum species. It is possible that these habitats are used predominantly as a refuge when the preferred box-ironbark habitats are affected by drought (Menkhorst et al. 1999).

The Regent Honeyeater is listed as Endangered under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of the Regent Honeyeater?

Breeding of the species has not been recorded in the Sydney area and breeding of the species in the vicinity of the M2 Corridor is considered highly unlikely. The population of Regent Honeyeater in Victoria and NSW is patchy, with little information available on the movement patterns of this highly mobile species (DEWHA, 2009). Given the low likelihood of the species breeding in the locality and the small extent of impact on potential foraging habitat (such as specimens of *E.gummifera*), the M2 Upgrade is not considered likely to significantly disrupt the breeding cycle of the population of the Regent Honeyeater.

How is the proposal likely to affect the habitat of the Regent Honeyeater?

The proposed works may result in the permanent removal of up to approximately 7 ha of native vegetation considered to be marginal potential foraging habitat for this species.

Areas of marginal potential foraging habitat (approximately 3 ha) would be modified through temporary clearing for access areas and compound sites. This may result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

How is the proposal likely to affect habitat connectivity?

The Regent Honeyeater is a highly mobile, wide-ranging species that moves considerable distances between breeding areas and temporarily variable food resources. In doing so, individuals move through and forage within highly cleared and fragmented landscapes. The relatively small amount of clearing proposed is not considered likely to significantly affect this species.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for the Regent Honeyeater.

The following Key Threatening Processes are considered to contribute to the decline of the Regent Honeyeater and are relevant to the M2 Upgrade:

- Fragmentation and degradation of habitat
- Loss of key habitat trees and remnant woodlands
- Suppression of natural regeneration of overstorey tree species and shrub species
- As the widening is alongside the existing Motorway vegetation fragmentation is not likely to be significantly increased.

A reduction in available foraging habitat in the short-term will occur but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Conclusion

Based on the above investigation, a significant impact on the Regent Honeyeater is unlikely.

F.1.6 Gang-gang Cockatoo *Callocephalon fimbriatum* and Gang-gang Cockatoo *Callocephalon fimbriatum* population in the Hornsby and Kur-ing-gai Local Government Areas

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 (DECCW, 2009).

In summer, Gang-gangs are generally found in tall mountain forests and woodlands, particularly heavily timbered and mature wet sclerophyll areas (DECCW, 2009). They move to lower altitudes in winter to drier, more open eucalypt forests and woodlands, including urban areas. Gang-gangs favour old growth, hollow-bearing trees for nesting and roosting (DECCW, 2006). Preferred breeding habitat is in hollows >10 cm in diameter and > 9m above the ground in eucalypts.

A population of Gang-gang Cockatoos persists in the Hornsby and Kur-ing-gai Local Government Areas and is listed as an endangered population under the TSC Act.

This endangered population is believed to be largely confined to an area bounded by Thornleigh and Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west and Turramurra/South Turramurra to the east (DECCW, 2009). The population encompasses, but is not restricted to, Pennant Hills Park and parts of Lane Cove National Park. Individual birds are likely on occasion to move across the population boundary and should still be considered as part of this population (Scientific Committee, 2008).

The Hornsby and Kuring-gai population is significant as it is the last known breeding population in the Sydney Metropolitan area. Current estimates of the population size are to be between 18 - 40 pairs (DECCW, 2009). The species shows strong nest site fidelity (NSW Scientific Committee, 2008).

The Gang-gang is listed as vulnerable in NSW under the TSC Act. The Gang-gang Cockatoo *Callocephalon fimbriatum* population in the Hornsby and Kur-ing-gai Local Government Areas is listed as an endangered population under the TSC Act.

How is the proposal likely to affect the lifecycle of the Gang-gang Cockatoo?

The Gang-gang Cockatoo was recorded during the current study flying overhead in the vicinity of the Terry Creek overpass near Crimea Road on the border of Epping and Marsfield.

Given the proximity of the existing motorway to the vegetation that would be affected, it is unlikely that sites used for breeding by this species would be affected.

Based on the above, the proposed M2 Upgrade works is not considered likely to have a significant adverse effect on lifecycle of the species and a viable local population is unlikely to be placed at risk of extinction.

How is the proposal likely to affect the habitat of the Gang-gang Cockatoo?

Loss of habitat, particularly core food and breeding trees, continues to be a major threat to the population (NSW Scientific Committee, 2008).

Although potential foraging habitat for the Hornsby and Kuring-gai population may be removed, it is not considered likely that breeding habitat will be significantly affected

Habitat for the species exists within the older, more intact stands of vegetation occurring within the study area.

Approximately 7 ha (predominantly native vegetation) of potential habitat for this species may be permanently lost. Much of this area is marginal as habitat for the species due to a lack of mature trees which provide abundant food and dominance of the understorey by introduced species. A significant reduction in the area of occupancy of this population is considered unlikely. Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Potential nesting hollows for the species are not known or considered likely to be abundant in the area affected by the proposed M2 Upgrade.

The density of mature, potentially hollow-bearing, trees within the M2 corridor is lower than would be expected to occur in undisturbed forest. Previous land use activities such as timber-getting and forestry (e.g. in the former Darling Mills State Forest) and clearing for infrastructure and residential development are likely to have reduced the local abundance of tree hollows.

No hollows of sufficient size to accommodate the species were observed in any of the trees that would be removed. The majority of the trees to be removed are relatively small due to low nutrient and low moisture soils, previous clearing for the existing motorway and the logging history of the area.

Large and medium-sized tree hollows are likely to exist within the larger, more mature trees particularly in mature *Eucalyptus pilularis* (Blackbutt). These larger trees are chiefly found on lower slopes of gullies and along streams where soils are deeper, moister and enriched by silt and organic material that are not considered likely to be affected by the proposed works.

While it is considered that potential foraging habitat for the Gang-gang Cockatoo will be removed by the proposed M2 upgrade, greater areas of suitable foraging habitat exist in the surrounding bushland areas. The more intact bushland areas of the sandstone valleys are likely to have the greatest importance as foraging habitat for this species. These are located beyond the study area particularly within Bidjigal Reserve and Lane Cove National Park. Therefore, habitat for the Hornsby and Kur-ing-gai Local Government Areas population is considered unlikely to be significantly affected by the proposed works.

The minimisation of vegetation clearing and post-construction vegetation rehabilitation targeted at creating appropriate foraging and sheltering habitat would minimise the extent of negative impact on potential habitat for the species.

The proposed installation of nest boxes of a variety of designs would also provide habitat for hollow-dependant fauna such as the Gang-gang Cockatoo.

How is the proposal likely to affect habitat connectivity?

Foraging habitat for the Gang-gang Cockatoo occurs throughout the study area. Much of the original vegetation of the study area has been cleared for residential development and road construction. This has resulted in fragmentation of the remaining vegetation. As the widening is alongside the existing Motorway, vegetation fragmentation is not likely to be significantly increased.

Much of the potential habitat to be removed is only likely to be used by this species as foraging habitat. Due to its mobility, the Gang-gang Cockatoo is not likely to be significantly affected as large areas of similar habitat exist in the local area. These areas are likely to contain the core foraging and breeding habitat for the species in the locality.

How is the proposal likely to affect critical habitat?

No Critical habitat has been declared for the Gang-gang Cockatoo.

The following Key Threatening Processes are considered to contribute to the decline of the Gang-gang Cockatoo:

- Urban development resulting in clearing of forest and woodland habitat
- Loss of nesting trees from clearing and frequent fire
- Ongoing disturbance to nesting and roosting sites
- Predation be cats

While it is considered that potential foraging habitat for the Gang-gang Cockatoo will be removed by the proposed M2 upgrade, greater areas of suitable foraging habitat exist in the surrounding bushland areas.

No hollows of sufficient size to accommodate the species were observed in any of the trees that would be removed.

The proposal is unlikely to affect the vegetation or otherwise affect habitat such that feral cats would be likely to increase in abundance or in their impact on native species.

Conclusion

Native vegetation would be cleared for the project however the impact of this clearing on the Gang Gang Cockatoo is not likely to have a significant impact on the local occurrence of the species. It is considered a significant impact on the Gang-gang Cockatoo is unlikely.

F.1.7 Glossy Black-cockatoo *Calyptorhynchus lathami*

The Glossy Black-cockatoo inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species, particularly Black She-oak (*Allocasuarina littoralis),* Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur. For breeding, this species is dependent on large hollow-bearing eucalypts as nest sites (DEC 2005). Adults only breed during the autumn and winter (NPWS, 1999). The species is usually recorded in family parties of seldom more than 10 (DEC, 1999). The species is locally nomadic and small flocks roam in search of feeding areas and roost communally (DEC, 1999). The Glossy Black-cockatoo is probably the most specialised member of its family feeding exclusively on seeds extracted from the wooden cones of casuarinas (she-oaks).

The Glossy Black-cockatoo is listed as vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of the Glossy Black-cockatoo?

The Glossy Black Cockatoo was not recorded within the study area during current surveys within the M2 corridor although this species has been previously recorded within the locality (DECCW, 2009).

Casuarina and Allocasuarina species within the M2 corridor are not mature enough to provide suitable feeding habitat for the Glossy Black-cockatoo. These species chiefly occur as stands of regrowth amongst disturbed riparian areas or are not considered to be present in enough numbers to support small flocks.

No large tree hollows or trees of sufficient size to support large hollows were observed within the M2 corridor. Whilst the Glossy Black-cockatoo may use the study area on a sporadic basis it is not considered likely that suitable breeding habitat exists within the M2 corridor.

The proposed activity is not likely to significantly affect the life cycle of the Glossy Black-cockatoo.

How is the proposal likely to affect the habitat of the Glossy Black-cockatoo?

Permanent removal of vegetation would occur in areas occupied by the widened Motorway.

The proposed works may result in the permanent removal of up to 7 ha of potential foraging habitat for this species. Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

The habitat affected by the proposed works is of marginal quality due to previous clearing, weed invasion and other forms of disturbance. Most of the trees removed are immature or semi-mature and are likely to contain chiefly small to medium-sized hollows that are potential habitat for smaller species of birds and mammals.

Large and medium-sized tree hollows that are likely to provide suitable nesting sites are more likely to occur within the larger, more mature trees, particularly in mature *Eucalyptus pilularis* (Blackbutt) beyond the study area. These larger trees are chiefly found on lower slopes of gullies and along streams where soils are deeper, moister and enriched by silt and organic material that are not considered likely to be affected by the proposed works.

Due to the lack of suitable roosting and foraging habitat within the M2 corridor, this area is considered to be of relatively low value as potential habitat for this species when compared to larger areas of vegetation at greater distance from the M2 Motorway.

The small increase in the distance between vegetated areas on either side of the Motorway created through the widening works is considered unlikely to have a significant impact on the ability of the species to move between potential habitats in the locality and further afield.

How is the proposal likely to affect habitat connectivity?

These birds are all highly mobile species and as the widening is alongside the existing Motorway vegetation fragmentation is not likely to be significantly increased.

Modification to areas as a result of vegetation clearance will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although vegetation removal will occur, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for the Glossy Black-cockatoo.

The following key threatening processes are known or considered likely to be affecting the habitat of these species in the study area.

- Clearing of native vegetation
- Removal of hollow-bearing trees
- Competition from feral honeybees

Due to the vegetation clearing involved the proposed works would contribute to the clearing of native vegetation. Given the small extent of clearing and the proposed weed control and revegetation measures, the contribution of the proposed works to the operation of these processes is considered to be minor and is not considered likely to significantly affect populations of this species.

No large tree hollows or trees of sufficient size to support large hollows were observed within the M2 corridor. Post-construction vegetation rehabilitation targeted at creating appropriate foraging and sheltering habitat would minimise the extent of negative impact on potential habitat for the species.

The proposed works are not considered likely to result to increase the effects of competition from feral honeybees.

Conclusion

Based on the above assessment, it is not considered likely that the proposed works will have a significant impact on the Glossy Black-cockatoo.

F.1.8 Powerful Owl *Ninox strenua*

The Powerful Owl is the largest owl in Australasia, reaching 60 cm in length and with a wingspan of 140 cm required to lift its 1.45 kg bulk (DEC, 2006). It is a typical hawk-owl, in that it lacks the facial-disc of the *Tyto* owls. The deep, resonant double hoot of the Powerful Owl can be heard throughout the year, however calling peaks in the winter breeding season (DEC, 2006).

The Powerful Owl is endemic to eastern Australia, mainly on the coastal side of the Great Dividing Range (DEC, 2006). In NSW, it is widely distributed throughout the eastern forests from the coast to the tablelands (DEC, 2006). Records on the western slopes and plains are mostly historical suggesting populations in that region are on the verge of extinction.

The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well (DECCW, 2009). The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation.

Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old (DECCW, 2009) and some of their prey species also rely on tree hollows for refuge.

Powerful Owls perch in the top one-third of roost trees but decrease their perch height with increasing temperature (and *vice versa*) suggesting that structurally heterogeneous habitat is fundamental for the species persistence in an area (Cooke *et al.* 2002).

The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat.

The Powerful Owl is listed as Vulnerable under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of the Powerful Owl?

The proposed activity is not considered likely to adversely affect potential breeding habitat for this species as the vegetation clearance is of a small extent when compared to the relatively large home range of these species. No hollows of sufficient size to accommodate the species were observed in any of the trees that would be removed. The majority of the trees to be removed are relatively small due to low nutrient and low moisture soils, previous clearing for the existing motorway and the logging history of the area.

Given the large home range of individuals and breeding pairs of this species, it is likely that the entire bushland area surrounding the motorway is within the home range of one or two breeding pairs. Given the proximity of the existing motorway to the vegetation that would be affected, it is considered unlikely that sites used for breeding by this species would be affected.

The likely ability of the owls to disperse over tens of kilometres through a mosaic of forested and cleared land suggests that there are unlikely to be any barriers to gene flow within NSW (DEC, 2006). Given the relatively small amount of potential habitat that would be affected, and the lack of mature size hollow bearing trees, the M2 Upgrade is not likely to significantly disrupt the breeding cycle of the Powerful Owl.

No other element of relevance to the lifecycle of this species is likely to be affected such that a viable local population of these species is likely to be placed at risk of extinction.

How is the proposal likely to affect the habitat of the Powerful Owl?

Permanent removal of vegetation would occur in areas occupied by the widened motorway.

The proposed works may result in the permanent removal of up to 7 ha of potential roosting and foraging habitat for this species. Additional areas of potential roosting and foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Permanent occupation of currently vegetated areas by the widened motorway would result in a reduction in available foraging and roosting habitat. Although vegetation will be removed, the Powerful Owl is also likely to hunt and roost throughout the bushland of the study area and contiguous areas of bushland in the locality.

Large and medium-sized tree hollows are likely to exist within the larger, more mature trees, particularly in mature *Eucalyptus pilularis* (Blackbutt). These larger trees are chiefly found on lower slopes of gullies and along streams where soils are deeper, moister and enriched by silt and organic material that are not considered likely to be affected by the proposed works.

Optimal habitat for the Powerful Owl which includes a tall shrub layer and abundant hollows supporting high densities of arboreal marsupials was not found to be within the areas of permanent vegetation removal. The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

How is the proposal likely to affect habitat connectivity?

The small increase in the distance between vegetated areas on either side of the motorway created through the widening works is considered unlikely to have a significant impact on the ability of the species to move between potential habitats in the locality and further afield.

