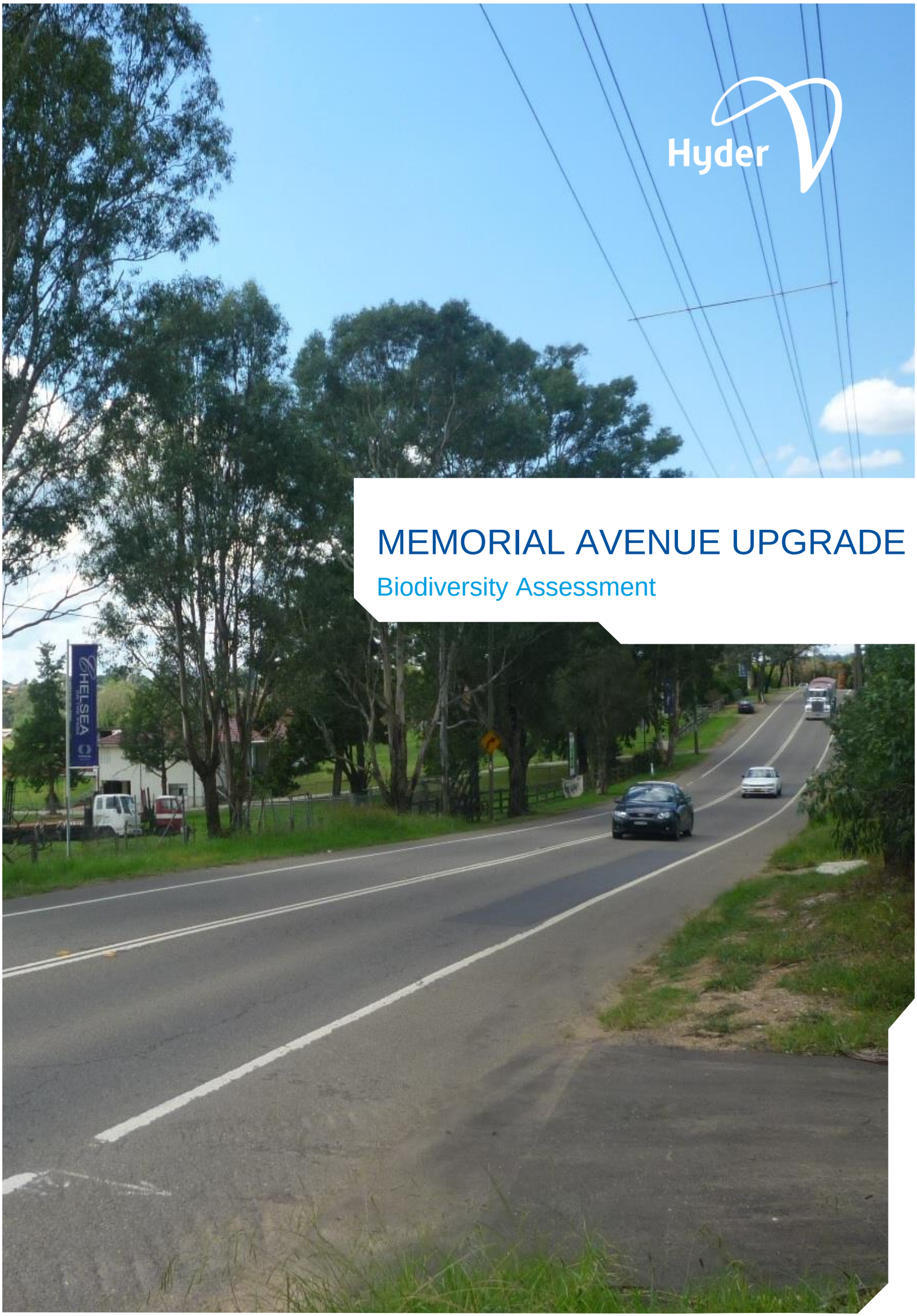
Appendix G

Biodiversity Assessment



MEMORIAL AVENUE UPGRADE

Biodiversity Assessment

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NSW ROADS AND MARITIME SERVICES

MEMORIAL AVENUE UPGRADE

Biodiversity Assessment

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This report has been prepared for NSW Roads and Maritime Services in accordance with the terms and conditions of appointment for Memorial Avenue Upgrade dated 20 December 2013. Hyder Consulting Pty Ltd (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

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EXECUTIVE SUMMARY

Roads and Maritime Services (Roads and Maritime) propose to upgrade about 2.2 kilometres of Memorial Avenue between Windsor Road and Old Windsor Road Kellyville (the proposal).

The study area for this assessment consists of an approximately 30.9 hectare area comprising the Memorial Avenue upgrade project boundary, plus an envelope to allow for design changes and assessment of indirect impacts. The study area extends further upstream and downstream at drainage crossings. The study area is intersected by Elizabeth Macarthur Creek and Strangers Creek, within the Hawkesbury Nepean River catchment.

This Biodiversity Assessment has been prepared to inform the Review of Environmental Factors being prepared under Part 5 of the EP&A Act and addresses the scope provided by RMS.

The purpose of this assessment is to describe terrestrial and aquatic flora and fauna species and their habitats which occur within the study area; determine the likely occurrence of threatened entities and their habitats; assess potential impacts of the proposal on biodiversity values and provide recommendations with regard to the avoidance, minimisation and mitigation of impacts on such values.

Database searches were conducted to identify existing records of threatened species, populations and endangered ecological communities occurring within the study area and the surrounding locality. Flora and fauna surveys were undertaken across the study area from 19 to 21 March 2014.

Flora surveys including a quadrat, random meanders and targeted threatened species searches recorded a total of 160 plant species in the study area, comprising 63 local native species, 10 non-local native species and 87 exotic species. No local native threatened plant species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or NSW *Threatened Species Conservation Act 1995* (TSC Act) were recorded in the study area, nor were any considered likely to occur following targeted surveys. Two of the non-local native species recorded in the study area are listed as threatened species under the EPBC Act and TSC Act: *Eucalyptus nicholii* (Narrow-leaved Peppermint) and *Syzygium paniculatum* (Magenta Lilly-pilly). These planted individuals are not of conservation significance.

The vegetation of the study area was highly modified, with most native vegetation historically cleared for agriculture and, more recently, for residential development. Much of the vegetation in the study area was planted. Two threatened ecological communities listed under the TSC Act were identified in the study area, based on review of existing vegetation maps and ground truthing:

- Cumberland Plain Woodland in the Sydney Basin Bioregion.
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions

The threatened ecological communities recorded within the study consisted of highly degraded fragments or scattered trees with a modified understorey dominated by exotic species.

Terrestrial fauna surveys across the study area including habitat quadrats, Anabat, targeted threatened species searches and general habitat assessment identified the presence or potential presence of four exotic and 27 native fauna species. Analysis of Anabat call data determined that one threatened microbat, *Mormopterus norfolkensis* (Eastern Freetail Bat) was present on site at Elizabeth Macarthur Creek. This species is listed as Vulnerable under the TSC Act. Furthermore, potential call sequences of three additional threatened microbats also listed Vulnerable under the TSC Act were identified. This included:

- *Falsistrellus tasmaniensis* (Eastern False Pipstrelle)

- *Myotis macropus* (Southern Myotis)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat)

Terrestrial fauna habitats in the study area were generally limited. Three broad fauna habitat types were identified: riparian woodland, disturbed roadside vegetation and aquatic vegetation. The study area comprises a disturbed roadside corridor of scattered native and exotic trees, weedy groundcover and landscaped native vegetation. The locality is urban and there is minimal habitat connectivity within and beyond the road corridor. Some fauna connectivity exists along riparian vegetation of Strangers Creek and Elizabeth Macarthur Creek.

Three highly modified and degraded creeklines pass through the study area – Strangers Creek, Elizabeth Macarthur Creek and an unnamed tributary of Strangers Creek. Emergent and floating aquatic vegetation is present at each of the creek lines in very small amounts, except for a large patch of *Typha orientalis* in Elizabeth Macarthur Creek. These creek lines would provide habitat for fish and frog species, however no threatened aquatic habitat is present; the creeks are highly degraded and fish and frogs likely to occur would be hardy and common species.

The proposal would have the following potential impacts on biodiversity:

- Loss of native vegetation, including threatened ecological communities in poor condition. A total of 0.65 hectares of native vegetation would be directly impacted, of which 0.257 hectares had been mapped as threatened ecological communities.
- Edge effects associated with the creation of a new road edge, including weed invasion, altered hydrology and increased sedimentation and runoff. Most areas of vegetation further back from the road edge are already very disturbed.
- Increased risk of weed and pathogen spread into adjacent areas.
- Loss of fauna habitat, including potential habitat for threatened fauna species.
- Further minor fragmentation of the already highly fragmented habitat in the study area.
- Mortality of fauna species.
- Alteration and degradation of aquatic habitats resulting from replacement and extension of culverts.

The impacts of the proposal on threatened species, populations and communities identified or considered likely to occur in the study area are as follows:

Type	Name	Likelihood of occurrence	Impacts
Threatened Ecological Communities	Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW)	Known	Loss of vegetation communities and edge impacts on adjoining retained vegetation.
	Swamp-oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF)		
Threatened fauna species	Eastern Freetail-bat (*Mormopterus norfolkensis*)	Known	Loss of potential foraging and roosting habitat
	Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	High	

Type	Name	Likelihood of occurrence	Impacts
	Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)		Loss of potential foraging and roosting habitat
	Southern Myotis (*Myotis macropus*)		
	Little Bentwing-bat (*Miniopterus australis*)	Moderate	Loss of potential foraging and roosting habitat
	Grey-headed Flying Fox (*Pteropus poliocephalus*)		
	Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)		
	Greater Broad-nosed Bat (*Scoteanax rueppellii*)		

The areas of the threatened ecological communities and potential habitat for threatened species that would be impacted by the proposal do not comprise a significant area of habitat occurring in the wider locality.

Assessments of significance under the TSC Act and Significant Impact Assessments under the EPBC Act were undertaken for all threatened species, populations and communities recorded or considered to have a high to moderate likelihood of occurrence in the study area. The assessments concluded that the proposal would not have a significant impact on any of the threatened species, populations or communities considered. A Species Impact Statement will not be required.

Mitigation measures have been recommended where impacts cannot be avoided, and the implementation of these measures should reduce adverse impacts on ecological values of the study area. Key mitigation measures for the proposal are:

- Preparation of a Flora and Fauna Management Plan as part of the Construction Environmental Management Plan (CEMP).
- Marking of retained native vegetation on site plans and in the field with inductions to include advice on the sensitivity of these areas.
- Creek bank stabilisation during construction and remediation of the riparian zone following construction in accordance with a riparian vegetation management plan.
- Weed and pathogen management measures during and following construction.

A review of the Roads and Maritime Biodiversity Offset Guidelines found that biodiversity offsets would not be required as a result of the proposal, as the extent of clearing of native vegetation is very low and vegetation of conservation significance in the study area is in poor condition.

GLOSSARY AND ACRONYMS

Term	Definition
BRRA	Balmoral Road Release Area
CMA	Catchment Management Authority
CPW	Cumberland Plain Woodland in the Sydney Basin Bioregion
dbh	Diameter at breast height (of tree trunks)
DEC	former NSW Department of Environment and Conservation (now OEH)
DECC	former NSW Department of Environment and Climate Change (now OEH)
DECCW	former NSW Department of Environment, Climate Change and Water (now OEH)
DoE	Commonwealth Department of the Environment
EEC	Endangered Ecological Community
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
KTP	Key Threatening Process - A process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities.
LGA	Local Government Area
Migratory Species	Species protected as Migratory under the *Environmental Protection and Biodiversity Conservation Act 1999.*
MNES	Matters of National Environmental Significance
NPWS	NSW National Parks and Wildlife
OEH	NSW Office of Environment and Heritage
Project boundary	The area of proposed direct impacts from the development
REF	Review of Environmental Factors
SIS	Species Impact Statement
SOFF	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions
study area	The project boundary and additional areas which are likely to be affected by the proposal, either directly or indirectly.
TEC	Threatened Ecological Community
TSC Act	NSW *Threatened Species Conservation Act 1995*

1 INTRODUCTION

Roads and Maritime Services (Roads and Maritime) propose to upgrade about 2.2 kilometres of Memorial Avenue (MR642) between Windsor Road and Old Windsor Road Kellyville (the proposal), as well as intersection upgrades. This would include widening Memorial Avenue with a central median strip along the length to accommodate a possible future upgrade to a six-lane configuration (three lanes in each direction). The proposal is located approximately 35 kilometres north-west of the Sydney Central Business District (CBD).

Memorial Avenue is a State arterial road, which runs in an east-west direction connecting Old Windsor Road in the west to Windsor Road in the east. It links the Blacktown LGA and some of its suburbs such as Glenwood, Stanhope Gardens and Parklea with the Hills Shire Council LGA and some of its suburbs such as Castle Hill and Kellyville. The road is located in the suburb of Kellyville within the Hills Shire Council LGA.

Memorial Avenue is located within mainly rural residential land that is in transition to low and medium density urban development and associated urban land uses. The road bisects the new Balmoral Road Release Area (BRRA), identified in The Hills Development Control Plan (DCP) 2012. The proposal is required to cater for future growth arising from increased residential and commercial expansion anticipated in the area.

1.1 STUDY AREA

The study area for this assessment consists of the area within the Memorial Avenue upgrade project boundary, plus an envelope of between 10 and 30 metres to allow for potential design changes and assessment of indirect impacts. The study area extends further upstream and downstream at drainage crossings. The study area is approximately 30.9 hectares in area and is shown on Figure 1-1. Memorial Avenue crosses Elizabeth Macarthur Creek and Strangers Creek, within the Hawkesbury Nepean River catchment.

1.2 PROPOSED ACTIVITY

The proposal (Figure 1-2) is to upgrade a 2.2 kilometre length of Memorial Avenue between Windsor Road and Old Windsor Road. The proposal would involve the following key features:

- Widening Memorial Avenue from a two-lane road to a four-lane divided road for a length of about 2.2 kilometres
- Providing a wide central median along Memorial Avenue to allow the road to be widened to six lanes, when required
- Upgrading the intersections of Memorial Avenue with Windsor Road, Arnold Avenue (west), and Old Windsor Road / Sunnyholt Road
- Closing the intersections of Memorial Avenue with Hector Court, Rutherford Avenue, and Arnold Avenue (east)
- Providing traffic signals at the intersections of Memorial Avenue with Arnold Avenue and Severn Vale Drive
- Providing left-in and left-out access for Burns Road and Stone Mason Drive
- Widening the alignment of Windsor Road generally to the west of the existing road between President Road and Wrights Road
- Slightly widening the alignment of Old Windsor Road for about 250 metres either side of the intersection

- Building a bridge to carry Memorial Avenue over Strangers Creek
- Providing a posted vehicle speed limit of 70 kilometres per hour along Memorial Avenue
- Providing a three-metre-wide shared pedestrian/cyclist path on both sides of Memorial Avenue
- Providing bus priority capability at traffic lights, and creating indented bus bays on both sides of Memorial Avenue
- Relocating and/or temporarily diverting underground utilities, including water, telecommunications, electricity and gas.

Figure 1-1 Location of the Study Area

Figure 1-2 Proposed Upgrade

1.3 LEGISLATIVE FRAMEWORK

1.3.1 COMMONWEALTH *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999*

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as matters of National Environmental Significance (MNES). MNES identified in the Act include:

- World heritage properties
- National heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- threatened species and communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines).

Under the EPBC Act, actions that have, or are likely to have, significant impact(s) on MNES require approval from the Australian Government Minister for the Environment (the minister). The minister would decide whether assessment and approval is required under the EPBC Act.

1.3.2 NSW *ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979*

Part 5 of *Environmental Planning and Assessment Act 1979* (EP&A Act) institutes a system of environmental assessment for matters not covered by Parts 3 and 4. Under Part 5 of the Act, a public authority carrying out or consenting to activity of certain types is required to examine fully and take into consideration all matters likely to affect the environment as a result of such activity. The review of environmental factors (REF) is prepared in accordance with Part 5 of the Act, and assists in establishing whether or not the activity is likely to significantly affect the environment and whether an environmental impact statement needs to be prepared for approval to be sought from the Minister for Planning and Infrastructure.

In accordance with Section 5A (s.5A) of the EP&A Act seven factors “must be taken into account” by a consent or determining authority in the administration of Sections 78A, 79C and 112 of the Act when considering an activity or development proposal. These seven factors comprises the Assessment of Significance, the aim of which is to determine “whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats”, as listed under Schedules 1, 1A and 2 of the Threatened Species Conservation Act 1995 and Schedules 4, 4A and 5 of the Fisheries Management Act 1994. If it is concluded that the proposal is likely to significantly impact threatened species, populations or ecological communities, a Species Impact Statement (SIS) must be prepared.

1.3.3 NSW *THREATENED SPECIES CONSERVATION ACT 1995*

The NSW *Threatened Species Conservation Act 1995* (TSC Act) provides for the protection and management of threatened species, populations and ecological communities listed under schedules 1, 1A and 2 of the Act. The purpose of the TSC Act is to:

- conserve biological diversity and promote ecologically sustainable development
- prevent the extinction and promote the recovery of threatened species, populations and ecological communities
- protect the critical habitat of those species, populations and ecological communities that are endangered
- eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities
- ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed, and
- encourage the conservation of threatened species, populations and ecological communities through co-operative management.

If a planned development or activity will have an impact on a threatened species, population or ecological community listed under the TSC Act, an Assessment of Significance under s.5A of the EP&A Act must be undertaken. If the impacts are likely to be significant, an SIS must be prepared and the Director-General of the Office of Environment and Heritage (OEH) must agree to the development approval.

A licence may be required under Section 91 of the TSC Act if an action is likely to result in:

- harm to, or picking of, a threatened species, population or ecological community.
- damage to critical habitat.
- damage to a habitat of a threatened species, population or ecological community.

1.3.4 NSW *FISHERIES MANAGEMENT ACT 1994*

The NSW *Fisheries Management Act 1994* (FM Act) provides for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. The Act also covers the identification and management of key threatening processes which affect threatened species or could cause other species to become threatened.

If a planned development or activity is likely to have any impact on a threatened entity listed under the FM Act, an Assessment of Significance must be undertaken. If the impacts are likely to be significant, or if critical habitat is affected, an SIS must be prepared.

Section 199 of the FM Act requires public authorities to provide written notice to the Minister of the Department of Primary Industries (DPI) (Fisheries) of any proposed dredging and reclamation works and consider any response received within 28 days of the notice.

Section 219 of the FM Act states fish passage cannot be blocked. In the event that an activity would require fish passage to be blocked, this could only be done in accordance with a permit issued by the Minister under Section 220(1) of the Act.

1.3.5 NSW *NOXIOUS WEEDS ACT 1993*

The NSW *Noxious Weeds Act 1993* provides for the identification and classification for noxious weeds in each New South Wales Local Government Area (LGA). The Act imposes obligations on occupiers of land to control noxious weeds declared for their LGA.

1.4 SCOPE OF REPORT

This report has been prepared to support the Review of Environmental Factors for the Memorial Avenue Upgrade. The assessment has been prepared in accordance with the *Biodiversity Assessment Standard Brief* (RMS 2014) for the proposal.

The key objectives of this biodiversity assessment are to:

- Identify and describe the flora and fauna species, habitat, populations and ecological communities within the study area that occur or are considered likely to occur in the study area
- Identify and describe the flora and fauna species, habitat, populations and ecological communities listed under the TSC Act, FM Act and EPBC Act that occur or are considered likely to occur within the study area
- Assess the direct and indirect impacts of the proposed activity on terrestrial and aquatic flora and fauna species, populations, critical habitats, ecological communities and their habitats
- Assess the extent to which the proposed activities contribute to threatening the survival of biota, and contribute to the operation of other threatening processes on the study area
- Identify and describe the most cost effective amelioration measures using the principles of “avoid, minimise, mitigate”, and to offset where residual impacts occur
- Assess the significance of the proposed activity on species, ecological communities and populations listed under the TSC Act, FM Act and the Commonwealth EPBC Act area that occur or are considered likely to occur in the study area
- Provide mapping of all threatened species and communities, critical habitats, ecological communities, hollow bearing and other sensitive ecological sites within the study area.

2 METHODOLOGY

2.1 NOMENCLATURE

The plant taxonomy used in this report follows the system and nomenclature presented in the most recent edition of *Flora of New South Wales* (Harden 1990-1993, 2002) and is supplemented by subsequent advice from The Royal Botanic Gardens and Domain Trust (2014a). In this report plant species are referred to by both their scientific and common names (if applicable) when first mentioned. Subsequent references to these species cite the scientific name only.

The names of vertebrate fauna follow the Australian Faunal Directory (AFD) database maintained by DoE (2014) and as used by OEH in the *Atlas of NSW Wildlife* (OEH 2011a). In this report fauna species are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only.

