

Appendix K

Biodiversity Assessments of Significance

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EP&A ACT ASSESSMENT OF SIGNIFICANCE

NOTE: The following seven part test(s) associated with the assessment of significant effect on threatened species, populations or ecological communities, or their habitats have been undertaken in accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act 1979* ('Act').

These/this assessment(s), under Part 5 of the Act, may have been undertaken with prescribed designated mitigation measures that form part of the 'Action Proposed'¹ for the 'Development'². The effect of which is that these mitigation measures become a mandatory obligation based on Consent Authority approval to proceed.

Duffys Forest

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

Not applicable.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The study area contains approximately 7 ha of DFEC which is located at the western end and eastern ends of the proposal. The mapped patch at the western end is about 6.7 ha and includes habitat within the study area and on adjoining land. The mapped patch at the eastern end is about 11.4 ha. The proposal requires the clearing of 3 ha of DFEC which represents about 42% of the total remaining area of DFEC in the local occurrence, however, many other remnants outside the study area are smaller and in poorer condition. Less than 16% of the original extent of the community remains (240 ha - OEH Threatened Species Profile 2012). Additional indirect impacts may also occur downslope of the construction zone and are particularly relevant in view of the linear development/bushland interface and adjoining national parks. The risk of local extinction is increased by the restricted ridge-line habitat (mostly 10-20 m wide on either side of Mona Vale Road).

¹ Action Planned is as detailed in Part 5 of the EP&A Act

² 'Development' has the same meaning as determined under Section 4 of the Environmental Planning and Assessment Act 1979

Conclusion: The proposed activity is likely to have an adverse impact on the extent of the community such that its local occurrence is likely to be placed at increased risk of extinction.

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

Clearing of up to 3 ha of DFEC will impact on 42% of the local occurrence in the study area. Vegetation removal is permanent. Due to the inclusion of a 6 m buffer zone within the construction impact area, all ancillary clearing and some of the indirect impacts are included in the above impact assessment. Additional indirect impacts may arise from increased exposure and the movement of stormwater, sediment and weeds downslope. Enrichment of the soil, change in micro-climates at the soil surface, an increase in weedy exotic species and change in relative abundance of native species are common impacts. The risk of local extinction is increased by the restricted ridge-line habitat of DFEC (mostly 10-20 metres wide on either side of exiting Mona Vale Road).

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

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The study area contains approximately 7 ha of DFEC at the western end and the eastern end of the proposed road upgrade. Clearing or modification of 3 ha of DFEC represents about 1% of the total remaining known area of DFEC. The level of clearing is relatively high when considering that less than 16% of the original extent of the community remains in NSW (about 240 ha based on OEH Threatened Species Profile). This may be overestimated with an area of 380 ha mapped within the Sydney Metropolitan Area (OEH 2013) although this figure incorporates a broader definition of the community that includes similar vegetation to the south of Sydney and is not reflected in the current final determination.

Due to the inclusion of a 6 m buffer zone within the construction impact area, all ancillary clearing and some of the indirect impacts are included in the above impact assessment. Additional indirect impacts may arise from increased exposure and the movement of stormwater, sediment and weeds downslope. Enrichment of the soil, change in micro-climates at the soil surface, an increase in weedy exotic species and change in relative abundance of native species are common impacts.

Conclusion: The proposed activity will result in about 3 ha of DFEC being directly or indirectly affected with additional modification through indirect impacts possible outside of the construction impact area, mostly downslope into adjoining national parks.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Habitat to be removed is already variously fragmented by Mona Vale Road, some surrounding roads, easements, tracks, and developments e.g. the Baha'i Temple.

The proposed activity will marginally increase the distance between remaining habitat areas by <50 m by increasing the width of Mona Vale Road and marginally between remnants along each side of the road.

Conclusion: The proposed activity will result in an increase in fragmentation of DFEC habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

The Duffys Forest EC has a very restricted distribution in Northern Sydney and less than 16% of the original extent of DFEC (about 240 ha) currently exists in the form of narrow, fragmented remnants. The community is inadequately conserved. Up to 3 ha of DFEC will be removed or modified for the project, 2.7 ha of this is in good condition with 0.1 ha comprising highly disturbed vegetation and 0.2 ha comprising translocation sites and regenerating shrubland. Species richness is comparable with other local remnants. Most remaining areas of DFEC are compromised by development (particularly road widening), ongoing impacts associated with ridge-top/roadside habitats and adverse fire regimes. Most remnants are less than 5 ha in size with only 8% larger than 10 ha. The two locally occurring patches mapped as extending beyond the study area are relatively large in comparison at about 6.7 ha (western end) and 11.4 ha (eastern end). Clearing or modification of 3 ha of DFEC represents about 1% of the area of DFEC mapped in a 5km radius (296 ha). Numerous threatened species, including *Grevillea caleyi*, are associated with DFEC within the study area thus further increasing the importance of the community proposed for removal.

Conclusion: DFEC to be affected by the proposal is important to the long-term survival of the ecological community. It is part of two of the largest local occurrences, predominantly in good condition, has good connectivity to adjoining bushland including areas of Garigal and Ku-ring-gai National Parks and provides habitat for an important population of the critically endangered *Grevillea caleyi*.

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

No critical habitat has been declared. Not applicable.

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

No recovery plan or threat abatement plan has been gazetted for DFEC, however, the NSW Priority Action Statement sets out the following management objectives for this species:

- Notify landowners and managers of the presence of DFEC remnants under their care and/or control.
- Liaise with public authorities to pursue active management for conservation.
- Develop Best Practice Management Guidelines for DFEC remnants.
- Prepare and implement Plans of Management (POM) on public land.
- Collect data for conservation assessment of all DFEC remnants.

Conclusion: The proposed activity is not consistent with the above priority actions as it will result in a substantial loss of habitat. Mitigation measures will be designed to minimise further impacts outside the construction impact area.

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

DFEC habitat will be removed as a result of the proposed activity which is a key threatening process, Clearing of Native Vegetation, as listed under the TSC Act.

Conclusion: The proposed action constitutes the key threatening process, Clearing of Native Vegetation.

Overall Conclusion

The proposed action will result in the removal or modification of up to 3 ha of DFEC with some additional indirect impacts possible. Clearing of up to 3 ha within two local occurrences (west and east) represents 42% of the local occurrence in the study area. DFEC to be affected is considered important to the long-term viability of the community which is largely restricted to the locality. The EIA Guidelines state that all remnants are considered significant due to the high level of historical clearing, highly restricted distribution and small size of remaining remnants. DFEC within the construction zone also provides habitat for an important population of the critically endangered *Grevillea caleyi*. Proposed removal of DFEC is inconsistent with current management priorities to conserve and rehabilitate the ecological community. The proposed action is likely to result in a significant impact.

***Grevillea caleyi* (Caley's Grevillea)**

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

The known range of *Grevillea caleyi* is largely restricted to the locality along ridge-lines

including the suburbs of Terrey Hills, Duffys Forest, Belrose and Ingleside areas. In the OEH Approved Recovery Plan for the species, 26 sites of *G. caleyi* are identified including Sites 2 (Tumbledown Dick Hill) and 5 (Baha'i Temple) and 11 (Terrey Hills Interchange) within the study area.

Smith and Smith (2011) recorded a total of 77 live plants (and 3 dead) in multiple locations throughout Duffys Forest EEC in western and eastern parts of the study area. Ecosure (2015) recorded 29 plants occurring in similar sections and predominantly in patches of Duffys Forest EEC but also in Bloodwood-Scribbly Gum Woodland.

A targeted search for *Grevillea caleyi* conducted in February 2016 by SMEC confirmed the number of *Grevillea caleyi* within and adjacent to the construction footprint. 218 seedlings (on the northern side of the road at Tumbledown Dick Hill, within Recovery Plan Site 2) and 11 adult plants east of the Terrey Hills Interchange) were recorded at the western end of the study area. There were also 34 live adults and 2 seedlings recorded at the eastern end of the proposal near the Baha'i Temple (within Recovery Plan Site 5).

The proposal will result in the removal of 75 above ground individuals of *G. caleyi* that were confirmed to be within the construction impact zone during the February 2016 surveys.

SMEC (2016) recorded a total of 208 *G. caleyi* seedlings within a 903 m² portion of a larger 13.8 ha patch of vegetation that was subject to a prescribed burn in August 2015). The burnt patch is situated within and adjoining the Tumbledown Dick Hill *G. caleyi* population on the northern side of Mona Vale Road, west of Kimbriki Road. Using the results from this detailed site inspection (SMEC February 2016), a *G. caleyi* seedling density of 0.23 plants/m² was derived based on the extent of the seedlings within this patch (903 m²). This plant density is slightly lower than that found by DEC (2004) for the Tumbledown Dick Hill population (average of 0.30 plants/m² across both sides of the road) and is a useful attribute to roughly calculate an overall population size through a coarse extrapolation of the extent of its habitat in the study area (that being Duffys Forest).

This regeneration is indicative of a much larger population size at this location and in other areas of known habitat unburnt since 1994. Auld and Scott (2013) noted that estimates of abundance before and after fire showed very large changes in numbers of plants above ground. It is likely that potential population size within the study area is in the thousands based on estimates for Sites 2 and 5 soon after the 1994 fire and recent observations. Auld and Scott (2004) estimated 2,878±496 and 1,847±301 plants at Tumbledown Dick Hill on the northern and southern side respectively. In the vicinity of the Baha'i Temple they recorded 281 adults, 544 dead adults and 428 seedlings on the northern side of road and 1,392±193 seedlings on the southern side. Based on recent post-fire observations in the western occurrence of DFEC and *Grevillea caleyi* habitat north of Mona Vale Road (part of Site 2 of the Recovery Plan) it was estimated that around 253 seedlings could occur within the subject site (construction impact zone) (approx. 0.11 ha of known habitat) based on a density of 0.23 plants/m².

Based on *G. caleyi*'s boom and bust-type ecology a more reliable estimate of likely impacts clearly requires consideration of the soil seedbank and the regeneration potential of habitat. Based on estimates of the density of plants per square metre after previous fires at the different

locations (up to 0.35 plants/m² in DEC 2004) it is expected that clearing or modification of around 3 ha of habitat could affect approximately 7,000+ individuals. It is unlikely, however, that plants occur at this density throughout the DFEC and this is likely to be an overestimate. However even when considered at densities found by SMEC (2016) of 0.23 plants/m², the potential population is still approximately 4,600 plants.

Habitat within the study area contains two of the largest known remnants with a potential mature population estimated to comprise >50% of the total population of the species (Auld and Scott 2013). The habitat is in relatively good condition and extends slightly into Ku-ring-gai Chase and Garigal National Parks. Few other local populations include habitat within the national parks and many are suffering population decline (Auld and Scott 2013). Other local populations are typically small (<3 ha) and in poor condition with high edge to core ratios.

Conclusion: It is concluded that the proposed action is likely to have an adverse effect on the life cycle of local populations of *Grevillea caleyi* through loss of plants, rootstock and seed within the soil seedbank increasing the risk of local extinction. Populations within the study area are identified in the Recovery Plan (DEC 2004) and important to conservation of the species.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Grevillea caleyi occurs predominantly in the Duffys Forest EC with a small occurrence in Bloodwood-Scribbly Gum Woodland along ridge-tops associated with ironstone laterite. Within the study area plants are largely restricted to a zone within 10-20 m of the road reflecting the extent of laterite soils. Up to 3 ha of this habitat is likely to be removed or modified as a result of the proposed action. The highest loss of habitat is south of Mona Vale Road at the western end and on the northern side near the Baha'i Temple (see Figure 13 for details). Nevertheless, 0.1 ha of approximately 0.5 ha of total *Grevillea caleyi* habitat (DEC 2004) on the northern

side of Mona Vale Road (part of Site 2 of Recovery Plan) is within the construction zone representing 22% of total habitat in this area.

Although the construction impact zone includes a 6 metre wide buffer zone, additional indirect impacts may also occur within adjoining sections of Ku-ring-gai and Garigal National Parks largely due their downslope location. These impacts can be minimised by effective mitigation measures.

Conclusion: The proposed activity will result in up to 3 ha of *G. caleyi* habitat being directly affected with modification through indirect impacts possible beyond the construction footprint, mostly downslope.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Habitat to be removed is already variously fragmented by Mona Vale Road, some surrounding roads, easements, tracks, and developments (e.g. the Baha'i Temple).

The proposed activity will increase the distance between remaining habitat areas (e.g. <50 m by increasing the width of Mona Vale Road and between remnants along each side of the road). The habitat of *G. caleyi* is already severely fragmented potentially disrupting pollination and gene flow (Llorens 2004; Llorens *et al.* 2004). This disruption has the potential to be increased by the proposed action.

Conclusion: The proposed activity will result in increased fragmentation of *G. caleyi* habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Grevillea caleyi is associated predominantly with the Duffys Forest Ecological Community (DFEC). DFEC habitat has a very restricted distribution in Northern Sydney and is listed as an endangered ecological community under the TSC Act. The remaining areas of this community are compromised by development (particularly road widening), ongoing impacts associated with ridge-top/roadside habitats and adverse fire regimes.

The area of habitat at Site 5 of the Recovery Plan is bisected by Mona Vale Road. It consists of 0.95 ha near the Bahia Temple (highly fragmented and modified in parts) and 1.2 ha to the south of Mona Vale Road (DEC 2004). The southern part of the remnant is the least-disturbed and is of higher priority for conservation (DEC 2004). The area of habitat at Site 2, east of McCarrs Creek Road is again bisected with about 0.5 ha on the northern side and 1 ha to the south. The recovery plan considers it a high priority to keep this important site intact, as the plants in this location were found at a higher density (0.35 plants/m², DEC 2004). It is estimated that 22% of the 0.5 ha of habitat on the northern side will be removed or modified based on an area of 0.1 ha within the construction zone.

This habitat within the study area is critical to the viability of *Grevillea caleyi* as it contains land that is part of the two largest known remnants. The potential mature population within this

habitat is estimated to comprise >50% of that of the species (Auld and Scott 2013). The habitat is mostly in good condition and extends slightly into the adjoining national parks. There are only two other sites where *Grevillea caleyi* occurs in secure conservation tenure (Auld and Scott 2013).

Conclusion: Due to the highly restricted distribution of *Grevillea caleyi* and its close association with DFEC, the size and condition of habitat remnants and the relatively high densities of plants, the habitat to be removed is considered important to the long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

A recovery plan has been developed for *Grevillea caleyi* (March 2004) and twenty-two (22) priority actions have been identified including:

- Implement appropriate fire management.
- Threat and habitat management including fencing, bush regeneration and weed control, pathogen and runoff control.
- Reservation and/or protection of remnant sites.
- Undertake ecological research.

The Saving our Species program identifies one key management site for this species at Terrey Hills, part of which is located within the project area. The NSW Threatened Species Priority Action Statement sets out the following management objectives:

- Prevent access of recreational users to site.
- Reduce and maintain weed densities at low levels.
- Maintain appropriate fire regime for the species.
- Ensure land management is sympathetic to the long-term requirements of the species.
- Augment extant wild populations.
- Track species abundance/condition over time.

Conclusion: The proposed activity is not consistent with the above recovery and priority actions as it may result in a substantial loss of habitat and reduction in size of the population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key

threatening process, Clearing of Native Vegetation, as listed under the TSC Act.

Conclusion: The proposed action constitutes the key threatening process, Clearing of Native Vegetation.

Overall Conclusion

The proposed action will result in the removal or modification of up to 3 ha of habitat for this species, 75 above ground individuals and potentially around 3000 seedlings. Due to the highly restricted distribution of *Grevillea caleyi* and its close association with Duffys Forest EC, the size and condition of habitat remnants and the relatively high plant densities, the habitat to be removed is considered important to the long-term survival of the species. The proposed activity is not consistent with the identified recovery and priority actions and is likely to result in a significant impact.

***Microtis angusii* (Angus's Onion Orchid)**

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

The Section 5A Assessment prepared below is based on the definitions prescribed in the assessment of significance guidelines (DECC 2007) and included at the start of this section.

With regard to the definition of 'viable' as it relates to *Microtis angusii*, life cycle stages would comprise germination of leaf, flowering, fruiting, dieback (summer/autumn) dormancy.

Populations of *M. angusii* within the study area are currently under investigation as part of a broader initiative to resolve taxonomic uncertainty around this species. This includes study of the methods of pollination, which have a direct bearing on the definition of a 'local viable population' and hence this element of the assessment of significance.

Direct impacts to the species include:

- loss of 1469 individuals in the subject site. This loss represents approximately 49% of the total known local Ingleside/Terrey Hills population, estimated to be around 3,000 individuals (Greg Steenbeeke pers. comm.) It is acknowledged that since the ELA study area only encompassed a portion of the Mona Vale Road study area, this percentage may be an over-estimate as the Ingleside/Terrey Hills *M. angusii* population is likely to be larger than that currently estimated.
- loss of genetic diversity; and
- loss of habitat for pollinators.

Indirect impacts on the species may result from reduced growth and flowering driven by changes in soil moisture, unknown degree and extent of potential edge effects as well as unscrupulous collecting from a likely increased exposure of the plant to the wider community.

It should be noted that the Kimbriki Road sub-population is entirely within the construction footprint. As such, the proposal will result in the extinction of the type (main) population of *M. angusii*.

Overall, the loss of the sub-populations may have an adverse effect on the local viable population through reduction in size and extent, and loss of genetic diversity, although this must now be viewed in the context of a larger and wider occurring population size based on the results from ELA (2015) study. There is likely to be an adverse effect on the life cycle of the species through loss of individuals across its distribution, loss of genetic diversity and potentially habitat for pollinators increasing the risk of local extinction. In the absence of any published minimum viable population sizes for the species (or for the *Microtis* genus) or any impact assessment threshold guidelines for the species, we have taken a precautionary approach and assumed that the proposal has the potential to result in a localised extinction of *M. angusii*, particularly when coupled with the potential impact from the future Ingleside planning development. As noted above, the proposal will result in the extinction of the type population of *M. angusii*.

Notwithstanding the above discussion, the assessment must be considered heavily in the context of the current knowledge of the species which may result in a marked change in its taxonomic and conservation status, although this is unlikely to be resolved within the timeframe of this proposal.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Microtis angusii occurs at several locations within the study area in highly disturbed low, grassy vegetation adjacent to roads and tracks generally associated with asphalt surfaces, diffuse drainage and exotic grasses. More natural habitat is likely to be grassy woodland on laterite (Jones 2006) and is likely to include Duffys Forest but sites may require regular

disturbance.

It is estimated that up to 3 ha of known and potential habitat would be removed or modified as a result of the proposed action based on areas of Duffys Forest EC and disturbed sites that were possibly formerly DFEC (SMEC, Jan 2015). Potential habitat includes linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road.

Conclusion: The proposed activity is likely to result in up to 3 ha of known and potential habitat being affected.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Known and potential habitat to be removed is already highly fragmented largely by roads, easements and tracks. The proposed action will increase fragmentation of habitat north of Mona Vale Road between the western end of Wirreanda Road and Addison Road. The distance between areas of potential habitat on either side of Mona Vale Road will also be slightly increased. Impacts of fragmentation on limited areas of habitat are poorly known for this species.

Conclusion: The proposed activity will result in a marginal increase in fragmentation and isolation of known and potential habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Microtis angusii has only been confirmed (based on genetic analysis) as occurring within or close to the study area. Any known and potential habitat, therefore, is likely to be critical to long-term survival of the species. Known habitat comprises highly disturbed and exotic dominated grassy areas but nevertheless still provides habitat suitable for growth and reproduction in this species. Potential habitat within existing DFEC similarly includes disturbed areas and includes linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road.

It is estimated that about 3 ha of known and potential habitat would be removed or modified as a result of the proposed action (SMEC Jan 2015). The type population (Kimbriki Site) is completely within the construction footprint. Maintaining suitable soil conditions (including specific fungi and soil moisture levels) appears to be crucial to the species. Remaining known habitat of *Microtis angusii* will be all or partly cleared, particularly within the eastern sub-population. This habitat supports individuals that are genetically distinct from the main population with genetic diversity also noted between these smaller sites (RBG Sept 2015).