Proposed environmental management measures including the minimisation of the clearing of mature vegetation and the regeneration and revegetation of disturbed areas post-construction are considered to be consistent with the aims of the recovery plan for the species.

How is the proposal likely to affect critical habitat?

The habitat found in the study area or subject site is not listed as critical habitat.

Key threatening processes considered to contribute to the decline of the Powerful Owl include:

- Fragmentation of suitable forest and woodland habitat from land clearing
- Disturbance during breeding period
- High frequency hazard reduction burning
- Predation by foxes, dogs and cats

No tree hollows of sufficient size to provide nesting opportunities for larger species, such as the Powerful Owl, were observed within the areas potentially affected by clearing activities.

Most of the trees removed are immature or semi-mature and are likely to contain chiefly small to medium-sized hollows that are potential habitat for smaller species of birds and mammals. These trees also have the potential to develop hollows as they mature, providing opportunities for populations of hollow-dependent fauna to recover.

Disturbances such as noise during the breeding period (late summer to mid-autumn) have the potential to affect breeding success however these are considered to be temporary during the construction phase only.

The proposal is unlikely to affect the vegetation or otherwise affect habitat such that feral animals would be likely to increase in abundance or in their impact on native species.

Conclusion

Based on the above investigation, a significant impact on the Powerful Owl is unlikely.

F. 1.9 Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-fox is distributed in a coastal belt from south-eastern Queensland to Melbourne, Victoria and is infrequently found west of the Great Dividing Range (Tidemann 1998). The species is highly mobile and the distribution of the national population varies within the species range with groups of bats moving up and down the east coast in response to seasonal food availability (Menkhorst 1995; Tidemann 1998).

Studies have indicated that there appears to be a single interbreeding population, with constant genetic exchange and movement between camps throughout the entire geographic range of the species. Bats commute daily between roosting sites (camps) and feeding areas which are usually located within 15 kilometres of camp sites (Tidemann 1998).

Roost sites are typically located near water, such as lakes, rivers or the coast and vegetation often consists of rainforest patches, paperbark forest, mangroves and riparian vegetation though colonies also use highly modified vegetation in urban and suburban areas (DEWHA 2009a).

The closest known camp site to the study area is in the Ku-ring-gai Flying-fox Reserve in Gordon which is located approximately 4 to 15 kilometres from the M2 Corridor. The population size of the Ku-ring-gai Flying-fox Reserve camp varies with an average of approximately 30,000 individuals. Two other flying-fox camps are known in the Sydney region, at Cabramatta Creek and in the Sydney Royal Botanic Gardens.

The Grey-headed Flying-fox was recorded flying overhead in several locations during field surveys and was recorded feeding in mature flowering Blackbutt *Eucalyptus pilularis* within the M2 Corridor near Bidjigal Reserve. Individuals feeding within the study area are considered most likely to roost in the Ku-ring-gai Flying-fox Reserve in Gordon.

The Grey-headed Flying-fox is listed as Vulnerable under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of the Grey-headed Flying-fox?

Critical phases of the life-cycle, including court-ship, mating, and raising of young all occur in the colonies or camps. The study area does not contain any camp sites for the Grey-headed Flying-fox. Therefore, the M2 Upgrade will not impact on the life cycle of the species.

How is the proposal likely to affect the habitat of the Grey-headed Flying-fox?

The proposed works may result in the permanent removal of up to approximately 7 ha of known and potential foraging habitat for this species. Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

The Grey-headed Flying Fox forages in larger areas of similar habitat throughout the Sydney Metropolitan area therefore the extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

How is the proposal likely to affect habitat connectivity?

The Grey-headed Flying-fox is a highly mobile, wide-ranging species that forages at distances of up to 15 km or more from roost sites during a single evening. In doing so, individuals move through and forage within highly cleared and fragmented landscapes. The existing M2 Motorway is currently a barrier to wildlife movement therefore the widening works will not significantly increase the barrier to any significant degree. It is not likely to significantly affect the subset of the population of the species that utilises the study area.

How is the proposal likely to affect critical habitat?

No Critical habitat has been declared for the Grey-headed Flying-fox as it is not listed on Schedule 1 of the TSC Act.

The following Key Threatening Processes are considered contribute to the decline of the Grey-headed Flying-Fox and are relevant to the M2 Upgrade:

- Loss of foraging habitat
- Disturbance of roosting sites

The Grey-headed Flying-Fox is a highly mobile species that forages throughout the Sydney Metropolitan area. As the widening is alongside the existing Motorway vegetation fragmentation is not likely to be significantly increased.

The M2 Upgrade will not impact upon known roost camps for this species.

Conclusion

Based on the above investigation, a significant impact on a local population of the Grey-headed Flying-fox is unlikely.

F.1.10 Insectivorous (microchiropteran) bats

- Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*
- Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*
- Greater Broad-nosed Bat *Scoteanax rueppellii*
- Large Footed Myotis *Myotis adversus*
- Eastern Freetail Bat *Mormopterus norfolkensis*
- Large-eared Pied Bat *Chalinolobus dwyeri*

Eastern Bentwing-bat

Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves provide their primary roosting habitat, but the species also inhabits derelict mines, storm-water tunnels, buildings and other man-made structures. They form discrete populations centred on maternity caves which have very specific temperature and humidity regimes. During the remaining part of the year, populations disperse within a 300 kilometre range of maternity caves. Breeding or roosting colonies can number from 100-50,000 individuals. This bat hunts in forested areas, above the tree tops (DEC, 2005).

Yellow-bellied Sheathtail

The Yellow-Bellied Sheathtail Bat occurs throughout tropical Australia with many records extending into south-eastern Australia (Churchill, 1998). In the most southerly part of its range - most of Victoria, south-western New South Wales (NSW) and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes (DEC, 2005). Most records reported between January and June (Churchill, 1998). The Yellow-Bellied Sheathtail Bat is found in a variety of habitats from wet and dry sclerophyll forests to open woodland, *Acacia* scrubland, mallee, grasslands and deserts. It forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. This species roosts singly or in groups of up to six in tree-hollows, and abandoned nests of Sugar Gliders and occasionally hanging from the outside walls of buildings in broad daylight (Churchill, 1998). In treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country (DEC, 2005).

Greater Broad-nosed Bat

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In New South Wales (NSW) the bat is widespread on the New England Tablelands, however does not occur at altitudes above 500 metres (except in the very north of its range, where it has been recorded at 780 metres (Churchill, 1998). This species utilises a variety of habitats from dry woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although usually roosting in tree hollows and branches, it has also been found in buildings. (DEC, 2005).

The Greater Broad-nosed Bat consumes beetles and other large, slow-flying insects after sunset. It has also been known to eat small bat species, including the threatened Little Bent-wing Bat *Miniopterus australis*. (DEC, 2005). It will also feed on ground beetles that are 'hawked' within 20 metres of the ground along rows of trees which line creeks and small rivers and the edges of patches of woodland in otherwise cleared paddocks (Churchill, 1998).

Large footed Myotis

This species has been recorded in mangroves, paperbark swamps and in a range of forest and woodland habitats (Churchill 1998). Large-footed Myotis are cave dwellers but are also known to roost in tree hollows, under bridges, in clumps of vegetation and in mine tunnels and stormwater drains (Menkhorst & Knight 2001; Churchill 1998). Roosts are usually in close proximity to water over which the bats forage. The large feet and hind claws are used to rake the water surface for insects and small fish, and Large-footed Myotis are known to forage in small groups of three or four (Churchill 1998). This species is also capable of foraging aerially (Menkhorst & Knight 2001).

Eastern Freetail Bat

The East Coast Freetail-bat occurs from southeast Queensland to Bateman's Bay on the south coast of NSW and east of the Great Dividing Range (NPWS Wildlife Atlas; NPWS 2000a). There is a paucity of information concerning the species' general biology and ecological requirements and there has been limited research regarding the species dietary requirements and reproductive biology (Churchill 1998; Duncan *et al* 1999). Its preferred habitat is dry sclerophyll forest and woodlands (Alison & Hoye 1995; NPWS 1994) where it utilises the forest canopy and edges for foraging and roosts in tree-hollows (Churchill 1998; Duncan *et al* 1999).

Large-eared Pied Bat

The Large-eared Pied Bat is found from south-eastern Queensland (Rockhampton) to New South Wales (NSW) (south to Bungonia), from the coast to the western slopes of the Divide. There are scattered records from the New England Tablelands and North West Slopes. The NSW distribution is generally rare and very patchy, with the species found predominantly in areas with extensive cliffs and caves.

The Large-eared Pied Bat remains loyal to the same maternity cave over many years. (Churchill1998). It is not known whether this species ever utilises tree hollows as roosting habitat (Environment Australia, 1999). It has been speculated (Churchill, 1998) that this species may also utilise tree hollows for roosting though the use of tree hollows by the species has not been reported. Although few details are currently known, it probably forages for small, flying insects, below the forest canopy (Churchill, 1998).

It roosts in caves and mines, crevices in cliffs, and in the disused, bottle-shaped mud nests of the Fairy Martin (*Hirundo ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. It roosts in colonies of 3-37, clustered in indentations in the ceiling, most commonly in the twilight areas of the caves, close to the entrance. Maternity caves are found in well-timbered areas containing gullies.

There are three records of this species on the Atlas of NSW Wildlife database within 10 km of the Motorway.

How is the proposal likely to affect the lifecycle of the threatened species?

The proposed activity is not likely to have a significant adverse effect potential breeding habitat of these species as:

- The vegetation clearance is of a small extent when compared to the relatively large home ranges of several of these species,
- Several of these species also use other types of habitat as sheltering sites such as bark, rock crevices and fallen timber in addition to tree hollows,
- Most of the semi-mature trees that would be removed are not considered likely to provide an abundant source of tree hollows.
- The small water bodies (detention basins) and streams within the study area are not considered to constitute high quality foraging habitat for the Large-footed Myotis due to the scarcity of pools of open water over which the species can readily forage.
- No cave habitat that may be suitable as breeding habitat would be affected by the project.
- Whilst it is unknown if the subject site is occupied by the Large-eared Pied Bat, the paucity of records in the sandstone valleys of the area and the marginal quality of the potential roosting habitat present indicates that the study area is unlikely to support an important population of the species.

No other element of relevance the lifecycles of these species is likely to be affected such that a viable local population of any of these species is likely to be placed at risk of extinction.

How is the proposal likely to affect the habitat of the threatened species?

Permanent removal of vegetation would occur in areas occupied by the widened motorway.

The proposed works may result in the permanent removal of up to 7 ha of potential roosting and foraging habitat for these species.

Additional areas of potential roosting and foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites. Although vegetation would be removed in these temporary clearing areas, upon completion of works, vegetation will be re-established. Although this vegetation may be of different structure and composition to that currently present, is likely to provide similar potential as foraging habitat for the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat as these species are high speed aerial foragers that feed in open air spaces.

The study area does not contain any caves, or mines near or above water and is consequently unlikely to provide preferred roosting or maternity sites for the Large-footed Myotis. Preferred habitat for the Greater Broad-nosed Bat is likely to be found lower within moister valleys of the locality rater than the upper slope areas in which motorway is chiefly located.

The extent of already disturbed habitat to be removed or modified by the proposed M2 upgrade is not considered significant in relation to areas of less-disturbed habitat in the locality.

The core likely foraging habitat for threatened microbats in the locality is concentrated in the larger areas of more mature vegetation that would not be substantially affected by the proposed works. The habitat affected by the proposed works is of marginal quality due to previous clearing, weed invasion and other forms of disturbance such as artificial lighting and traffic noise. Due to the lack of suitable roosting habitat, and disturbance, this area is considered to be of relatively low value as potential habitat for this species when compared to larger areas of vegetation at greater distance from the motorway.

Potential roosting habitat for the Large-eared Pied Bat is considered to be present in steep areas containing rock outcrops within the bushland valleys of the region, chiefly in the vicinity of the Darling Mills Creek crossing adjacent to Bidjigal Reserve, North Rocks. Potential foraging habitat is considered to exist within larger areas of native vegetation within a few kilometres of these areas. One large rock does contain a relatively deep, darkened cavity, but this area is near ground level and would likely provide easy access to potential predators. These overhangs are thus considered to be marginal as roosting habitat for cave-dwelling bats.

How is the proposal likely to affect habitat connectivity?

The microbat species listed are highly mobile species that are able to forage in fragmented landscapes including urban areas where these contain patches of native vegetation. The proposed works would not fragment forested areas or significantly increase their isolation from one another or other patches of potential habitat in the local area for mobile species such as microbats.

Microbats in general are highly mobile species that are capable of utilising modified landscapes including artificial breaks in woodland and forest for foraging activities (Churchill, 1998). Whilst it is unknown to what extent the Large-eared Pied Bat is capable of tolerating habitat fragmentation, the relatively small amount of clearing proposed and the barrier created by the existing M2 Motorway is unlikely to increase habitat fragmentation.

How is the proposal likely to affect critical habitat?

The habitat found in the study area or subject site is not listed as critical habitat (DECCW, 2008) for any threatened species.

Key threatening process considered to contribute to a decline in microbat species include:

- Clearing and isolation of forest and woodland habitats near cliffs and caves
- Loss of foraging habitat
- Damage to roosting and nesting sites
- Application of pesticides in or adjacent to foraging areas

Permanent removal of vegetation would occur in areas occupied by the widened motorway.

The proposed works may result in the permanent removal of up to 7 ha of potential roosting and foraging habitat for these species. Although vegetation would be removed, upon completion of works, vegetation will be re-established. The proposed works would not fragment forested areas or significantly increase their isolation from one another or other patches of potential habitat in the local area for mobile species such as microbats.

The core likely foraging habitat for threatened microbats in the locality is concentrated in the larger areas of more mature vegetation that would not be substantially affected by the proposed works.

Conclusion

Based on the above investigation, significant impacts on threatened microbat species are unlikely to occur as a result of the project.

F.1.11 FLORA

F.1.12 *Acacia bynoeana*

Acacia bynoeana 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 Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leafed Apple.

Found in central eastern NSW, from the Hunter District (Morisset), south to the Southern Highlands and west to the Blue Mountains.

It is known from 30 locations and typically only 1-5 individuals occur at each site. A few sites contain 30-50 individuals. The total population is estimated to be only a few hundred plants (DEWHA 2009a).

Records of this species in the vicinity of the M2 corridor are chiefly to the north in the Baulkham Hills and Ku-ring-gai LGAs (NPWS 2009). The closest records are within 2 km of the M2 corridor in the east in Gordon and in the west near the northern boundary of Bidjigal Reserve (NPWS 2009).

Acacia bynoeana is listed as Endangered under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of *Acacia bynoeana*?

At most recorded sites, this species occurs in low numbers. It is not known how many individuals of this species (if any) occur within the M2 corridor though it is considered unlikely that a large population would exist here as the

species has not been located here. It is considered unlikely that any population here would be considered a key source population either for breeding or dispersal as the potential habitat here is isolated from habitat containing known populations in the region as a result of urban development.

It is also considered unlikely that any population here is likely to be genetically distinct from other populations in the region or to be necessary for maintaining genetic diversity of the species as a whole.

The potential habitat for this species within the M2 corridor is not at the limit of the species known distribution as the species is distributed to the north, west and south of the locality on the outskirts of the Sydney metropolitan area and beyond. The species was not recorded during flora surveys within the M2 Corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a potentially important population exists within the M2 corridor.

The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.