2.2 LITERATURE AND DATABASE REVIEW

2.2.1 DATABASE SEARCHES

Database searches were conducted to identify State and Commonwealth records of threatened entities and Commonwealth matters of national environmental significance (MNES). Databases interrogated for this purpose were:

- The NSW Wildlife Atlas which is managed by OEH and accessed through the BioNet website. A search using a 10 kilometre buffer of the study area was carried out to determine threatened species records listed under the TSC Act to within 10 kilometres of the study area.
- The Protected Matters Search Tool which is managed by DoE. A line search using the proposed alignment was carried out to determine threatened species records listed under the EPBC Act to within 10 kilometres of the study area.
- Records of threatened fish species were obtained from the OEH BioNet Atlas of NSW Wildlife online database resource from within 10 kilometres of the study area. The NSW Primary Industries (DPI) Fisheries Database was also consulted.
- The NSW DPI maintains a list of noxious weed declarations for all control areas in NSW. The noxious weeds lists for the Hills Shire Council control area were searched.
- The NSW Vegetation Type Database was reviewed to ensure vegetation communities described in this assessment were consistent with one or more of the vegetation types.

Database searches were initially carried out in February 2014.

2.2.2 LITERATURE REVIEW

The available relevant information was reviewed to provide an understanding of ecological values occurring or potentially occurring in the study area and wider region. Reports, vegetation maps, topographic maps, aerial photography and literature reviewed included, but were not limited to, the following:

- *Soil Landscapes of the Penrith 1:100 000 Sheet* (Bannerman & Hazelton 1990).
- *Ecological Assessment for the North West Rail Link* (Eco Logical Australia 2012).

2.2.3 VEGETATION MAPPING

A number of large-scale vegetation mapping projects have been undertaken in the Sydney region. Those reviewed for this study are as follows:

- *Native vegetation maps of the Cumberland Plain, western Sydney* (NPWS 2002).
- *The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities* (Tozer 2003).
- *Changes in the distribution of Cumberland Plain Woodland* (DECC 2007a).
- *Hills Shire Vegetation Mapping* (Hills Shire Council 2010)

2.3 FIELD SURVEY

A diurnal terrestrial flora and fauna survey of the study area was conducted by ecologists Jane Rodd and Kate Carroll over three days and two nights from 19 to 21 March 2014.

Surveys were undertaken in accordance with the DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft).* The entire study area was traversed and inspected, with detailed surveys including vegetation quadrats and targeted threatened species searches in suitable habitat.

Weather conditions at the time of survey were hot, sunny and calm. The weather records from the Prospect Reservoir weather station (station 067019) for the surveyed dates are detailed in Table 2-1 (BOM 2014):

Table 2-1 Weather records from Prospect Reservoir weather station for the survey dates

Date	Temperature		Rain	Maximum wind gust	
	Minimum	Maximum		Direction	Speed
	°C	°C	Mm		km/h
19 March 2014	15.6	28	0	SW	6
20 March 2014	17.7	28.4	0	Calm	
21 March 2014	19.4	28	0	SW	2

2.3.1 FLORA

Site traverses

The entire study area was traversed on foot and all species observed were recorded. Notes were made on the structure and condition of the vegetation in the study area. An inventory of plant species observed in the study area was compiled (Appendix A).

Plot based survey (quadrats)

In order to comprehensively describe the structure and floristics of each sampled plant community, plot-based survey may be used. Plot-based surveys provide a concentrated search area for the detection of inconspicuous plant species that may be present at a particular site. Given the highly modified nature of the vegetation in the study area, only one small patch of vegetation was sampled using one 0.1 hectare quadrats. The quadrats were in the form of a 20

metre x 50 metre plot with a nested 20 x 20 metre plot (Figure 2-3). The locations of the quadrats are shown on Figure 2-4.

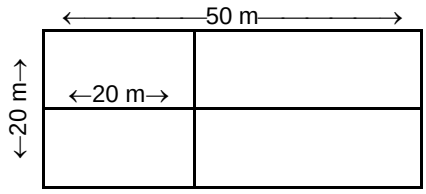

Figure 2-3 Flora quadrat layout

The approximate projective foliage cover of every species identified in the quadrat was estimated and recorded as a percentage. Structural data including the height and projective foliage cover of each stratum were recorded, as were the total length of fallen logs and number of trees with hollows within the quadrat.

Vegetation condition assessment

During the terrestrial flora survey the vegetation condition was assessed and rated according to the degree to which it resembled relatively natural, undisturbed vegetation. The condition assessment was based on visual assessment of the current habitat condition for each of the vegetation communities within the study area. Features examined to determine condition included: native species richness, native cover in each stratum, exotic cover, litter and bare ground cover, number of trees with hollows, woody debris, regeneration, diameter at breast height, canopy recruitment and tree health. These values were recorded quantitatively in transects/plots as well as qualitatively in general traverses across the study area.

The vegetation condition data obtained from the quadrat was compared with the Vegetation Type Benchmark for the identified vegetation type (DECC 2008).

Targeted threatened species searches

Targeted searches for threatened plant species with potential habitat within the study area were undertaken during the site traverses and quadrat surveys. Threatened flora species targeted were those considered to have a high to moderate likelihood of occurrence in the study area.

2.3.2 TERRESTRIAL FAUNA SPECIES

Fauna surveys, involving diurnal and nocturnal techniques, were conducted across the study area over three days and two nights. The entire study area was traversed on foot and all species and evidence of fauna presence observed was recorded. An inventory of all fauna species recorded in the study area was compiled (Appendix B). The fauna survey locations are shown in Figure 2-4.

Field surveys

Field surveys of terrestrial fauna species involved:

- Direct visual observations of animal activity.
- Aural recognition of bird and frog calls.
- Inspecting logs, debris and any built structures (e.g. culverts) for fauna species or signs of fauna habituation.

Figure 2-4 Flora and fauna survey effort

- Searches for indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks, scratches and diggings).
- Stationary placement of ultrasonic bat call detection equipment (Anabat) in potential flyways was used to record the echolocation calls of microchiropteran bats. Two Anabats were deployed for two nights at Strangers Creek and Elizabeth Macarthur Creek.

Anabat survey data was analysed with reference to Bat Calls of NSW (Pennay *et al.* 2004) and Anabat Techniques Workshop Course Manual (Livengood Consulting 2010) and used the following parameters for confidence in call analysis:

- Confident
- Likely
- Possible
- Call confusion

Fauna Habitat Assessment

A general assessment of each fauna habitat type occurring within the study area was made. This included an assessment of fauna habitat complexity, condition of fauna habitats, the availability of habitat features and the value of habitat features to threatened species previously recorded within the locality.

2.3.3 AQUATIC FAUNA HABITATS

Aquatic assessments were undertaken at Elizabeth Macarthur Creek and Strangers Creek. Survey locations are shown in Figure 2-4.

Aquatic assessments recorded the following:

- Channel features including channel width, substrate, water colour and turbidity.
- Instream habitat including rocks/pebbles, Coarse Woody Debris (CWD), aquatic vegetation.
- Riparian features including bank width and slope, riparian vegetation.

2.4 LIKELIHOOD OF OCCURRENCE OF THREATENED SPECIES

The database searches identified threatened flora and fauna species that have been recorded or that are likely to occur within 10 kilometres of the Study Area. The probability that each threatened species occurs within the Study Area was determined as being either low, moderate, high or known, based on the criteria in Table 2-2.

Table 2-2 Likelihood of occurrence criteria for threatened species

Likelihood of occurrence	Criteria one or more conditions apply for threatened flora species	Criteria one or more conditions apply for threatened fauna species
Low	The species has not been recorded previously within 10km of the Study Area. The species has historically (>20 years ago) been recorded within 10km of the Study Area, and suitable habitat is no longer present. The Study Area is beyond the current known geographic range of the species. The species has specific habitat requirements that are not present in the Study Area. The species has specific habitat requirements that are present in the Study Area, but in a poor or modified condition, and targeted searches in accordance with published guidelines have not identified the species (applies to conspicuous species only). The species is considered extinct.	The species has not been recorded previously within 10km of the Study Area; or The species has historically (>20 years ago) been recorded within 10km of the Study Area; and Preferred habitat features are not present; or The Study Area is beyond the current known geographic range of the species; or The preferred habitat features for this species are not present in the Study Area; or The species is considered extinct.
Moderate	The species has historically (>20 years ago) been recorded in the Study Area, or has been recorded more recently (<20 years ago) within 10km of the Study Area. The species has specific habitat requirements that are present in the Study Area, but in a poor or modified condition.	The species has historically (>20 years ago) been recorded in the Study Area, or has been recorded more recently (<20 years ago) within 10km of the Study Area; and The species has specific habitat requirements that are present in the Study Area, but in a poor or modified condition; or The species is known or likely to maintain resident populations in proximity to the Study Area and could utilise resources within the Study Area; or Targeted surveys have been undertaken for the species and it was not identified but habitat is present.
High	The species has recently (within the last 20 years) been recorded in the Study Area or nearby. The species has specific habitat requirements that are present in the Study Area and are in good condition. A known population of the species is located in similar habitat in proximity to the Study Area.	The species has recently (within the last 20 years) been recorded in the Study Area or nearby; and The species preferred habitat features are present in the Study Area; or The species is known or likely to regularly utilise resources in the Study Area.
Known	The species was recorded in the Study Area during the current survey.	The species was recorded in the Study Area during the current survey.

2.5 LIMITATIONS

The seasonal timing of the field investigation means that the full spectrum of flora and fauna species likely to occur on the Study Area may not be fully quantified or described in this report. Some plant species that occur in the local area, such as cryptic species, are annuals and are present only in the seed bank for much of the year. Other plant species are perennial but are inconspicuous or difficult to identify unless flowering.

Similarly, some fauna species that have been recorded in the local area occur on a seasonal or migratory basis, and may be absent from the locality for much for the year. Fauna behaviours may have also affected detectability; species that are easily disturbed or cryptic may not have been detected during surveys. It is possible that a number of flora and fauna species occurring in the Study Area were not detected during the current survey due to the above factors.

These potential limitations have been addressed by a thorough literature research and review and through identification of potential habitats for flora and fauna species and assessment of the potential for targeted species to occur in the study area based on:

- Previous records.
- The type and condition of habitats present.
- The land use throughout the Study Area and surrounds.
- The landscape context.

The precautionary principle was applied where marginal habitat was identified or predicted to occur or where species are migratory or nomadic and were therefore likely to utilise habitat components at some stage during their life cycle.

3 RESULTS

3.1 LANDSCAPE CONTEXT

3.1.1 GEOLOGY AND SOILS

The geology of the Penrith 1:100 000 sheet was mapped by Clark and Jones (1991). The study area was mapped as Ashfield Shale (map unit Rwa), described as “Dark-grey to black claystone-siltstone and fine sandstone-siltstone laminite”.

The soil landscapes of the Penrith 1:100 000 sheet were mapped by Bannerman and Hazelton (1990). There are two different soil landscapes mapped within the study area: the residual Blacktown soil landscape and the erosional Luddenham soil landscape (Figure 3-5). The features and location in the study area of the mapped soil landscapes are detailed in Table 3-3.

Table 3-3 Soil landscapes mapped in the study area by Bannerman and Hazelton *et al.* (1990)

Soil Landscape	Features (Bannerman and Hazelton 1990)	Location in study area
Blacktown (Residual)	Shallow to moderately deep hardsetting mottled texture contrast soils; red and brown podzolic soils on crests, draining to yellow podzolic soils on lower slopes and drainage lines. On gently undulating rises on Wianamatta Group Shales.	Most of extent of study area in vicinity of Memorial Avenue.
Luddenham (Erosional)	Shallow dark podzolic soils or massive earthy clays on crests; moderately deep red podzolic soils on upper slopes; moderately deep yellow podzolic soils and prairie soils on lower slopes and drainage lines. Landscape is undulating to rolling low hills on Wianamatta Group shales, often associated with Minchinbury Sandstone.	Small section of eastern end of study area in vicinity of Memorial Avenue and Windsor Road.

3.1.2 HYDROLOGY

The Study Area is located within the Cattai Creek subcatchment of the Hawkesbury Nepean Catchment. It is managed by the Hawkesbury Nepean Catchment Management Authority (CMA). The Cattai Creek subcatchment drains areas of new and ongoing development in north-western Sydney in the upper reaches of Cattai and O’Hara’s Creeks. The urbanisation of upstream areas has resulted in increased sedimentation and degradation, with poor water quality as a result of stormwater and sewage treatment plant discharges into creeks. Major woody weeds in the catchment include Privet and Willows (Hawkesbury Nepean CMA 2007).

Three mapped creeklines intersect Memorial Avenue: Elizabeth Macarthur Creek in the west, and Strangers Creek and one of its tributaries in the east of the study area. Both creeks flow northwards. Elizabeth Macarthur Creek is a second order stream using the Strahler stream classification system (Strahler 1952). Strangers Creek is a second order stream and its unnamed tributary is a first order stream.

Hydrological features are mapped in Figure 3-5.

Figure 3-5 Hydrological features and soil landscapes of the study area

3.1.3 LAND USE

The study area is characterised by existing rural/residential and industrial development, regrowth or remnant bushland areas, recent higher-density residential developments and lands currently subject to clearing and construction operations associated with development projects.

The study area bisects the Balmoral Road Release Area (BRRA). The 410 hectare BRRA has been identified in The Hills Development Control Plan (DCP) 2012. A total of 6,400 new dwellings are proposed in the BRRA, accommodating a population of about 16,000 people.

3.2 FLORA

3.2.1 VEGETATION MAPPING

National Parks and Wildlife Service (NPWS) (2002)/Tozer (2003) mapped the native vegetation of the Cumberland Plain at a 1:16 000 scale, based on aerial photograph interpretation, mapped geological boundaries and field sampling. The mapping was updated in 2008. A total of 22 plant communities were defined using multi-variate analysis of quantitative field survey data. Each community was described using structural features, habitat characteristics and diagnostic species.

Four different plant communities were mapped in the Study Area (Figure 3-6); all correspond with threatened ecological communities listed under the TSC Act (Table 3-4).

Table 3-4 Vegetation communities mapped by NPWS (2002a)/Tozer (2003) and corresponding TECs

Vegetation map unit (NPWS 2002/Tozer 2003)	Corresponding TEC under the EPBC Act	Corresponding TEC under the TSC Act
Shale Hills Woodland	Cumberland Plains Shale Woodland and Shale Gravel Transition Forest (EPBC CPW) (Critically Endangered)	Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW) (Critically Endangered)
Shale Plains Woodland		
Alluvial Woodland	Not listed	River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (RFEF) (Endangered) Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (SOFF) (Endangered)
Turpentine-Ironbark Margin Forest	Turpentine-Ironbark Forest in the Sydney Basin Bioregion (Critically Endangered)	Sydney Turpentine-Ironbark Forest (Endangered)

NPWS (2002) mapped the conservation significance of the vegetation in the Study Area as follows (Figure 3-7):

- Other Remnant Vegetation: Most of the Shale Hills Woodland and Shale Plains Woodland within the study area is mapped as this category.
- Core habitat: A patch of Turpentine-Ironbark Margin Forest slightly overlapping the northern edge of the study area.

Figure 3-6 Vegetation communities mapped in the study area (NPWS 2002/Tozer 2003)

Figure 3-7 Conservation significance mapping of the study area (NPWS 2002/Tozer 2003)

- Support to core habitat: Shale Hills Woodland slightly overlapping the southern edge of the study area.

The Hills Shire Council (HSC) (2010) mapped the vegetation of the Hills Shire LGA using vegetation data compiled from near-infrared aerial photography flown in 2005 combined with previous classifications derived from Landsat TM and Spot Satellite data in August 1999. No additional methodology is provided for the vegetation mapping, and vegetation classes are not described in any detail.

Most of the vegetation in the study area is mapped as “New Unclassified 2005” (Figure 3-8). A small patch of vegetation adjoining the north-western corner of the junction of Memorial Avenue and Arnold Avenue is mapped as Cumberland Plain Woodland. Review of the current aerial photograph of the study area shows that this area has been subsequently cleared and now supports residential development.

3.2.2 FIELD SURVEY

The vegetation of the study area was highly modified, with most native vegetation historically cleared for agriculture and, more recently, for residential development. Much of the vegetation in the study area was planted. Ground truthing of the vegetation in the study area identified six vegetation types:

- Disturbed Swamp Oak Forest
- Disturbed Regrowth Cumberland Plain Woodland
- Disturbed Native Regrowth
- Native Rehabilitation
- Typha Wetland
- Developed/Landscaped

Descriptions of each vegetation community within the study area are provided in Table 3-6 to Table 3-11. The observed distribution of vegetation communities in the study area was not consistent with the vegetation mapping by NPWS (2002)/Tozer (2003), as there has been considerable development and vegetation clearing since the date of the mapping. The mapping was refined after ground truthing (Figure 3-9).

Two of the vegetation types identified in the study area are broadly equivalent to the following Vegetation Types as defined in the NSW Vegetation Type Database (Table 3-5):

Table 3-5 Native Vegetation Types in the study area

Identified vegetation type	Equivalent Vegetation Type
Disturbed Regrowth Cumberland Plain Woodland	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin
Disturbed Swamp Oak Forest	Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains, Sydney Basin and South East Corner

The areas, condition and conservation status of vegetation communities mapped in the study area are described in Table 3-6 to Table 3-11.

Figure 3-8 Vegetation communities mapped in the study area (Hills Shire Council 2010)

Figure 3-9 Vegetation communities identified in the study area following ground-truthing

Table 3-6 Disturbed Swamp Oak Forest

Vegetation type	Description
Extent within the study area	0.243 hectares
Extent within the project boundary	0.067 hectares
Description	Adjoining Elizabeth Macarthur Creek on the north side of Memorial Avenue is a stand of *Casuarina glauca* (Swamp Oak) with an understorey dominated by exotic species. The mid layer is absent, except for occasional shrubs of *Ochna serrulata* (Mickey Mouse Plant). The ground layer is characterised by dense Swamp Oak leaf litter and patches of the exotics *Tradescantia fluminensis* (Wandering Jew), *Ehrharta erecta* (Panic Veld-grass). The exotic creepers *Passiflora caerulea* (Blue Passion Flower) and *Solanum seaforthianum* (Brazilian Nightshade) are abundant in the ground layer and climbing trees.
Condition	The Swamp Oak Forest is in poor condition, with very few native species present – only four were recorded in Quadrat 1 which sampled this community. The vegetation scored well below the benchmark values for this community in the Vegetation Types Database.
Threatened species of plant?	No threatened plant species were recorded and this vegetation is unlikely to represent potential habitat for any threatened species in the locality.
Threatened community?	Meets the criteria for Swamp Oak Floodplain Forest on the NSW North Coast, Sydney Basin and South East Corner bioregions, but in poor condition.
Photo	

Table 3-7 Disturbed Regrowth Cumberland Plain Woodland

Vegetation type	Description
Extent within the study area	0.283 hectares
Extent within the project boundary	0.190 hectares
Description	In the west, centre and east of the study area are scattered trees of *Eucalyptus tereticornis* (Forest Reg Gum) and *Eucalyptus crebra* (Narrow-leaved Ironbark) on road verges and in rural/residential properties. The trees are mature but not old growth, and are likely to be regrowth. There are very few native understorey species in these areas, with exotic grasses such as *Paspalum dilatatum* (Paspalum), *Pennisteum clandestinum* (Kikuyu) and *Chloris gayana* (Rhodes Grass) dominant. Along the roadside there are occasional patches of native ground cover species such as *Aristida vagans* (Threeawn Speargrass), *Microlaena stipoides* (Weeping Grass) and *Glycine tabacina,* but these are minor in extent.
Condition	This vegetation is in very poor condition, with native ground layer largely absent and trees varying in condition from good health to poor health and shape due to extensive lopping for powerline clearance. The community is reduced to scattered trees on disturbed road edges.
Threatened species of plant?	No threatened plant species were recorded and this vegetation is unlikely to represent potential habitat for any threatened species in the locality.
Threatened community?	This vegetation represents the final remains of the Cumberland Plain Woodland which once occurred across the study area. It is questionable whether the vegetation meets the criteria for Cumberland Plain Woodland in the Sydney Basin Bioregion, a critically endangered ecological community under the TSC Act. The vegetation does not meet the criteria for Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest as defined under the EPBC Act. This is further discussed in sections 4.1.1 and 4.21 of this report.
Photo	