Conclusion: The study area contains the only known habitat for *Microtis angusii* and although weedy and disturbed provides the conditions required for this critically endangered and sensitive species. Any loss of genetic diversity associated with this habitat is likely to reduce resilience and robustness of the species. The habitat to be removed is considered important

and probably critical to the long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

A national recovery plan has been developed for *Microtis angusii* (DECCW 2010) and objectives include:

- Habitat/population protection and management
- Determine habitat requirements and ecological information

The Saving our Species program identifies site specific management to reduce threats and promote recovery of the species. There is one management site identified along Mona Vale Road; the study area is located within the project area. The NSW Threatened Species Priority Action Statement sets out the following management objectives for this species:

- Prevent access of recreational users to site
- Reduce and maintain weed densities at low levels
- Minimise impacts of road development
- Minimise accidental damage on roads/track edges
- Track species abundance and condition over time
- Establish ex-situ storage of plant material

Conclusion: The proposed action will result in clearing or modification at six locations where *Microtis angusii* individuals have been identified. The main population (Kimbriki Site) is completely within the construction footprint. This is not consistent with the key recovery and priority actions. Planning for the proposal, however, has included funding research into a number of the priorities actions including determining habitat requirements and ecological information.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, Clearing of Native Vegetation, as listed under the TSC Act.

Conclusion: The proposed action constitutes the key threatening process, Clearing of Native Vegetation.

Overall Conclusion

The proposal will result in the loss of 1469 individuals in the subject site. This loss represents approximately 49% of the total known local Ingleside/Terrey Hills population, estimated to be around 3,000 individuals (Greg Steenbeeke pers. comm.). Furthermore, the proposal will result in the extinction of the type (main) population (Kimbriki Site) of *M. angusii*, as well as the removal of an estimated 3 ha of known or potential habitat for the species. As such, it is considered that the proposal is likely to have a significant impact on the species.

***Persoonia hirsuta* (Hairy Geebung)**

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

Persoonia hirsuta is only known from two records within the study area at Tumbledown Dick Hill and near the Baha'i Temple where recorded in 1994 (Scott *et al.* 1995; Smith and Smith 2000). This former site has been unburnt since 1994 and is now densely vegetated; the plant near the Temple was accidentally destroyed. These records were located in the Duffys Forest EEC. Potential habitat is also found in Bloodwood-Scribbly Gum Woodland, Sandstone Heath and Rocky Sandstone Heath.

Populations of *Persoonia hirsuta* are typically small consisting of 1-3 plants. The ecology or lifecycle of the species i.e. pollination, seed set, maintenance of a soil seed bank, seed germination and seedling survival is still poorly known. *Persoonia hirsuta* is known to be killed by high intensity fire with regeneration dependant on seed germination. The fruit only contains one seed that is likely to be dispersed by large birds or large mammals e.g. kangaroos or possums (Benson and McDougall 2000). The longevity of seed in the soil seedbank is unknown. A fire interval of <10-15 years together with dense vegetation is likely to reduce the level of seedling recruitment and population resilience.

This assessment assumes that *Persoonia hirsuta* may still be present as plants or seed in the vicinity of Tumbledown Dick Hill and that it constitutes a viable population.

The exact location of the 1994 record in relation to the construction impact zone is unclear (known to occur within Site 2 of the *Grevillea caleyi* Recovery Plan). It is assumed for the purpose of this assessment that any plants of *Persoonia hirsuta* present will be cleared. This species typically occurs as single or few plants. The proposed activity is likely to adversely affect the lifecycle of any local population present with loss of plants and seed within the soil seedbank.

Conclusion: It is concluded that the proposed action is likely to have an adverse effect on the life cycle of the local population of *Persoonia hirsuta* if present at the 1994 site increasing the likelihood of local extinction.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Known habitat (likely to be small) that is associated with an earlier record in 1994 is assumed likely to be removed as a result of the proposed action. About 3 ha of DFEC, 8.4 ha of Bloodwood-Scribbly Gum Woodland habitat and 0.2 ha of Heath is also likely to be cleared. Although the construction impact zone includes a 6 m wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised or negated by effective mitigation measures.

Persoonia hirsuta is vulnerable to ongoing losses with ridge-top or upper slope habitat favoured for development, the predominance of known sites on private or crown land (often on road reserves) and small population size.

Conclusion: The proposed activity is likely to result in the loss of a local population and removal of about 10 ha of known or potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Based on the two records of *Persoonia hirsuta* in 1994 with one known to have been destroyed, the proposed activity is unlikely to fragment or isolate an area of known habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Persoonia hirsuta is found in woodland or open forest on sandstone ridges and upper slopes with clay or laterite influence associated with Duffys Forest EEC (less commonly), Bloodwood-Scribbly Gum Woodland and Heathland. The extent of Duffys Forest within the local area (5 km radius) totals 296 ha but there are few sites undisturbed and protected long term in a national park (small areas known within or at edge of Ku-ring-gai and Garigal National Parks) with remaining patches unprotected on private and public lands. The extent of Bloodwood-Scribbly Gum Woodland and heathland communities are significantly larger and better

reserved.

There is inadequate population or habitat details associated with the 1994 record to reliably determine the significance of habitat to be affected in relation to other local populations. This record is similar to others in that it occurs on unprotected land and population size is likely to be very small. The occurrence within Duffys Forest EC is less common. There is good representation in conservation reserves across its range although populations can still be vulnerable due to very small population size, susceptibility to fire and low reproduction success. Reserves include Blue Mts. NP, Wollemi NP, Yengo NP, Dharug NP, Ku-ring-gai Chase NP, Marramarra NP, Royal NP and Bargo River SCA. The affected area is not within any of the key management sites identified under the Saving our Species Program.

Conclusion: If *Persoonia hirsuta* is still present within the Study Area its habitat is likely to be of low to moderate significance to its long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The Saving our Species program identifies site specific management to reduce threats and promote recovery of the species. There are seven key management sites identified; the Study Area is not located within these project areas. The NSW Threatened Species Priority Action Statement includes a targeted strategy for managing this species including identifying sites on maps used for planning road maintenance works, protecting known habitat, developing fire plans and continuing research on the reproduction of *Persoonia*.

- Protect populations and remaining habitat through identification on maps used for planning purposes, on-site markers and through education (e.g. able to identify the species)
- Protect known habitat from maintenance activities and recreation
- Maintain connectivity between populations
- Develop fire management plans for populations
- Searches in suitable habitat in proposed development areas

Conclusion: The proposed activity is not consistent with the clearing of habitat and loss of a local population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key

threatening process, Clearing of Native Vegetation, as listed under Schedule 3 of the TSC Act.

Overall Conclusion

The proposed action will result in the removal of an unknown (likely small) area of habitat associated with a single record from 1994. A further 10 ha of potential habitat will be affected. There is a reasonable likelihood of *Personia hirsuta* still being present as habitat at the site is now overgrown in the absence of fire for >20 years reducing the likelihood of sightings (blends easily into its environment), and limiting pollination and seed set, seed dispersal and germination. There is likely to be an adverse effect on the life cycle of this occurrence (local population). The importance of this habitat to the long-term survival of the species is likely to be low to moderate. It is not part of the key management areas identified under the Saving our Species Program. Although it has a wide distribution populations are not well represented in the local area (few sites on private and council land at Cromer, Collaroy and Oxford Falls), they are very small and vulnerable to extinction.

Based on current information although the proposed action could result in a significant impact at a local level, it is unlikely to result in a significant impact on the species.

***Pimelea curviflora* var. *curviflora* (Curved rice-flower)**

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

Pimelea curviflora var. *curviflora* is only known from one record within the study area at Tumbledown Dick Hill where it was recorded in 1996. This site has been unburnt since 1994 and is densely vegetated, a condition state considered unfavourable to the species. Seedlings are known to appear after fire. Both Duffys Forest EEC and Bloodwood-Scribbly Gum Woodland, associated with lateritic soils, provide potential habitat for the taxon. It is also recorded from similar habitat in the local area (within 5 km) including at Ingleside, Duffys Forest and Terrey Hills. Most sightings are from the last 20 years but population size and current status is unknown for most records. Sites are on freehold or crown land with only one close to the edge of Ku-ring-gai National Park at Duffys Forest.

This assessment assumes that the species may still be present as plants, rootstock or seed in the vicinity of the earlier record and that it constitutes a viable population.

The life cycle of *Pimelea curviflora* var. *curviflora* is poorly known. Plants are typically difficult to see among grasses and sedges, even when flowering. Growth appears to be strongly influenced by rainfall and soil moisture levels with no plants visible some years in monitored populations (T. James pers. comm.). Plants can persist through unfavourable years as rootstock underground but in a good year population size may be large (hundreds). Regeneration can occur from rootstock and seed with the latter seen after fire or disturbance.

The record of *Pimelea curviflora* var. *curviflora* occurs within the construction impact zone and associated habitat will be cleared. The proposed activity is likely to adversely affect the

lifecycle of any local population present with loss of plants, underground rootstock and seed within the soil seedbank. Due to lack of information relating to the 1996 record, the extent of this impact is unknown. Indirect impacts may also occur on adjoining and potential habitat although with the inclusion of a 6 m buffer zone within the construction impact area, all ancillary clearing and the some of the indirect impacts are included in the impact assessment for this species. Indirect impacts beyond this zone could include movement of stormwater, sediment and weeds downslope from the impact zone, though these are expected to minimal provided the proposed ameliorative measures are implemented.

Conclusion: It is concluded that the proposed action is likely to have an adverse effect on the life cycle of the local population of *Pimelea curviflora* var. *curviflora* if present at the 1996 site resulting in greater risk of local extinction.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Known habitat associated with a record in 1996 is likely to be removed although size of this area is unknown. About 3 ha of DFEC and 8.3 ha of Bloodwood-Scribbly Gum Woodland habitat is likely to be cleared. Although the construction impact zone includes a 6 m wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised by effective mitigation measures.

Pimelea curviflora var. *curviflora* is vulnerable to ongoing losses with ridge-top or upper slope habitat favoured for development, the predominance of known sites on private or crown land, its cryptic nature and marked population fluctuations.

Conclusion: The proposed activity is likely to result in the loss of a local population and removal of about 11 ha of known or potential habitat with possible indirect impacts downslope.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Based on the single record of *Pimelea curviflora* var. *curviflora* in 1996 the proposed activity is unlikely to fragment or isolate an area of known habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Pimelea curviflora var. *curviflora* is found in woodland or open forest on sandstone ridges and upper slopes with clay or laterite influence associated primarily with Duffys Forest EEC but also occurs in Bloodwood-Scribbly Gum Woodland. The extent of Duffys Forest within the local area (5 km) totals 296 ha but there are few sites undisturbed and protected long term in a national park (small areas known within or at edge of Ku-ring-gai Chase and Garigal National Parks) with remaining patches unprotected on private and public lands. The extent of Bloodwood-Scribbly Gum Woodland is significantly larger (2,776 ha).

There is inadequate population or habitat details associated with the 1996 record to reliably determine the significance of habitat to be affected in relation to other local populations. This record is similar to others in that it occurs in a small, unprotected patch of Duffys Forest EEC. It has good connectivity with intact native vegetation to the south approximately 300 m wide. There are relatively few local sites but larger populations are known from more widespread sandstone communities away from the locality both in northern and western Sydney. Suitable habitat along ridge-lines and on upper slopes in the local area is naturally restricted and vulnerable to development and ongoing impacts.

Conclusion: If *Pimelea curviflora* var. *curviflora* is still present within the study area its habitat is likely to be of low to moderate significance to its long-term survival. It has a relatively wide distribution across coastal areas of the Greater Sydney region (north to Berowra, west to Maroota and south to the Illawarra) and populations are often in the hundreds.

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

No critical habitat has been declared for this species. Not applicable.

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

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The Saving our Species program identifies site specific management to reduce threats and promote recovery of the species. There are three key management sites identified; the study area is not located within these project areas. The NSW Threatened Species Priority Action Statement sets out the following management objectives for this species:

- Protect areas of known and potential habitat from clearing and fragmentation

- Introduce measures to prevent habitat degradation related to unrestricted access and/or trail maintenance
- Weed control

Conclusion: The proposed activity is inconsistent with the clearing/fragmentation of habitat and loss of a local population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, Clearing of Native Vegetation, as listed under Schedule 3 of the TSC Act. Other key threatening processes listed under the TSC Act that are of particular relevance include:

- High frequency fire resulting in the disruption of the life cycle processes in plants and animals and loss of vegetation structure and composition.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion, establishment and spread of *Lantana camara*.

Conclusion: The proposed activity is inconsistent with the clearing/fragmentation of habitat and loss of a local population.

Overall Conclusion

The proposed action will result in the removal of an unknown area of habitat associated with a single record from 1996. A further 11 ha of potential habitat will be affected. There is a reasonable likelihood of *Pimelea curviflora* var. *curviflora* still being present as habitat at the site is now overgrown (requires open conditions), it is difficult to see and often persists below the ground. If present, there is likely to be an adverse effect on the life cycle of this local population which is assumed to be relatively small. The importance of this habitat to the long-term survival of *Pimelea curviflora* var. *curviflora* is likely to be low to moderate. It has a relatively wide distribution across coastal areas of the Greater Sydney region (north to Berowra, west to Maroota and south to the Illawarra) and populations are often in the hundreds although populations fluctuate considerably. Based on current information, the proposed action is unlikely to result in a significant impact to this species.

Tetratheca glandulosa

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

Tetratheca glandulosa is known from a few records within the study area at Tumbledown Dick Hill in 1996 and 1998 and between Mona Vale Road and Wirreanda Road in 2011. Populations size in 1998 was 120 plants and just 2 plants were recorded from the new location in 2011 (Smith and Smith 2000). This former site has been unburnt since 1994 and is now densely

vegetated. These records were located in the Duffys Forest EEC. Potential habitat is also found in Bloodwood-Scribbly Gum Woodland, and Sandstone Rocky Heath.

The ecology or lifecycle of the species is still poorly known. Juveniles appear to be uncommon with any given population with most plants re-sprouting adults. Life expectancy is estimated to be around 6-10 years although this may be an underestimate. Self-pollination is unlikely with successful pollination probably dependant on insects e.g. a species of native bee. Fruit set is typically low and the soil seed bank relatively small. Plants typically re-sprout after fire with the role fire plays in seed germination unclear. Fire is important in creating the more open conditions favourable to growth of the species.

This assessment assumes that *Tetratheca glandulosa* may still be present as plants, rootstock or seed in the vicinity of earlier records (particularly at Tumbledown Dick Hill) and that they constitute a viable population. The proposed activity may remove at least part of two sub-populations and associated habitat. The proposed activity is likely to adversely affect the lifecycle of any local population present with loss of plants, seed within the soil seedbank and habitat for pollinators.

Conclusion: It is concluded that the proposed action is likely to have an adverse effect on the life cycle of the local population of *Tetratheca glandulosa* if present increasing the likelihood of local extinction.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The exact extent of known habitat associated with the previous records is unknown. About 3 ha of DFEC, 8 ha of Bloodwood-Scribbly Gum Woodland habitat and 0.2 ha of Heath is also likely to be cleared. Although the construction impact zone includes a 6 m wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised or

negated by effective mitigation measures.

Tetratheca glandulosa is vulnerable to ongoing losses with ridge-top or upper slope habitat favoured for development, the predominance of known sites on private or crown land (often on road reserves) and small population size.

Conclusion: The proposed activity is likely to result in the loss of a local population and removal of about 11 ha of known or potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Based on the previous records of *Tetratheca glandulosa* the proposed activity is unlikely to fragment or isolate an area of known habitat as all known habitat is likely to be cleared.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Tetratheca glandulosa is found in woodland or open forest on sandstone ridges and upper slopes with clay or laterite influence associated with Duffys Forest EEC (less commonly), Bloodwood-Scribbly Gum Woodland and Heathland. It has been recorded from > 50 sites within 5 km of the study area at Ingleside, Duffys Forest, Terrey Hills, Belrose and North Seaforth. Approximately 30% of these sites occur within national park estate (mostly Ku-ring-gai National Park) and the species is considered to be reasonably conserved at the local level. Based on database records population size is generally low (<50) although information is lacking for many sites. The Berowra Valley area (a Save our Species key management site), however, is known to contain a population estimated as around 2,500 plants.

The extent of Duffys Forest within the local area (5 km radius) totals 296 ha but there are few sites undisturbed and protected long term in a national park (small areas known within or at edge of Ku-ring-gai and Garigal National Parks) with remaining patches unprotected on private and public lands. The extent of Bloodwood-Scribbly Gum Woodland and heathland communities are significantly larger and better reserved.

It appears that the number of plants within the study area has declined or the population may have become extinct. Any decline in numbers at the Tumbledown Dick Hill site would most likely be due to lack of fire. Other populations within the locality may also be in decline for the same reason. The Duffys Forest EEC habitat for this species within the study area is atypical in comparison with its wider distribution in woodland and heath or scrub communities.

Conclusion: If *Tetratheca glandulosa* is still present within the study area its habitat is likely to be of low significance to long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The Saving our Species program identifies three key management sites; the study area is not located within these project areas with Berowra Valley being the closest. The NSW Threatened Species Priority Action Statement identifies the following specific activities:

- Ensure sufficient vegetation buffers between development and populations
- Minimise habitat loss
- Maintain and improve connectivity between populations
- Protect habitat from degradation
- Restore degraded habitat

Conclusion: The proposed activity is not consistent with the clearing of habitat and loss of a local population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, *Clearing of Native Vegetation*, as listed under Schedule 3 of the TSC Act (1995).

Overall Conclusion

The proposed action will result in the removal of an unknown area of habitat associated with previous records in 1996, 1998 and 2011. A further approximately 9 ha of potential habitat will be affected. There is a reasonable likelihood of *Tetradlea glandulosa* still being present as some of its known habitat is now overgrown in the absence of fire for >20 years reducing the likelihood of sightings and limiting growth, flowering and pollination. There is likely to be an adverse effect on the life cycle. The importance of this habitat to the long-term survival of the species is relatively low with good representation within conservation reserves in most parts of its range (except the Hills). This habitat is not a key management site as identified under the Saving our Species Program. Based on current information the proposed action is unlikely to result in a significant impact on the species.

***Acacia bynoeana* (Bynoe's wattle)**

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

Acacia bynoeana has not been recorded from the study area but potential habitat exists within areas of Bloodwood-Scribbly Gum Woodland, and Sandstone Rocky Heath where restricted to ridgetops and upper slopes. Population size is typically small. Fire plays an important role

with plants readily re-sprouting from woody rootstock, it promotes seed germination and creates open conditions favourable to growth and flowering.

This assessment assumes that *Acacia bynoeana* may be present as plants, rootstock or seed (can live for >50 years) and that there is a viable population. The proposed activity may remove up to 8 hectares of potential habitat.

Conclusion: It is concluded that the proposed action could have an adverse effect on the life cycle of any local population of *Acacia bynoeana* if present increasing the likelihood of local extinction.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Approximately 8 ha of potential habitat is likely to be cleared or modified including 8 ha of Bloodwood-Scribbly Gum Woodland habitat and 0.2 ha of Heath. Although the construction impact zone includes a 6 m wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised or negated by effective mitigation measures.

Conclusion: The proposed activity could result in the loss of a local population and removal of about 8 hectares of potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The proposed activity is unlikely to fragment or isolate an area of habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

In view of the restricted occurrence of this species on ridgetops and upper slopes, the lack of local records and typically low population size, any population or associated habitat may be significant to the viability of the species at least in the local area. Bloodwood-Scribbly Gum Woodland and heathland communities, however, are relatively widespread and well reserved communities both locally and in the region.

Conclusion: If *Acacia bynoeana* is present within the study area its habitat is likely to be of low to moderate significance to long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The Saving our Species program identifies site specific management to reduce threats and promote recovery of the species. Five key management sites have been identified; the study area is not located within any of these areas. The NSW Threatened Species Priority Action Statement identifies the following specific activities:

- Protect remaining habitat through identification on maps used for planning purposes and through education (e.g. able to identify the species)
- Protect known habitat from maintenance activities and recreation
- Investigate appropriate fire regime
- Weed control

Conclusion: The proposed activity is not consistent with the clearing of habitat and loss of a local population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, *Clearing of Native Vegetation*, as listed under Schedule 3 of the TSC Act (1995).