How is the proposal likely to affect the habitat of *Acacia bynoeana*?

Whilst the proposed works may modify, destroy, remove or isolate or decrease the availability or quality of habitat for this species, the extent of such impact on the species (should it occur) is likely to be minor as any population present here is likely to be small and isolated from known important populations. This level of potential impact is considered unlikely to cause the species to decline.

How is the proposal likely to affect habitat connectivity?

The proposed works would result in additional vegetation removal and disturbance however as the widening is alongside the existing motorway vegetation fragmentation is not likely to be significantly increased. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring habitat as regenerating species and replanted vegetation begins to mature.

How is the proposal likely to affect critical habitat?

No critical habitat has been listed for this species..

Key threatening process considered to contribute to a decline in *Acacia bynoeana* include:

- Habitat disturbance during road, trail and powerline maintenance
- Invasion by exotic species
- High frequency fires

The minimisation of vegetation clearing and post-construction vegetation rehabilitation would minimise the extent of impact on potential habitat for the species.

The mitigation measures proposed are considered to be consistent with the priority actions identified as being required for the recovery of the species. Therefore, the project is considered unlikely to interfere substantially with the recovery of the species.

The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 Corridor.

Conclusion

Based on the above investigation, it is considered a significant impact on *Acacia bynoeana* is unlikely.

F.1.13 Netted Bottle Brush *Callistemon linearifolius*

This shrub is up to 3-4 m tall, with linear (long and narrow) to linear-lanceolate (lance shaped) leaves 8-10 cm long, and 5-7 mm wide with a sharp tip, thickened margins, and distinct lateral veins (DECCW, 2010). Flowers are clustered into the typical "bottlebrushes" of Callistemons.

Capsules are 7 mm diameter. The species flowers in spring – summer and grows in dry sclerophyll forest on the coast and adjacent ranges (DECCW, 2010).

Callistemon linearifolius has been recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River.

Callistemon linearifolius is listed as Vulnerable under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of *Callistemon linearifolius*?

Callistemon linearifolius was not recorded during surveys however records indicate the species has recently been located within 50 m of the proposed works at Marsfield (DECCW, 2010), towards the southern extent of the study area. It is considered unlikely that this forms part of a viable population that exists within the M2 Corridor.

Callistemon linearifolius was more widespread across its distribution in the past. There are currently only 5-6 populations in the Sydney area, of the 22 populations recorded in the past. Three of these are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve, and Spectacle Island Nature Reserve.

It is not considered likely that the proposed works will impact upon this local occurrence of *Callistemon linearifolius* or affect the lifecycle of *C.linearifolius* that may be located in the vicinity. Species located in the area are not likely to be genetically distinct from other populations in the Sydney region or to be necessary for maintaining genetic diversity of the species as a whole.

No certainty can be concluded that the proposed works will not impact upon the pollinator species for *C.linearifolius* however it is not considered likely that the proposed works will impact on areas of potential habitat for the species in adjacent areas of bushland and cross-pollination and seed dispersal is thus unlikely to be significantly affected.

How is the proposal likely to affect the habitat of *Callistemon linearifolius*?

Much of the habitat to be removed has been modified by previous road construction and is in poor to moderate condition, with a high degree of weed invasion and a high degree of fragmentation. Although vegetation will be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by bushland regeneration works and revegetation.

How is the proposal likely to affect habitat connectivity?

The proposed works would result in additional vegetation removal and disturbance however as the widening is alongside the existing motorway vegetation fragmentation is not likely to be significantly increased. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring habitat as regenerating species and replanted vegetation begins to mature.

How is the proposal likely to affect critical habitat?

No critical habitat has been listed for *Callistemon linearifolius* under the TSC Act.

Key threatening process considered to contribute to a decline in *Acacia bynoeana* include:

- Habitat disturbance during road, trail and powerline maintenance
- Invasion by exotic species
- High frequency fires

The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 corridor.

The proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. With the implementation of these measures, the impact of weed invasion is not considered likely to be increased significantly.

It is possible that *Phytopthora cinnamomi* could be introduced by the proposed action but this outcome is unlikely as mitigation measures would be implemented to prevent the introduction of this soil-borne pathogen during earthworks. The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.

The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 corridor.

Conclusion

Based on the above investigation, a significant impact on a local population of this species is unlikely.

F.1.14 *Darwinia biflora*

Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath. This species occurs at 129 sites in the northern and north-western suburbs of Sydney and within the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai local government areas (DEWHA 2009a).

There are 20 populations of *Darwinia biflora* within the Sydney Region that are not currently covered by the reserve system and have been identified as important and suitable to be targeted for conservation. The bushland of the M2 corridor and adjacent bushland (e.g. Bidjigal Reserve, Lane Cove National Park) are not included in these lists of important populations.

The species was not recorded during flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a large population exists here.

Darwinia biflora is listed as Vulnerable under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of *Darwinia biflora*?

The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of this species as: a potentially important population is not likely to exist within the M2 corridor.

How is the proposal likely to affect the habitat of *Darwinia biflora*?

The proposed works may result in the permanent removal or modification of approximately 10 ha of native vegetation however most of this area is considered to be unsuitable as habitat for the species due to minimal shale soil influence. Approximately 0.2 hectares of vegetation that may be affected has a shale influence and is potential habitat for the species.

Potential reduction in the area of occupancy as a result of the proposed works is expected to have minimal impact on an important population of the species as: a potentially important population is not considered likely to exist within the M2 corridor, and larger areas of similar potential habitat for this species also occur nearby within and beyond the M2 corridor.

How is the proposal likely to affect habitat connectivity?

As the widening is alongside the existing motorway vegetation fragmentation is not likely to be significantly increased. Although vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring habitat as regenerating species and replanted vegetation begins to mature. This would restore continuity between an already fragmented landscape.

How is the proposal likely to affect critical habitat?

No critical habitat has been declared for *Darwinia biflora* under the TSC Act.

Darwinia biflora is threatened by continuing loss of habitat due to primary urban development.

The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *Darwinia biflora* becoming established in the species' potential habitat.

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible. The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.

Conclusion

Based on the above investigation, a significant impact on a local population of *Darwinia biflora* is unlikely.

F.1.15 *Epacris purpurascens ssp. purpurascens*

Epacris pururascens ssp*. purpurascens* is an erect shrub, 50-180 cm high that is found in a range of habitat types, most of which have a strong shale soil influence and habitats which remain, particularly on ridgetops, are under increasing threat of clearance or habitat modification (DECCW, 2009).This species is listed as Vulnerable under the TSC Act.

During opportunistic observations while gaining access to the field survey locations, *E. p. purpurascens* was found to be locally abundant within several areas of Bidjigal Reserve outside of the M2 corridor, both within a few hundred metres of the corridor and at greater distances. These occurrences of the species and those within the M2 corridor are considered to form part of a single, apparently viable and moderately large, local population.

How is the proposal likely to affect the lifecycle of *E. p. purpurascens*?

Dispersal of the species is likely to be localised except during times of high winds or heavy rainfall when dispersal over a longer distance is probable however pollinators of the species are unknown (NPWS, 2002). *E. p. purpurascens*is killed by fire and re-establishes from soil-stored seed (NPWS, 2002). Information on seed germination is limited, but it is thought that a dormancy mechanism and minimum of 2-4 years is required before seed is produced in the wild (NPWS, 2002).

Based on the above considerations, no certainty can be concluded that the proposed works will not impact upon the pollinator species for *E. p. purpurascens.*However, mitigation measures have been designed to minimise the likelihood of disturbance regimes that may affect pollination of the species.

A conservative estimate of potential habitat for *E. p. purpurascens* within the M2 corridor is approximately 30 ha. Approximately 20 individuals of this species are likely to be removed. Within the M2 corridor, this species is restricted to translocated soils including earth mounds and rock armoured batter slopes.

It appears that these individuals have regenerated from soil removed from the location of the existing motorway. In light of this, regeneration of the species from soils translocated during the proposed project is considered likely.

The potential loss of approximately 20 individuals of this species is unlikely to significantly affect the viability of a local population of this species.

How is the proposal likely to affect the habitat of *E. p. purpurascens*?

Much of the habitat to be removed has been modified by previous road construction. The less-disturbed vegetation further from the edge of the M2 Motorway does not appear to contain any unique or rare features.

Although vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works. As the current populations observed appear to be growing in translocated soil amongst patches of moderately disturbed vegetation it is not considered likely that the proposed works would modify the extent of the local community.

How is the proposal likely to affect habitat connectivity?

The proposed works would result in vegetation removal and disturbance however as the widening is alongside the existing motorway vegetation fragmentation is not likely to be significantly increased. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring habitat as regenerating species and replanted vegetation begins to mature.

How is the proposal likely to affect critical habitat?

No critical habitat has been declared for *E. p. purpurascens* under the *Threatened Species Conservation Act 1995*. As the individuals located appear to have regenerated from soil removed from the location of the existing motorway, the study area is not considered to be critical to the survival of this species.

Key threatening processes that are considered to contribute to the decline of *E. p. Purpurascens* include:

- Habitat clearance
- Infection of native plants by *Phytophthora cinnamomi*
- Invasion and establishment of exotic vines and scramblers

- Invasion and establishment and spread of *Lantana camara*

Whilst the proposed M2 Upgrade would result in removal of approximately 20 individuals of *E. p. Purpurascens*, rehabilitation and revegetation works will be conducted post-construction and regeneration of this species from soils translocated during the proposed works is likely.

It is possible that *Phytopthora cinnamomi* could be introduced by the proposed action but this outcome is unlikely as mitigation measures would be implemented to prevent the introduction of this soil-borne pathogen during earthworks. The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. With the implementation of these measures, the impact of weed invasion is not likely to be increased significantly.

Conclusion

Based on the consideration of potential impacts, a significant impact on a local population of *E.p.purpurascens*is is unlikely.

F.1.16 *Persoonia hirsuta*

This species occurs in dry sclerophyll eucalypt woodland or forest and in shrub-woodland. It grows in sandy to stony soils derived from sandstone or very rarely on shale, from near sea level to 600 m altitude.

The species has been recorded from a number of National Parks (Blue Mountains, Wollemi, Dharug, Ku-ring-gai Chase, Marramarra, Royal and Sydney Harbour).

Most locations consist of one to three plants, with the exception of two currently known locations with between 10 and 20 plants. There is evidence of continued decline in the number of locations and the number of individuals. The species is particularly prone to local population extinction because of the small number of plants found at all locations.

Persoonia hirsuta is listed as Endangered under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of *Persoonia hirsuta*?

The species was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, the closest recent (post 1980) record of the species is approximately 5 km from the M2 corridor and the species has not been detected within the adjacent bushland reserves.

The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of this species asa potentially important population is not likely to exist within the M2 corridor.

How is the proposal likely to affect the habitat of *Persoonia hirsuta*t?

The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation.

How is the proposal likely to affect disturbance regimes?

The M2 Upgrade is thus unlikely to result in additional invasive species that are likely harmful to *P. hirsuta* becoming established in the species' potential habitat. Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

How is the proposal likely to affect habitat connectivity?

Fragmentation of habitat as a result of the proposed works is expected to have minimal impact on the species as continuity would be enhanced between potential habitat for the species adjacent to work areas and larger areas of similar potential habitat for this species within and beyond the M2 corridor.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for *P.hirsuta*.

Key threatening processes that are considered to contribute to the decline of *P.hirsuta* include:

- Loss of habitat
- Burning for hazard reduction
- Competition of feral honeybees

The proposed M2 Upgrade would result in additional vegetation removal however the potential habitat for this species on the site is presently subject to light to heavy weed invasion. Rehabilitation and revegetation works would restore habitat as regenerating species and replanted vegetation begins to mature.

The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 corridor.

The proposal is unlikely to affect the vegetation or otherwise affect habitat such that feral honeybees would be likely to increase in abundance or in their impact on native species.

Conclusion

Based on the above investigation, a significant impact on a local population of *P. hirsuta* is unlikely.

F.1.17 *Pimelea curviflora var. curviflora*

Pimelea curviflora var*. curviflora o*ccurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.

This species is confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west.

It is usually recorded as rare with only 2 sites with estimates of 300 plants, and most sites with only a few plants or estimates of <100 plants. The taxon has an inconspicuous cryptic habitat as it is fine and scraggly and often grows amongst dense grasses and sedges. It may not always be visible at a site as it appears to survive for some time without any foliage after fire or grazing, relying on energy reserves in its tuberous roots (DECCW 2009).

The species has been recorded in Lane Cove National Park and in Epping near the M2 Corridor (NPWS 2009). Species recorded during EIS for the western section though the specific location and numbers were not recorded (Mt King 1992b).

P. c. curviflora is listed as Vulnerable under the TSC Act 1995.

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

At most recorded sites, this species occurs in low numbers. *P. c. curviflora* is found in two fairly small populations in Lane Cove National Park, North Ryde and a few plants were recorded in the Pages Creek area. The Field of Mars Reserve, Ryde has a population estimated to be greater than 300 plants (Kubiak 1995).

It is not known how many individuals of this species (if any) occur within the M2 Corridor. It is considered unlikely that any population here would be considered key source populations, either for breeding or dispersal, as the potential habitat here is isolated from other areas of habitat in the region as a result of urban development.

It is also considered unlikely that any population here is likely to be genetically distinct from other populations in the region or to be necessary for maintaining genetic diversity of the species as a whole.

P. c. curviflora was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the study area, it is not considered likely that a potentially important population exists within the M2 corridor or that pollination and seed-dispersal vectors are unlikely to be affected. Therefore, the M2 Upgrade is unlikely to disrupt the breeding cycle of *P. c. curviflora.*

How is the proposal likely to affect the habitat of *P. c. curviflora*?

The proposed works may result in the permanent removal of up to approximately 7 ha of potential habitat for this species. Additional areas of potential habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites. The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation.

Potential reduction in the area of occupancy as a result of the proposed works is expected to have a minimal impact on an important population of the species as it is not likely that a potentially important population exists within the M2 corridor.

How is the proposal likely to affect habitat connectivity?

Whilst the proposed M2 Upgrade would result in vegetation removal it is not likely to be significantly increased as the widening is alongside the existing motorway vegetation. It is considered likely that continuity would be enhanced between potential habitat for the species adjacent to work areas and larger areas of similar potential habitat for this species within and beyond the M2 corridor through rehabilitation and revegetation works post-construction.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for *P. c. Curviflora.*

Key threatening processes that are considered to contribute to the decline of *P. c. Curviflora* include:

- Loss of habitat
- Invasion and establishment of exotic vines and scramblers (TSC)
- Invasion, establishment and spread of *Lantana camara*

Whilst the proposed M2 Upgrade would result in vegetation removal upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring habitat as regenerating species and replanted vegetation begins to mature.

The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *P. c. curviflora* becoming established in the species' potential habitat.

Conclusion

Based on the above investigation, it is considered a significant impact on a local population of the *P. c. curviflora* is unlikely.

F.1.18 Glandular Pink-bell *Tetratheca glandulosa*

Tetratheca glandulosa is associated with areas of shale-sandstone transition habitat. The vegetation varies from heaths and scrub to woodlands/open woodlands, and open forest. The larger populations of *Tetratheca glandulosa* occur in woodland/open woodland vegetation communities that provide semi-shade (NSW NPWS 2000).

Tetratheca glandulosa is considered to be part of the Endangered Shale/Sandstone Transition Forest and Cumberland Plain Woodland; the Critically Endangered Turpentine Ironbark Forest, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland; and the Blue Gum High Forest (DEWHA 2009a).