Table 3-8 Disturbed Native Regrowth

Vegetation type	Description
Extent within the study area	0.738 hectares
Extent within the project boundary	0.224 hectares
Description	This vegetation type incorporates areas dominated by native shrub regrowth, usually with a disturbed exotic dominated ground layer. To the west of the main arm of Strangers Creek to the north of Memorial Avenue are dense stands of *Acacia decurrens* (Black Wattle) with a sparse understorey of *Pennisetum clandestinum, Chloris gayana, Cynodon dactylon* (Couch), the native herb *Pratia purpurascens* (Whireroot) and *Sida rhombifolia* (Paddy's Lucerne). On the southern side of Memorial Avenue and to the west of Strangers Creek is more native shrubland dominated by *Acacia decurrens* with a weedy ground layer; it is unclear whether this is regrowth or the result of previous bush regeneration works.
Condition	This vegetation is in poor condition, with native ground layer largely absent.
Threatened species of plant?	No threatened plant species were recorded and this vegetation is unlikely to represent potential habitat for any threatened species in the locality.
Threatened community?	This vegetation does not meet the criteria for any threatened ecological communities.
Photo	

Table 3-9 Native Rehabilitation

Vegetation type	Description
Extent within the study area	0.638 hectares
Extent within the project boundary	0.106 hectares
Description	The areas adjoining the main (eastern) arm of Strangers Creek supports planted native trees, shrubs and groundcover. Trees are 5 to 6 metres in height and include *Angophora floribunda* (Rough-barked Apple)*, Eucalyptus tereticornis, Eucalyptus moluccana* (Grey Box) and *Casuarina glauca.* A dense shrub layer of *Acacia floribunda* (White Sally), *Acacia decurrens, Bursaria spinosa* (Blackthorn), *Kunzea ambigua* (Tick-bush) and *Leptospermum polygalifolium* (Tantoon) is present on the south side of Memorial Avenue; on the north side the midstorey is characterised by *Melaleuca decora* (White Cloud Tree), *Melaleuca styphelioides* (Flax-leaved Paperbark), *Bursaria spinosa* and the invasive exotic trees *Ligustrum sinense* (Small-leaved Privet) and *Ligustrum lucidum* (Broad-leaved Privet). This vegetation also includes a large multi-trunked tree of *Salix alba x fragilis* in the centre of Strangers Creek.
Condition	The vegetation on the southern side of Memorial Avenue is in relatively good condition, with high cover of native species and low abundance of exotics. This area has been subject to intensive planting and slope stabilisation. The planted section of Strangers Creek to the north of Memorial Avenue is in poorer condition, with high cover of invasive exotic species.
Threatened species of plant?	No threatened plant species were recorded and this vegetation is unlikely to represent potential habitat for any threatened species in the locality.
Threatened community?	This vegetation does not meet the criteria for any threatened ecological communities.
Photo	

Table 3-10 Typha Wetland

Vegetation type	Description
Extent within the study area	0.107 hectares
Extent within the project boundary	0.063 hectares
Description	The section of Elizabeth Macarthur Creek to the south of Memorial Avenue supported dense stands of *Typha orientalis* (Broad-leaf Cumbungi) interspersed with native and exotic herbs and sedges such as *Persicaria decipiens* (Slender Knotweed), *Alternanthera dentata* (Common Joyweed), *Tradescantia fluminensis, Aster subulatus* (Wild Aster), *Rumex conglomeratus* (Clustered Dock) and *Juncus acutus* (Spiny Rush). The Typha wetland in the drainage line was adjoined on both sides by uneven ground (possibly fill) supporting a dense carpet of *Pennisetum clandestinum* (Kikuyu) and *Paspalum dilatatum* (Paspalum) with *Plantago lanceolata* (Plantain) also abundant. There were scattered trees of *Callistemon citrinus* (Scarlet Bottlebrush), *Callistemon viminalis* (Weeping Bottlebrush), *Eucalyptus tereticornis* (Forest Red Gum) and *Schinus areira* (Pepper Tree) in the exotic grassland next to the drainage channel.
Condition	This vegetation was in poor condition with a high abundance of exotic species.
Threatened species of plant?	No threatened plant species were recorded and this vegetation is unlikely to represent potential habitat for any threatened species in the locality.
Threatened community?	This vegetation does not meet the criteria for any threatened ecological communities.
Photo	

Table 3-11 Developed/Landscaped

Vegetation type	Description
Extent within the study area	21.599 hectares
Extent within the project boundary	10.664 hectares
Description	The majority of the study area supports cleared, developed areas with vegetated areas comprising planted street trees, landscaping, residential gardens and grass or weed cover. Commonly occurring street trees are *Corymbia citriodora* (Lemon-scented Gum), *Eucalyptus microcorys* (Tallowwood), *Eucalyptus saligna* (Sydney Blue Gum), *Eucalyptus nicholii* (Narrow-leaved Black Peppermint), *Grevillea robusta* (Silky Oak), *Liquidambar styraciflua* (Liquidambar), *Lophostemon confertus* (Brush Box) and *Araucaria heterophylla* (Norfolk Island Pine). Ground cover in these areas mostly comprised mown residential lawns and planted garden beds, slashed exotic grasses on road verges and some areas of dense weed cover. The western section of the study area next to Old Windsor Road includes extensive areas of landscaping in roadside areas and in the median, associated with the previous upgrades of this road. These landscaped areas are characterised by planted trees with a mown exotic grass understorey, massed native shrub planting and edge and median plantings of dense *Lomandra longifolia* (Spiny-headed Mat-rush).
Condition	Native flora biodiversity values in this vegetation type are generally low, and most of the vegetation has been planted or colonised by invasive exotic species.
Threatened species of plant?	No local native threatened plant species were recorded and this vegetation is unlikely to represent potential habitat for any threatened species in the locality. Two non-local threatened flora species were recorded in this vegetation type: *Eucalyptus nicholii* (Narrow-leaved Ironbark) and *Syzygium paniculatum* (Magenta Lilly-pilly). These species are commonly planted as horticultural specimens and are not considered to be of conservation value in the locality of the study area.
Threatened community?	None of the vegetation mapped as developed/landscaped meets the criteria for any threatened ecological communities.
Photo	

3.3 FAUNA HABITAT

3.3.1 TERRESTRIAL FAUNA HABITAT

Terrestrial fauna habitats in the study area were generally limited. The study area comprised three broad fauna habitat types: riparian woodland, disturbed roadside vegetation and aquatic vegetation. Fauna habitat features within each habitat type are described below and mapped in Figure 3-10.

Riparian woodland

Small patches of riparian woodland are present at the three creeks that pass through the study area. Riparian vegetation provides some habitat connectivity along Elizabeth Macarthur Creek and Strangers Creek (Plate 1, Plate 2). Riparian vegetation could provide shelter and nesting habitat for arboreal and ground-dwelling fauna species that occur in fragmented and disturbed habitats. Foraging opportunities for a range of fauna species are present in riparian woodland. Canopy cover was high in comparison to the remainder of the study area and flowering shrubs and Casuarinas were present. Furthermore, this vegetation would provide foraging habitat for microbats, including threatened species, as discussed further in Section 4.2.3. One hollow-bearing tree was recorded in riparian vegetation of Elizabeth Macarthur Creek, 150 metres from the project boundary (Plate 3).

Plate 1 Riparian vegetation on Strangers Creek

Plate 2 Riparian vegetation on Elizabeth Macarthur Creek

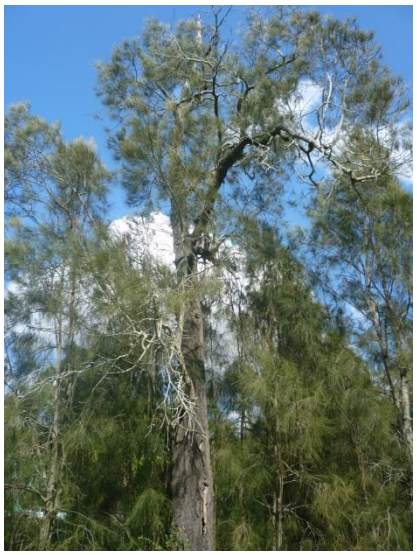

Plate 3 Hollow-bearing tree within riparian vegetation of Elizabeth Macarthur Creek

Disturbed roadside vegetation

The study area generally comprises a disturbed roadside corridor of scattered native and exotic trees, weedy groundcover and landscaped native vegetation. The locality is urban and there is minimal habitat connectivity within and beyond the road corridor. Street trees provide some refuge for highly mobile fauna along the road corridor. Two trees with potential hollows were recorded close to the project boundary. Figure 3-10 shows the location of the hollow-bearing tree in riparian woodland and potential hollow-bearing trees near the project boundary. The tree furthest to the west is located 13 metres from the project boundary (Plate 4) and the tree furthest to the east is located 5 metres from the project boundary (Plate 5).

Plate 4 Potential hollow-bearing tree (westernmost)

Plate 5 Potential hollow-bearing tree (easternmost)

The potential hollow-bearing trees are only likely to contain small hollows if present which would provide roosting habitat for microbats (including threatened species) and non-threatened birds. Culverts at the three creek crossings were concrete box or pipe culverts that would also provide roosting habitat for some microbat species, including threatened species. Street trees and remnant vegetation in the study area would provide shelter for common fauna species including

birds, reptiles and mammals. It would also provide some foraging and nesting opportunities for birds and reptiles.

Aquatic vegetation

Three highly modified and degraded creeklines pass through the study area – Strangers Creek, Elizabeth Macarthur Creek and an unnamed tributary of Strangers Creek. Emergent and floating aquatic vegetation is present at each of the creek lines in very small amounts, however, there is a large patch of *Typha orientalis* in Elizabeth Macarthur Creek (Figure 3-9). Aquatic habitat features at these creek lines are discussed further in Section 3.3.2. These creek lines would provide habitat for common frog species, such as the Striped Marsh Frog, *Limnodynastes peronii*, which was recorded at Strangers Creek. Grassy swales with ponding water and emergent vegetation also occurred near the creek lines which would provide habitat for frogs.

Figure 3-10 Fauna habitats identified in the study area

Figure 3-11 Threatened species and hollow-bearing trees within the study area

3.3.2 AQUATIC FAUNA HABITAT

Elizabeth Macarthur Creek

Elizabeth Macarthur Creek passes through the western end of Memorial Avenue. It is a highly degraded and modified creek line with a muddy substrate, low turbidity and a moderate stream flow at the time of the site visit. There are three square box culverts at the creek crossing below Memorial Avenue over a width of approximately 10 metres. The creek flows in a northerly direction and is part of the Cattai Creek Catchment. The creek is classified Class 3 - Minimal Fish Habitat in accordance with the NSW classification of fish habitat (Fairfull and Witheridge 2003). Upstream of the creek crossing and within 2 metres downstream there is dense *Typha orientalis* within the channel which would provide breeding habitat and shelter for fish and frogs. The channel is approximately 6 metres wide. The riparian zone upstream of the culvert comprises dense grass and occasional shrubs. A few mature trees are scattered along the banks including *E. tereticornis* and *S. areira*. Downstream of the culvert is a stand of Swamp Oak Forest within the riparian zone of the creek. The creek itself is heavily shaded and there is some instream vegetation including floating, emergent and submerged species. Snags are present and there is overhanging vegetation and exposed tree roots on the channel banks which would provide shelter and breeding habitat for fish and frogs, though unlikely to provide habitat for threatened species.

Plate 6 View upstream of Elizabeth Macarthur Creek

Plate 7 View downstream of Elizabeth Macarthur Creek

Unnamed tributary

An unnamed tributary of Strangers Creek passes through Memorial Avenue in the middle of the study area. Land surrounding the unnamed tributary has been highly modified up and downstream of Memorial Avenue such that there is no formal channel connecting to the study area. The creek is classified Class 4 - Unlikely Fish Habitat in accordance with the NSW classification of fish habitat (Fairfull and Witheridge 2003). The tributary contains small pools of standing water with some emergent aquatic vegetation (*Typha orientalis*). Water clarity was low, likely due to dirty water runoff from nearby developments. There are Willows (*Salix alba x fragilis*) in the riparian zone of the tributary downstream. The channel banks and riparian zone otherwise contained dense grass and weeds.

Plate 8 View upstream of unnamed tributary

Plate 9 View downstream of unnamed tributary

Strangers Creek

Strangers Creek passes through the eastern end of Memorial Avenue. It is a highly degraded and modified creek line with a rocky and muddy substrate, low turbidity and a slow stream flow at the time of the site visit. There are four concrete pipe culverts at the creek crossing below Memorial Avenue over a width of approximately 6 metres. The creek flows in a northerly direction and is part of the Cattai Creek Catchment. The creek is classified Class 3 - Minimal Fish Habitat in accordance with the NSW classification of fish habitat (Fairfull and Witheridge 2003). Upstream of the creek crossing the channel has been modified with constructed gabion rock baskets instream and on the channel banks for approximately 40 metres. The channel is approximately 5 metres wide. There is dense *T. orientalis* beyond the gabion rock channel and immediately between downstream of it, next to the culvert opening which would provide breeding habitat and shelter for fish and frogs. The riparian zone upstream of the culverts comprises rehabilitated native woodland. Downstream of the culverts the channel is eroded and contains minimal instream vegetation. The channel is approximately 5 metres wide. Exotic trees and shrubs line the channel banks. Further from the banks, the riparian zone contains native trees and shrubs including eucalypts and acacias. Snags are present which would provide breeding habitat for fish, though unlikely to provide habitat for threatened species.

Plate 10 View upstream of Strangers Creek

Plate 11 View downstream of Strangers Creek

3.4 RECORDED FLORA AND FAUNA SPECIES

Flora species

A total of 160 plant species were recorded in the study area, comprising 63 local native species, 10 non-local native species and 87 exotic species. The majority of species recorded, including local native species, were of planted specimens in residential gardens or as roadside street tree or landscape plantings. Local native species recorded consisted mostly of regrowth and planted trees and shrubs in road verges and residential properties, occasional native groundcover species in slashed or mown grassland, and native tree, shrub and groundcover species planted in rehabilitation areas associated with Strangers Creek. A list of flora species recorded during field surveys is provided in Appendix A.

Two of the non-local native species recorded in the study area are listed as threatened species under the EPBC Act and TSC Act: *Eucalyptus nicholii* (Narrow-leaved Peppermint) and *Syzygium paniculatum* (Magenta Lilly-pilly). These species are discussed further in section 4.1.2.

Noxious Weeds

Ten of the 87 exotic species recorded in the study area are listed as noxious weeds in the Hawkesbury River County Council control area, which encompasses the Hills Shire LGA (Table 3-12).

Table 3-12 Noxious weeds recorded in the study area

Scientific name	Common name	Control class
Asparagus asparagoides	Bridal Creeper	4
Celtis sinensis	Chinese Hackberry	4
Cortaderia selloana	Pampas Grass	3
Genista monspessulana	Montpelier Broom	3
Ligustrum lucidum	Broad-leaved Privet	4
Ligustrum sinense	Small-leaved Privet	4
Opuntia spp.	Prickly Pear	4
Rubus anglocandicans (part of the *R. fruticosus* agg. spp.)	Blackberry	4
Salix alba x fragilis	Willow	4
Senecio madagascariensis	Fireweed	4

The *NSW Noxious Weeds Act 1993* imposes obligations on occupiers of land to control noxious weeds declared for their area. The control requirements for the classes of noxious weeds recorded in the study area are presented in Table 3-13.

Table 3-13 Weed control classes and requirements

Control Class	Weed type	Control requirements
Class 3	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.	The plant must be fully and continuously suppressed and destroyed.
Class 4	Plants that pose a potentially serious threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

Fauna species

Common fauna species were identified in the study area, most of which were birds and included one frog. A rabbit warren and scats were observed in the western end of the study area and fox scats were identified. A total of nine microbat species were recorded on the Anabat with varying degrees of confidence in the analysis. This included four threatened microbats (refer to Section 4 for discussion and locations recorded in Figure 3-10). No species were observed utilising any hollows within the study area. A list of fauna species recorded during field surveys is provided in Appendix B.

4 SPECIES, POPULATIONS AND COMMUNITIES OF CONSERVATION CONCERN

4.1 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

4.1.1 THREATENED ECOLOGICAL COMMUNITIES

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search identified five Threatened Ecological Communities (TECs) as likely to occur within 10 kilometres of the study area:

- Blue Gum High Forest of the Sydney Basin Bioregion
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
- Shale/Sandstone Transition Forest
- Turpentine-Ironbark Forest in the Sydney Basin Bioregion
- Western Sydney Dry Rainforest and Moist Woodland on Shale.

Based on the review of soil, geology and vegetation mapping in the study area and the results of the field survey, Blue Gum High Forest of the Sydney Basin Bioregion, Shale/Sandstone Transition Forest, Turpentine-Ironbark Forest in the Sydney Basin Bioregion and Western Sydney Dry Rainforest and Moist Woodland on Shale are unlikely to occur in the study area.

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest has previously been mapped in the study area and some characteristic trees of this community were recorded in the field survey. In order to qualify as the listed critically endangered ecological community Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest under the EPBC Act, a patch must meet the following criteria as defined in the EPBC Act Policy Statement 3.3.1 (Commonwealth of Australia 2010):

- Native tree species present with a minimum projected foliage cover of 10 per cent.
- Patch 0.5 hectares or greater in size.
- Either:
    - Over 50 per cent of perennial understorey vegetative cover is made up of native species
    - Patch greater than five hectares in size and has over 30 per cent native perennial understorey vegetative cover
    - Patch contiguous with a native vegetation patch greater than five hectares in size and has over 30 per cent native perennial understorey vegetative cover
    - Patch contains at least one tree per hectares that is large (>80 cm dbh) or has a hollow, and has over 30 per cent native perennial understorey vegetative cover.

The scattered characteristic trees of Cumberland Plain Woodland in the study area do not meet any of the above criteria; this vegetation is not considered to fall within the EPBC Act definition of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

4.1.2 THREATENED FLORA SPECIES

A search of the Department of the Environment (DoE) Protected Matters Search Tool found 24 threatened flora species listed under the EPBC Act that are known or likely to occur within 10 kilometres of the study area. The likelihood of each threatened species occurring in the study area was assessed (Appendix C). It was found that potential habitat for two local native threatened flora species listed under the EPBC Act, *Acacia pubescens* (Downy Wattle) and *Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea) exists in the study area; however these species were considered to have a low likelihood of occurrence in the study area following targeted surveys.

Another two threatened flora species listed under the EPBC Act, *Eucalyptus nicholii* (Narrow-leaved Black Peppermint) and *Syzygium paniculatum* (Magenta Lilly-pilly), were recorded in the study area. It was noted in the likelihood of occurrence assessment that these two species, as well as *Eucalyptus scoparia* (Wallangarra White Gum) – which was considered to have a moderate likelihood of occurrence – do not naturally occur within the locality of the study area and any records are likely to be planted specimens.

Eucalyptus nicholii is endemic to the Northern Tablelands of NSW, occurring from Nundle to north of Tenterfield (Brooker and Kleinig 2006, OEH 2014). The species is widely planted as a street tree in south-eastern Australia.

Syzygium paniculatum naturally occurs in subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea, and is found in widely separated localities from Bulahdelah to Jervis Bay (RBGDT 2014). This species is commonly cultivated as an ornamental and often planted as a street tree.

The locations of the recorded individuals of *Eucalyptus nicholii* and *Syzygium paniculatum* in the study area, as street trees and fenceline plantings in rural/residential gardens, suggest that they are planted. These planted individuals are not of conservation significance.

4.1.3 THREATENED FAUNA SPECIES

A search of the DoE Protected Matters Search Tool found 21 threatened fauna species listed under the EPBC Act that are known or likely to occur within 10 kilometres of the study area. The likelihood of each threatened species occurring in the study area was assessed (Appendix D). It was found that only one threatened fauna species listed under the EPBC Act, *Pteropus poliocephalus* (Grey-headed Flying Fox) had a moderate likelihood of occurrence in the study area. The study area contains highly modified and disturbed foraging habitat for this species. All other threatened fauna species in the search results had a low likelihood of occurrence in the study area.

The riparian zone of Elizabeth Macarthur Creek has been mapped as secondary habitat for the Green and Golden Bell Frog (*Litoria aurea*), listed as Vulnerable under the EPBC Act, by Eco Logical (2012) as part of assessment for the North West Rail Link. The Green and Golden Bell Frog breeds in a variety of waterbodies that are typically unshaded, ephemeral, large permanent swamps and ponds with plenty of emergent vegetation, especially bulrushes (*Typha* sp.) or spikerushes (*Eleocharis* sp.) (DECC 2009, OEH 2014g). Foraging and/or refuge habitat typically features extensive grassy areas, an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover with a complexity of vegetation structure (DEC 2005). These habitat features are often but not always found peripheral to breeding habitat. Elizabeth Macarthur Creek is heavily shaded with *Casuarina glauca* and minimal emergent or fringing vegetation downstream of Memorial Avenue and would therefore be unsuitable for the species. Upstream of Memorial Avenue the creek contains a stand of tall dense *Typha orientalis* with minimal areas of open water. The channel banks and adjacent land contain dense grass

(mainly Kikuyu). Adjacent land is free of suitable diurnal shelter sites (e.g. rocks, logs) and vegetation lacks complexity in structure and diversity of species. Whilst the creek and adjacent land contains some elements of potential foraging and refuge habitat, it is sub-optimal and therefore unlikely to host this species. Strangers Creek and the unnamed tributary are similarly unsuitable for the species with limited emergent or fringing vegetation, heavy shading in patches and no suitable diurnal shelter sites available.