Overall Conclusion

Approximately 8 hectares of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be low. The proposed action is unlikely to result in a significant impact on the species.

***Acacia terminalis* subsp. *terminalis* (Sunshine wattle)**

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

Acacia terminalis subsp. *terminalis* has not been recorded from the study area but potential habitat exists within areas of Bloodwood-Scribbly Gum Woodland, and Sandstone Rocky Heath. Plants are typically killed by fire although some re-sprouting from the base can occur; seed viability is high with recruitment mainly after fire.

This assessment assumes that *Acacia terminalis* subsp. *terminalis* may be present as plants, rootstock or seed (can live for >50 years) and that there is a viable population. The proposed activity may remove up to 8 ha of potential habitat.

Conclusion: It is concluded that the proposed action could have an adverse effect on the life cycle of any local population of *Acacia terminalis* subsp. *terminalis* if present.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Approximately 8 ha of potential habitat is likely to be cleared or modified including 8 ha of Bloodwood-Scribbly Gum Woodland habitat and 0.2 ha of Heath. Although the construction impact zone includes a 6 metre wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised or negated by effective mitigation measures.

Conclusion: The proposed activity could result in the loss of a local population and removal of about 8 hectares of potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The proposed activity is unlikely to fragment or isolate an area of habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

In view of the inland location (most records closer to the coast) and lack of local records, any habitat present may be significant to the viability of the species in the local area. Bloodwood-Scribbly Gum Woodland and heathland communities, however, are relatively widespread and well reserved communities both locally and in the region.

Conclusion: If *Acacia terminalis* subsp. *terminalis* is present within the study area its habitat is likely to be of moderate significance to long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

There is a national recovery plan for *Acacia terminalis* subsp. *terminalis* (DECCW 2010). The Saving our Species Program identifies site specific management to reduce threats and promote recovery of the species. Five key management sites have been identified; the study area is not located within any of these areas. The NSW Threatened Species Priority Action Statement identifies the following activities:

- Ensure relevant personnel are able to identify the sub-species and are aware of locations
- Ensure appropriate fire regime (at least every 6-12 years)
- Protect known sites from clearing and degradation
- Establish monitoring programs
- Conduct surveys of all suitable habitat within Sydney Harbour and Botany Bay National Parks
- Undertake research into the biology and ecology of the sub-species

Conclusion: The proposed activity is not consistent with the clearing of habitat and loss of a local population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key

threatening process, *Clearing of Native Vegetation*, as listed under Schedule 3 of the TSC Act (1995).

Overall Conclusion

Approximately 8 hectares of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be low to moderate. The proposed action is unlikely to result in a significant impact on the species.

Callistemon linearifolius

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

Callistemon linearifolius has not been recorded from the study area although there is a recent 2014 record from just outside along Mona Vale Road at Ingleside. Potential habitat exists within the Duffys Forest EEC and Peppermint-Angophora Forest communities. The ecology of this species is poorly known.

This assessment assumes that *Callistemon linearifolius* may be present and that there is a viable population. The proposed activity may remove up to around 6.6 ha of potential habitat.

Conclusion: It is concluded that the proposed action is likely to have an adverse effect on the life cycle of a local population of *Callistemon linearifolius* if the species is present.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Approximately 6.6 ha of potential habitat is likely to be cleared or modified including 3 ha of

DFEC and 3.6 ha of Peppermint-Angophora Forest. Although the construction impact zone includes a six metre wide buffer zone, additional indirect impacts may also occur. Although these impacts can be minimised by effective mitigation measures.

Conclusion: The proposed activity could result in the loss of a local population and removal of about 6.6 ha of potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The proposed activity is unlikely to fragment or isolate an area of habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

In view of the lack of recent local records, high historical loss and low population size, any habitat present may be significant to the viability of the species within the local area. The species is restricted to the Hornsby Plateau with one record from the Illawarra. Although recorded from several conservation reserves it is not considered adequately conserved across its geographical range.

Conclusion: If *Callistemon linearifolius* is present within the study area its habitat is likely to be of moderate significance to long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

At the time of this report there is no approved recovery plan or threat abatement plan for the species. Under the Saving Our Species Program *Callistemon linearifolius* has been assigned to the data-deficient management stream (no site-specific conservation projects). The NSW Threatened Species Priority Action Statement outlines a strategy to address key knowledge gaps including searching for new sites and research on fire requirements, as well as protection of known habitat.

Conclusion: The proposed activity is not consistent with the clearing of habitat and loss of a local population.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, *Clearing of Native Vegetation*, as listed under Schedule 3 of the TSC Act

(1995).

Overall Conclusion

Approximately 6.6 ha of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be moderate. It is unlikely that a significant population is present within the study area and remains undetected. The proposed action is unlikely to have a significant impact on long-term viability of the species.

Darwinia biflora

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

Darwinia biflora has not been recorded from the study area although suitable habitat is found in Bloodwood-Scribbly Gum Woodland and Sandstone Rocky Heath and there is a relatively high frequency of records (81) within 10 km.

This assessment assumes that *Darwinia biflora* may be present and that there is a viable population. The proposed activity may remove up to around 8 ha of potential habitat.

Conclusion: It is concluded that the proposed action may have an adverse effect on the life cycle of a local population of *Darwinia biflora* if the species is present through removal of plants, seed and habitat.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Approximately 8 ha of potential habitat is likely to be cleared or modified including 8 ha of

Bloodwood-Scribbly Gum Woodland habitat and 0.2 ha of Heath. Although the construction impact zone includes a six metre wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised by effective mitigation measures.

Conclusion: The proposed activity may result in the loss of a local population and removal of about 8 hectares of potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The proposed activity will fragment an area of Bloodwood-Scribbly Gum Woodland habitat between Wirreanda Road and Mona Vale Road forming two patches of isolated habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Suitable habitat along ridge-lines and on upper slopes in the local area is naturally restricted and vulnerable to development and impacts generally. The relatively large number of records within the local area can be misleading with many records often relating to the same site and marked fluctuations in populations. On this basis any potential habitat within the study area is important.

Conclusion: If *Darwinia biflora* is present within the study area its habitat is likely to be of moderate significance to long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

There is an approved recovery plan for *Darwinia biflora* (2004). The NSW Threatened Species Priority Action Statement identifies four key management sites; the study area is not located within any of these areas, the Hornsby/Berowra conservation project being the closest. Specific activities include:

- Implement appropriate fire regimes
- Prevent mechanical damage and trampling by livestock
- Weed control
- Increase protection of sites

Conclusion: The proposed activity is not consistent with the clearing of habitat.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, *Clearing of Native Vegetation*, as listed under Schedule 3 of the TSC Act (1995).

Overall Conclusion

Approximately 8 ha of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be moderate. This habitat is not a key management site as identified under the Saving our Species Program. The proposed action is unlikely to have a significant impact on long-term viability of the species.

***Genoplesium baueri* (Bauer's midge orchid)**

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

Genoplesium baueri has not been recorded from the study area although suitable habitat is found throughout including Duffys Forest EEC, Peppermint-Angophora Forest, Bloodwood-Scribbly Gum Woodland, and Sandstone Rocky Heath. *Genoplesium baueri* is a cryptic, short-lived orchid that is difficult to detect for most of the year. There are 41 records within 10 km of the study area although few records have been confirmed in recent years.

This assessment assumes that *Genoplesium baueri* may be present and that there is a viable population. The proposed activity may remove up to around 15 ha of potential habitat.

Conclusion: It is concluded that the proposed action may have an adverse effect on the life cycle of a local population of *Genoplesium baueri* if the species is present through removal of plants, seed and habitat.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Approximately 15 hectares of potential *Genoplesium baueri* habitat is likely to be cleared or modified.

Conclusion: The proposed activity will result in the removal of about 15 hectares of potential habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The proposed activity will fragment an area of Bloodwood-Scribbly Gum Woodland habitat between Wirreanda Road and Mona Vale Road forming two patches of isolated habitat. There will be a minor increase in separation between habitat on either side of Mona Vale Road.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

In view of the lack of local records, low population size and poor knowledge base, any habitat is likely to be of significance to the viability of the species.

Conclusion: If *Genoplesium baueri* is present within the study area its habitat is likely to be of moderate significance to long-term survival of the species.

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

No critical habitat has been declared for this species. Not applicable.

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

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The NSW Threatened Species Priority Action Statement four key management sites for *Genoplesium baueri*. The study area is not located within any of these areas; the Ku-ring-gai Chase NP conservation project being the closest. Specific activities identified include:

- Protect remaining habitat from clearing and development
- Determine appropriate fire regimes
- Undertake further surveys to locate any additional populations
- Restore natural hydrology

- Erect fencing to reducing browsing impacts

Conclusion: The proposed activity is not consistent with the clearing of habitat.

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

Known and potential habitat will be removed as a result of the proposed activity which is a key threatening process, Clearing of Native Vegetation, as listed under Schedule 3 of the TSC Act.

Overall Conclusion

Approximately 15 ha of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be moderate. This habitat is not a key management site as identified under the Saving our Species Program. The proposed action is unlikely to have a significant impact on long-term viability of the species.

***Heleioporus australiacus* (Giant Burrowing Frog)**

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

Two Giant Burrowing Frog individuals were located outside the construction impact area along the Caley Trail in Garigal National Park during recent field surveys (Ecosure 2015). Observations were made during spotlighting surveys in February 2014. The Giant Burrowing Frog breeds in soaks, pools and seepage lines. Breeding is triggered by heavy rain and occurs in soaks or pools, seepage lines and small pools of collected water. Non-breeding habitat for the Giant Burrowing Frog is located below the soil surface and leaf litter, particularly along sandstone ridge tops (OEH 2012).

The Giant Burrowing Frog is only likely to occur in the study area south of Mona Vale Road, in Garigal National Park (Ecosure 2015) and in Ku-ring-gai Chase National Park to the north. Suitable foraging habitat occurs within the study area but no breeding habitat. Some potential non-breeding habitat in the north of the study area near Wirreanda Road will be removed by the proposal. The Giant Burrowing Frog was not recorded in this area during recent surveys and is unlikely to occur due to the limited extent of the suitable habitat.

A total of 11.6 ha of potential Giant Burrowing Frog non-breeding habitat will be removed by the proposal. This habitat contains suitable sites for the construction of burrows and occurs within 300 metres of suitable breeding habitat.

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposed post upgrade MVRW compared to the pre upgrade MVRW. Any changes to drainage and water quality may have a significant impact on Giant Burrowing Frog habitat downstream of the subject site.

Conclusion: It is possible that the actions proposed will have an adverse effect on the life cycle of this species such that a viable local population will be placed at risk of extinction, as changes to drainage regimes may impact Giant Burrowing Frog breeding habitat within the study area. Large areas of suitable foraging habitat will remain within the study area and beyond.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Non-breeding habitat for the Giant Burrowing Frog is generally restricted to the vicinity of breeding habitat, with home range sizes of approximately 0.04 ha (OEH 2012). Giant Burrowing Frogs shelter in burrows during non-breeding periods and show high fidelity to particular burrows (Penman *et al.* 2008).

The proposal will require the removal of 11.6 ha of vegetation that may be utilised by the Giant Burrowing Frog as non-breeding habitat. This habitat occurs below the ridgeline along which the existing Mona Vale Road runs. The habitat to be retained is unlikely to be modified by the proposal.

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposed post upgrade MVRW compared to the pre upgrade MVRW. Any changes to drainage and water quality may have a significant impact on Giant Burrowing Frog habitat downstream of the subject site.

Conclusion: The proposal will require the removal of 0.23 ha of breeding habitat and 11.6 ha of potential non-breeding habitat for the Giant Burrowing Frog. It is likely that some breeding habitat affected by indirect impacts.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The Giant Burrowing Frog has a home range of approximately 0.04 ha. They show a high fidelity for particular burrows and foraging areas (Stauber 2006). It is unlikely that the home range of any individual would include habitat on both sides of Mona Vale Road due to the high probability of vehicle strike through regular crossings. The existing Mona Vale Road is likely to fragment areas of suitable habitat in Ku-ring-gai Chase and Garigal National Parks, with no locations for safe passage of Giant Burrowing Frogs across the major road. The proposal will further fragment potential habitat located to the north of Mona Vale Road between Wirreanda Road and Addison Road. Habitat where the Giant Burrowing Frog was recorded during recent surveys will remain connected to other areas of suitable habitat.

A land bridge constructed across Mona Vale Road east of Kimbriki Road would restore connectivity between Ku-ring-gai Chase and Garigal National Parks, where suitable habitat for the Giant Burrowing Frog occurs.

Conclusion: The proposal will further isolate some areas of potential habitat for the Giant Burrowing Frog; however, the species was not identified in these areas during recent surveys. Construction of a land bridge would reconnect two national parks in which suitable breeding and non-breeding habitat for the Giant Burrowing Frog occurs.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

NPWS (2001) states that given the fragmented nature of Giant Burrowing Frog distribution and the few known locations, any loss or alteration of habitat should be regarded as significant. It is likely that due to the large area of occupancy of Giant Burrowing Frog individuals and their tendency to have non-overlapping home ranges that a large area is required to support a population of the species (Stauber 2006). Ku-ring-gai Chase and Garigal Chase National Parks provide suitable areas of habitat for the Giant Burrowing Frog.

The proposal will require the removal of 11.6 ha of habitat that may be used by the Giant Burrowing Frog during non-breeding periods. This is a very small proportion of the suitable non-breeding habitat available in the locality. This species spends at least 95% of its time in this habitat (OEH 2012). Non-breeding habitat occurs near ephemeral drainage lines that are used for breeding.

In addition to the non-breeding habitat, 0.23 ha of potential breeding habitat will be removed. Additional areas of breeding habitat may be affected by indirect impacts from changes to drainage and water quality as identified in the draft hydrology report (Aurecon 2016).

Conclusion: The non-breeding habitat to be removed is unlikely to be important to the long term survival of the Giant Burrowing Frog in the locality as there are larger areas of good quality habitat in Ku-ring-gai Chase and the adjacent Garigal National Park in which the species was identified. Removal and indirect impacts to breeding habitat may have a significant impact to Giant Burrowing Frogs in the locality.

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

No critical habitat has been declared for the Giant Burrowing Frog.

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

No recovery plan or threat abatement plan has been prepared for the Giant Burrowing Frog. The OEH priority action statement includes management actions to protect the species at a landscape level to ensure that the species is secure in the wild in NSW and that its NSW geographic range is extended or maintained. Management actions include:

- Determine the threats and other management issues affecting all key populations identified for this species.
- Prepare and implement site specific management plans to protect key Giant Burrowing frog populations from identified threats. Source funding to implement these plans.
- Develop habitat management guidelines that can be used by land managers to protect local populations and habitats across the landscape.

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

The following key threatening processes are considered relevant to the Giant Burrowing Frog in the study area:

- Clearing of native vegetation
- Bushrock removal
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.

As the proposal occurs in a developed area it is considered that the Chytrid fungus is already present on site. Mitigation measures should ensure that if the disease is not present on site, it is not introduced by actions associated with the proposal.

Within the study area, natural flow has been previously altered by construction of the existing Mona Vale Road. Natural flow regimes are likely to be altered as identified in the draft hydrology report (Aurecon 2016).

Overall Conclusion

The Giant Burrowing Frog was recorded outside the subject site along the Caley Trail in Garigal National Park during recent spotlighting surveys by Ecosure. Suitable foraging habitat occurs in the study area (Ecosure 2015), and larger areas of good quality habitat occur in Kuring-gai Chase National Park and the adjacent Garigal National Park in which the species was identified.

The proposal will require the removal of 11.8 ha of native bushland including suitable breeding

and foraging habitat for the Giant Burrowing Frog. Although the species was only recorded to the south of Mona Vale Road, suitable habitat occurs to the north in Ku-ring-gai Chase National Park. Non-breeding habitat is also present near Wirreanda Road although the species is unlikely to occur here due to the disturbed nature of the area.

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposal. Any changes to drainage and water quality may have a significant impact on Giant Burrowing Frog breeding habitat downstream of the subject site.

The proposed action is likely to result in a significant impact on the Giant Burrowing Frog within the locality due to the potential impacts on breeding habitat from changes to drainage and water quality.

***Pseudophryne australis* (Red-crowned Toadlet)**

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

The Red-crowned Toadlet was identified by its distinctive call to the north and south of the subject site during surveys conducted by Ecosure in 2013 and 2014. Red-crowned Toadlets breed exclusively in ephemeral drainage lines where they lay eggs in moist leaf litter that are then washed by heavy rain. They disperse outside the breeding period, but are generally quite localised and restricted to the area surrounding breeding habitat (OEH 2012; Stauber 2006). During non-breeding periods they use surrounding leaf litter and vegetation for shelter.

Red-crowned Toadlet individuals that were identified in Garigal National Park to the south were located along a fire trail just outside the study area in an area that contains extensive suitable habitat. Some potential non-breeding habitat adjacent to Mona Vale Road will be removed in this area.

Individuals located along Wirreanda Road occupy a smaller, more isolated area of habitat between Mona Vale Road and areas that have previously been cleared for other land uses. Foraging habitat will be removed in this area. Potential breeding habitat is restricted to one or two drainage lines upslope of Wirreanda Road. Further investigation of potential breeding habitat to determine if reproduction is successfully occurring out of this area would assist in providing a more accurate assessment of potential impacts to this species. However as this habitat drains into a road drain, it is unlikely that the breeding cycle is successfully being completed at this location.

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposal. Any changes to drainage and water quality may have a significant impact on Red-crowned Toadlet breeding habitat downstream of the subject site.

Conclusion: The Red-crowned Toadlet has been identified on either side of Mona Vale Road. Breeding habitat for the Red-crowned Toadlet in the study area may be affected by changes

to hydrology and water quality. These impacts may place local populations at risk of extinction.

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

Not applicable

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The proposal will require the removal of suitable sheltering and foraging habitat for the Red-crowned Toadlet. Non-breeding habitat is generally restricted to the immediate vicinity of breeding habitat. This species inhabits ridges with suitable refuges near breeding sites (NPWS 2001).

Approximately 0.2 ha of potential breeding habitat may be affected. Within this area there are small drainage lines as well as areas that may form soaks and seepages after heavy rainfall. Hydrological investigations (Aurecon 2016) have identified likely changes to drainage and water quality as a result of the proposal.

Conclusion: Approximately 1.1 hectare of habitat including 0.85 ha of suitable foraging and sheltering habitat will be removed or modified by the proposal. Potential breeding habitat is likely to be affected by hydrological changes.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The Red-crowned Toadlet colonies have a localised distribution and do not usually move far from breeding habitat (Stauber 2006) outside breeding time.

Potential habitat for the Red-crowned Toadlet on either side of the ridge is already divided by Mona Vale Road. It can be considered that the populations on either side of the road are independent.

The population in Garigal National Park will not be isolated from any additional areas of

suitable habitat by the proposal. Individuals identified near Wirreanda Road occupy an area of habitat isolated by roads and vegetation clearing.

Conclusion: The project will increase the distance between populations north and south of Mona Vale Road. Habitat occupied by these populations will remain connected to other areas of suitable habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

The study area provides suitable foraging, sheltering and some breeding habitat for the Red-crowned Toadlet. It is likely that higher quality breeding habitat and additional foraging and sheltering habitat occurs south of the study area within Garigal National Park and to the north in Ku-ring-gai Chase National Park.

Red-crowned Toadlets occupy drainage lines below sandstone ridges. Mona Vale Road is located along the ridgeline above habitat that is used by the Red-crowned Toadlet.

Habitat to be removed between Mona Vale Road and Wirreanda Road may include small areas of potential breeding habitat. Further investigation would assist in determining if reproduction is successfully occurring in this area and whether this habitat is important to a local viable population, as there is limited connectivity to downstream habitat across Wirreanda Road.

Breeding habitat downstream of the subject site may be indirectly affected by changes to drainage and water quality as identified in the hydrological report (Aurecon 2016).

Conclusion: Removal of habitat along Mona Vale Road is unlikely to be important to the long term survival of Red-crowned Toadlets occupying habitat south of Mona Vale Road within Garigal National Park. Further investigation of potential breeding habitat to determine if reproduction is successfully occurring out of this area would assist in providing a more accurate assessment of potential impacts on a viable local population of this species.