Tetratheca glandulosa is found in the following Local Government Areas: Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah and Wyong (NSW NPWS 2000).

Tetratheca glandulosa occurs in 150–200 populations. Strongholds for the species south of the Hawkesbury River include the Berowra Valley, Maroota-South Maroota area, and Marramarra National Park. Strongholds to the north of the Hawkesbury River are in Dharug National Park, the Mangrove Mountain-Central Mangrove area, and Ourimbah State Forest (NSW NPWS 2000).

Tetratheca glandulosa is listed as Vulnerable under the TSC Act 1995.

How is the proposal likely to affect the lifecycle of *Tetratheca glandulosa*?

The NSW NPWS (2000) considers that areas of habitat containing populations of *Tetratheca glandulosa* greater than 100 plants should be considered significant. However populations with less than 100 plants may also be significant depending on the subregional distribution of other populations in the locality.

The exact number of mature reproducing *Tetratheca glandulosa* plants is uncertain, but is estimated at about 11,100 plants (DEWHA). Population sizes at the species distributional limits are often low, at less than 20 plants.

The species was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a potentially important population exists within the M2 corridor.

The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.

How is the proposal likely to affect the habitat of *Tetratheca glandulosa*?

The extent of occurrence is estimated at 6174 km², based on herbarium data from the Australian Virtual Herbarium (AVH) project. The area of occupancy is estimated at 105 km², based on the number of 1 km² grid squares in which the species is thought to occur. The estimate is considered to be of low reliability, as recent ground-truthing at all populations has not occurred.

Potential reduction in the area of occupancy as a result of the proposed works is expected to have minimal impact on an important population of the species as a potentially important population is not considered likely to exist within the M2 corridor, and larger areas of similar potential habitat for this species also occur nearby within and beyond the M2 corridor.

The M2 Upgrade is unlikely to disrupt the breeding cycle of this species as potential pollination and seed-dispersal vectors are unlikely to be affected.

How is the proposal likely to affect habitat connectivity?

Tetratheca glandulosa populations have been fragmented by urban and rural development. They occur as scattered, discontinuous populations on ridge tops, upper slopes and associated sandstone benches (NSW NPWS 2000).

Fragmentation of habitat as a result of the proposed works is expected to have minimal impact on the species as connectivity to larger areas of similar potential habitat beyond the M2 corridor is expected to be enhanced through revegetation works and rehabilitation of disturbed areas.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for *Tetratheca glandulosa*.

Key threatening processes considered to contribute to the decline in *Tetratheca glandulosa:*

- Clearing of native vegetation and habitat fragmentation
- Invasion of exotic species
- High frequency fires

As the widening is alongside the existing Motorway vegetation fragmentation is not likely to be significantly increased. Whilst the proposed M2 Upgrade would result in vegetation removal upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring habitat as regenerating species and replanted vegetation begins to mature.

The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *Tetratheca glandulosa* becoming established in the species' potential habitat.

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.

The minimisation of vegetation clearing, post-construction vegetation rehabilitation and measures to prevent the spread of weeds and plant pathogens would minimise the extent of impact on potential habitat for the species.

Conclusion

Based on the above investigation, a significant impact on a local population of the *Tetratheca glandulosa* is unlikely.

F.1.19 ECOLOGICAL COMMUNITIES

Blue Gum High Forest in the Sydney Basin Bioregion

Within the study area Blue Gum High Forest, conforming to the national listing, is restricted to a single patch that is partially within the M2 corridor and partially within the adjacent Pennant Hills Golf Course.

This patch is approximately 1.36 hectares in area and varies considerably in condition. Some areas within this patch contain native species, consistent with the description of this community, in all vegetation layers. Other areas however lack one or more layers. The areas in poorest condition have a native canopy with very little native under-storey or ground layer vegetation. Weed invasion is moderate to high throughout this patch.

Several other areas within the M2 corridor would have once supported Blue Gum High Forest. Due to previous clearing and other forms of disturbance the original forest in these locations has been eliminated or reduced to isolated trees. These disturbed areas, including those containing isolated trees, are not within the context of other native vegetation and do not conform to the national listing of Blue Gum High Forest.

Several other native vegetation communities in the study area share a number of species with Blue Gum High Forest. This vegetation are likely to contribute to the viability of the patch near Pennant Hills Golf Course through interaction in the form of seed dispersal and cross-pollination and through providing habitat for the animals that pollinate and disperse the seeds of many plant species.

The Blue Gum High Forest is listed as a Critically Endangered Ecological Community under the TSC Act 1995.

How is the proposal likely to affect the habitat of the ecological community?

No reduction in the extent of the patch of Blue Gum High Forest occurring adjacent to the M2 corridor would occur as a result of the M2 Upgrade. The design option for the proposed M2 Motorway was specifically chosen to avoid vegetation clearing or modification to this ecological community.

The M2 Upgrade would have little detrimental impact on the ecological processes occurring within the Blue Gum High Forest of the study area. Vegetation removal in bushland areas in the vicinity of the Blue Gum High Forest is unlikely to significantly affect population of fauna (birds, flying foxes, insects) that are potential pollinators and dispersers of seed. Genetic interaction between the Blue Gum High Forest and adjacent areas of bushland through cross-pollination and seed dispersal is thus unlikely to be significantly affected.

The proposed works do have some potential to result in the introduction of species that may be detrimental to the ecological community as earthworks would be conducted in nearby areas. The weed management and restoration measures are however likely to prevent any additional weed species becoming established.

The proposed measures for the prevention of the spread of weeds and plant pathogens during construction and site rehabilitation would minimise the likelihood of diseases being introduced to the area containing the ecological community.

Proposed rehabilitation works within the Blue Gum High Forest are likely to improve the functioning of natural ecological processes such as nutrient cycling, and vegetative succession as a result of the removal of the dominant invasive weeds and the creation of conditions conducive to the recruitment of native plants.

How is the proposal likely to affect habitat connectivity?

No fragmentation of any patches of Blue Gum High Forest would occur as a result of the M2 Upgrade.

How is the proposal likely to affect critical habitat?

No habitat critical to the survival of Blue Gum High Forest would be affected by the proposed works.

The priority recovery and threat abatement actions required for this ecological community are:

- prevent further clearing or fragmentation of the ecological community through the protection of protected remnants and/or local council zoning;
- restore and enhance remaining areas of Blue Gum High Forest of the Sydney Basin Bioregion to create buffer zones and to link fragments with remnants of other native vegetation;
- manage weed infestation through weeding and bush regeneration activities; and
- develop and implement appropriate management regimes to prevent further loss or decline of functionally important species and reduction in community integrity (DEWHA 2009a).

The minimisation of vegetation clearing and post-construction vegetation rehabilitation and weed control would minimise the extent of potential indirect impacts such as weed invasion on the community.

Management measures, where possible, will be implemented that are consistent with the actions and best practice guidelines identified for the recovery of this ecological community.

Conclusion

Based on the above investigation, a significant impact on the Blue Gum High Forest is unlikely.

F.2 Commonwealth Assessments of Impact Significance

F.2.1 Assessments of Significance

Vulnerable Species

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

- *lead to a long-term decrease in the size of an important population of a species;*
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

These factors are addressed under separate headings for each vulnerable species.

F.2.2 FAUNA

F.2.3 Green and Golden Bell Frog *Litoria aurea*

Size of an important population

- *lead to a long-term decrease in the size of an important population of a species;*

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *key source populations either for breeding or dispersal;*
- *populations that are necessary for maintaining genetic diversity; and/or*
- *populations that are near the limit of the species range.*

The Green and Golden Bell Frog (GGBF) was once distributed along the coastal lowlands in NSW from approximately 50 kilometres south of the Queensland border to north-east Victoria. Since the 1970's the species has undergone a decline in its population and distribution, particularly in inland areas.

Extant key populations in the Sydney region include populations in the following locations (DEC 2005):

- Kurnell,
- Homebush Bay,
- Clyde/Rosehill,
- Merrylands,
- Arncliffe,
- St Marys,
- Hammonville

Occasional records have been reported from North Ryde near Macquarie University and tributaries of the Lane Cove River and other locations in the Sydney Region. Some of these scattered Sydney records could indicate the continued persistence of unknown populations with conservation significance (DEC 2005).

The three GGBF records in the NPWS Atlas of NSW Wildlife in the vicinity of the M2 Corridor are all from 1995 to 1999 in the vicinity of North Ryde, Macquarie Park and Epping.

The GGBF has not been recorded recently in the vicinity of the M2 Corridor and it is possible that the species is now locally extinct. It is also possible however that one or more populations may persist and hence consideration of potential impacts on this species is required.
The GGBF is often considered to be a colonising species that is tolerant of a wide range of environmental conditions but does not compete favourably with other frog species. The GGBF tends to be displaced from newly created or disturbed habitats in a form or ecological succession as environmental conditions change and additional frog species establish in such areas (DEC 2005).

GGBF habitat typically consists of four functional types:

- Breeding habitat: shallow, sunlit water bodies, permanent or temporary, natural or artificial, particularly those with emergent vegetation (typically *Typha* and *Eleocharis* spp.), which lack predatory fish such as the Plague Minnow *Gambusia holbrooki*.
- Foraging habitat: areas of low vegetation, typically dominated by grasses and other grass-like plants usually within one kilometre of breeding habitat,
- Overwintering habitat: features such as rocks, logs and other debris, including non-natural materials that provide moist conditions and a relatively stable temperature range during winter when the frogs are inactive,
- Corridor habitat: areas with appropriate environmental conditions (e.g. moisture, temperature) that act as movement corridors between breeding, foraging and overwintering habitat where these are not adjacent to one another – typically streams, ditches and drainage depressions (DEC 2005).

When constructed, the detention basins of the M2 corridor were planted with emergent aquatic native plants with the intention of providing wildlife habitat in addition to the primary purpose of slowing stormwater flows to minimise water pollution and impacts to the hydrology of adjacent waterways.

Emergent aquatic plants currently found growing in the detention basins include *Eleocharis sphacelata, Bolboschoenus fluviatilis,* and *Typha orientalis*. Frog surveys conducted in several of these detention basins in the vicinity of North Ryde did not detect the presence of GGBF however four other frog species were recorded there. The frog species recorded were *Litoria peronii, L. fallax, Limnodynastes peronii* and *Crinia signifera*.

The detention basins vary somewhat in the characteristics of the aquatic vegetation found within them, some having an almost complete cover of emergent vegetation whilst others have larger areas of open water. The height and structure of the vegetation surrounding the basins also varies with some overshadowed by tree regrowth and others in relatively open sunlit conditions. Water levels within these basins are likely to increase after rainfall and decrease during extended dry periods though it is likely that water is continually present in most if not all of these basins. Water quality in the basins is likely to be relatively poor due to the influx of pollutants from the road surface. As most of the basins are isolated from other water bodies, they are unlikely to be inhabited by fish though other potential GGBF predators such as tortoises, eels, snakes and wading birds may be found in these locations. It is unknown whether or not the Amphibian Chytrid Fungus is found in any of these basins but it is possible that it may have been introduced there by colonising frogs.

In general the basins appear to provide conditions that may be suitable for GGBF breeding however the abundance of other frog species present within the basins may have resulted in competitive exclusion of the species. Changing environmental conditions such as increased shading, greater height and density of adjacent vegetation and the possibility of Amphibian Chytrid Fungus may have favoured other frog species to the detriment of the GGBF.

The bushland in the vicinity of many of the detention basins is not considered to be favourable GGBF foraging habitat as it lacks the open grassy structure preferred by the species. Several of the detention basins in more disturbed locations do have some open grassy areas nearby with the most extensive of these being located in the North Ryde area.

Some potential sheltering (overwintering) habitat is likely to be found in the vicinity of all of the detention basins in the form of rocks, fallen logs, rubbish and clump-forming plants though, in general, the abundance and variety of this type of habitat appears to be relatively low within the M2 corridor.

The characteristics of any population that may persist here are unknown and hence the potential importance of any such population is also uncertain.

Key threatening processes affecting GGBF in the region include the following:

- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands,
- Clearing of native vegetation,
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis
- Predation by the European Red Fox, and
- Predation by the Plague Minnow (*Gambusia holbrooki*) (DEC 2005).

This species was not recorded during targeted surveys within the M2 corridor.

Area of occupancy

- *reduce the area of occupancy of an important population;*

The proposed works would result in the removal of approximately 3 ha of vegetation clearance for detention basin works and access roads. The detention basins within the M2 corridor contain an artificial assemblage of emergent native aquatic plants which were planted when the detention basins were constructed.

Detention basin works may alter the area of occupancy of potential foraging and shelter habitat of the GGBF temporarily due to an alteration to the environmental conditions such as water depth and light levels.

Vegetation clearance around detention basins is considered likely to improve the potential of these areas as GGBF foraging habitat as the initially low, dense regrowth that is likely to result is likely to be more suitable for the species than much of the existing vegetation. Vegetation clearance here is also likely to increase light levels.

Modification to other areas as a result of clearing for access may result in a reduction in available foraging habitat in the short-term but is not likely to prevent the species from using these areas as foraging sites in the medium to long term. The extent of habitat to be removed or modified by the proposed M2 Upgrade is not considered likely to have a significant negative impact on the GGBF. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating and replanted vegetation begins to mature.

Fragmentation

- *fragment an existing important population into two or more populations;*

The GGBF is a relatively mobile frog species that forages and seeks shelter at distances of up to 1 km or more from breeding sites during favourable weather conditions. In doing so, individuals may move through and forage within highly cleared and fragmented landscapes. Major roads may act as barriers to the movement of the species particularly if walls and culverts limit access to ground-dwelling fauna. The existing M2 Motorway is currently a barrier to wildlife movement therefore the widening works will not significantly increase the barrier to any significant degree.

The relatively small amount of clearing proposed and the resultant minor increase in habitat fragmentation is however not likely to significantly affect any population of the species that may utilise the study area.

Critical habitat

- *adversely affect habitat critical to the survival of a species;*

No critical habitat has been listed for the GGBF. The M2 corridor and surrounding bushland is not likely to contain habitat critical to the survival of the species.

Breeding cycle

- *disrupt the breeding cycle of an important population;*

The detention basins within the M2 corridor contain an artificial assemblage of emergent native aquatic plants which were planted when the detention basins were constructed. This species was not recorded during targeted surveys within the M2 corridor. Water quality in the basins is likely to be relatively poor due to the influx of pollutants from the road surface. It is unknown whether or not the Amphibian Chytrid Fungus is found in any of these basins but it is possible that it may have been introduced there by colonising frogs and therefore on this basis, is unlikely to provide suitable breeding habitat for the GGBF. Detention basin works are being designed to favour the GGBF through revegetation works with emergent aquatic plant species. Due to the very small area of impact and the absence of important populations of GGBF in the study area, the M2 Upgrade is not likely to affect the breeding cycle of the GGBF.

Habitat removal and modification

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

Vegetation clearance around detention basins is considered likely to improve the potential for GGBF foraging habitat as the initially low, dense regrowth is likely to be more suitable for the species than much of the existing vegetation. Vegetation clearance here is also likely to increase light levels.