The closest records to the site are from the 1960s and 1970s, including one record within Elizabeth Macarthur Creek from 1968. As there have been no recent records of the species in the area, it is likely that the historical local population has since gone extinct. A sub-population of the species is known to occur at Riverstone, approximately 7.3 kilometres northwest of the site (DEC 2005). Development in the locality and lack of connectivity between watercourses present significant barriers to movement from this sub-population to the site. Subsequently it is considered unlikely that the Green and Golden Bell Frog would occur within the study area due to the low likelihood of occurrence of a local population and lack of preferred habitat features.

4.1.4 MIGRATORY SPECIES

A search of the DoE Protected Matters Search Tool found 12 migratory species listed under the EPBC Act that are known or likely to occur within 10 kilometres of the study area. The likelihood of each threatened species occurring in the study area was assessed (Appendix D). All migratory species identified in the search were assessed to have a low likelihood of occurrence in the study area.

4.2 STATE-LISTED SPECIES, COMMUNITIES AND POPULATIONS

4.2.1 THREATENED ECOLOGICAL COMMUNITIES

A search of the New South Wales Wildlife Atlas identified 27 threatened ecological communities (TECs) occurring within 10 kilometres of the study area. The vegetation mapping of the study area and surrounding regions (NPWS 2002/Tozer 2003) mapped four TECs within one kilometre of the study area (Table 4-14).

Table 4-14 Threatened Ecological Communities mapped within one kilometre of the study area

Name	Status under TSC Act
Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Endangered
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Endangered
Sydney Turpentine-Ironbark Forest	Endangered

Of the four TECs mapped in the immediate locality, two were confirmed to occur in the study area following ground truthing:

- Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW).

- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF).

The TECs recorded within the study area consisted of highly degraded fragments or scattered trees with a modified understorey dominated by exotic species.

Cumberland Plain Woodland (CPW)

The areas of Cumberland Plain Woodland (CPW) vegetation mapped in the study area includes characteristic trees of this community, namely *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark). The trees are present as scattered individuals in residential gardens and in roadside areas, some under powerlines and subject to repeated lopping. The ground layer beneath these trees is highly modified and consists of slashed or mown exotic grasses. There were occasional herb and grass species typical of Cumberland Plain Woodland growing on road verges, but their occurrence was sparse.

Plate 12 Scattered CPW trees – mainly *Eucalyptus tereticornis* – to north of Memorial Avenue

Plate 13 Lopped CPW tree beneath powerline to south of Memorial Avenue

Paragraph 6 of the Final Determination for Cumberland Plain Woodland in the Sydney Basin Bioregion states that the structure of the community varies according to past and current disturbances, and that most tree-dominated stands are regrowth. It is stated:

> *After total or partial clearing, the tree canopy may remain sparse or may regrow to form dense stands of saplings and small trees, which are typically associated with a ground layer of reduced cover and diversity. Either or both of the upper-storey and mid-storey may be absent from the community.*

Although the ground layer of the community may be reduced in cover or diversity, there is no indication in the Final Determination that patches completely lacking the characteristic ground layer species can be included in the community.

The study area supports characteristic trees of the critically endangered ecological community Cumberland Plain Woodland in the Sydney Basin Bioregion that are likely to be regrowth. Some of these trees have been repeatedly lopped for maintenance of clearance around overhead power lines. Given the lack of characteristic native understorey species beneath most of the trees, they are unlikely to meet the criteria for CPW as stated in the Final Determination for this community. For the purposes of impact assessment, however, the mapped areas of Disturbed regrowth Cumberland Plain Woodland are considered to form fragmented and degraded regrowth CPW.

Swamp Oak Floodplain Forest (SOFF)

The area of Swamp Oak Floodplain Forest (SOFF) vegetation mapped along Elizabeth Macarthur Creek to the north of Memorial Avenue was in poor condition, consisting of *Casuarina glauca* (Swamp Oak) over an understorey dominated by exotic species (see Table 3-6 for further details).

The Final Determination for SOFF states that the community has been extensively cleared and modified, severely fragmented by past clearing and that most examples of SOFF are affected by weeds. There is no criteria in the Final Determination for vegetation condition or species diversity, except that the structure of the community varies from open forests to low woodlands, scrubs or reedlands with scattered trees. As such, it is considered that the vegetation mapped as Disturbed Swamp Oak Forest meets the criteria in the Final Determination for this TEC.

4.2.2 THREATENED FLORA SPECIES

A search of the NSW Wildlife Atlas found records of 23 threatened flora species within 10 kilometres of the study area (Figure 4-12).The likelihood of each threatened species occurring in the study area was assessed (Appendix C). It was found that:

- Potential habitat for two local native threatened flora species listed under the TSC Act, *Acacia pubescens* (Downy Wattle) and *Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea) exists in the study area; however these species were considered to have a low likelihood of occurrence in the study area following targeted surveys.
- Another two threatened flora species listed under the EPBC Act, *Eucalyptus nicholii* (Narrow-leaved Black Peppermint) and *Syzygium paniculatum* (Magenta Lilly-pilly), were recorded in the study area. It was noted in the likelihood of occurrence assessment that these two species, as well as *Eucalyptus scoparia* (Wallangarra White Gum) – which was considered to have a moderate likelihood of occurrence – do not naturally occur within the locality of the study area and any records are likely to be planted specimens that are not of conservation significance.

All the threatened flora species listed under the TSC Act that have potential habitat within the study area, a moderate likelihood of occurrence or which are known from the study area are also listed under the EPBC Act. These species are discussed in further detail in section 4.1.1 of this report. There is a low likelihood of occurrence of cryptic flora species identified in the background searches to occur within the study area.

Figure 4-12 Records of threatened flora within 10 kilometres of the study area

4.2.3 THREATENED TERRESTRIAL FAUNA SPECIES

A search of the NSW Wildlife Atlas found records of 42 threatened fauna species within 10 kilometres of the study area (Figure 4-13).The likelihood of each threatened species occurring in the study area was assessed (Appendix D).

Analysis of Anabat call data determined that one threatened microchiropteran species (microbats), *Mormopterus norfolkensis* (Eastern Freetail Bat) was present on site at Elizabeth Macarthur Creek. This species is listed as Vulnerable under the TSC Act. Furthermore, potential call sequences of three additional threatened microbats also listed Vulnerable under the TSC Act were identified. This included:

- *Falsistrellus tasmaniensis* (Eastern False Pipstrelle) (Strangers Creek)
- *Myotis macropus* (Southern Myotis) (Strangers Creek)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) (Elizabeth Macarthur Creek)

The proposal area also provides potential habitat for the following threatened microbat species, also listed as Vulnerable under the TSC Act, which are considered to have a moderate likelihood of occurrence:

- *Miniopterus australis* (Little Bentwing Bat)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat).

The Grey-headed Flying-fox (*Pteropus poliocephalus*), listed as Vulnerable under the TSC Act, was considered to have a moderate likelihood of occurrence due to the presence of suboptimal foraging habitat.

The riparian zone of Elizabeth Macarthur Creek has been mapped as secondary habitat for the Green and Golden Bell Frog, listed as Endangered under the TSC Act, by Eco Logical (2012) as part of assessment for the North West Rail Link. Based on a review of the records in the area and an assessment of the habitat values in the study area, it is considered unlikely that this species would occur as discussed in Section 4.1.3.

4.2.4 THREATENED AQUATIC FAUNA SPECIES

Two threatened fish species were identified in the database searches. These included the Macquarie Perch (*Macquaria australasica*), listed as Vulnerable under the EPBC Act and Endangered under the FM Act, and the Australian Grayling (*Prototroctes maraena*), Vulnerable under the EPBC Act and Protected under the FM Act. Both species are considered to have a low likelihood of occurrence in the study area.

Figure 4-13 Records of threatened fauna within 10 kilometres of the study area

5 POTENTIAL IMPACTS

5.1 PROPOSAL ACTIVITIES

The proposal activities involve the following:

- Widen Memorial Avenue to a four-lane divided road. The width of the upgraded Memorial Avenue would vary from about 38 metres to 45 metres. The road widening would consist of:
  - Widening Memorial Avenue generally to the north of the existing road between Windsor Road and Hector Court. At this location, Memorial Avenue would be widened about 27 metres on the northern side and about five metres on the southern side
  - Widening Memorial Avenue generally to the south of the existing road between Hector Court and Old Windsor Road. At this location, Memorial Avenue would be widened about four metres on the northern side and about 23 metres on the southern side
- Widen Windsor Road between President Road and Wrights Road for a distance of about 550 metres. Windsor Road would be widened about seven metres on the eastern side and about 10 metres on the western side of the existing alignment. Widening is generally within the road reserve. The widening would provide:
  - An additional southbound through lane
  - An additional northbound through lane
  - Signalised left turn slip lanes on Windsor Road southern approach
  - An additional westbound right turn lane from Windsor Road northern approach
- Widen Old Windsor Road for a distance of about 350 metres either side of the intersection with Memorial Avenue/Sunnyholt Road. Old Windsor Road would be widened about seven metres on the eastern side and five metres on the western side of the existing alignment. The widening would provide:
  - An additional southbound through lane
  - An additional northbound through lane
  - An additional right turn lane from Old Windsor Road southern approach
- Provide a central median on Memorial Avenue. Its width would vary, from about nine metres up to about 12 metres, with the exception of the approach to Old Windsor Road, near the proposed NWRL, where the median would narrow to 2.9 metres. The wide median would enable Memorial Avenue to accommodate six lanes if required in the future
- Provide a kerb and gutter for the full length of Memorial Avenue
- Maintain the medians along Windsor Road and Old Windsor Road near Memorial Avenue, although an additional northbound right-turn lane would be included in the Old Windsor Road median
- Provide a verge of variable width on both sides of Memorial Avenue, Windsor Road, Old Windsor Road and Sunnyholt Road within the proposal area

- Provide a three-metre wide shared path within the verge on both sides of Memorial Avenue. This would tie in with the existing shared paths along Windsor Road and Old Windsor Road. The shared path next to the northbound carriageway on Old Windsor Road would be shifted slightly to the west to accommodate the road widening
- Provide bus priority capability at traffic lights and indented bus bays on both sides of Memorial Avenue to allow buses a head start in the east–west direction
- Provide bus priority capability at the Memorial Avenue traffic lights heading northbound on Windsor Road and an indented bus bay beyond the traffic lights
- Upgrade three intersections with Memorial Avenue:
  - The Windsor Road intersection would have an additional through lane in both directions, and additional right and left turning lanes into Memorial Avenue. Memorial Avenue would have an additional left slip lane onto Windsor Road (northbound) and an additional westbound lane on Memorial Avenue
  - The Arnold Avenue (west) intersection would be upgraded to a signalised four-way intersection with an additional through lane and dedicated left and right turning bays in each direction along Memorial Avenue, two additional right turning lanes from Arnold Avenue (west) and a new approach on Free Settlers Drive
  - The Old Windsor Road intersection would have an additional through lane in both directions, an additional lane turning right from the Old Windsor Road into Memorial Avenue from Old Windsor Road and an additional left turn slip lane onto Old Windsor Road from Memorial Avenue
- Close three intersections with Memorial Avenue at:
  - Hector Court, which would become a cul-de-sac as part of the development of the Balmoral Road Release Area
  - Rutherford Avenue (the slip lane out of Rutherford Avenue onto Memorial Avenue would be closed)
  - Arnold Avenue (east), which would become a cul-de-sac as part of the development of the Balmoral Road Release Area
- Build a new intersection with Memorial Avenue at Severn Vale Drive and realign Arnold Avenue (east) about 100 metres east of current alignment
- Replace the pipe culvert with a bridge over Strangers Creek (this would be an 18-metre span concrete plank bridge with vertical abutments)
- Upgrade the multi-cell box culverts at Elizabeth Macarthur Creek with a reinforced concrete box culvert, and upgrade the pipe culverts at two low points along Memorial Avenue, including the unnamed tributary of Strangers Creek
- Provide 1:4 landscaped earthen batters along the alignment beside public land, and 1:2 batters and/or retaining walls beside private land (to minimise property impact)
- Provide safety barriers alongside fill retaining walls and at the culvert and bridge locations along Memorial Avenue
- Relocate and/or temporarily divert underground utilities, including water, telecommunications, electricity and gas, within the verges.

The proposal includes one proposed stockpile site and two proposed compound sites. Smaller stockpile and storage areas may also be required along the length of the proposal within the proposal area. The proposed possible locations for compound sites for construction activities are located at the intersection of Memorial Avenue and Windsor Road. The property on the northwest corner would be directly impacted by the proposal and would be subject to full acquisition. The site on the southwest corner of the intersection is currently vacant and owned by Roads and Maritime. The proposed stockpile site is located on the southern side of Memorial Avenue at the location of the current car park at Kellyville Memorial Park. No clearing of any vegetation would be required for the proposed stockpile and compound sites in addition to what is proposed for the alignment.

5.2 LIKELY IMPACTS

5.2.1 LOSS OF NATIVE VEGETATION

Removal of native vegetation is required for the proposal. Most of the vegetation in the study area consists of cleared and disturbed areas, landscaped road verges with planted street trees, and planted native gardens. The proposal would mostly impact cleared, developed area and landscaped vegetation. Other impacts include removal of small amounts of vegetation comprising two threatened ecological communities (TECs): *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregion* and *Cumberland Plain Woodland in the Sydney Basin Bioregion*. Both TECs are listed under the TSC Act. Impact to these communities would not be significant. The areas of each vegetation community that occur within the project boundary and would be impacted are listed in Table 5-15 and shown in Figure 3-9.

Table 5-15 Vegetation mapped within project boundary

Vegetation Community	Equivalent (Endangered Ecological CommunityTEC)	Area of vegetation community occurring within the study area (ha)	Within project boundary (ha)
Disturbed Swamp Oak Forest	Cumberland Plain Woodland in the Sydney Basin Bioregion (TSC Act)	0.243	0.067
Disturbed Regrowth Cumberland Plain Woodland	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (TSC Act)	0.283	0.190
Native Rehabilitation	N/A	0.638	0.106
Disturbed Native Regrowth	N/A	0.738	0.224
Typha Wetland	N/A	0.107	0.063
Developed/Landscaped	N/A	21.599	10.664
Total		**23.608**	**11.314**

5.2.2 EDGE EFFECTS

Potential indirect impacts on native vegetation in the study area comprise edge effects associated with the creation of a new road edge, and could include weed invasion, altered hydrology and increased sedimentation and runoff.

A comprehensive review on edge effects and their compensation (Bali 2000 & 2005) suggests that only 60 per cent of the 50 metre strip of edge affected habitat should apply to road corridors. This takes into account that edge effects reduce the quality of habitat, but do not

completely remove their habitat values. Therefore indirect impacts as a result of edge effects could potentially affect a 30 metre wide strip adjoining the construction footprint.

The areas of native vegetation to be removed from the existing edge of Memorial Avenue are currently subject to edge effects, with disturbed soils and large patches of weedy exotic species, particularly close to the road edge. The widening of the road could potentially result in expansion of the existing edge effects, but most areas of vegetation further back from the road edge are already very disturbed.

5.2.3 WEEDS AND PATHOGENS

Ten of the 87 exotic species recorded in the study area are listed as noxious weeds in the Hawkesbury River County Council control area, which encompasses the Hills Shire Local Government Area (LGA). Invasive exotic grasses such as *Pennisetum clandestinum* (Kikuyu), *Chloris gayana* (Rhodes Grass) and *Ehrharta erecta* (Panic Veld-grass) also represent a threat to native vegetation. These grasses are currently abundant at the existing road edge and increased movement of people, vehicles, machinery, vegetation waste and soil during and following construction of the proposal may facilitate the introduction or spread of these weeds within and outside the study area.

The proposal has the potential to increase the spread of a number of pathogens that threaten native biodiversity values. Pathogens that may be associated with the study area listed in Table 5-16.

Table 5-16 Pathogens that may impact the study area

Pathogen	Threats	Dispersal method
Phytophthora cinnamomi (Phytophthora)	Soil borne pathogen that infects roots and is associated with damage and death to native plants.	May be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of *P. cinnamomi* may also be dispersed by vehicles (e.g. cars and earth moving equipment), animals, walkers and movement of soil.
Batrachochytrium dendrobatidis (Chytrid fungus)	Infectious fungus causing disease and death in frogs.	Water-borne fungus that may be spread by handling frogs or through contamination of water bodies.
Uredo rangelii (Myrtle Rust)	Plant disease caused by the introduced fungus *Uredo rangelli,* attacks young leaves of myrtaceous plants, eventually killing them.	Air-borne fungus that can be spread by moving infected plant material, and on clothing, equipment and vehicles.

All the listed pathogens are Key Threatening Processes under *the Threatened Species Conservation Act 1995* (TSC Act). No evidence of these pathogens was observed in the study area, but there may be an increased risk of dispersal as a result of the proposal. Precautionary measures are recommended during construction.

Given the low biodiversity values recorded in the study area, it is unlikely that further spread of weeds and/or pathogens as a result of the proposal would greatly impact on native vegetation. Weeds in particular are already widespread and dominant in the study area, and there is little

native vegetation in the study area or nearby. However measures should be implemented to avoid the spread of weeds, particularly adjoining any areas of retained native vegetation and the rehabilitation areas next to Strangers Creek.

5.2.4 LOSS OF FLORA HABITAT

The only threatened flora species recorded in the study area were planted specimens of the non-local native species *Eucalyptus nicholii* and *Syzygium paniculatum.* These plants are not considered to be of conservation value in the locality of the study area. The proposal would not result in loss of potential habitat for threatened flora species. The areas of disturbed native vegetation are not considered to provide potential habitat for threatened plant species, given that the understorey in these roadside areas are dominated by exotic species, mainly dense exotic grass cover.

5.2.5 LOSS OF FAUNA HABITAT

Clearing of vegetation for the proposal would result in the removal of fauna habitat. The areas of each fauna habitat type that occur within the project boundary are listed in Table 5-17 and shown in Figure 3-10.

Table 5-17 Areas of fauna habitat to be removed for the proposal

Fauna habitat type	Within proposal footprint (ha)
Riparian woodland	0.173
Disturbed roadside vegetation	11.078 (includes 0.414 hectares of native vegetation)
Aquatic vegetation	0.063
Total	**11.314**

The proposal would result in the removal of remnant and planted street trees and landscaped vegetation within an area of about 11.078 hectares, 0.414 hectares of which is native vegetation. Vegetation removal would result in potential impacts on nesting, roosting and foraging habitat for native and exotic birds, mammals and reptiles. This would include common urban birds such as Noisy Miner (*Manorina melanocephala*), Crimson Rosella (*Platycercus elegans*) and Spotted Pardalote (*Pardalotus punctatus*), microchiropteran bats and other native and exotic mammals such as Rabbits (*Oryctolagus cuniculus*) and common skinks such as the Eastern Striped Skink (*Ctenotus robustus*). Riparian habitat at three creeks would also be impacted (0.173 hectares) – aquatic vegetation at Elizabeth MacArthur Creek and Strangers Creek would be removed on the edge of the road corridor over an area of 0.063 hectares, and a few exotic trees would be removed within the riparian zone of the tributary of Strangers Creek. Impacts to aquatic and riparian vegetation could result in impacts to native fish and frogs such as Striped Marsh Frog (*Limnodynastes peronii*) and terrestrial fauna that occur in riparian habitats or forage in waterways, such as native waterbirds.

Hollow-bearing trees

One hollow-bearing tree and two potential hollow-bearing trees are located within the study area, but outside of the project boundary. The project boundary is within 5 metres of the potential hollow-bearing tree in the middle of the study area and as such, the root systems could

be impacted by earthworks and removal may be required. Removal of one potential hollow-bearing tree could impact arboreal fauna roosting/nesting in hollows, if they are present. It is unlikely that the other hollow-bearing tree and potential hollow-bearing tree would be impacted by the proposal due to their distance from the project boundary.

Threatened species

The proposal has the potential to impact seven threatened microbats from the removal of potential roost sites. This includes the following species listed as Vulnerable under the TSC Act:

- Eastern False Pipstrelle
- Little Bentwing-bat
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Southern Myotis
- Grey-headed Flying-fox
- Yellow-bellied Sheathtail-bat
- Greater Broad-nosed Bat

The removal of up to one potential hollow-bearing tree, removal of mature trees with exfoliating bark and culvert/bridge works have the potential to temporarily disturb roost habitats during construction. Furthermore, a small amount of potential foraging habitat in riparian areas would be permanently removed which could impact some of these species. Given the small amount of potential foraging habitat to be removed (0.236 hectares), potential impacts would be minor and are unlikely to be significant to any species. An Assessment of Significance has been prepared in Appendix E.