Changes to drainage and water quality may have a significant impact of breeding habitat of the Red-crowned Toadlet in the study area.

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

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

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

No recovery plan or threat abatement plan has been prepared for the Red-crowned Toadlet. The following actions have been identified in the Saving Our Species program protect this species.

- Liaise with Councils responsible for areas of habitat in or close to urban areas to promote water-sensitive design, particularly with respect to drainage of slopes and ridges. Seek advice from Office of Environment and Heritage or relevant amphibian experts when designing fire trails and other tracks, including seismic lines, in bushland areas to prevent adverse impacts on hydrology and habitat
- Raise awareness among residential communities with a bush interface, e.g. via letterbox leaflet drop, of the potential impacts of pollutants in stormwater and run-off (e.g. pesticides, swimming pool waste water)
- Work with and raise awareness among the nursery industry in areas where the species' habitat occurs (Sydney metropolitan area) of the importance of bush rock to the species' habitat, in order to reduce the prevalence of unsustainable and illegal bush rock removal
- Conduct before and after monitoring of populations that are affected by planned or unplanned fires to better understand the species' fire response (e.g. survivorship) and inform future fire planning
- When maintaining roads, fire trails or tracks along ridges where the species occurs, minimise damage to substrate by ensuring bulldozers have lifted blades when not in use, and avoid additional damage to ground layer vegetation and soil structure wherever possible.

Conclusion: The proposal is not inconsistent with the actions identified to protect the Red-crowned Toadlet.

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

The following key threatening processes are considered relevant to the Red-crowned Toadlet in the study area:

- Clearing of native vegetation
- Bushrock removal
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Removal of dead wood and dead trees.

As the proposal occurs in a developed area it is considered that the Chytrid fungus is already present on site. Mitigation measures should ensure that if the disease is not present on site, it is not introduced by actions associated with the proposal.

Within the study area, natural flow has been previously altered by construction of the existing Mona Vale Road. Natural flow regimes are likely to be altered as identified in the draft hydrology report (Aurecon 2016).

Conclusion: The action proposed constitutes four key threatening processes relevant to the Red-crowned Toadlet.

Overall Conclusion

The Red-crowned Toadlet was detected at two separate locations; along the Caley trail in Garigal National Park to the south of Mona Vale Road and near Wirreanda Road to the north. In Garigal National Park they were observed in four locations close to each other and less than 50 metres from the construction impact area.

The proposal will require the removal of 1.1 ha of vegetation containing foraging and/or refuge habitat suitable for the Red-crowned Toadlet and small areas of potential breeding habitat. Additional suitable habitat for the Red-crowned Toadlet is located in Ku-ring-gai Chase and Garigal National Parks adjacent to the study area.

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposal. Any changes to drainage and water quality may have a significant impact on Red-crowned Toadlet breeding habitat downstream of the subject site.

The proposed action is likely to result in a significant impact on the Red-crowned Toadlet within the locality due to the potential impacts on breeding habitat from changes to drainage and water quality.

***Ninox strenua* (Powerful Owl)**

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

Powerful Owls have high site fidelity, with pairs defending a home range between 400 and 1,450 ha that will include a small number of hollow bearing nest trees and a large number of roost trees. Few large hollow bearing trees occur in the study area. Smaller hollows could be utilised by prey species of the Powerful Owl and it is likely that the species hunts within the study area on occasion.

Twelve tree hollows that are large enough to be used by the Powerful Owl will be removed by the proposal. These hollows are unlikely to provide suitable nesting sites for the Powerful Owl due to their proximity to the existing road. Numerous other smaller hollows are likely to be utilised by its prey species.

The Powerful Owl was detected less than 1.5 km from the study area during recent field surveys and breeding pairs are known to occur in surrounding areas.

Conclusion: Given the large home range of the Powerful Owl and lack of suitable breeding sites in the study area, it is unlikely that the proposed works will adversely affect the life cycle of this species to the extent that a local population will be placed at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered

population such that a viable population of the species is likely to be placed at risk of extinction.

Not applicable

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The proposal will remove about 16 ha of open woodland that provides potential foraging habitat for the Powerful Owl and suitable habitat for some of its prey species. Given the availability of suitable habitat in neighbouring Garigal and Ku-ring-gai Chase National Parks, the amount of habitat to be removed is considered to be a small proportion of one individual's potential home range.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The Powerful Owl is a highly mobile species occupying a large home range up to 4000 hectares where prey and hollows are sparse. They are capable of existing in fragmented landscapes. Potential habitat for the Powerful Owl is unlikely to become fragmented or isolated as a result of the proposed actions.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

This species is highly mobile and can survive in fragmented landscapes. However as a top order predator they are sensitive to habitat fragmentation through the loss of prey species. The habitat to be removed exists in the vicinity of a major road through native bushland.

Mitigation measures will assist the survival of prey species for the Powerful Owl in the locality; a rope bridge and land bridge will be constructed to increase connectivity between Garigal and Ku-ring-gai Chase National Parks and fauna fencing will reduce the frequency of road kill within the study area.

Conclusion: The habitat to be removed is unlikely to be important to the long-term survival of the Powerful Owl in the locality given its large home range and lack of suitable nesting sites

within the study area.

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

No critical habitat has been declared for this species.

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

A recovery plan for the large forest owls, including the Powerful Owl, has been developed by DEC (2006). The recovery plan recommends:

- Minimisation of vegetation removal to protect potential foraging habitat (including ground, understorey, logs and trees)
- Retention of habitat (hollow bearing) trees
- Protection of wildlife corridors and forest at a landscape level
- Exclusion zones around known nest and roost sites.

Conclusion: The proposed activity is not consistent with this recovery plan. The proposal will require the removal of foraging habitat and hollow-bearing trees. Recommended mitigation measures will reduce these impacts on the Powerful Owl through construction of fauna crossings to enhance connectivity between Ku-ring-gai Chase and Garigal National Parks.

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

The following key threatening processes are considered relevant to the Powerful Owl and its prey species in the study area:

- Clearing of native vegetation
- Loss of hollow-bearing trees

Conclusion: The actions proposed constitute two key threatening processes that may impact the Powerful Owl.

Overall Conclusion

The proposal would require the removal of 16 ha of vegetation that could be utilised by the Powerful Owl for hunting. This habitat also provides suitable habitat for prey species of the owl including hollow-bearing trees.

Powerful Owls have very large home ranges and are only likely to utilise the study area for hunting. Additional hunting habitat with suitable prey species is available in the neighbouring Ku-ring-gai Chase and Garigal National Parks.

The proposed action is unlikely to result in a significant impact on the species.

***Cercartetus nanus* (Eastern Pygmy Possum)**

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

Surveys have shown that the Eastern Pygmy-possum is present in the study area. It is likely that the species would use the subject site for foraging, breeding and movement. Thus, the subject site is important for all stage of the species' life cycle and a viable local population is present. The habitat in the study area is continuous with large areas of similar suitable habitat in Ku-ring-gai Chase NP to the north and Garigal NP to the south. There is also some limited habitat on private land to the north in the project area's eastern two-thirds, which also provides connectivity to Ku-ring-gai NP further north. Eastern Pygmy-possum records are known to occur within the Locality outside the study area.

The project would require 16 ha of habitat suitable for the Eastern Pygmy-possum to be removed, which is insignificant relative to the availability of similar, *Banksia*-rich habitat in the locality. However, it is likely that individual Eastern Pygmy-possums would be displaced from their home-ranges by clearing as a result of the loss of foraging resources and shelter sites (e.g. hollow-bearing trees, fallen logs, rock crevices). The use of a spotter/catcher to capture and relocate Eastern Pygmy-possums during clearing operations would maintain a level of individual welfare during the removal of den sites (hollow-bearing trees, fallen logs, rock crevices, etc.) Part of the mitigation strategy proposed for the project involves recovery and redeployment of tree hollows and fallen logs and the installation of nest boxes in adjacent habitat. Eastern Pygmy-possum displaced by clearing will be released into these (re)installed structures.

Some additional minor impacts may also result (e.g. weed establishment), as discussed in Section 5.5. With appropriate management directed by a Construction Management Plan to be prepared, these risks can be reduced to a negligible level.

Although there is no evidence that the Eastern Pygmy-possum currently crosses the existing road formation, application of the precautionary principle suggests that it should be assumed they do in the absence of information otherwise. Accordingly, the major project impact is an increase the intensity of habitat fragmentation and the creation or increase in barrier formation (note, a barrier can be formed directly or indirectly if mortality rates are sufficient high to effectively prevent movement). Habitat fragmentation would inhibit individual movement, resulting in the loss of genetic exchange between populations within the two conservation reserves, increased mortality due to vehicle strike and increase the risk of predation (particularly by owls). Connectivity would be maintained or restored by the installation of crossing structures, though it is noted that none of these measures are proven as effective for the Eastern Pygmy-possum as a species and/or within this location. Exclusion fencing would be installed to reduce road mortality and to direct Eastern Pygmy-possum towards the crossing structures. The exclusion fencing would have an unclimbable metal strip along its base to prevent Eastern Pygmy-possums from accessing the road corridor. While it may be difficult to achieve full exclusion due to the small size and climbing ability of the Eastern Pygmy-possum, this should be sufficient to reduce access to the road corridor to a level that diminishes mortality to a level that does not impact upon population processes.

While the use of crossing structures is not demonstrated, it is possible that a land bridge would be effective. This is because a land bridge is a large structure upon which habitat can be established. Created habitat can take some time to establish, but can be accelerated by salvaging trees removed during clearing activities and using these as fallen logs and by the strategic use of advanced saplings to provide substantial cover following construction. Over time, the use of tube stock and natural seeding would allow greater vegetative cover to become established. While the habitat growing on the land bridge may ultimately have some different structural characteristics to adjacent retained habitat, it is noted that habitat are naturally patchy and it is reasonable to assume that the land bridge would become part of the habitat mosaic. Law *et al.* (2013) observed individual Eastern Pygmy-possum on one ridge travelling over 500 m within a single night, crossing a gully to an adjacent ridge. This would require different habitat types to be traversed, indicating a propensity to move through patchy habitats.

Post-construction on-going monitoring in an adaptive management framework would be undertaken to identify residual project impacts. Strategies would be developed to ameliorate these impacts.

Given the area of Eastern Pygmy-possum removed as part of the proposed action, it is likely that the proposal will have a significant impact on the species.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The project would require 16 ha of foraging and breeding habitat of the Eastern Pygmy-possum to be removed.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Although it is unknown whether the Eastern Pygmy-possum currently crosses the existing road formation, the major project impact is an increase in the operation of habitat fragmentation. Habitat fragmentation would inhibit individual movement, resulting in the loss of genetic exchange between populations within the two conservation reserves, and cause mortality due to vehicle strike.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

The project area lies between Ku-ring-gai Chase NP and Garigal NP. Therefore, the habitat to be removed and fragmented is very important to the long-term survival of the Eastern Pygmy-possum in the locality.

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

To date, no critical habitat has been declared under the TSC Act for the Eastern Pygmy-possum.

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

To date, no recovery plan has been prepared under the TSC Act for the Eastern Pygmy-possum. No relevant threat abatement plans apply.

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

The project will, or is likely to, result in, or increase, the operation of several KTPs.

Overall Conclusion

Eastern Pygmy possums have been observed within the study area, and it is likely that the species utilises the area for breeding, foraging, and sheltering. The proposal will result in the removal of 16 ha of habitat suitable for the Eastern Pygmy-possum, which is likely to result in the displacement of numerous individuals. As such, the proposal is likely to have a significant impact on Eastern Pygmy-possum.

***Isoodon obesulus obesulus* (Southern Brown Bandicoot)**

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

The Southern Brown Bandicoot has been the subject of an intensive trapping program in

Garigal National Park, but is naturally rare and has not been located there since 2000. It has been trapped in Ku-ring-gai Chase National Park, particularly near Bobbin Head. It is unlikely that the area is important habitat for southern brown bandicoot, but they may be occasionally encountered (Ecosure 2015).

The study area contains limited breeding and foraging habitat for the Southern Brown Bandicoot. It is only likely to utilise the study area on rare occasions by dispersing individuals. The construction of crossing structures is likely to aid the dispersal of the Southern Brown Bandicoot through the landscape by reducing the likelihood of road mortality.

Conclusion: It is considered unlikely that the study area provides important habitat for the Southern Brown Bandicoot; therefore, the proposal will not place a viable local population at risk of extinction.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The proposal will require the removal of 16 ha of habitat that may be used by the Southern Brown Bandicoot for foraging and breeding. This habitat may also be used to travel to other areas of suitable habitat in Ku-ring-gai Chase and Garigal National Parks.

Conclusion: Potential foraging and breeding habitat for the Southern Brown Bandicoot will be removed by the proposal.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Southern Brown Bandicoots have a limited home range of between 0.5 - 9 ha. No individuals were recorded in the study area during recent surveys (Ecosure 2015).

Removal of habitat along Mona Vale Road as required by the proposal will result in the increase in width of an existing hazard to movement and dispersal of ground-dwelling mammals. Mitigation measures including a land bridge and fauna fencing will enhance connectivity between areas of suitable habitat for the Southern Brown Bandicoot and aim to reduce road kill.

Conclusion: Southern Brown Bandicoot habitat has been previously fragmented by the construction of Mona Vale Road. The proposal will not result in the further isolation of any potential habitat; however, the width of the existing barrier will be increased. Mitigation measures should increase connectivity and reduce road mortality across Mona Vale Road.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

No Southern Brown Bandicoots have been recently identified in the study area. Some potential foraging and breeding habitat occurs. Extensive areas of good quality habitat are available in the locality including in Ku-ring-gai Chase and Garigal National Parks adjoining the study area.

Conclusion: As no Southern Brown Bandicoots have been recently identified in the study area, the habitat to be removed is unlikely to be important foraging or breeding habitat. Extensive areas of good quality habitat are available in the locality including in Ku-ring-gai Chase and Garigal National Parks adjoining the study area.

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

No critical habitat has been declared for the Southern Brown Bandicoot.

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

A recovery plan has been developed for the Southern Brown Bandicoot by DEC (2006). The recovery plan recommends management (retention and restoration) of habitat and better understanding of this species distribution and abundance.

Conclusion: No Southern Brown Bandicoots have been identified in the vicinity of the study area since 2000, however there is potential habitat. The proposed action is not consistent with the objectives of the recovery plan.

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

Recognised threats to the Southern Brown Bandicoot include the following key threatening process listed under the TSC Act:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

- Infection of native plants by *Phytophthora cinnamomi*
- Predation by the European red fox (*Vulpes vulpes*)
- Predation by the feral cat (*Felis catus*)

Conclusion: The actions proposed constitute the key threatening process 'Clearing of Native Vegetation'.

Overall Conclusion

The study area contains limited breeding and foraging habitat for the Southern Brown Bandicoot. The species has a sparse distribution and has not been recorded in Garigal National Park since 2000 despite trapping efforts. It is only likely to utilise the study area on rare occasions.

The proposal would require the removal of 16 ha of potential foraging and breeding habitat for the Southern Brown Bandicoot. Given the species' absence in the locality it is not considered this will have a significant impact on the species. In addition, the installation of crossing structures for fauna as part of this project is likely to benefit this species by aiding dispersal, maintaining gene transfer and reducing the risk of road mortality.

***Chalinolobus dwyeri* (Large-eared Pied Bat) and *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) - Cave-dwelling microbats**

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

The Eastern Bentwing-bat was detected utilising the study area for foraging. The Large-eared Pied Bat was probably detected and suitable foraging habitat for this species occurs.

These microbat species predominately roost in caves but will also utilise man-made structures such as tunnels, mine shafts and buildings. Some suitable roosting habitat occurs within the study area. It is unlikely any potential roost sites will be removed by the proposal.

Eastern Bentwing-bats and Large-eared Pied Bats breed in selected maternity caves and disperse from these sites to forage. There are no breeding sites for these species in the study area.

Conclusion: The proposed actions are unlikely to have an adverse effect on the life cycle of these species such that a viable local population is placed at risk of extinction as no breeding sites will be affected.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The proposal will result in the removal of approximately 16 ha of open woodland that may be utilised by these microbat species as foraging habitat.

No breeding or roosting habitat has been identified within the construction impact area.

Conclusion: The actions proposed will result in the removal of about 14.6 ha of suitable foraging habitat for the Large-eared Pied Bat and Eastern Bentwing-Bat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The Large-eared Pied Bat and Eastern Bentwing-Bat are highly mobile species, capable of travelling great distances from breeding sites to forage.

Potential foraging habitat to be removed is located along a major road adjacent to large areas of suitable habitat. Construction of this road has previously fragmented potential habitat. It is likely that microbats are able to negotiate this barrier where suitable resources are located on either side of the road.

Conclusion: It is highly unlikely the microbat habitat will become further fragmented or isolated as a result of the proposed actions.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community

These species require suitable roosting, breeding and foraging habitat. Breeding sites would be considered most important for the Eastern Bentwing-Bat and Large-eared Pied Bat. No breeding sites will be disturbed or removed by the proposal.

The proposal will require the removal of 16 ha of vegetation containing suitable foraging and potentially roosting habitat for these species. There are extensive areas of suitable habitat in the neighbouring Ku-ring-gai Chase and Garigal National Parks.

Conclusion: The habitat to be removed is not considered to be very important to the Eastern Bentwing-Bat and Large-eared Pied Bat as it does not include any breeding sites.

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

To date, no critical habitat has been declared for either of these microbat species.

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

A National Recovery Plan has been prepared for the Large-eared Pied Bat (DERM 2011). None of the objectives in this plan are relevant to the proposal.

No recovery plan or threat abatement plan has been prepared for the Eastern Bentwing-Bat. Proposed management sites identified for conservation of the Eastern Bentwing-bat do not occur within the Sydney Region and are therefore not associated with the proposal.

Conclusion: The proposal will not interfere with the recovery actions for these microbat species.

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

The following key threatening processes are considered relevant to the Large-eared Pied Bat and Eastern Cave Bat:

- Clearing of native vegetation
- Bushrock removal
- Loss of hollow-bearing trees

Conclusion: The actions proposed constitute three key threatening processes.

Overall Conclusion

The proposal will require the removal of up to 16 hectares of vegetation containing suitable foraging and roosting habitat for the Eastern Bentwing-Bat and Large-eared Pied Bat. The Eastern Bentwing-Bat was recorded in the study area and a possible identification was made for the Large-eared Pied Bat.

These species are likely to utilise extensive areas of foraging habitat in the locality and are therefore unlikely to be affected by the removal of foraging habitat along a major road. Extensive areas of suitable foraging and roosting habitat will remain in the locality. It is unlikely the proposal will have a significant impact on these species of microbat.

***Miniopterus australis* (Little Bentwing-bat), *Mormopterus norfolkensis* (Eastern Freetail-bat) and *Scoteanax rueppellii* (Greater Broad-Nosed Bat) - Microbats that do not exclusively use caves as roosting sites**

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

The Little Bentwing-bat, Eastern Freetail-bat and Greater Broad-nosed Bat roost in a variety of habitats including tree hollows, under loose bark and in man-made structures. Suitable roosting sites are available in hollow-bearing trees along the construction corridor although these occur at low densities (Ecosure 2015).

Microbats forage in and above forest canopies. Suitable foraging habitat occurs in roadside vegetation that forms part of much larger areas of vegetation in the locality.

The Greater Broad-nosed Bat breeds in suitable tree hollows. The Little Bentwing-bat breeds in maternity colonies in caves. There are only five known breeding sites in NSW. Little is known about the habitat preferences of the Eastern Freetail-bat (OEH 2014).

None of these species were identified in the study area during the current field surveys conducted during summer of 2013 and 2014. The Little Bentwing-bat was identified to the east of the study area in surveys for the Mona Vale Road East upgrade (Ecosure 2015).

Conclusion: The proposed actions are unlikely to have an adverse effect on the life cycle of these species such that a viable local population is placed at risk of extinction. It is unlikely any breeding sites will be affected and suitable foraging habitat will be reduced, not removed.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

The proposal will require the removal of up to 16 ha of open woodland containing suitable foraging and roosting habitat for the Little Bentwing-bat, Eastern Freetail-bat and Greater Broad-nosed Bat.