The proposed works may result in the permanent removal of vegetation from an area of up to approximately 20 ha of which approximately 7 ha is dominated by native vegetation. While some of this area is considered to be potential foraging habitat for this species, most of this area is considered to be marginal or unsuitable as habitat due to a lack of suitable vegetation cover, dry surface conditions and distance from potential breeding habitat. Additional areas of marginal potential foraging habitat would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Only the permanent clearing for widening works is considered to permanently reduce the area of habitat (foraging and sheltering habitat only) for the species. Modification to other areas as a result of clearing for access may result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally. The area would also be supplemented by bushland regeneration works thereby restoring foraging habitat as regenerating and replanted vegetation begins to mature.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not likely to have a significant negative impact on the GGBF.

Invasive species

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;*

A number of invasive fauna species exist within the study area. Of these species, only the Plague Minnow *Gambusia holbrooki* and the European Red Fox *Vulpes vulpes* are considered to likely affect the GGBF.

With the use of equipment in wet environments in several locations within the M2 Corridor, there is a risk that juvenile Plague Minnow could be spread in wet mud. With the implementation of the proposed mitigation measures, the spread of this species is however unlikely.

The proposed works are not considered likely to modify the habitats of the study area in such a way as to encourage the establishment of any additional invasive fauna species. These include any fauna species that may compete with, parasitise or prey upon the GGBF or increase the impact of existing species (such as the European Red Fox).

The proposed works do have some potential to result in the introduction to the locality of invasive exotic plant species and plant diseases that may be detrimental to the habitat of the GGBF. With the implementation of the proposed measures to minimise the likelihood of spreading weeds and plant diseases the likelihood of introducing these species is low.

Disease

- *introduce disease that may cause the species to decline; or*

With the use of equipment in wet environments in several locations within the M2 Corridor, there is a risk that Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis* could be spread in wet mud. Chytridiomycosis caused by Amphibian Chytrid Fungus has been implicated in severe population declines and species extinctions of frogs in the past 20 years (DEH 2006). With the implementation of the proposed mitigation measures, this risk of spreading this disease to uninfected water bodies is considered to be low.

Recovery

- *interfere substantially with the recovery of the species.*

The following measures have been identified as being required for the recovery of the species:

- Maintain captive bred populations for future possible re-introduction programs.
- Initiate community awareness programs that highlight the presence of populations and catchment management approaches to improving stormwater quality, habitat retention and management.
- Develop measures to control or eradicate the introduced Plague Minnow.
- Establish protocols for handling of frogs and educational strategies to minimise the inadvertent spread of fungal pathogens from site to site.
- Develop strategies to provide for the development or enhancement of frog habitat to improve reproductive success and recruitment at known sites.
- Develop site specific plans of management to improve conservation outcomes for targeted populations.
- Develop strategies to provide disease-free and fish-free breeding habitat (DEC 2005).

No recovery plans have been finalised for this species. A draft recovery plan for the GGBF has been prepared (DEC 2005) and considers the conservation requirements of the species across its known range.

Most of these recovery objectives relate to research and management activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation.

The minimisation of vegetation clearing and post-construction vegetation rehabilitation targeted at creating appropriate foraging and sheltering habitat would minimise the extent of negative impact on potential foraging and sheltering habitat for the species.

Measures to minimise the likelihood of introducing Plague Minnow and Amphibian Chytrid Fungus would minimise the chance of habitat degradation as result of the introduction of these species.

The placement of large woody debris around detention basins would enhance the availability of sheltering habitat in these locations.

The proposed works are considered unlikely to interfere substantially with the recovery of the species. The proposed mitigation measures are consistent with the actions in the draft recovery plan (DEC 2005).

F.2.4 Grey-headed Flying-fox *Pteropus poliocephalus*

Size of an important population

- *lead to a long-term decrease in the size of an important population of a species;*

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

The Grey-headed Flying-fox is distributed in a coastal belt from south-eastern Queensland to Melbourne, Victoria and is infrequently found west of the Great Dividing Range (Tidemann 1998). The species is highly mobile and the distribution of the national population varies within the species range with groups of bats moving up and down the east coast in response to seasonal food availability (Menkhorst 1995; Tidemann 1998).
Studies have indicated that there appears to be a single interbreeding population, with constant genetic exchange and movement between camps throughout the entire geographic range of the species. Bats commute daily between roosting sites (camps) and feeding areas which are usually located within 15 kilometres of camp sites (Tidemann 1998).

Roost sites are typically located near water, such as lakes, rivers or the coast and vegetation often consists of rainforest patches, paperbark forest, mangroves and riparian vegetation though colonies also use highly modified vegetation in urban and suburban areas (DEWHA 2009a).

The closest known camp site to the study area is in the Ku-ring-gai Flying-fox Reserve in Gordon which is located approximately 4 to 15 kilometres from the M2 corridor. The population size of the Ku-ring-gai Flying-fox Reserve camp varies with an average of approximately 30,000 individuals. Two other flying-fox camps are known in the Sydney region, at Cabramatta Creek and in the Sydney Royal Botanic Gardens.

The Grey-headed Flying-fox was recorded flying overhead in several locations during field surveys and was recorded feeding in mature flowering Blackbutt *Eucalyptus pilularis* within the M2 corridor near Bidjigal Reserve. Individuals feeding within the study area are considered most likely to roost in the Ku-ring-gai Flying-fox Reserve in Gordon.

Foraging habitat for this species is considered to be present throughout the study area wherever fleshy-fruited and nectar-producing trees are present. This includes all bushland areas dominated by eucalypts and a variety of native and introduced trees within the urban landscape. Areas containing tall eucalypt forest are considered to be particularly important to this species as foraging habitat.

The study area does not contain any known camp sites for the Grey-headed Flying-fox and although the vegetation and topography in parts of the M2 Corridor (e.g. along Devlins Creek) may be suitable for roosting, the presence of the M2 and walking trails with associated noise disturbance in these locations is likely to dissuade the species from roosting here.

Area of occupancy

- *reduce the area of occupancy of an important population;*

The proposed works may result in the permanent removal of up to approximately 0.2 ha of marginal potential roosting habitat and up to approximately 7 ha of known and potential foraging habitat for this species. Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Only the permanent clearing for widening works is considered to permanently reduce the area of occupancy of the species. Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally. The area would also be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating and replanted trees begin to mature.

The Grey-headed Flying Fox forages in larger areas of similar habitat throughout the Sydney Metropolitan area therefore the extent of habitat to be removed or modified by the proposed M2 Upgrade is not considered significant in relation to areas of less-disturbed habitat in the locality.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Fragmentation

- *fragment an existing important population into two or more populations;*

The Grey-headed Flying-fox is a highly mobile, wide-ranging species that forages at distances of up to 15 km or more from roost sites during a single evening. In doing so, individuals move through and forage within highly cleared and fragmented landscapes.

The relatively small amount of clearing proposed and the resultant minor increase in habitat fragmentation is not considered likely to significantly affect the subset of the population of the species that utilises the study area.

Critical habitat

- *adversely affect habitat critical to the survival of a species;*

No critical habitat has been listed for the Grey-headed Flying-fox. The M2 corridor and surrounding bushland is not considered likely to contain habitat critical to the survival of the species.

Breeding cycle

- *disrupt the breeding cycle of an important population;*

Grey-headed Flying-foxes mate and give birth within maternity camps and initially carry their young while foraging. As they begin to mature, juvenile bats are left at the camp while their mothers forage.

No camp sites are present within or in the bushland adjacent to the M2 corridor. Whilst it is considered possible that the vegetation of the M2 corridor could be utilised as a camp site in future, it is not considered likely.

Given the relatively small amount of potential habitat that would be affected, the M2 Upgrade is not considered likely to significantly disrupt the breeding cycle of any subset of the population of the Grey-headed Flying-fox.

Habitat removal and modification

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

The proposed works may result in the permanent removal of up to approximately 0.2 ha of marginal potential roosting habitat and up to approximately 7 ha of known and potential foraging habitat for this species. Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

The Grey-headed Flying Fox forages in larger areas of similar habitat throughout the Sydney Metropolitan area and larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Invasive species

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;*

A number of invasive fauna species exist within the study area. None of these species are considered to be likely to affect the Grey-headed Flying-fox.

The proposed works are not considered likely to modify the habitats of the study area in such a way as to encourage the establishment of any additional invasive fauna species that may compete with, parasitise or prey upon the Grey-headed Flying-fox.

The proposed works do have some potential to result in the introduction to the locality of invasive exotic plant species and plant diseases that may detrimental to habitat of the Grey-headed Flying-fox. With the implementation of the proposed measures to minimise the likelihood of spreading weeds and plant diseases the likelihood of introducing these species is however considered to be low.

Disease

- *introduce disease that may cause the species to decline; or*

The M2 Upgrade is unlikely to introduce any disease that may infect bat species as no animals or material used in animal husbandry is proposed to be brought into the study area.

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*) that may degrade fauna habitat. The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The proposed upgrade works are unlikely to result in the introduction of diseases that may cause the Grey-headed Flying-fox to decline.

Recovery

- *interfere substantially with the recovery of the species.*

No recovery plans have been completed for this species. A recovery plan is in preparation.

The Action Plan for Australian Bats (Environment Australia, 1999) lists the following recovery objectives for the species:

- Stabilise the population at its current level.
- Define patterns of landscape use, and identify and protect essential habitat.
- Develop non-destructive methods for crop protection.
- Develop non-destructive methods for management of camps in problem areas.
- Ensure consistent management of the species across all range states (Queensland, New South Wales and Victoria).

Most of these recovery objectives relate to activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation.

The minimisation of vegetation clearing and post-construction vegetation rehabilitation would minimise the extent of impact on potential foraging habitat for the species.

The project is not likely to interfere substantially with the recovery of the species.

F.2.5 Large-eared Pied Bat *Chalinolobus dwyeri*

Size of an important population

- *lead to a long-term decrease in the size of an important population of a species;*

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *key source populations either for breeding or dispersal;*
- *populations that are necessary for maintaining genetic diversity; and/or*
- *populations that are near the limit of the species range.*

The Large-eared Pied Bat is found from south-eastern Queensland (Rockhampton) to New South Wales (NSW) (south to Bungonia), from the coast to the western slopes of the Divide. There are scattered records from the New England Tablelands and North West Slopes. The NSW distribution is generally rare and very patchy, with the species found predominantly in areas with extensive cliffs and caves.

The bat is most commonly found in dry sclerophyll forest and woodland, however also in sub-alpine woodland, and on the edge of rainforests and wet sclerophyll rainforest. It roosts in caves and mines, crevices in cliffs, and in the disused, bottle-shaped mud nests of the Fairy Martin (*Hirundo ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. It roosts in colonies of 3-37, clustered in indentations in the ceiling, most commonly in the twilight areas of the caves, close to the entrance. Maternity caves are found in well-timbered areas containing gullies.

The bats remain loyal to the same maternity cave over many years. (Churchill,1998). It is not known whether this species ever utilises tree hollows as roosting habitat (Environment Australia, 1999). It has been speculated (Churchill, 1998) that this species may also utilise tree hollows for roosting though the use of tree hollows by the species has not been reported. Although few details are currently known, it probably forages for small, flying insects, below the forest canopy (Churchill, 1998).

This distribution and habitat requirements of this species are poorly understood however in NSW the species is known from the following the areas shown in the table below (Environment Australia, 1999).

There are three records of this species on the Atlas of NSW Wildlife database within ten kilometres of the motorway.

It is likely that the density of threatened species records is somewhat biased by the extent of survey effort in the region with areas subject to greater development pressure receiving greater survey effort during environmental impact assessment.

This may account for the records of the species in the locality being within heavily cleared areas as opposed to the nearby bushland reserves.

The Large-eared Pied Bat was not recorded during the targeted bat surveys undertaken as part of this assessment. The Large-eared Pied Bat is readily identifiable from Anabat call recordings. Despite the collection of a large number of calls from other bat species, no calls attributable to this species were recorded.

Potential roosting habitat for this species is considered to be present chiefly in steep areas containing rock outcrops within the bushland valleys of the region. Potential foraging habitat is considered to exist within larger areas of native vegetation within a few kilometres of these areas.

There are some steep areas containing rock outcrops in close proximity to the motorway, chiefly in the vicinity of the Darling Mills Creek crossing adjacent to Bidjigal Reserve, North Rocks.

There are several rock overhangs in this locality. Most of these overhangs are relatively open and contain few fissures or cracks. One large rock does contain a relatively deep, darkened cavity however this area is near ground level and would likely provide easy access to potential predators. These overhangs are thus considered to be marginal as roosting habitat for cave-dwelling bats.

The proposed works may result in the removal of up to approximately less than one hectare of marginal potential roosting habitat and up to approximately 7 ha of potential foraging habitat. Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.
Whilst it is unknown if the subject site is occupied by this species, the paucity of records in the sandstone valleys of the area and the marginal quality of the potential roosting habitat present indicates that the study area is unlikely to support an important population of the species.

Area of occupancy

- *reduce the area of occupancy of an important population;*

The proposed works may result in the permanent removal of less than one hectare of marginal potential sandstone cave roosting habitat and up to approximately 7 ha of potential foraging habitat (includes roosting habitat). Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Only the permanent clearing for widening works are considered to reduce the potential area of occupancy of the species. Modification to other areas as a result of clearing for access is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Fragmentation

- *fragment an existing important population into two or more populations;*

Law and Chidel (1999) found that 30 percent of microbat taxa were sensitive to the effects of forest fragmentation while 60 percent appeared tolerant of fragmentation. Although total activity in small remnants and corridors was as great as that in large forests continuous within a 690,000 ha national park, feeding activity was greatest in continuous forests, suggesting that larger forests with high habitat diversity offered more foraging opportunities. Despite providing fewer feeding opportunities, remnants represent an important conservation resource for bats because activity is concentrated here and they provide potential roost sites. Law and Chidel (1999) also found that bats were generally insensitive to the effects of patch size and shape as well as the amount of remnant vegetation in the landscape.

Microbats in general are highly mobile species that are capable of utilising modified landscapes including artificial breaks in woodland and forest for foraging activities (Churchill, 1998).

Whilst it is unknown to what extent the Large-eared Pied Bat is capable of tolerating habitat fragmentation, the relatively small amount of clearing proposed and the barrier created by the existing M2 Motorway is unlikely to increase habitat fragmentation.

Critical habitat

- *adversely affect habitat critical to the survival of a species;*

No critical habitat has been listed for the Large-eared Pied Bat. The study area is not considered likely to support an important population of the species or to contain habitat critical to the survival of the species.

Breeding cycle

- *disrupt the breeding cycle of an important population;*

Some potential foraging habitat for the Large-eared Pied Bat may be affected however this habitat is considered to be marginal and unlikely to be used by the species as breeding habitat.

Given the relatively small amount of this potential habitat that would be affected, the M2 Upgrade is not likely to significantly disrupt the breeding cycle of any population of the Large-eared Pied Bat.

Habitat removal and modification

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

The proposed works may result in the permanent removal of less than one hectare of marginal potential sandstone cave roosting habitat and up to approximately 7 ha of potential foraging habitat (includes roosting habitat). Additional areas of potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Modification to other areas as a result of clearing for access is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Invasive species

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;*

A number of invasive fauna species exist within the study area. Of these, cats and foxes may prey upon the Large-eared Pied Bat occasionally if roost entrances are close to ground level. The Pied Currawong, a possibly over-abundant native bird species, may also prey on the species. This impact is expected to be minimal as the Pied Currawong is a day-active species and predation of bats is only likely to occur occasionally during twilight hours.