Furthermore, impacts to the Grey-headed Flying-fox, Vulnerable under the TSC Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), could occur as a result of the proposal. This would include the removal of potential foraging habitat for this species across the study area. Assessments of Significance under the TSC Act and EPBC Act have been undertaken in Appendix E. Impacts to this species are not likely to be significant.

5.2.6 HABITAT FRAGMENTATION

The study area is located in a highly modified and fragmented environment which has been historically cleared for urban and agricultural development in the surrounding lands and the road corridor. Some connectivity exists along riparian vegetation of Strangers Creek and Elizabeth Macarthur Creek. Removal of vegetation at these creeks would be over a small area (0.173 hectares) and impacts to habitat connectivity would be minor given vegetation removal would be undertaken on the edge of the road reserve which already fragments the vegetation.

5.2.7 MORTALITY OF FAUNA SPECIES

Fauna injury or mortality is most likely to occur during vegetation clearing activities, but also may result from collisions with vehicles or plant. The majority of fauna species recorded within the study area were highly mobile bird species and mammals. These species are likely to be able to move away from vegetation clearing activities quite readily. Any fauna inhabiting the hollows in hollow-bearing trees may be injured during tree-felling. This could potentially include hollow-dependent birds and mammals and threatened microchiropteran bat species. Those animals that are unable to disperse away from areas under active clearing are also particularly susceptible to injury or death. This includes amphibians, reptiles and fish during creek works

such as the Eastern Striped Skink (*Ctenotus robustus*) and Striped Marsh Frog (*Limnodynastes peroni*), species identified during site surveys.

5.2.8 ALTERATION AND DEGRADATION OF AQUATIC HABITATS

The Proposal would involve replacing the three culverts at Elizabeth Macarthur Creek with four three-metre wide culverts, and the culverts at Strangers Creek with a plank bridge 18 metres long. Works at these two creeks would require bank reshaping up and downstream of each crossing. The culvert at the unnamed tributary would be replaced with three 900 mm diameter pipes which would increase the current flow capacity. Fish passage would be maintained throughout the construction process at all creek crossings. Aquatic and riparian vegetation would be removed for creek works over a small area of 0.236 hectares, 0.063 hectares of which is instream vegetation. A total of 0.106 hectares of riparian/aquatic vegetation would be removed at Strangers Creek and 0.130 hectares would be removed at Elizabeth Macarthur Creek. Snags may also be removed from these creeks, though this would only occur within the disturbance footprints at each creek. Removal of aquatic vegetation and snags would have impacts to potential breeding and foraging habitat for frogs and fish. Scour protection would be installed at Strangers Creek and Elizabeth Macarthur Creek which would alter aquatic habitats in the immediate vicinity of each creek crossing. Whilst there would be a minor loss of instream vegetation and snags in this area as a result of the works and placement of scour protection, impacts are over a small area and are unlikely to impact aquatic ecosystems health of either creek. There is potential for sedimentation and spills to affect water quality in the creeks during the construction process which could also affect fish and frogs, including downstream of the study area. The creeks are highly degraded and existing fish and frogs likely to be impacted would be hardy and common species. No impacts to threatened aquatic species are anticipated as a result of the works.

Alterations to the natural flow regimes of rivers and streams is recognised as a major factor contributing to loss of biological diversity and ecological function in aquatic ecosystem and is recognised as a Key Threatening Process (KTP) under the TSC Act. Construction of the bridge at Strangers Creek and the culvert replacements at Elizabeth Macarthur Creek and the unnamed tributary would alter flow patterns at each creekline in the immediate vicinity of the crossings. The existing culverts at Strangers Creek convey flow over a width of 6 metres (4 pipes, 1.5 metres in diameter). It is proposed to replace the pipes with an 18 metres span plank bridge with a waterway opening of 7.5 metres, 1.5 metres wider than the current opening. The culvert at Elizabeth Macarthur Creek would be widened by 3 metres to convey flow over width of12 metres. One of the cells would be dropped to create a low-flow channel to allow fish passage when the creek is relatively dry. However, there would be a negligible increase in flow volumes at both creeks as a result of the proposal. As such, impacts to aquatic ecosystems from changes to flow regimes are therefore unlikely to occur at either creek. The culvert at the unnamed tributary would be increased by approximately 0.45 metres to convey flow over a width of 2.7 metres. There would be a small increase in flow at this creek however, it is identified as unlikely fish habitat and minor changes to the flow regimes of the tributary are unlikely to impact aquatic ecosystem function. .

5.3 KEY THREATENING PROCESSES

The proposal may result in the operation of a key threatening process or the exacerbation of a key threatening process currently in operation in the study area. Key threatening processes are listed under the TSC Act, *Fisheries Management Act 1994* (FM Act) and EPBC Act, and are generally defined as processes that adversely affect threatened species populations or

ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened.

The following Key Threatening Processes (KTP) have been considered with regard to the proposal (Table 5-18):

Table 5-18 Key Threatening Processes

Act	KTP	Applicability to Proposal
FM Act	Degradation of native riparian vegetation along NSW water courses.	The proposal requires the removal of degraded riparian vegetation, where it occurs within the project boundary. Given that a small area of this vegetation would be cleared (0.236 hectares) and the existing vegetation is currently heavily degraded, the proposal is unlikely to significantly contribute to this KTP.
FM Act	Removal of large woody debris from NSW rivers and streams.	During the construction phase of the proposal three creek beds would be disturbed and instream habitat would be impacted. This could include the removal of small snags.
FM Act	Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.	A plank bridge would replace the culverts at Strangers Creek. Culverts at Elizabeth Macarthur Creek and the unnamed tributary would be replaced for the proposal. All three creeks are heavily modified and the current flow regimes would be altered as a result of these works to a minor degree.
TSC Act EPBC Act	Clearing of native vegetation.	Native vegetation occurring within the project boundary requires removal. This includes regrowth native trees adjoining Memorial Avenue within the road reserve, and in residential gardens. A small area of disturbed Swamp Oak Floodplain Forest will also be cleared. The loss of native vegetation would result in the loss of habitat for a variety of species that forage, shelter, nest or roost in such vegetation in the study area.
TSC Act	Loss of hollow-bearing trees.	One potential hollow-bearing tree could be removed for the proposal.
TSC Act EPBC Act	Competition and grazing by the feral European rabbit.	Rabbits were recorded in the study area. Grazing by rabbits can reduce the survival and recruitment of several species of threatened plants, and reduce available foraging resources for native fauna. The proposal is unlikely to exacerbate this KTP.

Act	KTP	Applicability to Proposal
TSC Act	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.	A plank bridge would replace the culverts at Strangers Creek. Culverts at Elizabeth Macarthur Creek and the unnamed tributary would be replaced for the proposal. All three creeks are heavily modified and the current flow regimes would be altered as a result of these works to a minor degree. Construction activities of the proposal may increase the volumes of sediments carried downstream and reduce water quality occurring downstream.
TSC Act	Invasion of native plant communities by exotic perennial grasses.	Several exotic perennial grass species included in the final determination for this KTP occur in the study area: *Chloris gayana* (Rhodes Grass), *Cortaderia selloana* (Pampas Grass), *Ehrharta erecta* (Panic Veld-grass), *Paspalum urvillei* (Vasey Grass) and *Pennisetum clandestinum* (Kikuyu). The proposal may exacerbate this KTP by facilitating the spread of seeds or fragments, via plant or contaminated topsoil; given that these species are abundant ion the study area and adjoining areas, it is unlikely that spread of these grasses would extends to any areas where the species are not already present.

5.4 CUMULATIVE IMPACTS

The study area is characterised by existing rural/residential development, recent higher-density residential developments and lands currently subject to clearing and construction operations associated with development projects.

The proposal is located within the Balmoral Road Release Area and there is extensive current and future development planned for this area, including a 'Woolworths' supermarket near Hector Court Rd. Given the long history of clearing and modification of biodiversity values in the area, and the poor condition of the fragments of native vegetation currently occurring in the study area, it is considered that the proposal will not greatly add to the cumulative impacts of recent development of the area.

6 ASSESSMENT OF SIGNIFICANCE OF IMPACTS

Assessments of Significance were undertaken for all relevant threatened species, populations and communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) that were recorded, or for which potential habitat occurs in the study area. The assessments of significance are provided in Appendix E.

Significant Impact Assessments using the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Significant Impact Criteria (DEWHA 2009a) were undertaken for the threatened species and communities listed under the EPBC Act that were recorded or for which habitat occurs in the study area. No EPBC Act listed species or communities, or their habitat, were identified in the study area. The impact assessments are provided in Appendix E.

The threatened species, populations and communities recorded or considered to have a high to moderate likelihood of occurrence in the study area are listed in Table 6-19.

Table 6-19 Threatened Species, Populations and Ecological Communities for which impact assessments have been undertaken

Threatened entity	EPBC Act Status[1]	TSC Act Status[2]	Likelihood of occurrence	Impacts of proposal
Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW)		CE	Known	Loss of 0.190 ha
Swamp-oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF)		E	Known	Loss of 0.067 ha
Eastern Freetail-bat (*Mormopterus norfolkensis*)		V	Known	Loss of 0.236 ha of potential foraging habitat and scattered regrowth and planted trees representing potential roosting habitat.
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)		V	High	Loss of 0.236 ha of potential foraging habitat and scattered regrowth and planted trees representing potential roosting habitat.
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)		V	High	Loss of 0.236 ha of potential foraging habitat and temporary loss of potential roosting habitat in three culverts.

Threatened entity	EPBC Act Status[1]	TSC Act Status[2]	Likelihood of occurrence	Impacts of proposal
Southern Myotis (*Myotis macropus*)		V	High	Loss of 0.236 ha of potential foraging habitat and temporary loss of potential roosting habitat in three culverts.
Little Bentwing-bat (*Miniopterus australis*)		V	Moderate	Loss of 0.236 ha of potential foraging habitat and temporary loss of potential roosting habitat in three culverts.
Grey-headed Flying Fox (*Pteropus poliocephalus*)	V	V	Moderate	Loss of potential foraging habitat comprising scattered regrowth and planted trees.
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)		V	Moderate	Loss of 0.236 ha of potential foraging habitat and potential removal of roosting habitat in one hollow-bearing tree.
Greater Broad-nosed Bat (*Scoteanax rueppellii*)		V	Moderate	Loss of 0.236 ha of potential foraging habitat and potential removal of roosting habitat in one hollow-bearing tree.

1. Conservation status under EPBC Act: V = Vulnerable
2. Conservation status under TSC Act: CE = Critically Endangered, E = Endangered, V = Vulnerable

The findings of the assessments of significance are summarised in Table 6-20 and the findings of the EPBC Act significant impact assessments are summarised in Table 6-21.

Table 6-20 Summary of Assessments of Significance

Threatened species, population or communities	Significance assessment questions[1]							Likely significant impact?
	a	b	c	d	e	f	g	
Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW)	X	X	N	N	X	N	Y	No
Swamp-oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF)	X	X	N	N	X	N	Y	No
Eastern Freetail-bat (*Mormopterus norfolkensis*)	N	X	X	N	X	N	Y	No
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	N	X	X	N	X	Y	Y	No
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	N	X	X	N	X	N	Y	No

Threatened species, population or communities	Significance assessment questions[1]							Likely significant impact?
	a	b	c	d	e	f	g	
Southern Myotis (*Myotis macropus*)	N	X	X	N	X	Y	Y	No
Little Bentwing-bat (*Miniopterus australis*)	N	X	X	N	X	N	Y	No
Grey-headed Flying Fox (*Pteropus poliocephalus*)	N	X	X	N	X	N	Y	No
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	N	X	X	N	X	Y	Y	No
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	N	X	X	N	N	Y	Y	No

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

1. Significance Assessment Questions as set out in the Threatened Species Conservation Act 1995/ Environmental Planning and Assessment Act 1979.

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

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

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

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

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

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

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

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

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

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

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

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

Table 6-21 Summary of EPBC Act Assessments

Threatened species or communities	Important population[2]	Likely significant impact?
Grey-headed Flying Fox (*Pteropus poliocephalus*)	No	No

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

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

   b. is likely to be necessary for maintaining genetic diversity

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

7 PROPOSED DESIGN FEATURES AND MITIGATION MEASURES

The following approach is accepted by OEH and has been used in a number of case studies (DEC 2006) to provide biodiversity benefits:

- Avoid areas of high biodiversity value wherever possible;
- Mitigate actions and safeguard values identified for retention by prescribing appropriate controls; and
- Compensate for or offset the removal of biodiversity values.

7.1 AVOID IMPACTS

The impacts of the proposal on biodiversity have been minimised as far as other constraints allowed during the design process. The design includes a bridge at Strangers Creek to facilitate better outcomes for flora and fauna.

The identified ecological values should be avoided during construction as far as practicable (Table 7-22).

Table 7-22 Avoidance measures for the proposal

Activity	Issue	Avoidance Measure
Site establishment, earthworks and road construction	Vegetation removal	Avoid native vegetation including threatened ecological communities where possible. Locate sediment basins, stockpiles and other ancillary sites along disturbed edges, or in areas where the groundlayer is dominated by exotic grasses, or where an understorey is absent.
	Fauna habitat loss	• The design would be reviewed during the detailed design stage to determine whether it is possible to retain the potential hollow-bearing tree near the edge of the current design.

7.2 MITIGATE IMPACTS

7.2.1 SAFEGUARDS

Where impacts cannot be avoided, the safeguards in Table 7-23 would be implemented to mitigate these impacts during construction and operation of the proposal.

Table 7-23 Safeguards to be implemented

Impact	Environmental safeguards	Responsibility	Timing
Impacts on threatened species	A Biodiversity Management Plan (BMP) would be prepared and included within the CEMP. The BMP would include but not be limited to the following: - A map clearly showing vegetation clearing boundaries and sensitive areas/no-go zones - A site walk-over with the site personnel including RMS representatives to confirm clearing boundaries before the start of work - Identification (marking) of the clearing boundary and identification (marking) of habitat features to be protected. Eg. – use of flagging tape - A procedure for a suitably qualified ecologist to undertake pre-clearing surveys immediately before vegetation removal. Target species would include threatened microbats - Management measures identified as a result of the pre-clearing survey report, with actions to respond to the recommendations made - Incorporation of management measures identified as a result of the pre-clearing survey report, completed by an ecologist, (G40, section 2.4) and nomination of actions to respond to the recommendations made. This should include details of measures to be implemented to protect clearing limits and no go areas - A detailed clearing process in accordance with RMS Biodiversity Guidelines (2011) including requirements of Guide 1,2, 4 & 9. - Identify in toolbox talks where biodiversity would be included such as vegetation clearing or works in or adjacent to sensitive locations	RMS and construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	- Identify control/mitigations measures to prevent impacts on sensitive locations or no go zones - A stop works procedure in the event of identification of unidentified species, habitats or populations - A requirement that culverts be checked for roosting microbats by a suitably qualified ecologist with experience in microbat survey prior to construction. In the event microbats are found, a microbat management plan would be developed. - A requirement that culvert work and vegetation removal be carried out outside of summer, if possible (the breeding season of most threatened microbats that could be roosting on site) - A procedure for clearing potential habitat, including hollow-bearing trees in accordance with Roads and Maritime' *Specification G40*. An experienced, licensed wildlife carer or ecologist would be present to supervise vegetation clearing and capture then relocate fauna if required. Fauna handling and vegetation removal would be in accordance with Roads and Maritime' *Biodiversity Guidelines 2011*. An experienced, licensed wildlife carer or ecologist would be notified or be on call to supervise vegetation clearing and capture then relocate fauna if required. Fauna handling would be in accordance with Roads and Maritime' *Biodiversity Guidelines 2011 – Guide 9*. - Protocols to prevent the introduction or spread of pathogens (e.g. chytrid fungus and *Phytophthora*) in accordance with Roads and Maritime' *Biodiversity Guidelines 2011 – Guide 7*. - Provision of education to all personnel taking part in construction activities with regards to the importance of clearing limits, land uses and threatened species and communities and their legislative responsibilities.		
	If unexpected threatened flora or fauna are discovered, works would stop immediately and the *RTA Unexpected Threatened Species Find*	RMS and construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	Procedure in the RMS Biodiversity Guideline 2011 implemented.		
	The design would be reviewed during the detailed design stage to determine whether it is possible to retain the potential hollow-bearing tree near the edge of the current design.	RMS	Pre-construction
Impacts to riparian areas	Riparian areas disturbed by the proposal would be rehabilitated as soon as practicable. Where vegetation would be planted in disturbed riparian areas, only native species indigenous to the region would be used.	RMS and construction contractor	Pre-construction
Impacts on the aquatic environment	Creek bank stabilisation would be installed prior to and during the creek realignment works in order to minimise bank erosion, topsoil loss and sedimentation of the waterway.	RMS and construction contractor	Detailed design and construction
	Appropriate erosion and sediment controls would be established at creek crossings throughout construction.	RMS and construction contractor	Construction
	Fish passage would be maintained at all times. If required, water would be pumped to maintain flow at all times in the event of low flow ponding during creek works	Construction contractor	Construction
	Creek diversion would be scheduled during periods of predicted low flow to minimise impacts.	RMS and construction contractor	Construction
	DPI (Fisheries) would be notified of reclamation/dredging work prior to construction. Consideration would be given to any response within 28 days of notification.	RMS	Pre-construction
	Snag removal would be kept to a minimum.	RMS and construction contractor	Construction
Weeds and pathogens	Actions for weed management would be developed as part of the Vegetation Management Plan in accordance with the requirements of Roads and Maritime' *Specification G36* and *Specification G40*. The plan would include, but not be limited to the following measures: - The identification of the type and location of weeds of concern (including noxious weeds) within the proposal area - The identification of sensitive receivers (such as native vegetation and waterways) within or near the proposal area	RMS and construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	- Measures to prevent the spread of weeds and fungi, including hygiene procedures for equipment, footwear and clothing - A requirement that weeds (including Declared noxious weeds) be managed and disposed of in accordance with requirements of the *Noxious Weeds Act 1993* and *Roads and Maritime' Biodiversity Guidelines 2011 – Guide 6* - Communication strategies to improve contractor awareness of weeds and weed management.		
	Any application of herbicide for weed management would be undertaken in accordance with the requirements of the *Pesticides Act 1999* and herbicide that is appropriate to the sensitivity of the area would be used. Approval by the RMS Regional Environmental Officer would be obtained prior to use.	Construction contractor	Pre-construction and construction

7.3 OFFSET IMPACTS

If impacts are unable to be avoided or safeguarded against, biodiversity offsets may be used to counterbalance the impact of development on biodiversity. The Roads and Maritime *Guideline for Biodiversity Offsets* (Roads and Maritime Services 2011) was reviewed to determine whether biodiversity offsets would be required for the current proposal.

Step 1 of the guideline includes a table providing guidance on whether offsets should be considered for a project assessed under Part 5 of the EP&A Act. The biodiversity values identified in the study area were compared with the offset requirements in the guideline table (Table 7-24).

Table 7-24 Assessment of biodiversity values of the study area with Table 1 of the Roads and Maritime Biodiversity Offset Guidelines

Description of Activity or Impact	Consider Offsets?	Study area values
1. Activities in accordance with Roads and Maritime Services *Environmental assessment procedure: Routine and Minor Works* (RTA 2011).	No	N/A
2. Works on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present.	No	Most of the study area supports Cleared/Developed vegetation.
3. Works involving clearing of native vegetation with no potential habitat for threatened species but not involving native vegetation outlined in **5**.	No	All native vegetation in the study area provides potential habitat for threatened species.
4. Works involving clearing of native vegetation containing potential habitat for threatened species but not involving native vegetation outlined in **5**.	Where clearing area > **5 ha**.	Native vegetation containing potential habitat for threatened species comprises 0.236 ha of potential foraging habitat and scattered regrowth and planted trees.
5. Works involving clearing of native vegetation of **high** conservation value including: • A vegetation type more than 70% cleared in NSW or, • Threatened Ecological Communities in moderate to good condition. Contains threatened species or their habitat that cannot withstand any loss in the Catchment Management Authority region as defined in OEH Threatened Species Profile database.	Where clearing area > **1 ha**.	The area of Threatened Ecological Communities (TECs) to be impacted is 0.257 hectares. The TECS in the study area are in poor condition.