Indirect impacts on neighbouring vegetation will be increased (e.g. increased lighting and noise).

Conclusion: The actions proposed will result in the clearing of up to 16 ha of potential microbat foraging habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Microbats, including the Little Bentwing-bat, Eastern Freetail-bat and Greater Broad-nosed Bat, are aerial species that forage within and around tree canopies.

The existing road acts as a deterrent to movement, however, it is expected that species suited to foraging in more open habitats are able to negotiate this barrier. An increase in road width and traffic volumes may act as more of a deterrent to some species.

Conclusion: It is unlikely any microbat habitat will become fragmented or isolated as a result of the proposed actions as the proposal is located along an existing major road.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

Microbats require suitable roosting, breeding and foraging habitat. The study area is expected to provide suitable foraging and roosting habitat for the Little Bentwing-bat and Eastern Freetail-bat.

Conclusion: The proposal will require the removal of up to 16 hectares of suitable foraging and roosting habitat for microbats. Given the extent of habitat in the locality and location of existing habitat along a major road, it is unlikely the habitat to be modified or removed is important to the long-term survival of any of these microbat species.

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

To date, no critical habitat has been declared for these microbat species.

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

No recovery plans or threat abatement plans have been developed for the Little Bentwing-bat,

Eastern Freetail-bat or Greater Broad-nosed Bat.

Management sites identified for conservation of the Little Bentwing-bat do not occur within the Sydney Region and are therefore not associated with the proposal.

Management actions for the Eastern Freetail-bat aim to address key knowledge gaps for this species, which once resolved, can inform effective management of this species.

Management actions for the Greater Broad-nosed Bat relate to conservation of the species and its habitat at a landscape scale. Actions that are relevant to the proposal include:

- Ensure largest hollow bearing trees, including dead trees and paddock trees are given highest priority for retention in PVP assessments (offsets should include remnants in high productivity) and/or other land assessment tools.
- Prepare EIA guidelines which address the retention of hollow bearing trees maintaining diversity of age groups, species diversity, and structural diversity. Give priority to largest hollow bearing trees.

Conclusion: Management actions for the Little Bentwing-bat and Eastern Freetail-bat are not relevant to the proposal. Mitigation measures recommended the retention of hollow-bearing trees where possible to assist the Greater Broad-nosed Bat and other species.

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

The following key threatening processes are considered relevant to these three species of microbat:

- Clearing of native vegetation
- Loss of hollow-bearing trees

Conclusion: The proposal constitutes two key threatening processes.

Overall Conclusion

The proposal will require the removal of up to 16 hectares of open woodland containing suitable foraging and roosting habitat for the Little Bentwing-bat, Eastern Freetail-bat and Greater Broad-nosed Bat. None of these species were identified during recent surveys.

These species are likely to utilise extensive areas of foraging habitat in the locality and is therefore unlikely to be affected by the removal of foraging habitat along a major road. Extensive areas of suitable foraging and roosting habitat will remain in the locality. It is unlikely the proposal will have a significant impact on these three species of microbat.

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

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

The Grey-headed Flying-fox was observed foraging in the study area during recent surveys. It is expected the species forages on occasion within the study area when suitable species are in flower. There are additional food resources available in the neighbouring Ku-ring-gai Chase and Garigal National Parks as well as streetscapes, parks and gardens in the locality.

Mating occurs in early autumn in roosting camps and young are carried by mother for the first four-five weeks after giving birth. Subsequently young are left in maternal camps while females forage. Three known camps have been identified in the locality; Warriewood (5 km east), Gordon (10 km south-west) and Balgowlah (12 km south).

The proposal will not affect any breeding activities or camps of the Grey-headed Flying-fox. The nearest camp is located 5 km from the study area.

Conclusion: The proposed actions are unlikely to have an adverse effect on the life cycle of the species such that any potential viable population will be placed at risk of extinction as there are no breeding sites present within the study area.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

About 16 ha of suitable foraging habitat is likely to be removed as a result of the proposed action. Dominant feed tree species that have been identified in the study area include Smooth-barked Apple (*Angophora costata*), Old-man Banksia (*Banksia serrata*), Red Bloodwood (*Corymbia gummifera*) and Sydney Peppermint (*Eucalyptus piperita*).

This habitat is adjacent to a major road and part of extensive areas of additional habitat in the neighbouring Ku-ring-gai Chase and Garigal National Parks.

No Grey-headed Flying-fox camps will be disturbed.

Conclusion: The proposal will require the removal of approximately 16 ha of potential foraging habitat for the Grey-headed Flying-fox.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

The Grey-headed Flying-fox is a highly mobile species; capable of daily foraging movements of around 15 kilometres from permanent camps, but can exceed 50 kilometres per night. This species is also capable of migrating between camps in response to the availability of foraging resources.

Conclusion: Given the level of mobility, it is highly unlikely any potential Grey-headed Flying-fox habitat will become fragmented or isolated as a result of the proposed action.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the community.

The study area does not support a permanent Grey-headed Flying-fox population, with no camps located within the study area.

The Grey-headed Flying-fox is expected to utilise some of the 14.6 hectares of foraging habitat opportunistically as eucalypts are in flower. It is unlikely to rely on food resources within the study area, but forages opportunistically within range of camps. There are large expanses of potential foraging habitat in the locality in National Parks, reserves and streetscapes.

Conclusion: The habitat to be removed as a result of the proposed actions is unlikely to be important to the long-term survival of this species.

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

To date, no critical habitat has been declared under the TSC Act for this species.

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

A draft recovery plan has been prepared for the Grey-headed Flying-fox (DECCW, 2009). The main objectives of the recovery plan are; reduce the impact of threatening processes, conserved their functional role as seed dispersers and pollinators, and improve information available to guide recovery plan.

Conclusion: Given the small extent of foraging habitat to be removed, the proposal is unlikely to interfere with the objectives of the recovery plan.

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

The following key threatening processes are considered relevant to the Grey-headed Flying-fox and the proposal:

- Clearing of native vegetation

Conclusion: The proposed actions constitute one key threatening process relevant to the Grey-headed Flying-fox.

Overall Conclusion

The Grey-headed Flying-fox was identified in the study area during recent surveys. Numerous individuals were observed foraging within the study area or flying overhead. It is expected the species forages on occasion within the study area when suitable trees are in flower. There are additional food resources available in neighbouring national parks as well as streetscapes, parks and gardens in the locality.

The proposal will not disturb any Grey-headed Flying-fox camps.

The proposed action is unlikely to result in a significant impact on this species.

***Varanus rosenbergi* (Rosenberg's Goanna)**

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

Rosenberg's Goanna was recorded during recent surveys by Ecosure 2015 and was captured on an infrared camera by SMEC in 2015.

Key habitat requirements for the Rosenberg's Goanna are active termite mounds for nesting and large expanses of vegetation for movement and foraging. The study area contains numerous termite mounds and is located near a major road separating Ku-ring-gai Chase and Garigal National Parks.

It is expected that up to 22 termite mounds will be removed by the proposal. Five of these were suitable for use by female Rosenberg's goannas and three had evidence of recent excavation by lizards. These termite mounds occur within 50 metres of a major road (Ecosure 2015).

It is expected that at least some of the termite mounds identified in the study area would be utilised by the Rosenberg's Goanna for breeding as the species has been observed nearby on numerous occasions and there is evidence of recent excavations at three mounds (Ecosure 2015). Termite mounds are likely to be a limiting habitat feature in the landscape.

Sufficient suitable foraging and sheltering habitat will remain in the locality within Ku-ring-gai Chase and Garigal National Parks. Rock outcrops are a sheltering option for the Rosenberg's Goanna and are abundant within the study area.

Conclusion: The study area contains suitable resources for the Rosenberg's Goanna including breeding and foraging habitat. The species has been observed in the study area during recent surveys and there is evidence to suggest breeding activities occur within the study area.

Removal of up to 22 termite mounds that may be utilised by the Rosenberg's Goanna may impact a local population if these mounds are used as nesting sites on a regular basis. The inability of the female to locate a suitable nesting site will reduce reproductive success.

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

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

Not applicable.

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed.

Rosenberg's Goannas shelter in hollow logs, burrows and under rock crevices, and require termite mounds for nesting. The amount of hollow logs varies across the study area from low to high.

The proposal will require the removal of 16 hectares of vegetation containing suitable resources for the Rosenberg's Goanna in the form of foraging habitat, sheltering sites and termite mounds for breeding. This habitat is located in the vicinity of a major road through Kuring-gai Chase and Garigal National Parks and has been previously fragmented by development.

Conclusion: The study area contains suitable habitat for the Rosenberg's Goanna. Some of these resources, including 22 termite mounds that are potential breeding sites, will be removed by the proposal.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Rosenberg's Goannas occupy large home ranges and move throughout these areas to forage

on carrion, birds, eggs, other reptiles and small mammals.

The existing road network acts as a physical barrier to fauna movement. Suitable habitat for the Rosenberg's Goanna in Ku-ring-gai Chase and Garigal National Parks is currently divided by Mona Vale Road. Animals are required to cross the road to reach other areas of suitable habitat. The proposal will increase the width of the road and increase traffic volumes, both of which will increase the chance of vehicle strike. Road kill of other species may also attract goannas to the road side as they feed on carrion. Mitigation measures including a land bridge and fauna fencing will increase connectivity between areas of suitable habitat and aim to reduce road kill within the study area.

Conclusion: The proposal is likely to contribute to the increased fragmentation of Rosenberg's Goanna habitat in the locality through road widening.

The implementation of mitigation measures including the construction of fauna crossing structures and fauna fencing will assist the Rosenberg's Goanna by reducing the probability of road kill and reconnecting isolated areas of habitat.

(iii) the importance of the habitat to be removed, modified or fragmented or isolated to the long-term survival of the species, population or endangered ecological community in the locality

Rosenberg's Goannas require hollow logs, burrows and rock crevices for sheltering and termite mounds for nesting. The proposal will require the removal of some sheltering and potential nesting sites, some of which show signs of recent activity. Additional habitat is available in Ku-ring-gai Chase National Park to the north and Garigal National Park to the south.

The Rosenberg's Goanna has been observed in the study area so is considered likely to utilise the resources to be removed by the proposal.

Conclusion: Rosenberg's Goannas require hollow logs, burrows and rock crevices for sheltering and termite mounds for nesting. The proposal will require the removal of some sheltering and potential nesting sites, some of which show signs of recent activity. Additional habitat is available in Ku-ring-gai Chase National Park to the north and Garigal National Park to the south.

The Rosenberg's Goanna has been observed in the study area so is considered likely to utilise the resources to be removed by the proposal.

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

To date, no critical habitat has been declared under the TSC Act for this species.

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

To date, no recovery plan or threat abatement plan has been prepared for the Rosenberg's Goanna. Management actions that have been identified to assist this species include:

- Undertake investigations into general biology and ecology of the species, particularly movement patterns and tree use, rock crevice use and termitaria use.
- Undertake investigations into taxonomic distinctions/genetic (DNA) differences between the various forms of the 'species'.
- Identify key habitats or areas for protection and enhanced management on private land through management agreements and incentives.
- Identify suitable habitat across the range of the species with reference to satellite imagery and vegetation surveys.
- Undertake surveys for the species within identified suitable habitat.
- Develop habitat identification, management and enhancement guidelines.
- Implement management strategies that reduce the prevalence of bush rock removal, including surveillance.
- Develop and undertake community education strategy that reduces demand for bush rock as landscaping material and provides/promotes alternatives.
- Provide map of known occurrences to Rural Fire Service and seek protection of rocky outcrops and riparian zones on Bush Fire Risk Management Plan(s), risk register and/or operation map(s).

Surveys undertaken as part of this proposal can contribute to knowledge of the Rosenberg's Goanna. No other management actions are considered relevant to the proposal.

Conclusion: The proposal is consistent with actions that have been identified to assist the Rosenberg's Goanna. Mitigation measures including a land bridge and fauna fencing will assist in enhancing connectivity between areas of suitable habitat and reducing road kill within the study area.

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

The following key threatening processes are considered relevant to the Rosenberg's Goanna and the proposal:

- Bushrock removal
- Clearing of native vegetation
- Removal of dead wood and dead trees

Conclusion: The proposed action will result in these three key threatening processes; bushrock removal, clearing of native vegetation and removal of dead wood and trees.

Overall Conclusion

The Rosenberg's Goanna has been recorded within the study area on more than one occasion and is known to utilise key habitat resources that may be removed by the proposal.

The proposed actions require the removal of termite mounds that are required for breeding. Sixteen termite mounds occur in the subject site (construction impact area), of which five are suitable for use by female Rosenberg's Goannas and three show signs of recent activity by lizards. The Rosenberg's Goanna is likely to compete with the Lace Monitor for these breeding sites and at least one mound was observed to be regularly use by Lace Monitors.

In light of the relatively minor amount of habitat to be removed and the abundance of breeding and foraging resources in the region the proposed action is considered unlikely to result in a significant impact on this species.

In addition, construction of fauna crossing structures will improve foraging and dispersal opportunities for the Rosenberg's Goanna by reducing the likelihood of road mortality for individuals moving between Ku-ring-gai Chase and Garigal National Parks.

EP&A ACT ASSESSMENT OF SIGNIFICANCE

NOTE: In assessing matters of National Environmental Significance (NES) associated with impact or potential impact on:

- Wetlands of international importance
- Listed threatened species and communities
- Listed migratory species

These/this assessment(s) may have been undertaken with prescribed designated mitigation measures that form part of the 'Action'. The effect of which is that these mitigation measures become a mandatory obligation based on Consent Authority approval to proceed.

Endangered Species: *Grevillea caleyi* (Caley's Grevillea)

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:

(i) lead to a long-term decrease in the size of a population

Grevillea caleyi is restricted to DFEC. There are over 300 records of this species within an 8km radius (OEH 2014). The species was found in multiple locations within the study area.

Some 26 sites of *G. caleyi* are identified in the Recovery Plan for the species. These sites represent remaining patches of the three major populations originally thought to exist across areas of suitable habitat in the Belrose, Terrey Hills/Duffys Forest and Ingleside areas. Sites 2 (Tumbledown Dick Hill) and 5 (Baha'i Temple) occur within the study area

Grevillea caleyi were found on ironstone laterite in patches of Duffys Forest Endangered Ecological Community (DFEC) in the far eastern and far western part of the study area as well as in the bloodwood-scribbly gum woodland in the far eastern part of the study area (Ecosure 2015). In addition to these findings, Smith and Smith (2011) recorded Caley's Grevillea in multiple locations throughout the Duffys Forest EEC in the central-eastern part of the study area (Ecosure 2015; GHD 2011).

SMEC confirmed the number of *G. caleyi* within and adjacent to the construction footprint in February 2016. At the western end of the study area 218 seedlings (on the northern side of the road at Tumbledown Dick Hill, within Recovery Plan Site 2) and 11 adult plants (east of the Terrey Hills Interchange) were recorded. At the eastern end of the proposal area there were 34 live adults and 2 seedlings recorded near the Baha'i Temple (within Recovery Plan Site 5).

A total of 75 above ground individuals of *G. caleyi* plants would be removed as part of the proposal based on the number of individuals falling within the construction footprint.

As *G. caleyi* produces a soil seedbank, there may be a considerable proportion of the real abundance of the species at a site in the soil (DEC 2004). Consequently, estimates of aboveground abundance at one point in time should be viewed with caution and may be a

poor predictor of the potential abundance of *G. caleyi* at a site. Fluctuations in plant numbers are high over time between fires and in response to fire. Auld and Scott (2004) note that changes in abundance of over two orders of magnitude were sometimes observed. Auld and Scott (2004) provide population estimates for 21 remnant patches of *G. caleyi*, albeit at varying times since the last fire. Population estimates for Site 2 and 5 soon after the 1994 fire were 2878 ± 496 and 1847 ± 301 (Auld & Scott 2004).

A recent report to the NSW Scientific Committee stated that 'Given that plants occur only within 10-20 m of the existing road verge (and not further down slope off the ridgetop laterite soils), the road widening could potentially result in a worst case scenario of removal or serious disruption of habitat of some 5000 mature plants (see Auld and Scott 2004 for population estimates), thus reducing or eliminating 45-60% of the potential mature population of the species. The estimate of 45-60% is based on a worst case scenario of loss of plants at Tumbledown Dick Hill and opposite the Baha'i Temple to roadworks' (Auld & Scott 2013).

Road design refinements mean that it is unlikely the project would result in this level of worst case scenario loss in relation to soil seedbank losses.

Conclusion: The proposed action will result in the removal of 75 *G. caleyi* that were recorded within the construction impact area. Population estimates likely to be impacted would be higher than the above ground abundance according to Auld and Scott (2004). Mitigation measures such as weed, sediment and erosion control will be designed to minimise the indirect impacts on individuals adjoining or located close to the construction impact area. Further information on population estimates likely to be directly and indirectly affected by the project, age class and fire history would assist in providing a more accurate assessment of potential impacts to this species. At this stage it is considered that the proposed action is likely to have an adverse effect on the life cycle of the local populations of *Grevillea caleyi* associated with Recovery Plan Sites 2 and 5 identified in the approved recovery plan for *Grevillea caleyi* (DEC 2004) based on the potential population size from the soil seedbank to be impacted.

(ii) reduce the area of occupancy of the species

The total area of occupancy for the species across all 26 sites according to the approved recovery plan (DEC 2004) is about eight hectares. The area of occupancy for Site 2 is about 1.2 hectares and the area of occupancy for Site 5 is about 2.3 hectares.

The survey area contains Duffys Forest Ecological Community (DFEC). *G. caleyi* is closely associated with DFEC and has a very restricted distribution in Northern Sydney. Occasionally, *G. caleyi* occurs at the boundaries of the laterite soils in low open forests of *C. gummifera* and *E. haemastoma*. About 3 hectares of *G. caleyi* habitat will be removed associated with Sites 2 and 5.

(iii) fragment an existing population into two or more populations

G. caleyi habitat is already considered to be severely fragmented. Existing fragmentation of its ridge habitat is thought to have disrupted pollination and subsequent gene flow (Llorens 2004, Llorens et al. 2004) although there was pre-existing differentiation between ridge populations.

Plants occurring at these two sites generally occur only within 10-20 m of the existing road verge (and not further down slope off the ridgetop laterite soils) (Auld & Scott 2013) and parts of each remnant patch are in a National Park.

The area of habitat at Site 5 near the Baha'i Temple is about 0.95 hectares on the northern side of Mona Vale Road and 1.2 hectares south of Mona Vale Road (DEC 2004). Habitat on the north-east side of Mona Vale Road is fragmented by land clearing for the Temple, a car park, residential properties and Mona Vale Rd, which bisects the habitat. The south east side of Mona Vale Rd, on the boundary of Garigal National Park, is the least-disturbed part of this population (DEC 2004). A strip of land 10m wide adjacent to the road has been excluded from the Park and is road reserve.

The area of habitat at Site 2 near McCarrs Creek Road is about 0.5 hectares on the northern side of Mona Vale Road and 1 hectares south of Mona Vale Road, Mona Vale Road bisects this large remnant patch. The approved recovery plan considers it a high priority to keep this important site intact, as the plants are both larger and denser per unit area of habitat (DEC 2004). The population on the north side of the road is just within the boundary of Ku-ring-gai Chase National Park.

The habitat to be removed as a result of the proposal (3 hectares) is along the existing Mona Vale alignment which already bisects both sites. Habitat to be removed is mostly between Mona Vale Road and either national park estate or rural residential development at the eastern and western extents of the survey area. The proposed activity will marginally increase the distance between individuals on either side of Mona Vale Road.

Pollination is by birds although it is thought that this species may be self-compatible (Llorens 2004). Casual observations indicate that honeyeaters, such as New Holland, White Cheeked and White Eared, as well as Little Wattlebirds, Silvereyes and Eastern Spinebills, are the most likely common pollinators of *G. caleyi*. It is unlikely that road widening would affect the ability of individuals to cross pollinate.

Conclusion: Clearing along the edge of Mona Vale Road as a result of the proposed action is unlikely to fragment an existing population into two or more populations.