The proposed works are not considered likely to modify the habitats of the study area in such a way as to encourage the establishment of any invasive fauna species that may compete with, parasitise or prey upon the Large-eared Pied Bat.

The proposed works do have some potential to result in the introduction to the locality of invasive exotic plant species and plant diseases that may be detrimental to the habitat of the Large-eared Pied Bat. With the implementation of the proposed measures to minimise the likelihood of spreading weeds and plant diseases the likelihood of introducing these species is low.

Disease

- *introduce disease that may cause the species to decline; or*

The M2 Upgrade is unlikely to introduce any disease that may infect bat species as no animals or material used in animal husbandry is proposed to be brought into the study area.

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*) that may degrade fauna habitat. The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The proposed upgrade works are unlikely to result in the introduction of diseases that may cause the Large-eared Pied Bat to decline.

Recovery

- *interfere substantially with the recovery of the species.*

No recovery plans have been completed for this species. A recovery plan is in preparation.

The Action Plan for Australian Bats (Environment Australia, 1999) lists the following recovery actions for the species:

- Protection of known roosts and associated foraging habitats.
- Undertake targeted surveys for the species to clarify distribution and status.
- Carry out ecological research to determine habitat requirements, roost and maternity site selection; foraging strategy, population dynamics and threatening processes.
- Encourage active management actions such as installation of 'Fairy Martin (bird species) friendly structures' in road culverts and bridges (as a means to promote bat roost sites, see Schulz 1998); and inspection of bridges/culverts prior to demolition or major capital works to reduce impact on colonies already utilising these structures by State and local government authorities with responsibility for construction and maintenance of roads.

Most of these recovery actions relate to activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation.

The minimisation of vegetation clearing and post-construction vegetation rehabilitation would minimise the extent of impact on potential habitat for the species.

The project is considered unlikely to interfere substantially with the recovery of the species.

F.2.6 FLORA

F.2.7 *Acacia bynoeana*

- 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 Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leafed Apple.
- Found in central eastern NSW, from the Hunter District (Morisset), south to the Southern Highlands and west to the Blue Mountains.
- It is known from 30 locations, typically only 1-5 individuals occur at each site. A few sites contain 30-50 individuals. The total population is estimated to be only a few hundred plants (DEWHA 2009a).

Records of this species in the vicinity of the M2 corridor are chiefly to the north in the Baulkham Hills and Ku-ring-gai LGAs (NPWS 2009).

The closest records are within 2 km of the M2 corridor in the east in Gordon and in the west near the northern boundary of Bidjigal Reserve (NPWS 2009).

Impact Criteria	Assessment of Impact
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal; • *populations* that are necessary for maintaining genetic diversity; and/or • *populations* that are near the limit of the species range.
lead to a long-term decrease in the size of an important population of a species;	No recovery plan has been prepared for this species and no important populations have been specifically identified. At most recorded sites, this species occurs in low numbers. It is not known how many individuals of this species (if any) occur within the M2 corridor though it is considered unlikely that a large population would exist here as the species has not been located here. It is considered unlikely that any population here would be considered a key source population either for breeding or dispersal as the potential habitat here is isolated from habitat containing known populations in the region as a result of urban development. It is also considered unlikely that any population here is likely to be genetically distinct from other populations in the region or to be necessary for maintaining genetic diversity of the species as a whole. The potential habitat for this species within the M2 corridor is not at the limit of the species known distribution as the species is distributed to the north, west and south of the locality on the outskirts of the Sydney metropolitan area and beyond. The species was not recorded during flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a potentially important population exists within the M2 corridor. The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.

Impact Criteria	Assessment of Impact
reduce the area of occupancy of an important population;	As a potentially important population is not considered likely to exist within the M2 corridor, no reduction in the area of occupancy of an important population is considered likely.
fragment an existing important population into two or more populations;	As a potentially important population is not considered likely to exist within the M2 corridor, no fragmentation of an important population is considered likely.
adversely affect habitat critical to the survival of a species;	A potentially important population is not considered likely to exist within the M2 corridor and no critical habitat has been listed for this species. The M2 Upgrade would not adversely affect habitat critical to the survival of this species.
disrupt the breeding cycle of an important population;	A potentially important population is not considered likely to exist within the M2 corridor and hence the M2 Upgrade is unlikely to disrupt the breeding cycle of an important population 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;	A potentially important population is not considered likely to exist within the M2 corridor. Whilst the proposed works may modify, destroy, remove or isolate or decrease the availability or quality of habitat for this species, the extent of such impact on the species (should it occur) is likely to be minor as any population present here is likely to be small and isolated from known important populations. This level of potential impact is unlikely to cause the species to decline.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *Acacia bynoeana* becoming established in the species' potential habitat.
introduce disease that may cause the species to decline; or	Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible. The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.
interfere substantially with the recovery of the species.	No recovery plan has been completed for this species. Thirteen priority actions have been identified as being required for the recovery of the species (DECCW 2009). Most of these recovery objectives relate to activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation. The minimisation of vegetation clearing and post-construction vegetation rehabilitation would minimise the extent of impact on potential habitat for the species. The mitigation measures proposed are considered to be consistent with the priority actions identified as being required for the recovery of the species. Therefore, the project is unlikely to interfere substantially with the recovery of the species.

F.2.8 *Darwinia biflora*

- Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath.
- Occurs at 129 sites in the northern and north-western suburbs of Sydney, in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai local government areas (DEWHA 2009a).

The nearest populations to the M2 Corridor occur in Lane Cove NP and Pennant Hills Park. This species has been recorded within 1 km of the M2 Corridor (NPWS 2009).

Impact Criteria	Assessment of Impact
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal; • *populations* that are necessary for maintaining genetic diversity; and/or • *populations* that are near the limit of the species range.
lead to a long-term decrease in the size of an important population of a species;	The following sites that have been recorded as containing > 5000 individuals (DEWHA 2009a). **Site** — **Tenure** Bobbin Head track — DEC (National Park) Murrua track — DEC (National Park) Gibberagong track — DEC (National Park) Berowra Valley Regional Park, Dural — Berowra Valley Regional Park Beaumont track — DEC (National Park) Berowra Valley Regional Park, — Galston Berowra Valley Regional Park Mt Colah — DEC (National Park) There are 20 populations within the Sydney Region that are not currently covered by the reserve system and have been identified as important and suitable to be targeted for conservation. The bushland of the M2 Corridor and adjacent bushland (e.g. Bidjigal Reserve, Lane Cove National Park) are not included in these lists of important populations. The species was not recorded during flora surveys within the M2 Corridor. Whilst it is considered possible that this species may exist within the M2 Corridor, it is considered unlikely that a large population exists here. A potentially important population is not considered likely to exist within the M2 Corridor. The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.
reduce the area of occupancy of an	The proposed works may result in the permanent removal or modification of approximately 10 ha of native vegetation

Impact Criteria	Assessment of Impact
important population;	however most of this area is considered to be unsuitable as habitat for the species due to minimal shale soil influence. Approximately 0.2 hectares of vegetation that may be affected has a shale influence and is potential habitat for the species. Potential reduction in the area of occupancy as a result of the proposed works is expected to have minimal impact on an important population of the species as: • a potentially important population is not considered likely to exist within the M2 Corridor, and • larger areas of similar potential habitat for this species also occur nearby within and beyond the M2 Corridor.
fragment an existing important population into two or more populations;	Fragmentation of habitat as a result of the proposed works is expected to have minimal impact on an important population of the species as: a potentially important population is not considered likely to exist within the M2 Corridor, and continuity would be maintained between potential habitat for the species adjacent to work areas and larger areas of similar potential habitat for this species within and beyond the M2 Corridor.
adversely affect habitat critical to the survival of a species;	A potentially important population is not considered likely to exist within the M2 Corridor and no critical habitat has been listed for this species. The M2 Upgrade would not adversely affect habitat critical to the survival of this species.
disrupt the breeding cycle of an important population;	The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of this species as: a potentially important population is not considered likely to exist within the M2 Corridor, proposed mitigation measures would minimise the likelihood of spreading weeds which could suppress seedling recruitment, and potential pollination and seed-dispersal vectors are unlikely to be affected
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	A potentially important population is not considered likely to exist within the M2 Corridor. The proposed works may modify, destroy, remove, isolate or decrease the availability or quality of habitat for this species. However, the extent of such impact on the species (should it occur) is likely to be minor as any population present here is likely to be small and isolated from known important populations. This level of potential impact is unlikely to cause the species to decline.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *Darwinia biflora* becoming established in the species' potential habitat.
introduce disease that may cause the species to decline; or	Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible. The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.
interfere substantially with the	The overall objective of the Darwinia biflora recovery plan is to prevent the status of D. biflora from becoming

Impact Criteria	Assessment of Impact
recovery of the species.	endangered, by reducing the continual loss of populations and by implementing management regimes aimed at maintaining representative populations across the species' range. Actions identified as being required for the recovery of the species are: • Identify sites that are a high priority to protect • Carry out negotiations with public authorities to protect sites • Liaise with private landholders to protect sites • Threat and habitat management programs will be implemented by public authorities on public lands • Easement maintenance activities will not affect the long term survival of populations of D. biflora • Informed environmental assessment and planning decisions will be made • Investigate aspects of the ecology of the species • Identify and survey potential habitat • Encourage community involvement • Provide advice and assistance to private landholders • DEC to be advised of any consents or approvals that affect D. biflora • Re-assess conservation status of species (DEC 2004). Most of these recovery objectives relate to research and education activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation. The minimisation of vegetation clearing, post-construction vegetation rehabilitation and measures to prevent the spread of weeds and plant pathogens would minimise the extent of impact on potential habitat for the species and is considered to be consistent with the primary objective of the recovery plan. The proposed mitigation measures will be included in the EMP and are consistent with the actions of the recovery plan for the species.

F.2.9 *Pimelea curviflora var. curviflora*

- Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.
- Confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west.
- It is usually recorded as rare with only 2 sites with estimates of 300 plants, and most sites with only a few plants or estimates of <100 plants. The taxon has an inconspicuous cryptic habitat as it is fine and scraggly and often grows amongst dense grasses and sedges. It may not always be visible at a site as it appears to survive for some time without any foliage after fire or grazing, relying on energy reserves in its tuberous roots (DECCW 2009).

Species recorded in Lane Cove NP and in Epping near the M2 Corridor (NPWS 2009).

Species recorded during EIS for the western section though the specific location and numbers were not recorded (Mt King 1992b).

Impact Criteria	Assessment of Impact
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal; • *populations* that are necessary for maintaining genetic diversity; and/or • *populations* that are near the limit of the species range.
lead to a long-term decrease in the size of an important population of a species;	No recovery plan has been prepared for this species and no important populations have been specifically identified. At most recorded sites, this species occurs in low numbers. *Pimelea curviflora var. curviflora* is found in two fairly small populations in Lane Cove National Park, North Ryde and a few plants were recorded in the Pages Creek area. The Field of Mars Reserve, Ryde has a population was estimated to be greater than 300 plants (Kubiak 1995). It is not known how many individuals of this species (if any) occur within the M2 corridor. It is considered unlikely that any population here would be considered key source populations, either for breeding or dispersal, as the potential habitat here is isolated from other areas of habitat in the region as a result of urban development. It is also considered unlikely that any population here is likely to be genetically distinct from other populations in the region or to be necessary for maintaining genetic diversity of the species as a whole. The potential habitat for this species within the M2 corridor is not at the limit of the species known distribution as the species is distributed within Hornby and Baulkham Hills (Hills Shire) LGA to the north and an important population is found within Ryde area to the south (Kubiak 1995). The species was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a potentially important population exists within the M2 corridor. The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.
reduce the area of occupancy of an important population;	The proposed works may result in the permanent removal of up to approximately 7 ha of potential habitat for this species. Additional areas of potential habitat (approximately 3 ha) would be modified through temporary clearing and

Impact Criteria	Assessment of Impact
	subsequent rehabilitation of access areas and compound sites. Potential reduction in the area of occupancy as a result of the proposed works is expected to have minimal impact on an important population of the species as: • a potentially important population is not considered likely to exist within the M2 corridor, and • larger areas of similar potential habitat for this species also occur nearby within and beyond the M2 corridor.
fragment an existing important population into two or more populations;	Fragmentation of habitat as a result of the proposed works is expected to have minimal impact on an important population of the species as: • a potentially important population is not considered likely to exist within the M2 corridor, and • continuity would be maintained between potential habitat for the species adjacent to work areas and larger areas of similar potential habitat for this species within and beyond the M2 corridor.
adversely affect habitat critical to the survival of a species;	A potentially important population is not considered likely to exist within the M2 corridor and no critical habitat has been listed for this species. The M2 Upgrade would not adversely affect habitat critical to the survival of this species.
disrupt the breeding cycle of an important population;	The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of this species as: • a potentially important population is not considered likely to exist within the M2 corridor, • proposed mitigation measures would minimise the likelihood of spreading weeds which could suppress seedling recruitment, and • potential pollination and seed-dispersal vectors are unlikely to be affected
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	Whilst the proposed works may modify, destroy, remove or isolate or decrease the availability or quality of habitat for this species, the extent of such impact on the species (should it occur) is likely to be minor as any population present here is likely to be small and isolated from known important populations and proposed mitigation measures would minimise impacts on potential habitat. This level of potential impact is unlikely to cause the species to decline.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *Pimelea curviflora var curviflora* becoming established in the species' potential habitat.
introduce disease that may cause the species to decline; or	Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible. The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.
interfere substantially with the recovery of the species.	No recovery plan has been prepared for this species. Seven priority actions identified as being required for the recovery of the species (DECC 2009). Most of these recovery objectives relate to activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation.

Impact Criteria	Assessment of Impact
	The minimisation of vegetation clearing, post-construction vegetation rehabilitation and measures to prevent the spread of weeds and plant pathogens would minimise the extent of impact on potential habitat for the species and is considered to be consistent with the primary objective of the recovery plan. The project is considered unlikely to interfere substantially with the recovery of the species and the EMP will seek to include the priority actions identified as being required for the recovery of the species.

F.2.10 *Tetratheca glandulosa*

- *Tetratheca glandulosa* (Glandular Pink-bell) is associated with areas of shale-sandstone transition habitat. The vegetation varies from heaths and scrub to woodlands/open woodlands, and open forest. The larger populations of Glandular Pink-bell occur in woodland/open woodland vegetation communities that provide semi-shade (NSW NPWS 2000).
- Glandular Pink-bell is considered to be part of the Endangered Shale/Sandstone Transition Forest and Cumberland Plain Woodland; the Critically Endangered Turpentine Ironbark Forest, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland; and the Blue Gum High Forest (DEWHA 2009a).
- Glandular Pink-bell is found in the following Local Government Areas: Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah and Wyong (NSW NPWS 2000).

Glandular Pink-bell occurs in 150–200 populations. Strongholds for the species south of the Hawkesbury River include the Berowra Valley, Maroota-South Maroota area, and Marramarra National Park. Strongholds to the north of the Hawkesbury River are in Dharug National Park, the Mangrove Mountain-Central Mangrove area, and Ourimbah State Forest (NSW NPWS 2000).