Description of Activity or Impact	Consider Offsets?	Study area values
6. Works involve clearing of native vegetation or threatened species and/or threatened species habitat of **very high** conservation value including: • A vegetation type that is more than 90% cleared in NSW where the patch size of the impacted vegetation is greater than 4 ha or, • Areas where any removal would likely result in local extinctions of communities or species. • Type 1 or Type 2 sensitive key fish habitat (as identified by NSW Fisheries) where the impact cannot be otherwise mitigated.	Where there is any clearing.	This vegetation/habitat is not present in the study area.
7. Works other than clearing that would lead to an impact on the long term survival of the species in the region and there is no reasonable or feasible measure available to mitigate the impact. For example creating a barrier to the movement of threatened species.	Yes	This impact will not occur as a result of the proposal.

According to the Roads and Maritime Biodiversity Offset Guidelines, biodiversity offsets would not be required as a result of the proposal.

8 CONCLUSION

This Biodiversity Assessment is based on desktop research and detailed field surveys, carried out over three days in late March 2014.

A total of 160 plant species were recorded in the study area, comprising 63 local native species, 10 non-local native species and 87 exotic species. No local native threatened plant species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *Threatened Species Conservation Act 1995* (TSC Act) were recorded in the study area, nor were any considered likely to occur following targeted surveys. Two of the non-local native species recorded in the study area are listed as threatened species under the EPBC Act and TSC Act: *Eucalyptus nicholii* (Narrow-leaved Peppermint) and *Syzygium paniculatum* (Magenta Lilly-pilly). These planted individuals are not of conservation significance.

The majority of vegetation in the study area was cleared and disturbed and varied from highly modified or cleared lands dominated by planted native and exotic species to scattered roadside trees with a disturbed understorey. Two threatened ecological communities listed under the TSC Act were identified in the study area, based on analysis of existing vegetation maps and ground truthing:

- Cumberland Plain Woodland in the Sydney Basin Bioregion.
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions.

The threatened ecological communities recorded within the study area consisted of highly degraded fragments or scattered trees with a modified understorey dominated by exotic species.

Fauna surveys identified the presence or potential presence of four exotic and 27 native fauna species in the study area. Analysis of Anabat call data determined that one threatened microbat, *Mormopterus norfolkensis* (Eastern Freetail Bat) was present on site at Elizabeth Macarthur Creek. This species is listed as Vulnerable under the TSC Act. Furthermore, potential call sequences of three additional threatened microbats also listed Vulnerable under the TSC Act were identified. This included:

- *Falsistrellus tasmaniensis* (Eastern False Pipstrelle)
- *Myotis macropus* (Southern Myotis)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat)

Three broad fauna habitat types were identified in the study area: riparian woodland, disturbed roadside vegetation and aquatic vegetation. The locality is urban and there is minimal habitat connectivity within and beyond the road corridor. Some fauna connectivity exists along riparian vegetation of Strangers Creek and Elizabeth Macarthur Creek.

Three highly modified and degraded creeklines pass through the study area – Strangers Creek, Elizabeth Macarthur Creek and an unnamed tributary of Strangers Creek. These creek lines would provide habitat for fish and frog species, however no threatened aquatic habitat is present; the creeks are highly degraded and fish and frogs likely to occur would be hardy and common species.

The proposal would have the following impacts on biodiversity:

- Loss of native vegetation, including threatened ecological communities in poor condition. A total of 0.65 hectares of native vegetation would be directly impacted, of which 0.257 hectares had been mapped as threatened ecological communities.

- Edge effects associated with the creation of a new road edge, including weed invasion, altered hydrology and increased sedimentation and runoff. Most areas of vegetation further back from the road edge are already very disturbed.
- Increased risk of weed and pathogen spread into adjacent areas.
- Loss of fauna habitat, including potential habitat for threatened fauna species. This includes the removal of culverts at the three creek crossings and potential removal of one potential hollow-bearing tree which could impact threatened microbat roosts and the removal of potential foraging habitat for threatened microbats and the threatened Grey-headed Flying-fox (*Pteropus poliocephalus*), listed under the TSC Act and EPBC Act.
- Further minor fragmentation of the already highly fragmented habitat in the study area.
- Mortality of fauna species.
- Alteration and degradation of aquatic habitats resulting from replacement and extension of culverts.

Assessments of significance under the TSC Act and Significant Impact Assessments under the EPBC Act were undertaken for all threatened species, populations and communities recorded or considered to have a high to moderate likelihood of occurrence in the study area. The assessments concluded that the proposal would not have a significant impact on any of the threatened species, populations or communities considered. A Species Impact Statement or a referral to the Australian Government Minister for the Environment will not be required.

Mitigation measures have been recommended where impacts cannot be avoided, and the implementation of these measures should reduce adverse impacts on ecological values of the study area. Key mitigation measures for the proposal are:

- Preparation of a Flora and Fauna Management Plan as part of the Construction Environmental Management Plan (CEMP).
- Marking of retained native vegetation on site plans and in the field with inductions to include advice on the sensitivity of these areas.
- Creek bank stabilisation during construction and remediation of the riparian zone following construction in accordance with a riparian vegetation management plan.
- Weed and pathogen management measures during and following construction.

A review of the Roads and Maritime Biodiversity Offset Guidelines found that biodiversity offsets would not be required as a result of the proposal, as the extent of clearing of native vegetation is very low and vegetation of conservation significance in the study area is in poor condition.

REFERENCES

Bannerman S.M. and Hazelton P.A. (1990) *Soil Landscapes of the Penrith 1:100,000 Map Sheet* (Soil Conservation Service NSW, Sydney)

Brooker M.I.H. and Kleinig D.A. (2006) *Field Guide to Eucalypts. Volume 1: South-eastern Australia.* Bloomings Books Pty Ltd, Melbourne.

Churchill, S. (1998) *Australian Bats*. Reed New Holland, Frenchs Forest.

Clark, N. R. and Jones, D. C. (1990) *Geology of the Penrith 1:100 000 map sheet.*NSW Department of Mineral Resources.

Commonwealth of Australia (2010) *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest: A guide to identifying and protecting the nationally threatened ecological community.*Environment Protection and Biodiversity Conservation Act 1999 Policy Statement 3.3.1.

DEC (2005) *Draft Recovery Plan for the Green and Golden Bell Frog (*Litoria aurea*).* NSW Department of Environment and Conservation, Hurstville.

DECC (2007) *Threatened Species Assessment Guidelines: the assessment of significance.* NSW Department of Environment and Climate Change, Hurstville.

DECC (2007a) *Changes in the distribution of Cumberland Plain Woodland*. NSW Department of Environment and Climate Change Hurstville.

DECC (2008) *Best Practice Guidelines: Green and Golden Bell Frog Habitat*. NSW Department of Environment and Climate Change, Hurstville.

DECC (2009) *Threatened Species Survey and Assessment Guidelines Amphibians: Field Survey Methods for Fauna*. NSW Department of Environment and Climate Change, Hurstville.

DECCW (2009) *Draft National Recovery Plan for the Grey-headed Flying-fox* Pteropus poliocephalus. Prepared by Dr Peggy Eby. Department of Environment, Climate Change and Water NSW, Sydney.

DECCW (2010) *Cumberland Plain Recovery Plan.* Department of Environment, Climate Change and Water NSW, Sydney.

DEWHA (2009) *Matters of National Significance. Significant Impact Guidelines 1.1.* Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia 2009.

DoE (2014) *National Flying-Fox Monitoring Program - Flying Fox Census.* Commonwealth Government Department of the Environment.

DoE (2014a) Pteropus poliocephalus - *Grey-headed Flying-fox SPRAT Profile*. Commonwealth Government Department of the Environment.

Eco Logical Australia (2012) *Ecological Assessment for the North West Rail Link.* Prepared for Transport NSW.

Fairfull, S. and Witheridge, G. (2003) *Why do Fish Need to Cross the Road?* Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla, 16 pp.

Harden G. (1990-1993) *Flora of New South Wales Volumes 1-4.* University of New South Wales Press, Kensington.

Harden G. (2002) *Flora of New South Wales Volume 2 (Revised Edition).* University of New South Wales Press, Kensington.

Livengood Consulting (2010) *Anabat Techniques Workshop Course Manual*.

Harden G. (1990-1993) *Flora of New South Wales Volumes 1-4.* University of New South Wales Press, Kensington.

Harden G. (2002) *Flora of New South Wales Volume 2 (Revised Edition).* University of New South Wales Press, Kensington.

Hills Shire Council (2010) *Vegetation Cover Map: Sheets 3 and 5.* Sheets prepared on 10 August 2010.

NPWS (2001) *Threatened Species Information: Grey-headed Flying-fox* Pteropus poliocephalus *Temminck, 1825*. National Parks and Wildlife Service, NSW.

OEH (2008) *Vegetation Types Database*. Office of Environment and Heritage, Hurstville NSW.

OEH (2014) *Bionet NSW Atlas of Wildlife*. Office of Environment and Heritage, NSW.

OEH (2014a) Threatened Species Profile: *Eucalyptus nicholii* (Narrow-leaved Black Peppermint). NSW Office of Environment and Heritage. Updated 20 January 2014.

OEH (2014b) *Eastern False Pipistrelle – profile*. Office of Environment and Heritage, NSW.

OEH (2014c) *Little Bentwing-bat – profile*. Office of Environment and Heritage, NSW.

OEH (2014d) *Southern Myotis – profile*. Office of Environment and Heritage, NSW.

OEH (2014e) *Yellow-bellied Sheathtail Bat – profile*. Office of Environment and Heritage, NSW.

OEH (2014f) *Greater Broad-nosed Bat – profile*. Office of Environment and Heritage, NSW.

OEH (2014g) *Green and Golden Bell Frog - Profile*. Office of Environment and Heritage, NSW.

Pennay, M., Law, B. & Reinhold, L. (2004) *Bat Calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.

Roads and Maritime Services (2011) *Guideline for Biodiversity Offsets.* Dated November 2011.

RTA (2011) *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects*.

The Royal Botanic Gardens and Domain Trust (2014a) *PlantNET - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney, Australia (version 2.0).* http://plantnet.rbgsyd.nsw.gov.au

Tozer (2003) The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities*. Cunninghamia* **8(1)**: 1-75.

APPENDIX A

FULL LIST OF FLORA SPECIES RECORDED

Flora species recorded in the study area

Note: * indicates exotic species; # indicates non-local native species

Family	Scientific name	Common name
Gymnosperms		
Araucariaceae	*Araucaria heterophylla*	Norfolk Island Pine
Cupressaceae	* *Cupressus sp.*	
Pinaceae	* *Pinus sp.*	
Podocarpaceae	*Podocarpus elatus*	Plum Pine, Brown Pine
Angiosperms - Dicotyledons		
Amaranthaceae	*Alternanthera denticulata*	Common Joyweed
Anacardiaceae	* *Schinus areira*	Pepper Tree, Peppercorn
Apiaceae	*Centella asiatica*	Indian Pennywort
	* *Cyclospermum leptophyllum*	Slender Celery
	* *Foeniculum vulgare*	Fennel
Apocynaceae	* *Araujia sericifera*	Moth Vine, Cruel Plant
Araliaceae	# *Schefflera actinophylla*	Queensland Umbrella Tree
Asteraceae	* *Aster subulatus*	Wild Aster
	* *Bidens pilosa*	Cobblers Pegs
	* *Cirsium vulgare*	Black Thistle, Spear Thistle
	* *Conyza sumatrensis*	Tall Fleabane
	* *Hypochaeris radicata*	Catsear, False Dandelion
	* *Lactuca serriola*	Prickly Lettuce, Compass Plant
	* *Senecio madagascariensis*	Fireweed, Madagascar Ragwort
	* *Sonchus oleraceus*	Common Sow-thistle, Milk-thistle
	* *Taraxacum officinale*	Dandelion
Basellaceae	* *Anredera cordifolia*	Madeira Vine, Lamb's Tail
Bignoniaceae	* *Jacaranda mimosifolia*	Jacaranda
	Pandorea jasminoides	Bower Creeper
Brassicaceae	* *Brassica sp.*	
Buxaceae	* *Buxus sempervirens*	Common Box
Cactaceae	* *Opuntia stricta*	Prickly Pear, Common Pest Pear
Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell
Caprifoliaceae	* *Lonicera japonica*	Japanese Honeysuckle
Casuarinaceae	*Casuarina glauca*	Swamp Oak, Swamp She-oak

Family	Scientific name	Common name
Celastraceae	* *Euonymus japonicus*	
Chenopodiaceae	* *Chenopodium album*	Fat Hen
	Einadia hastata	Berry Saltbush
	Einadia nutans subsp. linifolia	Climbing Saltbush
Convolvulaceae	*Dichondra repens*	Kidney-weed, Mercury Bay Weed
Euphorbiaceae	* *Euphorbia peplus*	Petty Spurge, Radium Plant
	* *Triadica sebifera*	Chinese Tallow Tree
Fabaceae Faboideae	* *Cytisus scoparius*	English Broom, Common Broom
	Daviesia ulicifolia	Gorse Bitter-pea
	* *Erythrina x sykesii*	Coral Tree
	* *Genista monspessulana*	Montpelier Broom
	Glycine tabacina	
	Hardenbergia violacea	False Sarsaparilla
	* *Medicago polymorpha*	Burr Medic
	* *Robinia pseudoacacia*	Black Locust, False Acacia
	* *Trifolium pratense*	Red Clover
	* *Trifolium repens*	White Clover
	* *Wisteria sinensis*	Chinese Wisteria
Fabaceae Mimosoideae	*Acacia decurrens*	Black Wattle
	Acacia floribunda	White Sally
	Acacia parramattensis	Parramatta Green Wattle
Fagaceae	* *Quercus robur*	English Oak, Pedunculate Oak
Geraniaceae	* *Pelargonium (Zonal hybrid)*	Zonal Geranium
Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia
Hamamelidaceae	* *Liquidambar styraciflua*	Liquidambar, Sweet Gum
Lobeliaceae	*Pratia purpurascens*	Whiteroot
Loranthaceae	*Muellerina eucalyptoides*	Creeping Mistletoe
Malaceae	* *Eriobotrya japonica*	Loquat
Malvaceae	* *Malva sp.*	Mallow
	* *Modiola caroliniana*	Red-flower Mallow
	* *Sida rhombifolia*	Paddy's Lucerne
Meliaceae	*Melia azedarach*	White Cedar, Persian Lilac
Moraceae	* *Morus alba*	Mulberry

Family	Scientific name	Common name
Myrtaceae	*Angophora costata*	Sydney Red Gum, Smooth-barked Apple
	Angophora floribunda	Rough-barked Apple
	Callistemon citrinus	Scarlet Bottlebrush
	Callistemon viminalis	Weeping Bottlebrush
	# *Corymbia citriodora*	Lemon-scented Gum
	Corymbia eximia	Yellow Bloodwood
	Corymbia maculata	Spotted Gum
	Eucalyptus crebra	Narrow-leaved Ironbark
	# *Eucalyptus microcorys*	Tallowwood
	Eucalyptus moluccana	Grey Box
	# *Eucalyptus nicholii*	Narrow-leaved Black Peppermint
	# *Eucalyptus saligna*	Sydney Blue Gum
	Eucalyptus tereticornis	Forest Red Gum
	Kunzea ambigua	Tick-bush
	Leptospermum polygalifolium	Tantoon
	# *Lophostemon confertus*	Brush Box
	Melaleuca armillaris	Bracelet Honey-myrtle
	Melaleuca decora	White Cloud Tree
	Melaleuca linariifolia	Flax-leaved Paperbark
	Melaleuca quinquenervia	Broad-leaved Paperbark
	Melaleuca styphelioides	Prickly Paperbark
	Syncarpia glomulifera	Turpentine
	# *Syzygium paniculatum*	Magenta Brush Cherry
Nyctaginaceae	* *Bougainvillea sp.*	
Ochnaceae	* *Ochna serrulata*	Mickey Mouse Plant
Oleaceae	* *Ligustrum lucidum*	Broad-leaved Privet, Glossy Pribet
Oleaceae	* *Ligustrum sinense*	Small-Leaved Privet, Chinese Privet
	* *Olea europaea*	Olive
Passifloraceae	* *Passiflora caerulea*	
Phytolaccaceae	* *Phytolacca octandra*	Inkweed
Pittosporaceae	*Bursaria spinosa*	Blackthorn
	Pittosporum undulatum	Pittosporum
Plantaginaceae	* *Plantago lanceolata*	Plantain, Ribwort

Family	Scientific name	Common name
Polygonaceae	*Persicaria decipiens*	Slender Knotweed
	* *Polygonum aviculare*	Wire Weed
	* *Rumex conglomeratus*	Clustered Dock
Portulacaceae	*Portulaca oleracea*	Pigweed, Purslane
Proteaceae	*Banksia ericifolia*	Heath-leaved Banksia
	# *Grevillea (hybrid)*	
	# *Grevillea (hybrid) 'Robyn Gordon'*	
	# *Grevillea robusta*	Silky Oak
Punicaceae	* *Punica granatum*	Pomegranate
Rosaceae	* *Rubus anglocandicans*	Blackberry
Rutaceae	* *Murraya paniculata*	Jasmine-orange, Cosmetic Bark
Salicaceae	* *Salix alba x fragilis*	
	* *Salix babylonica*	Weeping Willow
Sapindaceae	*Dodonaea viscosa*	Sticky Hopbush
Simaroubaceae	* *Ailanthus altissima*	Tree-of-Heaven
Solanaceae	* *Brugmansia aurea*	Angels Trumpet (Golden-Pink)
	* *Lycianthes rantonnetii*	Blue Potato Bush
	Solanum americanum	Blackberry Nightshade
	* *Solanum seaforthianum*	Brazilian Nightshade
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia
Ulmaceae	* *Celtis sinensis*	Chinese Hackberry
	* *Ulmus parvifolia*	Chinese Elm
Verbenaceae	* *Verbena bonariensis*	Purpletop
Angiosperms - Monocotyledons		
Agavaceae	* *Agave americana*	Century Plant, American Aloe
Alismataceae	*Alisma plantago-aquatica*	Water-plantain
Anthericaceae	*Tricoryne elatior*	Yellow Rush Lily
Araceae	* *Monstera deliciosa*	Fruit-salad Plant, Ceriman, Imbe
Arecaceae	* *Phoenix canariensis*	Canary Island Date
	* *Syagrus romanzoffiana*	Cocos Palm, Queen Palm
Asparagaceae	* *Asparagus asparagoides*	Bridal Creeper, Florists' Smilax
Commelinaceae	*Commelina cyanea*	Blue Spiderwort
	* *Tradescantia fluminensis*	Wandering Jew

Family	Scientific name	Common name
Cyperaceae	*Carex appressa*	Tall Sedge
	* *Cyperus eragrostis*	Drain Flat-sedge, Umbrella Sedge
	Cyperus gracilis	Slender Sedge
Dracaenaceae	* *Sansevieria trifasciata*	Mother-in-law's Tongue
Juncaceae	* *Juncus acutus*	Spiny Rush
	Juncus usitatus	Common Rush
Lomandraceae	*Lomandra filiformis subsp. coriacea*	Wattle Mat-rush
	Lomandra longifolia	Spiny-headed Mat-rush
Phormiaceae	*Dianella caerulea*	Blue Flax-lily
Poaceae	*Aristida vagans*	Threeawn Speargrass
	* *Axonopus fissifolius*	Narrow-leaved Carpet Grass
	Bothriochloa macra	Redleg Rass
	* *Briza maxima*	Quaking Grass
	* *Chloris gayana*	Rhodes Grass
	* *Chloris virgata*	Feathertop Rhodes Grass
	* *Cortaderia selloana*	Pampas Grass
	Cynodon dactylon	Couch, Bermuda Grass
	* *Digitaria ciliaris*	Summer Grass
	*	Barnyard Grass
	* *Ehrharta erecta*	Panic Veld-grass
	* *Eleusine indica*	Crowsfoot Grass
	Imperata cylindrica	Blady Grass
	Microlaena stipoides	Weeping Grass
	Oplismenus imbecillis	Narrow-leaved Basket Grass
	* *Paspalum dilatatum*	Paspalum
	* *Paspalum urvillei*	Vasey Grass
	* *Pennisetum clandestinum*	Kikuyu Grass
	* *Setaria parviflora*	
	* *Sporobolus africanus*	Rat-tail Grass, Parramatta Grass
	Sporobolus creber	Slender Rat's-tail Grass
	Themeda australis	Kangaroo Grass
Strelitziaceae	* *Strelitzia reginae*	Bird-of-Paradise Flower
Typhaceae	*Typha orientalis*	Broad-leaf Cumbungi, Bulrush

APPENDIX B

FULL LIST OF FAUNA SPECIES RECORDED

Legend

General Status	
*	Exotic/introduced species
(?)	Uncertain identification
P	Protected
U	Unprotected

Conservation Status	
V TSC	Vulnerable - listed under Schedule 2 of the TSC Act

Observation Type			
O	Observed	F	Warren
P	Scat		
W	Heard call		
AR	Anabat recording		