(iv) adversely affect habitat critical to the survival of a species

The survey area contains Duffys Forest Ecological Community (DFEC). *G. caleyi* is closely associated with DFEC and has a very restricted distribution in Northern Sydney. About 3 hectares of *G. caleyi* habitat will be removed.

The proposed action will directly affect individuals that are part of the two largest known remnants of *Grevillea caleyi* (even though parts of each remnant patch are in a National Park) (Auld & Scott 2013). Plants generally occur only within 10-20 m of the existing road verge (and not further down slope off the ridgetop laterite soils). There are only two other sites where *G. caleyi* occurs in secure conservation tenure (Auld & Scott 2013).

The area of habitat at Site 5 near the Baha'i Temple is about 0.95 hectares on the northern side of Mona Vale Road and 1.2 hectares south of Mona Vale Road (DEC 2004). Habitat on

the north-east side of Mona Vale Road is fragmented by land clearing for the Temple, a car park, residential properties and Mona Vale Rd, which bisects the habitat. The south east side of Mona Vale Rd, on the boundary of Garigal National Park, is the least-disturbed part of this population and is of higher priority (than the Temple side) for conservation (DEC 2004). A strip of land 10m wide adjacent to the road has been excluded from the Park and is road reserve.

The area of habitat at Site 2 near McCarrs Creek Road is about 0.5 hectares on the northern side of Mona Vale Road and 1 hectares south of Mona Vale Road, Mona Vale Road bisects this large remnant patch. The approved recovery Plan considers it a high priority to keep this important site intact, as the plants are both larger and denser per unit area of habitat (DEC 2004). The population on the north side of the road is just within the boundary of Ku-ring-gai Chase National Park.

The habitat to be removed as a result of the proposal (3 hectares) represents more than half of the area of habitat associated with these two local populations.

The proposed activity is unlikely to adversely affect habitat critical to the survival of the species.

(v) disrupt the breeding cycle of a population

Grevillea caleyi is restricted to DFEC. There are over 300 records of this species within an 8km radius (OEH 2014). The species was found in multiple locations within the survey area.

Some 26 sites of *G. caleyi* are identified in the Recovery Plan for the species. These sites represent remaining patches of the three major populations originally thought to exist across areas of suitable habitat in the Belrose, Terrey Hills/Duffys Forest and Ingleside areas.

A targeted search for *Grevillea caleyi* conducted in February 2016 by SMEC confirmed the number of *Grevilleas caleyi* within and adjacent to the construction footprint. 218 seedlings (on the northern side of the road at Tumbledown Dick Hill, within Recovery Plan Site 2) and 11 adult plants east of the Terrey Hills Interchange) were recorded at the western end of the study area. There were also 34 live adults and 2 seedlings recorded at the eastern end of the proposal near the Baha'i Temple (within Recovery Plan Site 5).

A total of 75 above ground individuals of *G. caleyi* plants would be removed as part of the proposal based on the number of individuals falling within the construction footprint. . These individuals are associated with Site 5 near the Baha'i Temple and Site 2 on either side of Mona Vale Road around Tumbledown Dick Hill as identified in the Recovery Plan (DEC 2004). These sites are considered as two separate local populations for the purposes of this assessment of significance.

As *G. caleyi* produces a soil seedbank, there may be a considerable proportion of the real abundance of the species at a site in the soil (DEC 2004). Consequently, estimates of aboveground abundance at one point in time should be viewed with caution and may be a poor predictor of the potential abundance of *G. caleyi* at a site. Fluctuations in plant numbers are high over time between fires and in response to fire. Auld and Scott (2004) note that changes in abundance of over two orders of magnitude were sometimes observed. Auld and Scott (2004) provide population estimates for 21 remnant patches of *G. caleyi*, albeit at varying

times since the last fire. Population estimates for Site 2 and 5 soon after the 1994 fire were 2878 ± 496 and 1847 ± 301 (Auld & Scott 2004).

A recent report to the NSW Scientific Committee stated that 'Given that plants occur only within 10-20 m of the existing road verge (and not further down slope off the ridgetop laterite soils), the road widening could potentially result in a worst case scenario of removal or serious disruption of habitat of some 5000 mature plants (see Auld and Scott 2004 for population estimates), thus reducing or eliminating 45-60% of the potential mature population of the species. The estimate of 45-60% is based on a worst case scenario of loss of plants at Tumbledown Dick Hill and opposite the Baha'i Temple to roadworks.' (Auld & Scott 2013).

The plant is killed by fire and relies entirely on seed that is stored in the soil for regeneration. Too frequent or too infrequent fire, are a major threat to the species. Large fires in January 1994 burnt Site 2 and 60% of the Site 5. Parts of Site 5 have been burnt in recent years. As fire is an integral part of the life cycle of the species, detailed investigation into fire history of the remnants will assist in determining the level of impact to the local viable population.

Generally seedlings do not flower and produce seed before 2-5 years of age. Flowering is sporadic throughout the year, but with a definite spring pulse. Casual observations indicate that honeyeaters, such as New Holland, White Cheeked and White Eared, as well as Little Wattlebirds, Silvereyes and Eastern Spinebills, are the most likely common pollinators of *G. caleyi*. Fecundity of *G. caleyi* is low with only about 3% of flowers resulting in seed. Seed dispersal is low and predation is high, therefore it is estimated that 8-12 years is required to develop a sufficient seedbank to replace a population. Further detail on the size and age structure of the populations at Sites 2 and 5 both within and adjoining the survey area would assist in providing a more accurate assessment of the potential impact of the project on the life cycle of the species and the risk to the local population.

Conclusion: The proposed action will result in the removal of at least 75 individuals of *G. caleyi* that were observed within the construction impact area. Population estimates likely to be impacted would be higher than the above ground abundance according to Auld and Scott (2004). Mitigation measures such as weed, sediment and erosion control will be designed to minimise the indirect impacts on individuals adjoining or located close to the construction impact area. Further information on population estimates likely to be directly and indirectly affected by the project, age class and fire history would assist in providing a more accurate assessment of potential impacts to this species. At this stage it is considered that the proposed action is likely to have an adverse effect on the breeding cycle of the local populations of *Grevillea caleyi* associated with Sites 2 and 5 identified in the approved recovery plan for *Grevillea caleyi* (DEC 2004).

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The survey area contains Duffys Forest Ecological Community (DFEC). *G. caleyi* is closely associated with DFEC and has a very restricted distribution in Northern Sydney. About 3 hectares of *G. caleyi* habitat will be removed. Of the 3 hectares of habitat identified in the subject site, about 2.7 hectares is in good condition.

Only about 265 hectares of Duffys Forest Ecological Community occurs within the local area (5 km radius). Habitat removal is permanent and can also result in increased edge effects and indirect impacts to remaining areas of vegetation if mitigation measures are not adequately implemented.

The proposed action will directly affect individuals that are part of the two largest known remnants of *Grevillea caleyi* (even though parts of each remnant patch are in a National Park) (Auld & Scott 2013).

Plants generally occur only within 10-20 m of the existing road verge (and not further down slope off the ridgetop laterite soils). There are only two other sites where *G. caleyi* occurs in secure conservation tenure (Auld & Scott 2013).

The area of habitat at Site 5 near the Baha'i Temple is about 0.95 hectares on the northern side of Mona Vale Road and 1.2 hectares south of Mona Vale Road (DEC 2004). Habitat on the north-east side of Mona Vale Road is fragmented by land clearing for the Temple, a car park, residential properties and Mona Vale Rd, which bisects the habitat. The south east side of Mona Vale Rd, on the boundary of Garigal National Park, is the least-disturbed part of this population and is of higher priority (than the Temple side) for conservation (DEC 2004). A strip of land 10m wide adjacent to the road has been excluded from the Park and is road reserve.

The area of habitat at Site 2 near McCarrs Creek Road is about 0.5 hectares on the northern side of Mona Vale Road and 1 hectare south of Mona Vale Road, Mona Vale Road bisects this large remnant patch. The approved recovery Plan considers it a high priority to keep this important site intact, as the plants are both larger and denser per unit area of habitat (DEC 2004). The population on the north side of the road is just within the boundary of Ku-ring-gai Chase National Park.

The habitat to be removed as a result of the proposal (3 hectares) represents more than half of the area of habitat associated with these two local populations

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, will be implemented for the proposal to manage impacts on abiotic factors adjacent the construction impact area.

Conclusion: The proposed activity will result in up to 3 ha of *G. caleyi* habitat being directly affected with modification through indirect impacts possible beyond the construction footprint, mostly downslope. Due to the highly restricted distribution of *Grevillea caleyi* and the relatively high densities of plants, the habitat to be removed is considered to decrease the availability or quality of habitat to the extent that the species is likely to decline

(vii) 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 proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

The habitat to be removed as a result of the proposal (3 hectares) is along the existing Mona Vale alignment mostly between Mona Vale Road and either national park estate or rural residential development at the eastern and western extents of the survey area. There is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken done in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

Conclusion: with implementation of machinery hygiene and weed control and erosion and sediment control measures, it is unlikely that the proposed action will result in invasive species becoming established in the *Grevillea caleyi* habitat.

(viii) introduce disease that may cause the species to decline

Infection of native plants by *Phytophthora cinnamomi* is listed as a key threatening process and is identified as a threat to the *G. caleyi* (NSW Scientific Committee, 2002a). There are no known infestations of *Phytophthora* within *G. caleyi* habitat however this species is considered at risk due to the proximity of habitat to existing infestations. This risk could lead to outbreaks of *Phytophthora* within *G. caleyi* habitat or to habitat degradation of unaffected habitat adjacent to infected areas (DEC 2004).

Habitat disturbance may aid the spread of *Phytophthora*. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of *Phytophthora cinnamomi*, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

Conclusion: It is unlikely that the proposed action will introduce disease that may cause the species to decline.

(ix) interfere with the recovery of the species

A recovery plan has been developed for Caley's *Grevillea* (March 2004) and twenty-two (22) priority actions have been identified to aid in its recovery, including:

- Implement appropriate fire management.
- Threat and habitat management including fencing, bush regeneration and weed control, pathogen and runoff control.
- Reservation and/or protection of remnant sites.
- Undertake ecological research.

The NSW priority action statement sets out the following management objectives for this species:

- Prevent access of recreational users to site.
- Reduce and maintain weed densities at low levels.
- Maintain appropriate fire regime for the species.
- Ensure land management is sympathetic to the long term requirements of the species.
- Augment extant wild population(s).
- Track species abundance/condition over time.

Conclusion: The proposed action is likely to result in clearing of individuals at two *G. caleyi* sites identified in the recovery plan and is therefore likely to interfere with the recovery of the species.

Overall Conclusion

The proposed action will result in the removal of 75 above ground adult individuals of *G. caleyi* that were observed within the construction impact area, based on a recent site inspection by SMEC in February 2016 and 3 hectares of known and potential habitat for the species. Population estimates likely to be impacted would be significantly higher than the above ground abundance according to Auld and Scott (2004) and DEC (2004). Mitigation measures such as weed, sediment and erosion control will be designed to minimise the indirect impacts on individuals adjoining or located close to the construction impact area. Further information on population estimates likely to be directly and indirectly affected by the project, age class and fire history would assist in providing a more accurate assessment of potential impacts to this species. At this stage it is considered that the proposed action is likely to have a significant impact on populations of *Grevillea caleyi* associated with Sites 2 and 5 identified in the approved recovery plan for *Grevillea caleyi* (DEC 2004).

Referral to DoE is recommended.

Endangered Species: *Genoplesium baueri* (Bauer's midge orchid)

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:

(i) lead to a long-term decrease in the size of a population

Genoplesium baueri grows in dry sclerophyll forest and moss gardens over sandstone (OEH 2014; NSW Scientific Committee 2004).

The survey area is predominantly Bloodwood - Scribbly Gum Woodland, Peppermint-Angophora Forest and Duffys Forest Ecological Community. This vegetation type may provide potential habitat in the survey area (about 15 hectares) for this species. However, commonly preferred habitat for the species (moist areas of moss on sandstone) does not exist within the survey area.

There are 41 records within 10 km of the study area although few records have been confirmed in recent years. Only 1 record falls within the locality about 4km to the south east at Narrabeen lakes. *Genoplesium baueri* is a cryptic, short-lived orchid that is difficult to detect for most of the year

The Bauer's Midge Orchid was not recorded within the survey area during targeted seasonal field surveys for the project. This included survey of a nearby reference site at St. Ives to ensure the species was flowering during the survey period.

Given that no individuals of the species occur in the survey area, the proposed action is unlikely to lead to a long-term decrease in the size of a population.

(ii) reduce the area of occupancy of the species

Potential habitat for this species has been identified in the survey area (about 15 hectares of sparse sclerophyll forest). Extensive areas of potential habitat for this species occurs in the locality (>7000ha) (estimated using OEH 2013).

There is some potential habitat (sparse sclerophyll forest) within the survey area, but commonly preferred habitat for the species (moist areas of moss on sandstone) does not exist within the survey area.

The Bauer's Midge Orchid was not recorded within the survey area during targeted seasonal field surveys for the project. This included survey of a nearby reference site at St. Ives to ensure the species was flowering during the survey period.

Given that no individuals of these species occur in the survey area and potential habitat is sub-optimal, it is unlikely the proposed action will reduce the area of occupancy of the species.

(iii) fragment an existing population into two or more populations

Genoplesium baueri was not recorded within the survey area during targeted field surveys throughout the study area including Duffys Forest EEC, Peppermint-Angophora Forest, Bloodwood - Scribbly Gum Woodland, Sandstone Heath and Rocky Sandstone Heath. .

The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. Although the proposal will result in clearing of about 14 hectares of sub-optimal potential habitat, it will not fragment an existing population into two or more populations.

(iv) adversely affect habitat critical to the survival of a species

Potential habitat for this species has been identified in the survey area (about 15 hectares), the majority of which is in moderate to good condition. However commonly preferred habitat for the species (moist areas of moss on sandstone) does not exist within the survey area.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road. The potential habitat within the survey area is already somewhat fragmented by Mona Vale Road

and some of the surrounding roads as well as rural and residential development.

Other areas of known and potential habitat for the species occurs in the locality (>7000ha). Large areas of similar habitat are protected in conservation reserves including Ku-ring-gai Chase and Garigal National Parks to the immediate north and south of the survey area and the species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park.

(v) disrupt the breeding cycle of a population

Genoplesium baueri was not previously recorded within the survey area and the bulk of the Sydney population occurs in a strip from Gladesville to Lane Cove, Wahroonga and Hornsby, including in Berowra Valley Regional Park, Ku-ring-gai Chase and Lane Cove National Parks.

Given that no individuals of the species will be removed, the lack of records close to the survey area and sub-optimal habitat available in the survey area, the proposed action is unlikely to disrupt the breeding cycle of this species

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The vegetation on the site may provide potential habitat (about 15 hectares) for this species. However commonly preferred habitat for the species (moist areas of moss on sandstone) is not present within the survey area. In view of the lack of local records, low population size and poor knowledge base, any habitat is likely to be of significance to the viability of the species.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road. The potential habitat within the survey area is already somewhat fragmented by Mona Vale Road and some of the surrounding roads as well as rural and residential development.

Other areas of known and potential habitat for the species occurs in the locality (>7000ha). Large areas of similar habitat are protected in conservation reserves including Ku-ring-gai Chase and Garigal National Parks to the immediate north and south of the survey area and the species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park

Although there will be removal of about 15 hectares of potential but sub-optimal habitat, this is unlikely to be to the extent that the species is likely to decline as no individuals or populations have been found within or close to the survey area.

(vii) 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 proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road will be adjoining the existing Addison Road so there is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken done in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

It is unlikely that the proposed action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

(viii) introduce disease that may cause the species to decline

The species is not known to be susceptible to specific disease. The project is unlikely to introduce a disease that may cause the species to decline.

The study area is potentially infected with *Phytophthora cinnamomi*. Habitat disturbance may aid the spread of Phytophthora. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of Phytophthora cinnamomi, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

It is unlikely that the proposed action will introduce disease that may cause the species to decline.

(ix) interfere with the recovery of the species

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The NSW Threatened Species Priority Action Statement identifies the need for site specific management to reduce threats and promote recovery of the species. Four key management sites have been identified; the study area is not located within any of these areas, the Ku-ring-gai Chase NP conservation project being the closest. Specific activities identified include:

- Protect remaining habitat from clearing and development
- Determine appropriate fire regimes
- Undertake further surveys to locate any additional populations
- Restore natural hydrology
- Erect fencing to reducing browsing impacts

Overall Conclusion

Approximately 15 hectares of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be moderate. This habitat is not a key management site as identified under the Saving our Species Program. The Bauer's Midge Orchid was not recorded within the survey area during targeted seasonal field surveys for the project. Given that no individuals of these species will be removed, the lack of records close to the survey area and sub-optimal habitat available, the proposed action is not likely to result in a significant impact to *Genoplesium baueri*. The proposed action is unlikely to have a significant impact on long-term viability of the species.

Endangered Species: *Microtis angusii* (Angus's Onion Orchid)

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:

(i) lead to a long-term decrease in the size of a population

Until recently, *Microtis angusii* was known from only one site at Ingleside, north of Sydney. This site is within the survey area for the project and is referred to in this assessment as the 'main population'. This population has been undergoing monitoring for a number of years by the Royal Botanic Gardens in accordance with the National Recovery Plan for *M. angusii* (Department of Environment, Climate Change and Water 2010).

As part of the targeted flora survey undertaken for this project, *M. angusii* was recorded in multiple locations across the survey area (Ecosure 2015). Approximately 593 individuals of three *Microtis* species were recorded at 15 sites within the survey area. In those 15 sites, 34 samples were collected with 10 of these samples confirmed to be the endangered orchid, Angus' onion orchid (Ecosure 2015). However, all additional sites have the potential to contain individuals of this species, since this species can only be differentiated from two other common species in the laboratory. It is estimated that between 10-562 *Microtis angusii* individuals exist within the 15 sites between McCarrs Road, Terrey Hills and Powder Works Road, Ingleside in addition to the previously known main population of Angus's onion orchid adjoining the existing Mona Vale Road alignment opposite Kimbriki Resource Recovery Centre.

The species was found growing approximately 1.1 km west of the Kimbriki site and at another three locations up to 4.1 km east, all on the northern side of Mona Vale Rd. Two more locations were identified at the western end of Wirreanda Rd. Due to difficulties with field differentiation between all three *Microtis* spp., 34 sample specimens were collected from each of the 15 sites located and sent to the Royal Botanic Gardens, Sydney for formal identification. Of the 34 samples collected, ten were determined to be *M. angusii* whilst the other specimens were one of the two more common species, *M. parviflora*, and *M. unifolia* (Ecosure 2015).

Given that ten of the samples collected were identified by the Royal Botanic Gardens as *M. angusii*, it is considered that up to 562 individuals are likely to exist within the survey area (Ecosure 2015). Samples were taken to establish whether the areas of *Microtis* spp. were an extension to the previously highly restricted distribution of Angus's onion orchid. At this stage, to get an estimate of the population size, Ecosure (2015) have assumed that all individuals at

each of the sample locations are from the same species as the one positively identified. This provides an estimate of 229 *M. angusii* individuals at at least six sites. A larger sample of the local populations of *Microtis* spp. would enable a more accurate assessment of the local population of Angus's onion orchid.

In addition to the estimated 99 individuals across six sites, 2014 estimates of population size for the previously known site near Kimbriki Road is 1,240, the highest count recorded since survey of this location began (Newby, ZJ unpublished data 2014 in Ecosure 2015).

Conclusion: The main population of *Microtis angusii* is entirely within the construction impact area with an estimated population size of 1240. At least six locations away from the main population where *Microtis angusii* has been recorded are within the construction impact area for the project with an estimated total number of 229 individuals likely to be affected by the project which is likely to lead to a long-term decrease in the size of a population. Additional sampling of the local populations of *Microtis* spp. would enable a more accurate assessment of the size of the local population of Angus's onion orchid.

(ii) reduce the area of occupancy of the species

It is not easy to define the preferred natural habitat of this orchid as the Ingleside location where the main population occurs is highly disturbed. The dominant species occurring on the site are introduced weeds *Hyparrhenia hirta* (Coolatai grass) and *Acacia saligna* (OEH 2012). It is estimated that about 3 hectares of known and potential habitat would be removed as a result of the proposed action (that is DFEC and disturbed areas that were possibly formerly DFEC).