Impact Criteria	Assessment of Impact
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal; • *populations* that are necessary for maintaining genetic diversity; and/or • *populations* that are near the limit of the species range.
lead to a long-term decrease in the size of an important population of a species;	The NSW NPWS (2000) considers that areas of habitat containing populations of Glandular Pink-bell greater than 100 plants should be considered significant. However populations with less than 100 plants may also be significant depending on the subregional distribution of other populations in the locality. The exact number of mature reproducing Glandular Pink-bell plants is uncertain, but is estimated at about 11 100 plants (DEWHA). Population sizes at the species distributional limits are often low, at less than 20 plants. Populations recorded with more than 200 plants exist in the Berowra Valley, Maroota-South Maroota area, Marramarra National Park, Dharug National Park, Mangrove Mountain-Central Mangrove area and the Ourimbah State Forest (NSW NPWS 2000). The species was not recorded during recent flora surveys within the M2 Corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is d unlikely that a potentially important population exists within the M2 corridor. The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.

Impact Criteria	Assessment of Impact
reduce the area of occupancy of an important population;	The extent of occurrence is estimated at 6174 km², based on herbarium data from the Australian Virtual Herbarium (AVH) project. The area of occupancy is estimated at 105 km², based on the number of 1 km² grid squares in which the species is thought to occur. The estimate is considered to be of low reliability, as recent ground-truthing at all populations has not occurred. Potential reduction in the area of occupancy as a result of the proposed works is expected to have minimal impact on an important population of the species as: • a potentially important population is not considered likely to exist within the M2 corridor, and • larger areas of similar potential habitat for this species also occur nearby within and beyond the M2 corridor.
fragment an existing important population into two or more populations;	Glandular Pink-bell populations have been fragmented by urban and rural development. They occur as scattered, discontinuous populations on ridge tops, upper slopes and associated sandstone benches (NSW NPWS 2000). Fragmentation of habitat as a result of the proposed works is expected to have minimal impact on an important population of the species as: • a potentially important population is not considered likely to exist within the M2 corridor, and • continuity would be maintained between potential habitat for the species adjacent to work areas and larger areas of similar potential habitat for this species within and beyond the M2 corridor.
adversely affect habitat critical to the survival of a species;	A potentially important population is not considered likely to exist within the M2 corridor and no critical habitat has been listed for this species. The M2 Upgrade would not adversely affect habitat critical to the survival of this species.
disrupt the breeding cycle of an important population;	The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of this species as: • a potentially important population is not considered likely to exist within the M2 corridor, • proposed mitigation measures would minimise the likelihood of spreading weeds which could suppress seedling recruitment, and • potential pollination and seed-dispersal vectors are unlikely to be affected.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	Whilst the proposed works may modify, destroy, remove or isolate or decrease the availability or quality of habitat for this species, the extent of such impact on the species (should it occur) is likely to be minor as any population present here is likely to be small and isolated from known important populations and proposed mitigation measures would minimise impacts on potential habitat. This level of potential impact is unlikely to cause the species to decline.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation. The M2 Upgrade is thus unlikely to result in additional invasive species that are harmful to *Tetratheca glandulosa* becoming established in the species' potential habitat.

Impact Criteria	Assessment of Impact
introduce disease that may cause the species to decline; or	Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible. The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.
interfere substantially with the recovery of the species.	No recovery plan has been prepared for this species. The minimisation of vegetation clearing, post-construction vegetation rehabilitation and measures to prevent the spread of weeds and plant pathogens would minimise the extent of impact on potential habitat for the species. The EMP will seek to include the priority actions identified as being required for the recovery of the species therefore the project is unlikely to interfere substantially with the recovery of the species.

F.2.11 Endangered Species

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

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

These factors are addressed under separate headings for each endangered species.

F.2.12 Regent Honeyeater *Anthochaera (Xanthomyza) phrygia*

The Regent Honeyeater is a generalist forager on the nectar of eucalypts and mistletoes (DECCW, 2009). Key eucalypt species include Mugga Ironbark *Eucalyptus sideroxylon*, Yellow Box *E. melliodora*, Blakely's Red Gum *E. blakelyi*, White Box *E. albens* and Swamp Mahogany *E. robusta* but the Regent Honeyeater also utilises *E. microcarpa*, *E. punctata*, *E. polyanthemos*, *E. moluccana*, *Corymbia robusta*, *E. crebra*, *E. caleyi*, *Corymbia maculata*, *E.mckieana*, *E. macrorhyncha*, *E. laevopinea*, and *Angophora floribunda* (DECC, 2009). Nectar and fruit from the Mistletoes *Amyema miquelii, A. pendula* and *A. cambagei* are also eaten during the breeding season (DECCW, 2009). When nectar is scarce, lerp and honeydew comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. A shrubby understorey is an important source of insects and nesting material (DECCW, 2009).

The Regent Honeyeater generally inhabits dry, temperate woodlands and open forests of the inland slopes of south-eastern Australia (DECCW, 2009). There are only three known major breeding locations and two of these occur in NSW. In NSW the distribution is very patchy and largely confined to Capertee Valley and in the Bundarro-Barraba region and surrounding fragmented woodlands (DECCW, 2009).

Regent Honeyeaters sometimes occur in coastal forest, especially in stands dominated by Swamp Mahogany and Spotted Gum, but also on sandstone ranges with banksias *Banksia spp.* in the understorey (DEWHA 2009a). The species is occasionally observed in a variety of other vegetation types including low open forest with dry heathy understorey on and coastal scrub or heathland dominated by *Banksia* and *Leptospermum* species. It is possible that these habitats are used predominantly as a refuge when the preferred box-ironbark habitats are affected by drought (Menkhorst et al. 1999).

Size of population

- *lead to a long-term decrease in the size of a population;*

The Regent Honeyeater has three main population centres; the Bundarra-Barraba area and the Capertee Valley in NSW, and north-eastern Victoria. Evidence of movement of birds between these areas and little discernable difference in their genetics indicates that the species exists as a single population (DEWHA 2009a).

The limited removal of marginal potential drought period foraging habitat for this species as described in the following sections is considered unlikely to lead to a short-term or long-term decrease in the size of this population.

Area of occupancy

- *reduce the area of occupancy of the species;*

Potential drought period foraging habitat for the Regent Honeyeater in the vicinity of the M2 corridor consists of stands of open forest, particularly areas winter-flowering eucalypt species, lerp-infested trees and areas with a heath understorey.

Eucalypt species usually have regular flowering seasons, though many also show a degree of variability in flowering patterns as a result of the age of plants, local environmental conditions and variation in rainfall and other environmental conditions between years (DEC 2004).

None of the dominant tree species within the bushland areas of the M2 corridor are primarily winter-flowering. One of the dominant or sub-dominant species throughout much of the bushland is Red Bloodwood *Corymbia gummifera* which chiefly flowers in February and March however it is also known to flower sporadically during late autumn and winter.

The original native vegetation at the western end of the M2 corridor may have contained grassy woodland with winter-flowering eucalypts that may have been potential foraging habitat for the Regent Honeyeater. None of this original vegetation remains here, however revegetation along the edges of the M2 has involved the planting of some individuals of such species. This revegetation consists of narrow bands of immature trees between the edge of the M2 Motorway and adjacent residential lands and includes the following winter flowering species:

- *Grey Box Eucalyptus molucanna*
- *Grey Ironbark Eucalyptus paniculata*
- *Forest Red Gum Eucalyptus tereticornis*
- *Spotted Gum Corymbia maculata*

Of these species only Spotted Gum flowers chiefly during autumn and winter. The remaining species chiefly flower during summer but have variable flowering patterns that include occasional winter flowering.

Commonly used lerp infested trees include found in the M2 corridor include *E. moluccana* (in revegetated areas) and *E. pilularis* in bushland areas.

The proposed works may result in the permanent removal of up to approximately 7 ha of marginal potential foraging habitat for this species. Additional areas of marginal potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Only the permanent clearing for widening works is considered to permanently reduce the potential area of occupancy of the species. Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating and replanted trees begin to mature.

Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve, Lane Cove National Park and Pennant Hills Park.

The extent of marginal potential habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Fragmentation

- *fragment an existing population into two or more populations;*

The Regent Honeyeater is a highly mobile, wide-ranging species that moves considerable distances between breeding areas and temporally variable food recourses. In doing so, individuals move through and forage within highly cleared and fragmented landscapes.

The relatively small amount of clearing proposed and the resultant minor increase in habitat fragmentation is not considered likely to significantly affect the subset of the population of the species that may utilise vegetation within the M2 Corridor.

Critical habitat

- *adversely affect habitat critical to the survival of a species;*

No critical habitat has been listed for the Regent Honeyeater. The M2 corridor and surrounding bushland is not considered likely to contain habitat critical to the survival of the species.

Breeding cycle

- *disrupt the breeding cycle of a population;*

There are only two known major breeding locations for the Regent Honeyeater in NSW. Occasional small breeding events have also been recorded in several locations in NSW and the ACT. Breeding of the species has not been recorded in the Sydney area and breeding of the species in the vicinity of the M2 Corridor is considered highly unlikely.

Given the low likelihood of the species breeding in the locality and the small extent of impact on potential foraging habitat, the M2 Upgrade is not considered likely to significantly disrupt the breeding cycle of any subset of the population of the Regent Honeyeater.

Habitat removal and modification

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

The proposed works may result in the permanent removal of up to approximately 7 ha of marginal potential foraging habitat for this species. Additional areas of marginal potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Invasive species

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat;*

A number of invasive fauna species exist within the study area. Of these, only the Noisy Miner *Manorina melanocephala* is considered to potentially affect the Regent Honeyeater. The Noisy Miner is an aggressive colonial native honeyeater that has increased in urban areas most likely as a result of alteration to vegetation structure and excludes many other bird species from potential foraging resources.

The proposed works are not considered likely to modify the habitats of the study area in such a way as to encourage the establishment of any additional invasive fauna species that may compete with, parasitise or prey upon the Regent Honeyeater.

There may be some temporary increase competitive advantage of the Noisy Miner over other native birds due to a reduced density of native vegetation in areas of temporary clearing. This effect is however expected to be short-term as revegetation would re-establish the prior structure in the medium to long term.

The proposed works do have some potential to result in the introduction to the locality of invasive exotic plant species and plant diseases that may be detrimental to potential habitat for the Regent Honeyeater. With the implementation of the proposed measures to minimise the likelihood of spreading weeds and plant diseases the likelihood of introducing these species is considered to be low.

Disease

- *introduce disease that may cause the species to decline; or*

The M2 Upgrade is unlikely to introduce any disease that may infect bird species as no animals or material used in animal husbandry is proposed to be brought into the study area.

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*) that may degrade fauna habitat. The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The proposed upgrade works are unlikely to result in the introduction of diseases that may cause the Regent Honeyeater to decline.

Recovery

- *interfere substantially with the recovery of the species.*

A recovery plan (Menkhorst et al 1999) has been completed for this species which lists the following recovery objectives for the species:

- Effectively organise and administer the recovery effort to ensure that recovery plan objectives are met.
- Maintain and enhance the value of Regent Honeyeater habitat at the key sites and throughout the former range, by active participation in land-use planning processes and by active vegetation rehabilitation at strategic sites
- Monitor trends in the Regent Honeyeater population size and dispersion across its range to allow assessment of the efficacy of management actions.
- Facilitate research on strategic questions which will enhance the capacity to achieve the long-term objectives. In particular, determine the whereabouts of Regent Honeyeaters during the non-breeding season and during breeding season absences from known sites. Identify important sites and habitat requirements at these times.
- Maintain and increase community awareness, understanding and involvement in the recovery effort.
- Maintain the captive population of Regent Honeyeaters at a size which will provide adequate stock to: provide insurance against the demise of the wild population; continuously improve captive-breeding and husbandry techniques; provide adequate stock for trials of release strategies; and maintain 90% of the wild heterozygosity in the captive population.

Most of these recovery objectives relate to activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation.
The minimisation of vegetation clearing and post-construction vegetation rehabilitation would minimise the extent of impact on potential foraging habitat for the species.

Where possible, the EMP will incorporate management measures consistent with the Regent Honeyeater Recovery Plan. The project is therefore not considered likely to interfere substantially with the recovery of the species.

F.2.13 Swift Parrot *Lathamus discolor*

The Swift Parrot breeds in Tasmania during spring and summer and migrates to eastern Australia in autumn and winter. The breeding population has declined from in excess of 10,000 pairs to less than 1,000 with only a fraction of this number occurring in NSW (DECC 2009).

On the mainland, Swift Parrots occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations (DECC 2009). Favoured feed trees include Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens* (DECC 2009). Commonly used lerp trees are Grey Box *E. microcarpa*, Grey Box *E. moluccana* and blackbutt *E. pilularis* (DECC 2009). Swift Parrots show little site fidelity between years (Mac Nally & Horrocks, 2000) and this is probably due to the random variation in lerp infestation and flowering of their feed trees.

Size of population

- *lead to a long-term decrease in the size of a population;*

As a wide-ranging, nomadic and migratory species that breeds in a localized area in Tasmania, all Swift Parrots are likely to comprise a single population with high levels of genetic mixing.

The limited removal of marginal potential winter foraging habitat for this species as described in the following sections is unlikely to lead to a short-term or long-term decrease in the size of this population.

Area of occupancy

- *reduce the area of occupancy of the species;*

Potential winter foraging habitat for the Swift Parrot consists of stands of trees containing winter-flowering eucalypt species and lerp-infested trees.

Eucalypt species usually have regular flowering seasons, though many also show a degree of variability in flowering patterns as a result of the age of plants, local environmental conditions and variation in rainfall and other environmental conditions between years (DEC 2004).

None of the dominant tree species within the bushland areas of the M2 corridor are primarily winter-flowering. One of the dominant or sub-dominant species throughout much of the bushland is Red Bloodwood *Corymbia gummifera* which chiefly flowers in February and March however it is also known to flower sporadically during late autumn and winter.

The original native vegetation at the western end of the M2 corridor may have contained winter-flowering eucalypts. None of this original vegetation remains here however revegetation along the edges of the M2 has involved the planting of some individuals of these species. This revegetation consists of narrow bands of immature trees between the edge of the M2 Motorway and adjacent residential lands and includes the following winter flowering species:

- Grey Box Eucalyptus *molucanna*
- Grey Ironbark Eucalyptus *paniculata*
- Forest Red Gum Eucalyptus *tereticornis*
- Spotted Gum *Corymbia maculata*

Of these species only Spotted Gum flowers chiefly during autumn and winter. The remaining species chiefly flower during summer but have variable flowering patterns that include occasional winter flowering. Commonly used lerp infested trees include found in the M2 corridor include *E. moluccana* (in revegetated areas) and *E. pilularis* in bushland areas.

The proposed works may result in the permanent removal of up to approximately 7 ha of marginal potential foraging habitat for this species. Additional areas of marginal potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Only the permanent clearing for widening works is considered to permanently reduce the area of occupancy of the species. Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works thereby restoring foraging habitat as regenerating and replanted trees begin to mature.

Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve, Lane Cove National Park and Pennant Hills Park.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not considered significant in relation to areas of less-disturbed habitat in the locality.

Fragmentation

- *fragment an existing population into two or more populations;*

The Swift Parrot is a highly mobile, wide-ranging migratory species that forages within coastal and inland areas of eastern Australia. In doing so, individuals move through and forage within highly cleared and fragmented landscapes.

The relatively small amount of clearing proposed and the resultant minor increase in habitat fragmentation is not considered likely to significantly affect the subset of the subset of the national population of the species that may utilise the study area.

Critical habitat

- *adversely affect habitat critical to the survival of a species;*

No critical habitat has been listed for the Swift Parrot. The M2 corridor and surrounding bushland is not considered likely to contain habitat critical to the survival of the species.