Status	Group	Scientific Name	Common Name	Observation Type
P	Amphibian	*Limnodynastes peronii*	Striped Marsh Frog	W
P	Bird	*Acanthiza nana*	Yellow Thornbill	O
*	Bird	*Acridotheres tristis*	Common Myna	W
P	Bird	*Chenonetta jubata*	Australian Wood Duck	O
P	Bird	*Coracina novaehollandiae*	Black-faced Cuckoo Shrike	O
P	Bird	*Cormobates leucophaeus*	White-throated Treecreeper	W
P	Bird	*Corvus coronoides*	Australian Raven	W
P	Bird	*Dacelo novaeguineae*	Laughing Kookaburra	O
P	Bird	*Grallina cyanoleuca*	Magpie Lark	W
P	Bird	*Gymnorhina tibicen*	Australian Magpie	W
P	Bird	*Malurus cyaneus*	Superb Fairy Wren	O
P	Bird	*Manorina melanocephala*	Noisy Miner	W
P	Bird	*Ocyphaps lophotes*	Crested Pigeon	O
P	Bird	*Pardalotus punctatus*	Spotted Pardalote	W
P	Bird	*Platycercus elegans*	Crimson Rosella	W
P	Bird	*Psephotus haematonotus*	Red-rumped Parrot	W

Status	Group	Scientific Name	Common Name	Observation Type
*	Bird	*Streptopelia chinensis*	Spotted Turtle-Dove	W
P	Bird	*Trichoglossus haematodus*	Rainbow Lorikeet	O/W
P	Bird	*Vanellus miles*	Masked Lapwing	W
P	Mammal	*Chalinolobus gouldii*	Gould's Wattle Bat	AR
V-TSC	Mammal	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	AR Potential
V-TSC	Mammal	*Mormopterus norfolkensis*	Eastern Freetail Bat	AR
P	Mammal	*Mormopterus sp. 2*	Mormopterus Species 2	AR Potential
V-TSC/P	Mammal	*Miniopterus schreibersii oceanensis/Vespadelus sp.*call confusion	Eastern Bentwing-bat/ Vespadelus sp.	AR Call confusion
V-TSC	Mammal	*Myotis macropus*	Southern Myotis	AR Potential
P	Mammal	*Nyctophilus sp.*	Unidentified Nyctophilus sp.	AR
*	Mammal	*Oryctolagus cuniculus*	Rabbit	P/F
P	Mammal	*Tadarida australia*	White-striped Mastiff Bat	AR
P	Mammal	*Vespadelus pumilis*	Eastern Forest Bat	AR Potential
*	Mammal	*Vulpes vulpes*	Fox	P
P	Reptile	*Ctenotus robustus*	Eastern Striped Skink	O

APPENDIX C

THREATENED FLORA SPECIES IN THE LOCAL AREA

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Acacia bynoeana	Bynoe's Wattle	Endangered	Vulnerable	Semi-prostrate shrub to 1m high. Occurs from the coast to the Blue Mountains and Morisset in the north to the Southern Highlands in the south. Found in heath or dry sclerophyll forest on sandy soils, often in slightly disturbed areas, in association with Red Bloodwood, Scribbly Gum, Parramatta Red Gum.	15	Low. Closest record is 3 km to the east. No potential habitat within study area.
Acacia gordonii		Endangered	Endangered	Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops. Restricted to the north-west of Sydney with disjunct distributions in the lower Blue Mountains and the Maroota/Glenorie area.	1	Low. Closest record is 3.5 km to the east. No potential habitat within study area.
Acacia pubescens	Downy Wattle	Vulnerable	Vulnerable	Known from Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones	13	Low. Closest record is 2.5 km to east. Although marginal potential habitat occurs within the study area, targeted searches for this conspicuous shrub did not locate any individuals of the species.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Allocasuarina glareicola		Endangered	Endangered	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil. Found in open woodland with *Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri, Eucalyptus sclerophylla* and *Melaleuca decora.*	0	Low No records within 10 km of study area. No potential habitat within study area.
Asterolasia elegans	-	Endangered	Endangered	Found in sheltered forests on mid- to lower slopes and valleys on Hawkesbury Sandstone. Known from only seven populations north of Sydney in the Baulkham Hills. Hawkesbury and Hornsby Local Government Areas.	0	Low No records within 10 km of study area. No potential habitat within study area.
Cryptostylis hunteriana	Leafless Tongue-orchid	Vulnerable	Vulnerable	Known from a range of communities including swamp, heath and most typically woodland dominated by *Eucalyptus sclerophylla, E. sieberi, Corymbia gummifera* and *Allocasuarina littoralis.*	0	Low No records within 10 km of study area. No potential habitat within study area.
Darwinia biflora		Vulnerable	Vulnerable	An erect to spreading shrub to 80cm high. Occurs on margin of weathered shale-capped ridges in north-western Sydney, where these intergrade with Hawkesbury Sandstone. Occurs in woodland or open forest in association with *Eucalyptus haemastoma, Corymbia gummifera* and/or *E. squamosa.*	326	Low. Closest record is 2 km to the north-east. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Dillwynia tenuifolia		Vulnerable	Vulnerable	The core distribution is on the Cumberland Plain from Windsor to Penrith east to Deans Park; in Liverpool LGA the species has been recorded from Voyager Point and Kemps Creek. May be locally abundant within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest; may also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	17	Low. Closest record is 7.5 km to the west. No potential habitat within study area.
Epacris purpurascens var. purpurascens		Vulnerable		Grows in sclerophyll forest, scrubs and swamps on sandstone from Gosford and Sydney districts.	241	Low. Closest record is 1.5 km to the east. No potential habitat within study area.
Eucalyptus camfieldii	Camfield's Stringybark	Vulnerable	Vulnerable	Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges	1	Low. Closest record is dated from 1967 and is located 8.5 km to the east. No potential habitat within study area

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Eucalyptus nicholii	Narrow-leaved Black Peppermint	Vulnerable	Vulnerable	Natural distribution confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield. Widely planted as an urban street tree and in gardens.	6	Known. Occurs as a planted street tree. The study area is outside the natural range of this species, and the recorded individuals are not of conservation significance.
Eucalyptus scoparia	Wallangarra White Gum	Endangered	Vulnerable	In NSW it is known from only three locations near Tenterfield, including Bald Rock National Park. Widely planted as an urban street tree and in gardens.	1	Moderate. Closest record is 7 km to the south-east. May occur as planted street or garden tree. The study area is outside the natural range of this species, and the records in the locality are not of conservation significance.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Eucalyptus sp. Cattai		Endangered		Occurs in the area between Colo Heights and Castle Hill, northwestern Sydney, with historical records from central Sydney. Occurs as a rare emergent tree in scrub, heath and low woodland on sandy soils, usually as isolated individuals or occasionally in small clustered groups. The sites at which it occurs are generally flat and on ridge tops. Associated soils are laterised clays overlying sandstone.	44	Low. Closest record is 2 km to the north-east. No potential habitat within study area.
Galium australe	Tangled Bedstraw	Endangered		Tangled Bedstraw is widespread in Victoria and is also found in South Australia and Tasmania. Once regarded as presumed extinct in NSW, this species is now known from a few near-coastal sites south of Nowra. Most flowering collections have been made in late spring to early autumn. In NSW Tangled Bedstraw has been found in moist gullies of tall forest, *Eucalyptus tereticornis* forest, coastal Banksia shrubland, and *Allocasuarina nana* heathland. In other States the species is found in a range of near-coastal habitats, including sand dunes, sand spits, shrubland and woodland.	1	Low. Closest record is nearly 10 km to the east. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Genoplesium baueri	Yellow Gnat-orchid, Bauer's Midge Orchid	Vulnerable	Endangered	Grows in sparse sclerophyll forest and moss gardens over sandstone. Recorded from locations between Ulladulla and Port Stephens; most older records are from northern Sydney suburbs. No collections have been made from those sites in recent years. Currently the species is known from just over 200 plants across 13 sites. 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. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments.	0	Low. No records within 10 km of study area. No potential habitat within study area.
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	Vulnerable		Broadly spreading to erect shrub endemic to Western Sydney. Associated canopy species include *Eucalyptus tereticornis, E. moluccana, E. crebra, E. fibrosa* and *E. eugenioides*. Known to occur in association with Cumberland Plain Woodland, Shale/Gravel Transition Forest, Castlereagh Woodland. Species tolerates moderate disturbance and is known from urbanised areas.	58	Low. Closest record is 2.5 km to the south-west. Although marginal potential habitat occurs within the study area, targeted searches for this conspicuous shrub did not locate any individuals of the species.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	Vulnerable	Vulnerable	A low spreading to erect shrub occurring on sandy clay loam soils, often with lateritic ironstone gravels. Generally found on crests, upper slopes or flats. Distribution generally associated with Nepean and Georges Rivers. Small populations occur at Kemps Creek & Voyager Point.	0	Low. No records within 10 km of study area. No potential habitat within study area.
Haloragis exalata subsp. *exalata*	Wingless Raspwort	Vulnerable	Vulnerable	Occurs in four widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. Square Raspwort appears to require protected and shaded damp situations in riparian habitats. Flowering specimens in NSW are recorded from November to January.	0	Low. No records within 10 km of study area. No potential habitat within study area.
Hibbertia superans		Endangered		Occurs from Baulkham Hills to South Maroota in the northern outskirts of Sydney, where there are currently 16 known sites, and at one locality at Mount Boss, inland from Kempsey. The species occurs on sandstone ridgetops often near the shale/sandstone boundary.	172	Low. Closest record is 2 km to the north-east. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Lasiopetalum joyceae		Vulnerable	Vulnerable	Has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. It is currently known from 34 sites between Berrilee and Duffys Forest. Seventeen of these are reserved. Grows in heath on sandstone.	1	Low. Only record within 10 km is 6.5 km to the north-west and dated from 1955. No potential habitat within study area.
Leptospermum deanei	Deane's Tea-tree	Vulnerable	Vulnerable	Occurs in Hornsby, Warringah, Ku-ring-gai and Ryde LGAs. Woodland on lower hill slopes or near creeks. Sandy alluvial soil or sand over sandstone. Occurs in Riparian Scrub - e.g. *Tristaniopsis laurina, Baeckea myrtifolia;* Woodland - e.g. *Eucalyptus haemastoma*; and Open Forest - e.g. *Angophora costata, Leptospermum trinervium, Banksia ericifolia.* Flowers October-November.	0	Low. No records within 10 km of study area. No potential habitat within study area.
Leucopogon fletcheri subsp. *fletcheri*		Endangered		Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils generally on flat to gently sloping terrain along ridges and spurs. Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains.	27	Low. Closest record is 2 km to the north-east. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Melaleuca biconvexa	Biconvex Paperbark	Vulnerable	Vulnerable	Scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	0	Low. No records within 10 km of study area. No potential habitat within study area.
Melaleuca deanei	Deane's Melaleuca	Vulnerable	Vulnerable	A shrub that typically grows in wet heath on sandstone. Known from two areas in the north and south of Sydney (Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas) with isolated occurrences in the Blue Mountains, Nowra and Central Coast areas.	6	Low. Closest record is 5.5 km to the north. No potential habitat within study area.
Micromyrtus minutiflora		Endangered	Vulnerable	Slender spreading shrub to 2 m high restricted to Tertiary sediments in western Sydney. Known from Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest and open forest.	5	Low. Closest record is 9 km to the north-west. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Pelargonium sp. *striatellum* (G.W. Carr 10345)	Omeo Stork's-bill	Endangered	Endangered	Associated with irregularly inundated or ephemeral lakes, in the transition zone between grasslands/pasture and wetland communities. Known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst.	0	Low No records within 10 km of the study area. The study area is far outside of the typical range for this species – it is unclear why this species is in the search results. No potential habitat within study area.
Persoonia hirsuta	Hairy Geebung	Endangered	Endangered	The Hairy Geebung has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands. The Hairy Geebung is found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. It is usually present as isolated individuals or very small populations.	19	Low. Closest record is 2 km to the east. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Persoonia mollis subsp. *maxima*		Endangered	Endangered	Highly restricted, known from the Hornsby Heights-Mt Colah area north of Sydney in the Sydney Basin Bioregion. Occurs in sheltered aspects of deep gullies or on the steep upper hillsides of narrow gullies on Hawkesbury Sandstone. These habitats support relatively moist, tall forest vegetation communities, often with warm temperate rainforest influences. Associated species include Angophora costata, Eucalyptus piperita, Corymbia gummifera, Syncarpia glomulifera, Ceratopetalum apetalum and Callicoma serratifolia. Flowers late December – March.	2	Low. Closest record is 7 km to the north-east. No potential habitat within study area.
Persoonia nutans	Nodding Geebung	Endangered	Endangered	An erect to spreading shrub restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	2	Low. Closest record is 9 km to the south. No potential habitat within study area.
Pilularia novae-hollandiae	Austral Pillwort	Endangered		A semi-aquatic fern that grows in shallow swamps and waterways, often among grasses and sedges. Known from the Hawkesbury Nepean CMA.	1	Low. Only record within 10 km is 8 km to the south-west and dated from 1966. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Pimelea curviflora var. curviflora	-	Vulnerable	Vulnerable	A small shrub confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region. Distribution associated with shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	25	Low. Closest record is 2 km to the north-east. No potential habitat within study area.
Pimelea spicata	Spiked Rice Flower	Endangered	Endangered	A small spreading or erect shrub Cumberland Plain and coastal Illawarra. In western Sydney, occurs an undulating topography of substrates derived from Wianamatta Shale in associated with Cumberland Plain Woodland.	59	Low. Closest records are 3 km to the north-west and south-west. No potential habitat within study area.
Pterostylis gibbosa	Illawarra Greenhood	Endangered	Endangered	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage.	0	Low. No records within 10 km of study area. No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Pterostylis saxicola	Sydney Plains Greenhood	Endangered	Endangered	A ground orchid known from few populations in western Sydney. Distribution restricted between Freemans Reach in the north and Picton in the south. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines.	1	Low. Only record within 10 km is 9 km to the south-west. No potential habitat within study area.
Pultenaea parviflora	-	Endangered	Vulnerable	A small erect branching shrub endemic to the Cumberland Plain from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. Associated with scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays.	15	Low. Closest record is 5 km to the south-west. No potential habitat within study area.
Streblus pendulinus	Siah's Backbone		Endangered	On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest.	0	Low. No records within 10 km of the Study Area. The Study Area is far outside of the typical range for this species – it is unclear why this species is in the search results No potential habitat within study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Habitat	Number of records within 10 km of study area	Likelihood of occurrence within the study area
Syzygium paniculatum	Magenta Lilly Pilly	Endangered	Vulnerable	Natural occurrence is in littoral rainforest in scattered small populations along a narrow, linear coastal strip from Bulahdelah to Conjola State Forest.	6	Known. Three individuals recorded in the study area; all appear to be planted horticultural specimens. The study area is outside the natural range of this species, and the recorded individuals are not of conservation significance.
Tetratheca glandulosa	Glandular Pink-bell	Vulnerable	Vulnerable	A small, spreading shrub distributed from Ingleside in the east to East Kurrajong in the west, Sampons Pass on the north to West Pymble in the south. Strongly associated with areas of shale-sandstone transition. Where it occurs on ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches.	68	Low. Closest record is 2 km to the north-east. No potential habitat within study area.

APPENDIX D

THREATENED FAUNA SPECIES IN THE LOCAL AREA

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Anthochaera phrygia	Regent Honeyeater	Critically Endangered	Endangered		Distribution is extremely patchy; in NSW the species has been recorded from coastal areas to Narrabri with important breeding areas west of Armidale. Occurs in temperate eucalypt woodlands, most commonly box-ironbark associations and wet lowland coastal forests. Nests usually constructed in eucalypts, casuarinas or mistletoes. Forages for nectar and arthropods.	11	Low. Preferred habitat features not present in study area.
Apus pacificus	Fork-tailed Swift		Migratory		Migrates from north-eastern Asia for the summer. Summer distribution is throughout Australia. Spend almost all day and night on the wing, hunting resting and sleeping.	13	Low. Species is largely aerial and typically do not occur over habitats such as those found in the study area.
Ardea alba	Great Egret		Migratory		Occurs throughout Australia excluding arid areas. Inhabit lakes, swamps, dams and rivers and occasionally damp grasslands. Wades through shallows to hunt fish and invertebrates. Constructs a nest platform in a tree over water.	22	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Ardea ibis	Cattle Egret		Migratory		The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation.	44	Low. Preferred aquatic and terrestrial habitat features not present in study area.
Botaurus poiciloptilus	Australasian Bittern	Endangered	Endangered		Widespread distribution but uncommon across south-eastern Australia. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spike rushes (*Eleocharis* spp), where it forages at night for amphibians, invertebrates and crustaceans. Nests are built within densely vegetated wetlands on a platform of reeds.	2	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Callocephalon fimbriatum	Gang-gang Cockatoo	Vulnerable			Found in the central NSW coast and tableland areas, including Canberra and the Hawkesbury/Nepean and Sydney Metro region. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes. Also utilises less heavily timbered woodlands and urban fringe areas to forage, but appears to favour well timbered country.	9	Low. Preferred habitat features not present in study area.
Calyptorhynchus lathami	Glossy Black-Cockatoo	Vulnerable			Occurs from the coast inland to the southern tablelands and central western plains of NSW. Inhabits forests and woodlands supporting Casuarina and Allocasuarina species, the seeds of which Glossy-Black Cockatoos feed upon almost exclusively. Requires large hollow-bearing eucalypts for nesting habitat.	8	Low. Preferred habitat features not present in study area.
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Vulnerable		Found mainly in areas with extensive cliffs and caves. It is generally rare with a very patchy distribution in NSW, with scattered records from the New England Tablelands and North-west Slopes. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Hirundo ariel). Forage in low to mid-elevation dry open forest and woodland and well-timbered areas containing gullies close to roosting habitat, for small, flying insects. Most likely hibernates through coolest months.	3	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Chthonicola sagittata	Speckled Warbler	Vulnerable			In NSW, occurs throughout the hills and tablelands of the Great Dividing Range, rarely from the coast. Inhabits Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies where it forages for insects and seeds. Nests in a depression in the ground or the base of a low dense plant, often among fallen branches and other litter.	1	Low. Preferred habitat features not present in study area.
Climacteris picumnus victoriae	Brown Treecreeper	Vulnerable			Occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. Western boundary of its distribution is through Wagga Wagga, Forbes, Dubbo and Inverell. It is less commonly found on coastal plains and ranges. Forage mainly for invertebrates in fallen timber, trees and shrubs. Require hollows in standing dead or live trees and tree stumps for nesting.	1	Low. Preferred habitat features not present in study area.
Daphoenositta chrysoptera	Varied Sittella	Vulnerable			Widespread throughout mainland Australia, where it is found in eucalypt woodlands and forests, most commonly in areas of rough-barked eucalypts. Forages for insects in rough-bark eucalypts such as ironbark and stringybarks. Nests in a tree branch or fork.	23	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Dasyornis brachypterus	Eastern Bristlebird	Endangered	Endangered		Distribution confined to three disjunct areas in NSW: the Queensland/NSW border, the Illawarra and the NSW/Victoria border. Species inhabits dense, low vegetation including heath and open woodland with a heathy understorey. Forages on the ground for insect, rarely flies. Nest constructed on the ground amongst dense vegetation.	0	Low. Preferred habitat features not present in study area. Species has not been recorded within 10km of the study area.
Dasyurus maculatus	Spotted-tail Quoll	Vulnerable	Endangered		Found along the escarpments, tablelands and coast of the eastern seaboard from the Bundaberg area in south-east Qld south through NSW to Victoria and Tasmania. Known from dry and moist eucalypt forests and rainforest. Species tends to move along drainage lines and make dens in fallen hollow logs or among large rocky outcrops. Usually nocturnal but are known to hunt and bask during the day. Hunts terrestrially and arboreally.	8	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Falco subniger	Black Falcon	Vulnerable			The Black Falcon inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. The Black Falcon is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. Habitat selection is generally influenced more by prey densities than by specific aspects of habitat floristics or condition, although in agricultural landscapes the Black Falcon tends to nest in healthy, riparian woodland remnants with a diverse avifauna	1	Low. Preferred habitat features not present in study area.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable			Occurs along the east coast of NSW, where it inhabits tall moist forests. Roosts in hollows of eucalypts, occasionally under loose bark on trees or in buildings. Hunts for flying insects above or below the tree canopy.	20	High. Potential call recorded on Anabat at Strangers Creek.
Gallinago hardwickii	Latham's Snipe		Migratory		Migrates to south-east Australia for the summer. Inhabits freshwater wetlands on or near the coast, generally among dense cover. Also known from short-grassed marshes and wet, treeless grasslands. Occasionally found in crops and pasture. An omnivorous species that forages in soft mudflats or shallow water. Roosts amongst low vegetation during the day.	6	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Glossopsitta pusilla	Little Lorikeet	Vulnerable			In NSW, the species occurs from the coast to the western slopes of the Great Dividing Range. Inhabits forests and woodlands, where it forages for nectar and pollen within the canopy stratum. Requires living, hollow-bearing eucalypts for nesting habitat.	6	Low. Preferred habitat features not present in study area.
Haliaeetus leucogaster	White-bellied Sea-Eagle		Migratory		Occurs throughout coastal Australia, along the coast, large lowland rivers and lakes. Occasionally found in association with inland lakes. Mainly hunts over water for aquatic animals; small terrestrial mammals and carrion may be taken from land. Typically nests in large trees to 30m, less often in smaller trees, on rocks or the ground.	5	Low. Preferred habitat features not present in study area.
Heleioporus australiacus	Giant Burrowing Frog	Vulnerable	Vulnerable		Distribution largely restricted to sandstone geology of Sydney Basin, within heath, woodland and open dry sclerophyll forest. Moves to breeding habitat before or after heavy rain in autumn; typically soaks, pools in first or second order streams or hanging swamps. Outside of breeding period, inhabits burrows below soil surface or leaf litter, within 300m of breeding habitat. Generalist diet of invertebrates.	1	Low. Preferred habitat features not present in study area.
Hieraaetus morphnoides	Little Eagle	Vulnerable			Widespread throughout mainland Australia, often observed over woodland, forested land and open country. Appears to avoid rainforest and dense forest. Hunts for small terrestrial and arboreal mammals. Nests in a large living tree in open woodland or tree-lined watercourses.	8	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Hirundapus caudacutus	White-throated Needletail		Migratory		Migrates from northern Asia to eastern Australia for the summer. In NSW, occurs from the coast to the western slopes of the Great Dividing Range. Species is almost exclusively aerial, most commonly recorded above open forest and rainforest. Rarely recorded flying over treeless areas. Forages aerially for insects. May roost aerially or in tree canopies or hollows in forests and woodland.	45	Low. Preferred habitat features not present in study area. Species is largely aerial.
Hoplocephalus bungaroides	Broad-headed Snake	Endangered	Vulnerable		Distribution restricted to sandstone habitats within approximately 250 kilometres of Sydney. Requires rock crevices and flat sandstone rocks on exposed cliff edges for sheltering in cooler months, shelters in tree hollows near sandstone escarpments in summer. Forages for small reptiles, occasionally frogs and small mammals		Low. Preferred habitat features not present in study area.
Isoodon obesulus obesulus	Southern Brown Bandicoot	Endangered	Endangered		Occurs east of the Great Dividing Range, south from the Hawkesbury River, where it is found in heath or open forest with a heathy understorey on sandy or friable soils. Nests in a shallow depression in the ground covered by vegetation. Searches for insects or underground-fruiting fungi by digging conical holes in the soil.		Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Ixobrychus flavicollis	Black Bittern	Vulnerable			Scattered distribution throughout the NSW coast, although rarely recorded south of Sydney or inland. Inhabits areas of permanent water and dense vegetation. Forages for aquatic prey including invertebrates and small vertebrates. Roosts in trees or amongst dense reeds on the ground. Nest is constructed on a branch overhanging water.	3	Low. Preferred habitat features not present in study area.
Lathamus discolor	Swift Parrot	Vulnerable	Endangered		Migrates from breeding grounds in Tasmania to the south-eastern Australian mainland in winter. Preferred over-winter habitat is woodlands and riparian vegetation where there are winter flowering eucalypts. Forage for pollen, nectar, lerps, insects, seeds and berries.	26	Low. Preferred habitat features not present in study area.
Litoria aurea	Green and Golden Bell Frog	Endangered	Vulnerable		Isolated, scattered populations throughout coastal NSW, several within the Sydney metropolitan area, Shoalhaven and mid-north coast. Breeding habitat comprises natural and constructed waterbodies including wetlands, stormwater detention basins, marshes, dams and streams-side, preferably those that are unshaded but with fringing vegetation. Forage for invertebrates within grassy habitats near breeding habitat. May shelter under vegetation, rocks and building materials such as fibro, sheet iron or bricks.	9	Low. Preferred habitat features not present in study area (see discussion in Section 4.1.3).