The main population occurs on soils that have been modified but were originally those of the restricted ridge-top lateritic soils in the Duffys Forest - Terrey Hills - Ingleside and Belrose areas. These soils support a specific and distinct vegetation type, the Duffys Forest Ecological Community (OEH 2012). It is possible that *M. angusii* may be found in other locations that support this vegetation community (Smith and Smith 1997). It is also possible that *M. angusii* is a disturbance specialist as it has not been found in surrounding undisturbed habitat despite extensive searches (DECCW 2010).

Although preferred habitat for the species is difficult to define, for the purposes of this assessment the area of occupancy is the estimated area of habitat where *Microtis angusii* is known to occur.

The area of occupancy of the main population is about 0.12 ha. Fifteen other potential locations have been identified where *Microtis* spp. occurs. It is difficult to estimate the area of occupancy of *M. angusii* as it can only be differentiated from two other common species in the laboratory. At least six locations away from the main population where *Microtis angusii* is confirmed to occur are within the construction impact area for the project. The area of occupancy of these additional locations is estimated to be between 0.1 and 0.5 hectares.

Throughout the study area, habitats occupied by the additional populations were similar to those of the known Angus's onion orchid population, i.e., disturbed road and track edges, generally associated with an asphalt surface, diffuse drainage and exotic perennial grasses

(such as *Hyparrhenia hirta*) (Ecosure 2015).

Conclusion: Preferred habitat for the species is difficult to define, however it is estimated that about 3 hectares of potential habitat (that is DFEC and disturbed areas that were possibly formerly DFEC) would be removed as a result of the proposed action. The proposed action is likely to reduce the area of occupancy of the species by less than 0.5 ha, however the total area of occupancy of the species is highly restricted (estimated to be no more than 2 hectares).

(iii) fragment an existing population into two or more populations

Approximately 593 individuals of three *Microtis* species were recorded at 15 sites within the survey area. In those 15 sites, 34 samples were collected with 10 of these samples were confirmed to be the endangered orchid, Angus' onion orchid (Ecosure 2015). However, all additional sites have the potential to contain individuals of this species, since this species can only be differentiated from two other common species in the laboratory. It is estimated that between 10-562 *Microtis angusii* individuals exist within the 15 sites between McCarrs Road, Terrey Hills and Powder Works Road, Ingleside in addition to the previously known main population of Angus's onion orchid adjoining the existing Mona Vale Road alignment opposite Kimbriki Resource Recovery Centre.

Habitats occupied by *Microtis* in the survey area are disturbed road and track edges, generally associated with an asphalt surface, diffuse drainage and exotic perennial grasses (such as *Hyparrhenia hirta*) (Ecosure 2015).

Potential habitat is to be removed in linear strips along the existing Mona Vale Road, in the road reserve around Wirreanda Road, Tumburra Street, Addison Road, Bungendore and Powderworks Road. The potential habitat within the survey area is already fragmented by Mona Vale Road, Wirreanda Road and some of the surrounding roads as well as rural and residential development.

The proposed action will also result in an increase in fragmentation of habitat and removal of individuals north of Mona Vale Road near the Baha'i Temple and between the western end of Wirreanda Road and Addison Road. The distance between areas of potential habitat on either side of Mona Vale Road will be slightly increased as a result of the road widening.

Investigations into the reproductive strategies utilised by *M. angusii* revealed that it potentially self-pollinates, as has been observed in some other species in the genus (Bates 1984, RBG 2014). Preliminary experiments on pollinators have identified a species from Order Thysanoptera (thrips) on the plant, which could be assisting with pollination (Ecosure 2015). Thrips can move long distances floating with the wind.

There is a suggestion the population may be entirely clonal. Investigations into genetic diversity are currently only looking at the internal transcribed spacer (ITS) region. Results so far indicate a little bit of diversity in that region for the main population. Individuals sampled from other locations appear to be genetically similar to the main population (ie they are falling in the same branch of the genetic tree) (Zoe-Joy Newby pers. comm. Nov 2014). The RBG is planning to look at multiple genetic regions to gain further insights into inter and intra-specific diversity over the coming months (RBG 2014). This information will assist in determining the

importance of the other *Microtis* locations to the main population.

Conclusion: In addition to the removal of habitat for the main type population opposite Kimbriki Road, the proposed action will result in an increase in fragmentation of habitat and removal of individuals north of Mona Vale Road near the Baha'i Temple and between the western end of Wirreanda Road and Addison Road and at Powderworks and Bungendore Road. The distance between areas of potential habitat on either side of Mona Vale Road will be slightly increased as a result of the road widening. Research into the ecology of the species is continuing and further information regarding the reproductive strategies and genetics of the species will assist in determining the likely impact of increasing the level of fragmentation on the existing population.

(iv) adversely affect habitat critical to the survival of a species

The national recovery Plan for *M. angusii* states that 'there is insufficient information to accurately define and locate all habitat critical to the survival of *M. angusii*. Until more is known of the habitat requirement of the species, habitat critical to survival consists of the area of occupancy of the known and any newly discovered populations; areas of similar habitat surrounding the population; and additional occurrences of potential habitat that may contain undiscovered populations or be suitable for future translocations'.

The main population occurs on soils that have been modified but were originally those of the restricted ridge-top lateritic soils in the Duffys Forest - Terrey Hills - Ingleside and Belrose areas. These soils support a specific and distinct vegetation type, the Duffys Forest Ecological Community (OEH 2012). It is possible that *M. angusii* may be found in other locations that support this vegetation community (Smith and Smith 1997). It is also possible that *M. angusii* is a disturbance specialist as it has not been found in surrounding undisturbed habitat despite extensive searches (DECCW 2010).

Throughout the study area, habitats occupied by the additional populations were similar to those of the known Angus's onion orchid population, ie, disturbed road and track edges, generally associated with an asphalt surface, diffuse drainage and exotic perennial grasses (such as *Hyparrhenia hirta*) (Ecosure 2015).

Other areas of potential habitat are hard to quantify but are probably associated with lateritic soils and therefore likely to be restricted.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street, Addison Road, Powderworks Road and Bungendore Road. The potential habitat within the survey area is already fragmented by Mona Vale Road, Wirreanda Road and some of the surrounding roads as well as rural and residential development.

The area of occupancy of the main population is about 0.12 ha. The main population is entirely within the construction footprint with an estimated 1240 individuals likely to be affected.

Fifteen other potential locations have been identified where *Microtis* spp. occurs. It is difficult to estimate the area of occupancy of *M. angusii* as it can only be differentiated from two other

common species in the laboratory. At least six locations away from the main population where *Microtis angusii* is confirmed to occur are within the construction impact area for the project. The area of occupancy of these additional locations is estimated to be between 0.1 and 0.5 hectares.

Conclusion: Preferred habitat for the species is difficult to define, however it is estimated that about 3 hectares of habitat critical to the survival of the species (that is the area of occupancy, areas of mapped DFEC and disturbed areas that were possibly formerly DFEC) would be affected as a result of the proposed action.

(v) disrupt the breeding cycle of a population

Microtis angusii exists as subterranean tubers during most of the year. It produces leaves and then flowering stems in late winter and spring and flowers from May to October. By summer, the above ground parts have withered leaving no parts above ground (OEH 2012).

There appears to be a complex interaction between the amount and timing of rainfall in the current and previous growing season, and potentially an effect of temperature, influencing the size and rate of flowering in the population (RBG 2014). Large fluctuations in population numbers have been observed at the main population from zero in some years to several hundred in other years. This appears to be in response to rainfall and therefore soil moisture in the 12 months preceding survey which stimulates germination (RBG 2014).

Spring surveys (September 2014) have found the highest number of individual orchids (1,240) at the Kimbriki site since surveys began in the 1990's (Ecosure 2015). They also found seedlings which have probably germinated in the last 12 months, suggesting successful recruitment. Investigations into the reproductive strategies utilised by *M. angusii* revealed that it potentially self-pollinates, as has been observed in some other species in the genus (Bates 1984, RBG 2014). Preliminary experiments on pollinators have identified a species from Order Thysanoptera (thrips) on the plant, which could be assisting with pollination (Ecosure 2015). Thrips can move long distances floating with the wind.

There is a suggestion the population may be entirely clonal. Investigations into genetic diversity are currently only looking at the internal transcribed spacer (ITS) region. Results so far indicate a little bit of diversity in that region for the main population. Individuals sampled from other locations appear to be genetically similar to the main population (ie. they are falling in the same branch of the genetic tree) (Zoe-Joy Newby pers. comm. Nov 2014). The RBG is planning to look at multiple genetic regions to gain further insights into inter and intra-specific diversity over the coming months (RBG 2014). This information will assist in determining the importance of the other *Microtis* locations to the main population.

Propagation at PlantBank has seen successful germination and growth of Angus's onion orchid seedlings, including the production of chlorophyll (Newby, ZJ unpublished data, 2014 in Ecosure 2015).

Seeds require suitable fungus to germinate. Fungal associations are currently being investigated by the Royal Botanic Gardens. Mycorrhizae obtained from *M. angusii* tissue and developing protocorms have been tested for their ability to germinate seeds of *M. angusii*.

Several isolates have been identified as true mycorrhizae and are in the process of being identified (RBG 2014). The same mycorrhizae are occurring multiple times, common to many orchid species - these are positive indications for translocation potential as long as all other environmental variables are in place (Zoe Newby pers. comm. Nov 2014).

Research will progress over the coming months.

Conclusion: The main (type) population of *Microtis angusii* (Kimbriki Site) is entirely within the construction impact area. At least six other locations are within the construction impact area for the project. Additional sampling of the local populations of *Microtis* spp. would enable a more accurate assessment of the local population of Angus's onion orchid. Research into aspects of the life cycle of the species by the RBG will assist in determining the impacts of the project on the life cycle of the species. However, it is assumed at this stage that the proposed action is likely to disrupt the breeding cycle of *Microtis angusii* due to likely impacts on individuals at the main (Kimbriki site) location and at least six other locations within the construction impact area.

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The main population of *Microtis angusii* is entirely within the construction impact area with an estimated 1240 individuals likely to be affected.

At least six locations away from the main population where *Microtis angusii* has been recorded are within the construction impact area for the project with an estimated total number of 229 individuals across the six sites likely to be affected by the project. Additional sampling of the local populations of *Microtis* spp. would enable a more accurate assessment of the size of the local population of Angus's onion orchid.

Habitats occupied by *Microtis* in the survey area are disturbed road and track edges, generally associated with an asphalt surface, diffuse drainage and exotic perennial grasses (such as *Hyparrhenia hirta*) (Ecosure 2015). Other areas of potential habitat are hard to quantify but are probably associated with lateritic soils and therefore likely to be restricted. It is estimated that about 3 hectares of potential habitat for the species would be affected by the proposed action.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, will be implemented for the proposal to manage impacts on abiotic factors adjacent the construction impact area.

Soil samples from other locations where *Microtis* plants were identified along Mona Vale Rd were collected in November 2013. This soil and its ability to stimulate germination of *M. angusii* is currently being tested at PlantBank. Seeds of *M. angusii* require suitable fungus to germinate. Fungal associations are currently being investigated by the Royal Botanic Gardens. Mycorrhizae obtained from *M. angusii* tissue and developing protocorms have been tested for their ability to germinate seeds of *M. angusii*. Several isolates have been identified as true mycorrhizae and are in the process of being identified (RBG 2014). These are positive indications for the possibility of growing *M. angusii* at other locations as long as all other

environmental variables are in place.

This research is continuing.

Conclusion: At least six locations away from the main population where *Microtis angusii* has been recorded are within the construction impact area for the project with an estimated total number of 229 individuals across the six sites likely to be affected by the project. It is estimated that about 3 hectares of known and potential habitat for the species would be affected by the proposed action which is likely to cause the species to decline. Research into aspects of the species growth and habitat requirements is continuing over the coming months by the RBG.

(vii) 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 proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road so there is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken done in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

Conclusion: It is unlikely that the proposed action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

(viii) introduce disease that may cause the species to decline

The species is not known to be susceptible to specific disease. The project is unlikely to introduce a disease that may cause the species to decline.

The study area is potentially infected with *Phytophthora cinnamomi*. Habitat disturbance may aid the spread of Phytophthora. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of *Phytophthora cinnamomi*, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

(ix) interfere with the recovery of the species

A national recovery plan has been developed for Angus's Onion Orchid and objectives include:

- Habitat/population protection and management.
- Determine habitat requirements and ecological information.

The NSW priority action statement sets out the following management objectives for this species:

- Reduce and maintain weed densities at low levels.
- Minimise impacts of road development.
- Prevent access of recreational users to the site.
- Minimise accidental damage on road/track edges.
- Track species abundance /condition over time.

A number of these priority actions are currently being investigated by the RBG and funded by Roads and Maritime in planning for this project.

Conclusion: The proposed activity will affect at least six locations where *Microtis angusii* individuals have been identified including the main population with an estimated 1240 individuals. Planning for the proposed action has involved funding research into a number of the priority actions for the species including determining habitat requirements and ecological information and establishing ex-situ storage of plant material which will assist in the recovery of the species.

Overall Conclusion:

The main population of *Microtis angusii* is entirely within the construction impact area with an estimated population of 1240 individuals. At least six other locations where *Microtis angusii* have been recorded are within the construction impact area for the project with an estimated total number of 229 individuals likely to be affected by the project. It is estimated that about 3 hectares of known and potential habitat for the species would be affected by the proposed action. Research into aspects of the species reproductive strategies, genetic diversity, growth requirements and habitat is continuing over the coming months by the RBG. These investigations will assist in adequately assessing the level of impact of the proposed action on *M. angusii* in the survey area, however at this stage it is considered that a significant impact is likely.

Referral to DoE is recommended.

Endangered Species: *Acacia terminalis* subsp. *terminalis* (Sunshine wattle) and *Persoonia hirsuta* (Hairy Geebung)

Reason for grouping: Shrub species with similar habitat requirements (sandstone soils).

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:

(i) lead to a long-term decrease in the size of a population

The study area is predominantly Bloodwood - Scribbly Gum Woodland and Peppermint-Angophora Forest (about 20 hectares). The vegetation in the area proposed for clearing may provide potential habitat (about 12 hectares) for these species and its removal is permanent. *Persoonia hirsuta* has also been recorded in DFEC.

Neither of these species were identified during seasonal surveys and targeted searches.

Acacia terminalis subsp. *terminalis*:

Sunshine Wattle flowers in autumn, and is pollinated by small birds and bees. The seeds mature in November and are dispersed by ants. Recruitment in this species mainly occurs after fire (DECCW 2010). Smith and Smith (2011) had possibly recorded sunshine wattle (*Acacia terminalis* subsp. *terminalis*) in 2011 (Ecosure 2015). It was not observed during current field surveys being undertaken for the project, but was previously noted as a 'probable' record by Smith and Smith within the survey area, however there was no flowering material available at that time. It has since been confirmed that this specimen is not the threatened sub-species, but rather the more common *A. terminalis* subsp. *angustifolia* (Ecosure 2015). The closest known location of *Acacia terminalis* subsp. *terminalis* is over 5km away in Beacon Hill.

Persoonia hirsuta:

Although records are known within the locality, *Persoonia hirsuta* was not recorded within the study area during current or previous field surveys. The closest known records are less than 1km from the survey area in Terrey Hills.

Conclusion: Given that no individuals of these species occur in the study area, the proposed action is not likely to have a significant impact on these species leading to a long-term decrease in the size of a population.

(ii) reduce the area of occupancy of the species

The proposed activity will remove potential habitat of these species, however no populations or individuals of these species have been recorded in or close to the survey area, either as a result of targeted seasonal surveys for this project or from a review of historical records.

Given that no individuals of these species occur in the survey area, it is unlikely the proposed action will reduce the area of occupancy of the species

(iii) fragment an existing population into two or more populations

Potential habitat for these species has been identified in the study area (about 20 hectares), however no populations or individuals of these species have been recorded in or close to the survey area, either as a result of targeted seasonal surveys for this project or from a review of

historical records.

Given that no individuals of these species occur in or close to the survey area, the proposed activity is unlikely to fragment an existing population into two or more populations

(iv) adversely affect habitat critical to the survival of a species

Potential habitat for these species has been identified in the Study area (about 20 ha), the majority of which is in moderate to good condition.

Potential habitat to be removed is about 12 hectares, mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road. The potential habitat within the survey area is already somewhat fragmented by Mona Vale Road and some of the surrounding roads as well as rural and residential development.

Other areas of known and potential habitat for these species occurs in the locality (>7000ha). Large areas of similar habitat are protected in conservation reserves including Ku-ring-gai Chase and Garigal National Parks to the immediate north and south of the survey area, and about 28% of sites where the species has been recorded within conservation reserves, mainly Sydney Harbour National Park.

Given that no populations of these species occur in or close to the survey area, the proposed activity is unlikely to adversely affect habitat critical to the survival of these species.

(v) disrupt the breeding cycle of a population

The survey area is predominantly Bloodwood - Scribbly Gum Woodland and Peppermint-Angophora Forest (about 20 hectares). The vegetation in the area proposed for clearing may provide potential habitat (about 12 hectares) for these species and its removal is permanent. *Persoonia hirsuta* has also been recorded in Duffys Forest Ecological Community.

Neither of these species were identified during seasonal surveys and targeted searches undertaken for the project. There are also no historical records of these species within or close to the survey area.

Acacia terminalis subsp. *terminalis*:

Sunshine Wattle flowers in autumn, and is pollinated by small birds and bees. The seeds mature in November and are dispersed by ants. Recruitment in this species mainly occurs after fire (DECCW 2010). Smith and Smith (2011) had possibly recorded sunshine wattle (*Acacia terminalis* subsp. *terminalis*) in 2011 (Ecosure 2015). It was not observed during current field surveys being undertaken for the project, but was previously noted as a 'probable' record by Smith and Smith within the survey area, however there was no flowering material available at that time. It has since been confirmed that this specimen is not the threatened sub-species, but rather the more common *A. terminalis* subsp. *angustifolia* (Ecosure 2015). The closest known location of *Acacia terminalis* subsp. *terminalis* is over 5km away in Beacon Hill.

Persoonia hirsuta:

Although records are known within locality, *Persoonia hirsuta* was not recorded within the survey area during current or previous field surveys. The closest known records are less than 1km from the survey area in Terrey Hills.

Given that no individuals of these species occur within or close to the survey area, it is unlikely the proposed action will disrupt the breeding cycle of a population of these species.

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The survey area is predominantly Bloodwood - Scribbly Gum Woodland and Peppermint-Angophora Forest. The vegetation proposed for removal may provide potential habitat (about 12 hectares) for this species.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road. The potential habitat within the study area is already somewhat fragmented by Mona Vale Road and some of the surrounding roads as well as rural and residential development.

Other areas of known and potential habitat for these species occurs in the locality (>7000ha). Large areas of similar habitat are protected in conservation reserves including Ku-ring-gai Chase and Garigal National Parks to the immediate north and south of the study area.

No populations or individuals of these species have been recorded in or close to the study area, either as a result of targeted seasonal surveys for this project or from a review of historical records.

(vii) 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 proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road will be adjoining the existing Addison Road so there is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken done in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

It is unlikely that the proposed action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

(viii) introduce disease that may cause the species to decline

The study area is potentially infected with *Phytophthora cinnamomi*. Habitat disturbance may aid the spread of Phytophthora. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of *Phytophthora cinnamomi*, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

It is unlikely that the proposed action will introduce disease that may cause the species to decline.

(ix) interfere with the recovery of the species

A national recovery plan has been developed for Sunshine Wattle (April 2010) and 29 actions have been identified to aid in its recovery, including:

- Facilitate survey of potential habitat.
- Review of Plans of Management or Fire Management Plans.
- Encourage private landholders to implement threat abatement measures.

Five management sites have been identified by the OEH priority action statement for the species. The closest management site to the study area is at Curl Curl on the Northern Beaches.

No recovery plan has been developed for Hairy Geebung, but the OEH priority action statement requires site-based management in order to secure the species from extinction in NSW for 100 years. None of the identified management sites are in the Ingleside/Terry Hills area. The closest management site to the study area is more than 5km away at Cromer.