Breeding cycle

- *disrupt the breeding cycle of a population;*

The Swift Parrot does not breed on mainland Australia.

Given the lack of breeding habitat and the relatively small amount of marginal potential foraging habitat that would be affected, the M2 Upgrade is not likely to significantly disrupt the breeding cycle of the Swift Parrot.

Habitat removal and modification

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

The proposed works may result in the permanent removal of up to approximately 7 ha of marginal potential foraging habitat for this species. Additional areas of marginal potential foraging habitat (approximately 3 ha) would be modified through temporary clearing and subsequent rehabilitation of access areas and compound sites.

Modification to other areas as a result of clearing for access will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve.

The extent of habitat to be removed or modified by the proposed M2 Upgrade is not significant in relation to areas of less-disturbed habitat in the locality.

Invasive species

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat;*

A number of invasive fauna species exist within the study area. Of these, only the Noisy Miner *Manorina melanocephala* is considered to potentially affect the Swift Parrot. The Noisy Miner is an aggressive colonial native honeyeater that has increased in urban areas most likely as a result of alteration to vegetation structure and excludes many other bird species from potential foraging resources.

The proposed works are not considered likely to modify the habitats of the study area in such a way as to encourage the establishment of any additional invasive fauna species that may compete with, parasitise or prey upon the Swift Parrot.

There may be some temporary increase competitive advantage of the Noisy Miner over other native birds due to a reduced density of native vegetation in areas of temporary clearing. This effect is however expected to be short-term as revegetation would re-establish the prior structure in the medium to long term.

The proposed works do have some potential to result in the introduction to the locality of invasive exotic plant species and plant diseases that may be detrimental to potential habitat for the Swift Parrot. With the implementation of the proposed measures to minimise the likelihood of spreading weeds and plant diseases the likelihood of introducing these species is considered to be low.

Disease

- *introduce disease that may cause the species to decline; or*

The M2 Upgrade is unlikely to introduce any disease that may infect bird species as no animals or material used in animal husbandry is proposed to be brought into the study area.

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*) that may degrade fauna habitat. The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The proposed upgrade works are unlikely to result in the introduction of diseases that may cause the Swift Parrot to decline.

Recovery

- *interfere substantially with the recovery of the species.*

A recovery plan (Swift Parrot Recovery Team, 2001) has been completed for this species which lists the following recovery objectives for the species:

- To identify priority habitats and sites across the range of the swift parrot.
- To implement management strategies to protect and improve priority habitats and sites resulting in a sustained improvement in carrying capacity.
- To reduce the incidence of collisions with man-made structures.
- To determine population trends within the breeding range.
- To quantify improvements in carrying capacity by monitoring changes in extent and quality of habitat.
- To increase public awareness about the recovery program and to involve the community in the recovery

Most of these recovery objectives relate to activities carried out by universities and government agencies and the proposed works would neither contribute to nor detract from their implementation.

The minimisation of vegetation clearing and post-construction vegetation rehabilitation would minimise the extent of impact on potential foraging habitat for the species.

Where possible, the EMP will incorporate management measures consistent with the Swift Parrot Recovery Plan.

F.2.14 Hairy Geebung Persoonia hirsuta

This species occurs in dry sclerophyll eucalypt woodland or forest and in shrub-woodland. It grows in sandy to stony soils derived from sandstone or very rarely on shale, from near sea level to 600 m altitude.

The species has been recorded from a number of National Parks (Blue Mountains, Wollemi, Dharug, Ku-ring-gai Chase, Marramarra, Royal and Sydney Harbour).

Most locations consist of one to three plants, with the exception of two currently known locations with between 10 and 20 plants. There is evidence of continued decline in the number of locations and the number of individuals. The species is particularly prone to local population extinction because of the small number of plants found at all locations.

Size of population

- *lead to a long-term decrease in the size of a population*;

The species was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, the closest recent (post 1980) record of the species is approximately 5 km from the M2 corridor and the species has not been detected within the adjacent bushland reserves.

The proposed works are thus unlikely to lead to a long-term decrease in the size of an important population of this species.

Area of occupancy

- *reduce the area of occupancy of the species;*

An important population of this species is not known within the M2 Corridor.

Fragmentation

- *fragment an existing population into two or more populations;*

Fragmentation of habitat as a result of the proposed works is expected to have minimal impact on an important population of the species as a potentially important population is not considered likely to exist within the M2 corridor and continuity would be maintained between potential habitat for the species adjacent to work areas and larger areas of similar potential habitat for this species within and beyond the M2 corridor.

Critical habitat

- *adversely affect habitat critical to the survival of a species;*

Critical habitat has not been declared for *P.hirsuta*.

Breeding cycle

- *disrupt the breeding cycle of a population;*

The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of this species as a potentially important population is not considered likely to exist within the M2 corridor. The proposed mitigation measures would minimise the likelihood of spreading weeds which could suppress seedling recruitment and potential pollination and seed-dispersal vectors are unlikely to be affected

Habitat removal and modification

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

It is considered unlikely that a population of this species occurs within the M2 corridor and therefore it is unlikely that the proposed project will modify, destroy, remove or isolate or decrease the availability or quality of habitat for thisspecies.

Invasive species

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat;*

The potential habitat for this species on the site is presently subject to light to heavy weed invasion. Proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation.

The M2 Upgrade is thus unlikely to result in additional invasive species that are likely harmful to *Persoonia hirsuta* becoming established in the species' potential habitat.

Disease

- *introduce disease that may cause the species to decline; or*

Mitigation measures are proposed that would minimise the likelihood of the introduction of plant pathogens (e.g. Phytophthora Root Rot Fungus *Phytophthora cinnamoni*). The importation of soil and mulch into bushland areas would be minimised through the use of in situ materials wherever feasible.

The M2 Upgrade is thus unlikely to introduce disease that may cause this species to decline.

Recovery

- *interfere substantially with the recovery of the species.*

No recovery plan has been prepared for this species. The minimisation of vegetation clearing, post-construction vegetation rehabilitation and measures to prevent the spread of weeds and plant pathogens would minimise the extent of impact on potential habitat for the species. Rehabilitation and revegetation works would restore habitat as regenerating species and replanted vegetation begins to mature.

The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 corridor.

The proposal is unlikely to affect the vegetation or otherwise affect habitat such that feral honeybees would be likely to increase in abundance or in their impact on native species.

F.2.15 Critically endangered and endangered ecological communities

Blue Gum High Forest in the Sydney Basin Bioregion

Within the study area Blue Gum High Forest, conforming to the national listing, is restricted to a single patch that is partially within the M2 corridor and partially within the adjacent Pennant Hills Golf Course.

This patch is approximately 1.36 hectares in area and varies considerably in condition. Some areas within this patch contain native species, consistent with the description of this community, in all vegetation layers. Other areas however lack one or more layers. The areas in poorest condition have a native canopy with very little native under-storey or ground layer vegetation. Weed invasion is moderate to high throughout this patch.

Several other areas within the M2 corridor would have once supported Blue Gum High Forest. Due to previous clearing and other forms of disturbance the original forest in these locations has been eliminated or reduced to

isolated trees. These disturbed areas, including those containing isolated trees, are not within the context of other native vegetation and do not conform the national listing of Blue Gum High Forest.

Several other native vegetation communities in the study area share a number of species with Blue Gum High Forest. This vegetation are likely to contribute to the viability of the patch near Pennant Hills Golf Course through interaction in the form of seed dispersal and cross-pollination and through providing habitat for the animals that pollinate and disperse the seeds of many plant species.

Impact Criteria	Assessment of Impact
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will: *reduce the extent of an ecological community;*	No reduction in the extent of any Blue Gum High Forest patches that meet the EPBC Act listing criteria would occur as a result of the M2 Upgrade.
fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;	No fragmentation of any patches of Blue Gum High Forest that meet the EPBC Act listing criteria would occur as a result of the M2 Upgrade.
adversely affect habitat critical to the survival of an ecological community;	No habitat critical to the survival of Blue Gum High Forest would be affected by the proposed works.
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;	The M2 Upgrade would have little detrimental impact on the ecological processes occurring within the Blue Gum High Forest of the study area. Vegetation removal in bushland areas in the vicinity of the Blue Gum High Forest is unlikely to significantly affect population of fauna (birds, flying foxes, and insects) that are potential pollinators and dispersers of seed. Genetic interaction between the Blue Gum High Forest and adjacent areas of bushland through cross-pollination and seed dispersal is thus unlikely to be significantly affected. Proposed rehabilitation works within the Blue Gum High Forest are likely to improve the functioning of natural ecological processes such as nutrient cycling, and vegetative succession as a result of the removal of the dominant invasive weeds and the creation of conditions conducive to the recruitment of native plants.
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;	No removal of habitat for Blue Gum High Forest that meets the EPBC Act listing criteria would occur as a result of the M2 Upgrade. Proposed rehabilitation works within the Blue Gum High Forest are likely to improve the condition of this patch.
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*	The proposed works do have some potential to result in the introduction of species that may be detrimental to the ecological community as earthworks would be conducted in nearby areas. The weed management and restoration measures are however likely to prevent any additional weed species becoming established. The proposed measures for the prevention of the spread of weeds and plant pathogens during construction and site rehabilitation would minimise the likelihood of diseases being introduced to the area containing the ecological community.
interfere substantially with the recovery of the	The priority recovery and threat abatement actions required for this ecological community are:

Impact Criteria	Assessment of Impact
species.	• prevent further clearing or fragmentation of the ecological community through the protection of protected remnants and/or local council zoning; • restore and enhance remaining areas of Blue Gum High Forest of the Sydney Basin Bioregion to create buffer zones and to link fragments with remnants of other native vegetation; • manage weed infestation through weeding and bush regeneration activities; and • develop and implement appropriate management regimes to prevent further loss or decline of functionally important species and reduction in community integrity (DEWHA 2009a). The minimisation of vegetation clearing and post-construction vegetation rehabilitation and weed control would minimise the extent of potential indirect impacts such as weed invasion on the community. The EMP will incorporate management measures, where possible, that are consistent with the actions identified in the recovery plan for this ecological community.

F.2.16 Migratory Species

- Black-faced Monarch *Monarcha melanopsis*
- Rainbow Bee-eater *Merops ornatus*
- Rufous Fantail *Rhipidura rufifrons*
- Satin Flycatcher *Myiagra cyanoleuca*
- White-throated Needletail *Hirundapus caudacutus*

Black-faced Monarch *Monarcha melanopsis*

The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. This species is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies and in more open woodland when migrating. The Black-faced Monarch is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March (Australian Musuem, 2005).

This species forages for insects among foliage and builds nests from Casuarina needles, bark, roots, moss and spider webs (Birds Australia, 2010).

Rainbow Bee-eater *Merops ornatus*

Widely distributed throughout Australia (DEWHA, 2009) the species occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (SPRAT, 1999). In Australia it is widespread, except in desert areas, usually near water (Birds of Australia, 2006). The Rainbow Bee-eater has not been formally identified to occur in any threatened ecological communities (DEWHA, 2010).

Southern populations move north, often in huge flocks during winter before returning to summer breeding areas Birds of Australia, 2010). Rainbow bee-eaters eat insects, and forages around beehives preferring honey bees and wasps. This species is usually seen in pairs or small flocks, although when migrating it may occur in groups of up to 500 birds or more (Higgins, 1999). The loss of eggs has been attributed to predation by dingoes, feral dogs and flooding.y

Rufous Fantail *Rhipidura rufifrons*

The Rufous Fantail is found in northern and eastern coastal Australia, being more common in the north. During migration, it may be found in more open habitats or urban areas. Strongly migratory in the south of its range, it moves northwards in winter (DEWHA, 2009).

Satin Flycatcher *Myiagra cyanoleuca*

The Satin Flycatcher is an active, mobile species that is found along the east coast of Australia from far northern Queensland to Tasmania (Birds of Australia, 2010). This species breeds in southern Australia and occurs at numerous and widespread sites in eastern Australia (DEWHA, 2010). The species is found in tall forests, preferring wetter habitats such as heavily forested gullies (Birds of Australia, 2010). The Satin Flycatcher is a migratory species, moving northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring (Birds of Austalia, 2010).

The Satin Flycatcher breeds from October to February and nests in loose colonies of two to five pairs nesting at intervals of about 20 m-50 m apart (Birds of Australia, 2010).

White-throated Needletail *Hirundapus caudacutus*

In eastern Australia, White-throated Needletails are widespread in eastern and south-eastern Australia and has been recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (DECCW, 2010). White-throated Needletails are non-breeding migrants in Australia with breeding taking place in northern Asia (DEWHA, 2009). This species almost

always foarges aerially on flying insects although, they sometimes forage closer to the gorund in open habitats. The species breeds in wooded lowlands and sparsely vegetated hills, as well as mountains covered with coniferous forests.

Impact Criteria	Assessment of Impact
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
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;	Modification to areas as a result of clearing will result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent any migratory species with a moderate likelihood of occurrence from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation will be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works. As the widening is alongside the existing Motorway vegetation fragmentation is not likely to be significantly increased. The extent of habitat to be removed or modified by the proposed M2 Upgrade is not considered significant in relation to areas of less-disturbed habitat in the locality. Larger areas of similar potential habitat for this species also occur nearby but beyond the study area, particularly within Bidjigal Reserve. The increased road surface as a result of the works could further alter the natural flow regime of the waterways of the study area however the detention basin works proposed are being designed with capacity for the additional stormwater from the motorway. Proposed rehabilitation works within the aras proposed to be cleared are likely to improve the functioning of natural ecological processes such as nutrient cycling, and vegetative succession as a result of the removal of the dominant invasive weeds and the creation of conditions conducive to the recruitment of native plants. The proposed works are not likely to exacerbate the frequency of fires within bushland areas adjacent to the M2 corridor.
result in an invasive speciesthat is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or	The proposed works are not considered likely to result in an invasive speciesthat is harmful to migratory species becoming established in an area of important habitat for the migratory species as: • The proposal is unlikely to affect the vegetation or otherwise affect habitat such that rabbits would be likely to increase in abundance or in their impact on native species • The proposal is unlikely to affect the vegetation or otherwise affect habitat such that feral cats would be likely to increase in abundance or in their impact on native species • The proposal is unlikely to affect the vegetation or otherwise affect habitat such that the European

Impact Criteria	Assessment of Impact
	Red Fox would be likely to increase in abundance or in its impact on native species • The minimisation of vegetation clearing, post-construction vegetation rehabilitation and measures to prevent the spread of weeds and plant pathogens would minimise the extent of impact on potential habitat for the species.
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	The M2 Upgrade is unlikely to disrupt the breeding cycle of an important population of migratory species as: • potentially important populations are not considered likely to exist within the M2 corridor • potential breeding habitat is not considered likely to occur within the M2 corridor due to the level of disturbance and susception of predation as a result of the highly urbanised environment adjacent to the M2 Motorway. Breeding habitat is more likely to be located in core bushland areas beyond the study area. • Species such as the White-throated Needletails are non-breeding migrants in Australia with breeding taking place in northern Asia. • Suitable foraging habitat is only considered to be marginal at best with preferred habitat more likely to be located in areas of less-disturbed habitat in the locality. • The mobility of such species also suggests that it is unlikely that any local or regional populations would be genetically isolated from the remainder of the Australain population. Migratory species are unlikely to rely on the affected areas as breeding or foraging or roosting habitat.

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