The proposed activity is unlikely to interfere with the recovery of these species.

Overall Conclusion

The proposed action will permanently remove approximately 12 hectares of remnant native vegetation that has been identified as potential habitat for these species. Neither the Sunshine Wattle nor Hairy Geebung were recorded within the study area during targeted seasonal field surveys for the project. Given that no individuals of these species will be removed, the lack of records close to the study area and large areas of potential habitat in conservation reserves to the north and south of the study area, the proposed action is not likely to result in a significant impact to these species.

No further assessment is recommended for *Acacia terminalis* subsp. *terminalis* or *Persoonia hirsuta*.

Vulnerable Species: *Pimelea curviflora* var. *curviflora* (Curved rice-flower)

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

(i) lead to a long-term decrease in the size of an important population of a species

The survey area contains Duffys Forest Ecological Community (DFEC) and lateritic soils.

DFEC in the Study Area may provide potential habitat for the species (about 7 hectares). *Pimelea curviflora* var. *curviflora* was not identified during seasonal surveys and targeted searches within the survey area.

The curved rice-flower (*Pimelea curviflora* var. *curviflora*) was previously recorded in the survey area in 1996, Duffys Forest Ecological Community at the western end of the survey area on the southern side of Mona Vale Road, but was not recorded during recent surveys by Smith and Smith (2011) or during extensive targeted searches undertaken in 2013/14 as part of this project at multiple times during the flowering period. Two reference sites for the species were checked nearby at Duffys Forest and Beacon Hill to confirm appropriate flowering conditions. There are known populations of the species in the locality including at Terrey Hills Oval.

No individuals of the species are likely to be affected by the project.

Given that no individuals of the species occur in the survey area, the proposed action is not likely to lead to a long-term decrease in the size of an important population.

(ii) reduce the area of occupancy of an important population

The proposed activity will remove potential habitat for the species, however no populations or individuals of *Pimelea curviflora* var. *curviflora* have been recorded in or close to the survey area, either as a result of targeted seasonal surveys for this project, including checking of two reference sites to confirm appropriate flowering conditions.

Given that no individuals of the species occur in the survey area, it is unlikely the proposed action will reduce the area of occupancy of the species.

(iii) fragment an existing important population into two or more populations

Potential habitat for this species has been identified in the survey area (about 7 hectares), however no populations or individuals of *Pimelea curviflora* var. *curviflora* have been recorded in or close to the survey area, as a result of targeted seasonal surveys for this project.

Given that no individuals of the species occur in or close to the survey area, the proposed activity is unlikely to fragment an existing population into two or more populations.

(iv) adversely affect habitat critical to the survival of a species

Potential habitat for this species has been identified in the study area (about 7 hectares), the majority of which is in moderate to good condition.

About 3 hectares of potential habitat for this species will be removed. Other areas of known and potential habitat for the species occur in the region. About 240 hectares of Duffys Forest Ecological Community (OEH 2012) and greater than 1700 hectares of shale enriched sandstone vegetation (OEH 2013) occurs within a 10km radius.

The proposed activity will remove potential habitat for the species at the eastern and western extents of the survey area, however no populations or individuals of the species have been recorded on the site despite seasonal targeted surveys for the project.

It is unlikely the proposed actions will adversely affect habitat critical to the survival of this species.

(v) disrupt the breeding cycle of an important population

Pimelea curviflora var. *curviflora* was previously recorded in the survey area in 1996, Duffys Forest Ecological Community at the western end of the survey area on the southern side of Mona Vale Road, but was not recorded during recent surveys by Smith and Smith (2011) or during extensive targeted searches undertaken in 2013/14 as part of this project at multiple times during the flowering period. Two reference sites for the species were checked nearby at Duffys Forest and Beacon Hill to confirm appropriate flowering conditions. There are known populations of the species in the locality including at Terrey Hills Oval.

Given that no individuals of this species occur within or close to the study area, it is unlikely the proposed action will disrupt the breeding cycle of an important population.

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The study area contains Duffys Forest Ecological Community (DFEC) and lateritic soils.

DFEC in the study area may provide potential habitat for the species (about 7 hectares). *Pimelea curviflora* var. *curviflora* was not identified during seasonal surveys and targeted searches within the survey area.

The proposed activity will remove potential habitat for the species at the eastern and western extents of the study area along the existing Mona Vale Road alignment. The potential habitat within the survey area is already somewhat fragmented by Mona Vale Road and some of the surrounding roads as well as rural and residential development.

Other areas of known and potential habitat for the species occur in the region. About 240 hectares of Duffys Forest Ecological Community (OEH 2012) and greater than 1700 hectares of shale enriched sandstone vegetation (OEH 2013) occurs within a 10km radius.

The proposed activity will remove potential habitat for the species at the eastern and western

extents of the survey area, however no populations or individuals of the species have been recorded on the site despite seasonal targeted surveys for the project.

Although there will be removal of about 3 hectares of potential habitat, this is unlikely to be to the extent that the species is likely to decline as no individuals or populations occur within or close to the survey area.

(vii) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road alignment so there is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

It is unlikely that the proposed action will result in invasive species that are harmful to the vulnerable species becoming established in the species habitat.

(viii) introduce disease that may cause the species to decline

The study area is potentially infected with *Phytophthora cinnamomi*. Habitat disturbance may aid the spread of Phytophthora. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of *Phytophthora cinnamomi*, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

It is unlikely that the proposed action will introduce disease that may cause the species to decline.

(ix) interfere substantially with the recovery of the species

No recovery plan has been developed for *Pimelea curviflora* var. *curviflora*, but three priority actions have been identified, including:

- Introduce measures to prevent habitat degradation related to unrestricted access and/or trail maintenance.

- Manage weed infestation.
- Protect areas of known and potential habitat from clearing and further fragmentation.

The proposed activity is unlikely to interfere substantially with the recovery of the species.

Overall Conclusion

The proposed action will permanently remove approximately 3 hectares of remnant native vegetation that has been identified as potential habitat for *Pimelea curviflora* var. *curviflora*. The species was not recorded within the survey area during targeted seasonal field surveys for the project, including checking of two nearby reference sites to ensure appropriate flowering conditions. Given that no individuals of this species occur within or close to the survey area, it is unlikely the proposed action will result in a significant impact to this species.

No further assessment is recommended for *Pimelea curviflora* var. *curviflora*.

Vulnerable Species: *Acacia bynoeana* (Bynoe's wattle)

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

(i) lead to a long-term decrease in the size of an important population of a species

Acacia bynoeana is currently known from about 30 locations, with the size of the populations at most locations being very small (1-5 plants). *Acacia bynoeana* has potential habitat in the study area within areas of Bloodwood-Scribbly Gum Woodland, Sandstone Heath and Rocky Sandstone Heath where restricted to ridgetops and upper slopes. Population size is typically small. It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches all of which occur on the site. Fire plays an important role with plants readily re-sprouting from woody rootstock, it promotes seed germination and creates open conditions favourable to growth and flowering. *Acacia bynoeana* has not been recorded from the study area during targeted field surveys covering the range of habitats.

Given that no individuals of the species occur in the survey area, the proposed action is not likely to lead to a long-term decrease in the size of an important population.

(ii) reduce the area of occupancy of an important population

Potential habitat for this species has been identified in the survey area. Approximately 8.6 hectares of potential habitat is likely to be cleared or modified including 8.4 hectares of Bloodwood-Scribbly Gum Woodland habitat and 0.2 hectares of Heath. Although the construction impact zone includes a 6 m wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised or negated by effective mitigation measures.

Given that no individuals of the species occur in the survey area, it is unlikely the proposed action will reduce the area of occupancy of the species.

(iii) fragment an existing important population into two or more populations

Acacia bynoeana was not recorded within the survey area during targeted field surveys for this species. Although the proposal will result in clearing of 8.6 hectares of potential habitat, it will not fragment an existing population into two or more populations.

(iv) adversely affect habitat critical to the survival of a species

In view of the restricted occurrence of this species on ridgetops and upper slopes, the lack of local records and typically low population size, any population or associated habitat may be significant to the viability of the species at least in the local area. Bloodwood - Scribbly Gum Woodland and heathland communities, however, are relatively widespread and well reserved communities both locally and in the region.

Most of the known sites are not reserved, although populations are known from several reserves including Marramarra National Park, Castlereagh Nature Reserve, Lake Macquarie SRA, Blue Mountains National Park. Recent vegetation surveys in Royal National Park have not located the species. The species was also known from one site within Ku-ring-gai Chase National Park, but several subsequent searches of the site have failed to find any plants.

It is unlikely the proposed actions will adversely affect habitat critical to the survival of this species.

(v) disrupt the breeding cycle of an important population

Acacia bynoeana is an erect or spreading shrub, 0.2 - 1m high with single flower heads, on short hairy stems appear anytime from September to March. Its seedpods are mature from September to January when they are shed. The seed presumably survives as long-term soil-stored seedbank and plants may appear periodically perhaps in response to local disturbance, but often not be evident. There is apparently little local dispersal of seed and 50% of records are pre-1920 (Benson and McDougall 1996).

There are no records of the species within the locality according to the OEH Atlas of NSW Wildlife, with the closest record (6km from the study area) being recorded in 1911.

Given that no individuals of the species will be removed and the lack of records close to the survey area, the proposed action is unlikely to disrupt the breeding cycle of this species.

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road. The potential habitat within the survey area is already somewhat fragmented by Mona Vale Road and some of the surrounding roads as well as rural and residential development.

Although there will be removal of about 8.6 hectares of potential habitat, this is unlikely to be to the extent that the species is likely to decline as no individuals or populations have been

found within or close to the survey area.

(vii) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road will be adjoining the existing Addison Road so there is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken done in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

It is unlikely that the proposed action will result in invasive species that are harmful to the vulnerable species becoming established in the species habitat.

(viii) introduce disease that may cause the species to decline

The study area is potentially infected with *Phytophthora cinnamomi*. Habitat disturbance may aid the spread of Phytophthora. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of *Phytophthora cinnamomi*, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

It is unlikely that the proposed action will introduce disease that may cause the species to decline.

(ix) interfere substantially with the recovery of the species

At the time of this report there is no approved recovery plan or threat abatement plan for the species. The Saving our Species program identifies site specific management to reduce threats and promote recovery of the species. Five key management sites have been identified; the study area is not located within any of these areas. The NSW Threatened Species Priority Action Statement identifies the following specific activities:

- Protect remaining habitat through identification on maps used for planning purposes and through education (e.g. able to identify the species)
- Protect known habitat from maintenance activities and recreation

- Investigate appropriate fire regime
- Weed control

The proposed activity is unlikely to interfere substantially with the recovery of the species.

Overall Conclusion

Approximately 8.6 hectares of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be low. The proposed action is unlikely to result in a significant impact on the species.

Vulnerable Species: *Darwinia biflora*

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

(i) lead to a long-term decrease in the size of an important population of a species

Darwinia biflora has been recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde local government areas (LGAs), in the Central Coast Botanical Subdivision, NSW. The northern, southern, eastern and western limits of the range are at Maroota, North Ryde, Cowan and Kellyville, respectively.

Darwinia biflora grows in Eucalypt woodland, Bloodwood-Scribbly Gum Woodland habitat, or scrub or heath. *D. biflora* has not been previously recorded from the study area although suitable habitat is found in Bloodwood - Scribbly Gum Woodland, and Sandstone Rocky Heath and there is a relatively high frequency of records (81) within 10 km. There are no records within the 5km radius locality of the study area.

Potential habitat exists in the study area, however this species was not recorded during targeted searches for this project.

Given that no individuals of the species occur in the study area, the proposed action is unlikely to lead to a long-term decrease in the size of a population.

(ii) reduce the area of occupancy of an important population

Approximately 8.6 hectares of potential habitat is likely to be cleared or modified including 8.4 hectares of Bloodwood-Scribbly Gum Woodland habitat and 0.2 hectares of Heath. Although the construction impact zone includes a 6 m wide buffer zone, additional indirect impacts may also occur downslope. These impacts can be minimised by effective mitigation measures.

Given that no individuals of these species occur in the study area, it is unlikely the proposed action will reduce the area of occupancy of the species.

(iii) fragment an existing important population into two or more populations

Darwinia biflora was not recorded within the study area during targeted field surveys in Eucalypt woodland, Bloodwood-Scribbly Gum Woodland habitat, and scrub or heath. Although

the proposal will result in clearing of 8.6 hectares of potential habitat, it will not fragment an existing population into two or more populations.

(iv) adversely affect habitat critical to the survival of a species

Darwinia biflora grows in Eucalypt woodland, Bloodwood-Scribbly Gum Woodland habitat, or scrub or heath, usually on ridgetops with a shallow layer of shale or ironstone gravel, overlying sandstone or shale/sandstone transition. Potential Habitat has been identified in the study area the majority of which is in moderate to good condition.

Suitable habitat along ridge-lines and on upper slopes in the local area is naturally restricted and vulnerable to development and impacts generally. The relatively large number of records within the local area can be misleading with many records often relating to the same site and marked fluctuations in populations. On this basis any potential habitat within the study area is important. No critical habitat has been declared for this species.

(v) disrupt the breeding cycle of an important population

Darwinia biflora is an erect or spreading shrub to 80cm high with flowers in pairs. It is short lived, 5 to 10 years, and flowers at any time, mostly during July to August. It usually self-pollinates before flower-opening producing a one-seeded fruit. It is killed by fire and can re-establish from soil stored seed. Given that no individuals of the species will be removed, and the lack of records close to the study area, the proposed action is unlikely to disrupt the breeding cycle of a population of this species.

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Although there will be removal of about 8.6 hectares of potential habitat, this is unlikely to be to the extent that the species is likely to decline as no individuals or populations have been found within or close to the study area. It is known to colonise appropriate disturbed sites.

(vii) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed action has the potential to aid the spread of weeds due to the movement and/or introduction of soil, vehicles and equipment. Vegetation within the study area is already subject to the operation of edge effects and some minor weed incursion.

Potential habitat to be removed is mainly in linear strips along the existing Mona Vale Road and in the road reserve around Wirreanda Road, Tumburra Street and Addison Road will be adjoining the existing Addison Road so there is only likely to be minor increase in edge effects as a result of the proposal. A six metre buffer zone to construction is included in the construction impact area for the project to account for edge effects/indirect impacts.

Weed management works will be undertaken done in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and Managing Biodiversity on Roads and Maritime Projects (RTA, 2011). Implementation of machinery hygiene and weed control measures will

prevent invasive species becoming established as a result of the proposal.

A Site Erosion and Sediment Control Plan or Soil Water Management Plan, in accordance with the Blue Book, is to be implemented for the project.

It is unlikely that the proposed action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

(viii) introduce disease that may cause the species to decline

The species is not known to be susceptible to specific disease. The project is unlikely to introduce a disease that may cause the species to decline.

The study area is potentially infected with *Phytophthora cinnamomi*. Habitat disturbance may aid the spread of *Phytophthora*. Controls on the movement of vehicles, and human traffic into native vegetation habitat will be implemented. Protocols to prevent introduction or spread of *Phytophthora cinnamomi*, either Sydney Region Pest Management Strategy or Best Practice Guidelines for *Phytophthora cinnamomi* (DECC 2008) will be followed.

(ix) interfere substantially with the recovery of the species

There is an approved recovery plan for *Darwinia biflora* (DEC 2004). The NSW Threatened Species Priority Action Statement identifies site specific management to reduce threats and promote recovery of the species. Four key management sites have been identified; the study area is not located within any of these areas, the Hornsby/Berowra conservation project being the closest. Specific activities include:

- Implement appropriate fire regimes
- Prevent mechanical damage and trampling by livestock
- Weed control
- Increase protection of sites

As no species were recorded, the proposal of not likely to interfere substantially with the recovery of the species

Overall Conclusion

Approximately 8.6 hectares of potential habitat is likely to be cleared or modified, the importance of this habitat to the long-term survival of the species is considered to be moderate. This habitat is not a key management site as identified under the Saving our Species Program. The proposed action is unlikely to have a significant impact on long-term viability of the species.

Vulnerable Species: *Heleioporus australiacus* (Giant Burrowing Frog)

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

(i) lead to a long-term decrease in the size of an important population of a species

Two Giant Burrowing Frog individuals were located outside the subject site along the Caley Trail in Garigal National Park during recent field surveys (Ecosure 2015). Observations were made during spotlighting surveys in February 2014. These individuals are considered to form part of an important population as the Sydney Basin is at the northern extent of the Giant Burrowing Frog's distribution.

The proposed actions will result in the removal of 11.6 hectares of potential non-breeding habitat for the Giant Burrowing Frog. The habitat to be removed is located along an existing major road and is not considered essential habitat for this species. Other suitable non-breeding habitat occurs in the neighbouring Ku-ring-gai Chase and Garigal National Parks and is more likely to be used due to lower levels of disturbance and presence of more suitable location for the construction of burrows.

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposed post upgrade compared to the pre upgrade. Any changes to drainage and water quality may have a significant impact on Giant Burrowing Frog habitat downstream of the subject site. It is possible that the action will have an adverse effect on the breeding cycle of this species as changes to drainage regimes are likely to impact breeding habitat.

Impacts to breeding habitat through hydrological changes are likely to lead to the long-term decrease in the size of the population of Giant Burrowing Frogs occurring within the study area.

(ii) reduce the area of occupancy of an important population

The Giant Burrowing Frog appears to occur as two distinct populations over its range. The northern population is largely restricted to the Sydney Basin down to Ulladulla in the south (OEH 2016). The subject site occurs within the extent of the northern population.

The removal of 11.6 hectares of potential non-breeding habitat for the Giant Burrowing Frog along the edge of Mona Vale Road will not reduce the area of occupancy of an important population as suitable breeding and non-breeding habitat occurs to the north and south of the subject site in Garigal and Ku-ring-gai Chase National Parks.

(iii) fragment an existing important population into two or more populations

The Giant Burrowing Frog has a home range of approximately 0.04 ha. The existing Mona Vale Road is likely to fragment areas of suitable habitat in Ku-ring-gai Chase and Garigal National Parks. Habitat where the Giant Burrowing Frog was recorded during recent surveys will remain connected to other areas of suitable habitat in Garigal National Park.

This habitat removal is not likely to fragment an existing important population into two or more populations.

(iv) adversely affect habitat critical to the survival of a species

The habitat within the subject site is not likely to be critical to the survival of the Giant Burrowing Frog in the locality.

(v) disrupt the breeding cycle of an important population

The Giant Burrowing Frog breeds in soaks, pools and seepage lines. Breeding is triggered by heavy rain and occurs in soaks or pools, seepage lines and small pools of collected water. Non-breeding habitat for the Giant Burrowing Frog is located below the soil surface and leaf litter, particularly along sandstone ridge tops (OEH 2012).

A draft hydrology report prepared by Aurecon (2016) indicates that the flow regimes are anticipated to change as a result of the proposed post upgrade compared to the pre upgrade. Any changes to drainage and water quality may have a significant impact on Giant Burrowing Frog habitat downstream of the subject site. It is possible that the action will have an adverse effect on the breeding cycle of this species as changes to drainage regimes are likely to impact breeding habitat.

(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

During non-breeding periods Giant Burrowing Frogs shelter in burrows in soft soil and leaf litter. The proposal will require the removal of 11.6 hectares of vegetation that may be utilised by the Giant Burrowing Frog as non-breeding habitat. This habitat occurs below the ridgeline along which the existing Mona Vale Road runs. Removal of a small percentage of the habitat available within the locality is unlikely to result in the decline of the Giant Burrowing Frog.

It is possible that the actions proposed will have an adverse effect on the life cycle of this species such that a viable local population will be placed at risk of extinction, as changes to drainage regimes may impact Giant Burrowing Frog breeding habitat within the study area. Large areas of suitable foraging habitat will remain within the study area and beyond.

(vii) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposal is unlikely to result in the introduction of an invasive species that is harmful to the Giant Burrowing Frog. Introduced predators such as foxes and cats are likely to already be present on site.

Invasive plants are present along the edge of Mona Vale Road. These species have the potential to invade and degrade habitat for the Giant Burrowing Frog. The proposal is unlikely to result in the introduction of any new invasive plants into the study area.