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Litoria littlejohni	Littlejohn's Tree Frog	Vulnerable	Vulnerable		Distributed throughout the plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Breeds in the upper reaches of permanent streams and in perched swamps where it lays eggs on temporary or permanent slow flowing pools. Outside of the breeding season, inhabits forests and woodlands where it shelters under leaf litter and low vegetation and hunts for invertebrates.	0	Low. Species has not been recorded within 10km of the study area. Preferred habitat features not present in study area.
Litoria raniformis	Growling Grass Frog	Endangered	Vulnerable		Occurs in association with the Murray and Murrumbidgee River valleys and their tributaries. Inhabits emergent vegetation within or fringing still or slow-flowing waterbodies, including lagoons, ponds, swamps and dams. Basks on rocks or vegetation in summer and shelters in soil cracks, fallen timber, dense vegetation. Requires permanent, freshwater shallow lagoons for breeding.	0	Low. Species has not been recorded within 10km of the study area. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Lophoictinia isura	Square-tailed Kite	Vulnerable			Widespread but sparsely distributed throughout mainland Australia. Is a resident of the north and north-east of NSW and in association with major river systems where it is often found in association with forest dominated by Woolybutts (*Eucalytus longiflora*), Spotted Gum (E. *maculata*) or Peppermint Gum (*E. elata*). Hunts for smaller birds such as honeyeaters amongst the canopy layer. Nests on a large limb of a eucalypt or angophora along or near a watercourse.	1	Low. Preferred habitat features not present in study area.
Macquaria australasica	Macquarie Perch		Vulnerable	Endangered	Found within the southern tributaries of the Murray Darling Basin (particularly the upstream reaches), Hawkesbury-Nepean and Shoalhaven river systems of NSW. Inhabits rivers and lakes, utilising the upper reaches of rivers and their tributaries. Feeds on aquatic insects, crustaceans and molluscs. Breeds in in spring and summer in shallow upland streams or flowing rivers; requires riffle over cobble and gravel substrates in which to spawn deposit eggs. Deep rock pools, overhanging vegetation and snags provide refuge habitat for this species.	0	Low. Preferred habitat features not present in study area. Species has not been recorded within 10km of the study area.
Melanodryas cucullata cucullata	Hooded Robin	Vulnerable			Widespread throughout much of inland NSW, with the exception of the extreme north-west of the state. Typically inhabits structurally diverse open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas where it hunts for insects. Nests in tree fork or crevice, 1- 5 m above the ground.	1	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Vulnerable			Eastern subspecies occurs from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range. Inhabits forests or woodlands dominated by box and ironbark eucalypts where it forages for insects and nectar. Nests high in tree crown.	2	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Meridolum corneovirens	Cumberland Plain Land Snail	Endangered			Distribution restricted to Cumberland Plain Woodland in western Sydney, from Richmond in the north to Picton in the south. Found under leaf litter, bark, logs or loose soil at the base of trees, may bury deep into the soil to evade drought. Species is a fungus specialist.	125	Low. Species is restricted to CPW. CPW recorded on site was found in a highly modified state within a roadside which has historically been cleared and the CPW exists as regrowth. It is unlikely that this species would persist in the area given the historical clearing and current disturbed state of the understorey and groundcover.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Merops ornatus	Rainbow Bee-eater		Migratory		Occurs throughout mainland Australia, excluding arid areas. Southern populations migrate north in winter. Found in open forest, woodland, shrubland and occasionally remnant vegetation within farmland, orchards and vineyards. Forages aerially for insects. Roosts in small shrubby trees. Constructs a tunnel in which to nest, in sandy bank or bare flat ground.	2	Low. Preferred habitat features not present in study area.
Miniopterus australis	Little Bentwing-bat	Vulnerable			Distributed throughout the east coast and ranges of Australia, from Cape York in Queensland to Wollongong in NSW. Found in association with moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges. At night forages for small insects beneath the canopy of densely vegetated habitats.	6	Moderate. Prefers densely vegetated habitats. Roosts in culverts. Was not recorded during targeted surveys.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable			Distributed throughout eastern and north-western Australia. In NSW, recorded from the coast to the western slopes of the Great Dividing Range. Occurring in forests and woodlands the species live in colonies and roost in caves, old mines and occasionally buildings. The species forages for insects above the tree canopy	63	High. Potential call recorded on Anabat at Elizabeth Macarthur Creek.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Mixophyes balbus	Stuttering Frog	Endangered	Vulnerable		In NSW, known only from three locations south of Sydney. Inhabits rainforest and wet, tall forest in the foothills and escarpment east of the Great Dividing Range. Requires streams with rock shelves or shallow riffles for breeding in summer. Outside of breeding period, species is found under deep leaf little and thick understorey vegetation on forest floor.	0	Low. Species has not been recorded within 10km of the study area.
Monarcha melanopsis	Black-faced Monarch		Migratory		Migrates to south-eastern coast of Australia from the north-eastern coast. Found in rainforests, wet eucalypt forest, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Forages on the wing or amongst vegetation for insects. Nests in small tree or shrub 3-6m above ground, within a sheltered gully or rainforest.	27	Low. Preferred habitat features not present in study area.
Monarcha trivirgatus	Spectacled Monarch		Migratory		Occurs in coastal north-east and eastern Australia, from Cape York south to Port Stephens. Habitat is in understorey of mountain/lowland rainforests, thickly wooded gullies, and waterside vegetation including mangroves, mostly well below canopy. Summer breeding migrant to south Queensland and north-east NSW.	0	Low. Species has not been recorded within 10km of the study area.
Mormopterus norfolkensis	Eastern Freetail-bat	Vulnerable			Occurs along the east coast of NSW inland to the Great Dividing Range, where it is found in dry sclerophyll forest, woodland, swamp forest and mangrove forest. Roosts in trees hollows, occasionally under bark or in man-made structures. Forages for insects.	34	Known. Recorded at Elizabeth Macarthur Creek.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Myiagra cyanoleuca	Satin Flycatcher		Migratory		Occurs along east coast of Australia, migrates north to Cape York Peninsula and Papua New Guinea in winter. Inhabits tall, wet eucalypts forests in gullies where it forages for insects. Nests in tree 3-25m above ground.	14	Low. Preferred habitat features not present in study area.
Myotis macropus	Southern Myotis	Vulnerable			Distribution generally limited to within 100 kilometres of the coast. Forages over streams and pools for insects and small fish. Roosts communally in mine shafts, tree hollows, under bridges and storm water channels.	21	High. Potential call at Strangers Creek.
Neophema pulchella	Turquoise Parrot	Vulnerable			In NSW, occurs from the coastal plains to the western slopes of the Great Diving Range. Found along the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Forages on the ground for seeds and grasses. Nests in a tree hollow, log or post.	1	Low. Preferred habitat features not present in study area.
Ninox connivens	Barking Owl	Vulnerable			Scattered distribution throughout Australia, excluding central arid areas. In NSW, core populations located on western slopes and plains. Inhabits woodland and open forest, where it hunts for arboreal mammals, occasionally birds, invertebrates and small terrestrial mammals. Roosts in canopy or tall mid-storey trees. Requires large, hollow-bearing eucalypts for nesting habitat.	6	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Ninox strenua	Powerful Owl	Vulnerable			Widely distributed throughout NSW, from the coast inland to the tablelands. Inhabits woodland, open forest, tall wet forest and rainforest, where it hunts for arboreal mammals, occasionally birds. Roosts in dense vegetation, requires old, large hollow-bearing eucalypts for nesting habitat.	60	Low. Preferred habitat features not present in study area.
Oxyura australis	Blue-billed Duck	Vulnerable			The Blue-billed Duck is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed.	2	Low. Preferred habitat features not present in study area.
Petaurus australis	Yellow-bellied Glider	Vulnerable			In NSW, distributed from the east coast to the western slopes of the Great Dividing Range. Occurs in association with tall mature eucalypt forest, generally in high rainfall areas and nutrient rich soils. Extract sap from favoured food trees, most commonly smooth-barked eucalypts. Dens in large tree hollows.	1	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Petrogale penicillata	Brush-tailed Rock-wallaby	Endangered	Vulnerable		Occurs along NSW coast, inland to the Warrumbungle Ranges. Occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Shelter in rock crevices and overhangs. Forages in and adjacent to rocky areas for grasses, foliage and fruits of shrubs and trees.	0	Low. Species has not been recorded within 10km of the study area.
Petroica boodang	Scarlet Robin	Vulnerable			Distributed from the coast, inland to the western slopes of the Great Dividing Range. Inhabits open forests and woodlands, also found in grasslands in winter. Constructs a cup-shaped nest in a tree fork. Forages for insects on the ground. In NSW, the species breeds in tall moist eucalypt forests and woodlands in upland areas. In winter, moves to dry forests, open woodlands and grasslands of the inland slopes and plains. Forages amongst low branches for invertebrates. Nests near the ground in sheltered areas such as tree cavities or stumps.	8	Low. Preferred habitat features not present in study area.
Petroica phoenicea	Flame Robin	Vulnerable			In NSW, the species breeds in tall moist eucalypt forests and woodlands in upland areas. In winter, moves to dry forests, open woodlands and grasslands of the inland slopes and plains. Forages amongst low branches for invertebrates. Nests near the ground in sheltered areas such as tree cavities or stumps.	2	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Petroica rodinogaster	Pink Robin	Vulnerable			Partly resident and partly dispersive thoughout breeding habitat, typically rainforest, in Tasmania, King and Flinders Islands and the wetter parts of Victoria and far south eastern New South Wales. Nests in a mossy or lichen-covered fork of a tree or shrub. May migrate to areas in southern New South Wales in winter, after breeding. Forages for insects on the ground or from low bushes.	1	Low. Preferred habitat features not present in study area.
Phascolarctos cinereus	Koala	Vulnerable	Vulnerable		Distribution of the species throughout Australia is highly fragmented. In NSW it mainly occurs on the central and north coasts with some populations in the western region inhabiting eucalypt woodlands and forests. The species feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	2	Low. Preferred habitat features not present in study area.
Polytelis swainsonii	Superb Parrot	Vulnerable	Vulnerable		Occurs across Riverina area in summer, migrates along Macquarie and Namoi Rivers to northern NSW in winter. Inhabits timbered watercourses and nearby woodlands. Requires deep hollows or hollow limbs for nesting, typically in Red Gums. Forages mainly on the ground for seeds, fruit and insects.	2	Low. Preferred habitat features not present in study area.
Potorous tridactylus tridactylus	Long-nosed Potoroo	Vulnerable	Vulnerable		Distribution in NSW restricted to coastal heaths and forests east of the Great Dividing Range. Also known from dry and wet sclerophyll forest. Requires dense understory and groundlayer vegetation for sheltering. Forages from fungi, roots tubers and insects in the soil.	0	Low. Species has not been recorded within 10km of the study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Prototroctes maraena	Australian Grayling		Vulnerable	Protected	Found in freshwater streams and rivers to the east of the Great Dividing Range, extending from Sydney southwards. Prefers habitats with a moderate flow over clear gravelly substrates in coastal streams, and estuarine areas. Feeds on aquatic algae and invertebrates. Eggs are deposited during late summer to autumn, in rivers with gravelly substrates. Larvae migrate to marine waters and return as juveniles and remain in freshwater for their adult life.	0	Low. Species has not been recorded within 10km of the study area.
Pseudomys novaehollandiae	New Holland Mouse		Vulnerable		Fragmented distribution across Tasmania, Victoria, NSW and Queensland where it inhabits open heathlands, open woodlands with a heathland understorey and vegetated sand dunes. Forages for seeds, insects, leaves, flowers and fungi. Shelters and nests communally in burrows.	0	Low. Species has not been recorded within 10km of the study area.
Pseudophryne australis	Red-crowned Toadlet	Vulnerable			Distribution restricted to the Sydney Basin, from Pokolbin, south to Nowra, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, where it typically inhabits periodically wet drainage lines below sandstone ridges. Breeds in dense vegetation and debris beside ephemeral creeks and gutters. Outside of breeding season, is found under rocks and logs on sandstone ridges where it forages amongst leaf-litter.	16	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable		Found within 200 kilometres of the east coast of Australia. Roosting camps commonly found in gullies, close to water, in vegetation with a dense canopy. Camps typically located within 20 kilometres of a regular food source; nectar and pollen of native trees and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.	64	Moderate. Foraging habitat is present in a poor condition.
Rhipidura rufifrons	Rufous Fantail		Migratory		Occurs throughout east coast of Australia, migrates from eastern NSW to north-eastern Queensland and Papua New Guinea in winter. Inhabits rainforest, wet forest, swamp woodlands and mangroves, where it forages amongst a shrubby understorey for insects. Constructs a nest suspended from a tree fork.	0	Low. Species has not been recorded within 10km of the study area.
Rostratula australis	Australian Painted Snipe	Endangered	Endangered, Migratory		Occurs throughout Australia. Inhabits shallow freshwater wetlands, vegetated ephemeral and permanent lakes and swamps, and inundated grasslands. Roosts during the day in dense vegetation and is active at dusk, throughout the night and dawn. It nests on the ground amongst tall reed-like vegetation near water, and forages near the water's edge and on mudflats for invertebrates and seeds.	0	Low. Species has not been recorded within 10km of the study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable			Occurs throughout tropical and south-east of Australia, excluding Tasmania. Found in a variety of habitat types including wet and dry sclerophyll forest, open woodland, *Acacia* shrubland, mallee, grassland and desert. Forages for insects above the tree canopy. Roost in tree hollows, abandoned sugar glider nests or animals burrows.	7	Moderate. The study area provides suboptimal foraging habitat within woodland areas and riparian habitat.
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable			Found mainly in the gullies and river systems that drain the Great Dividing Range. Distribution of the species in NSW is widespread on the New England Tablelands, however does not occur at altitudes above 500m. The species is known from woodland through to moist and dry eucalypt forest and rainforest; most commonly found in tall wet forest. The species forages along creek and river corridors. The species typically roosts in tree hollows but has also been found roosting in buildings. Maternity roosts usually comprise a suitable tree hollow.	14	Moderate. The study area provides suboptimal foraging habitat within woodland areas and riparian habitat.
Stagonopleura guttata	Diamond Firetail	Vulnerable			It is widely distributed in NSW. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	1	Low. Preferred habitat features not present in study area.

Scientific Name	Common Name	Status under TSC Act	Status under EPBC Act	Status under FM Act	Habitat preference/ known distribution	Number of records within 10 km of study area	Likelihood of occurrence in the study area
Tyto novaehollandiae	Masked Owl	Vulnerable			Occurs from the eastern coast of NSW inland to the western plains. Found in eucalypt forests and woodlands from sea level to 1100 m. Hunts in and along the edges of forests, including roadsides for arboreal and terrestrial mammals. Roosts and nests in large tree hollows within moist eucalypt forested gullies.	3	Low. Preferred habitat features not present in study area.
Tyto tenebricosa	Sooty Owl	Vulnerable			Occurs on the coast, coastal escarpment and eastern tablelands. Inhabits rainforest and moist eucalypt forests, where it hunts for small arboreal and terrestrial mammals. Roosts in a large tree hollow or amongst thick vegetation. Nests in a large tree hollow.	1	Low. Preferred habitat features not present in study area.

APPENDIX E

SIGNIFICANCE ASSESSMENTS

Assessments of Significance were undertaken for the following threatened species and endangered ecological communities found to have a moderate or high likelihood of occurrence:

Threatened entity	EPBC Act Status	TSC Act Status	Likelihood of occurrence
Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW)		Critically Endangered	Known
Swamp-oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF)		Endangered	Known
Eastern Freetail-bat (*Mormopterus norfolkensis*)		Vulnerable	Known
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)		Vulnerable	High
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)		Vulnerable	High
Southern Myotis (*Myotis macropus*)		Vulnerable	High
Little Bentwing-bat (*Miniopterus australis*)		Vulnerable	Moderate
Grey-headed Flying Fox (*Pteropus poliocephalus*)	Vulnerable	Vulnerable	Moderate
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)		Vulnerable	Moderate
Greater Broad-nosed Bat (*Scoteanax rueppellii*)		Vulnerable	Moderate

There were three additional threatened species either recorded in the study area during the current survey or with records within 10 kilometres of the study area, that do not naturally occur within the locality of the study area. The individuals recorded in the study area, as well as any other records, are likely to be planted specimens that are not of conservation significance. As such, no assessments of significance were prepared for these species, which are listed below:

Threatened entity	EPBC Act Status	TSC Act Status	Likelihood of occurrence
Eucalyptus nicholii (Narrow-leaved Black Peppermint)	Vulnerable	Vulnerable	Known
Syzygium paniculatum (Magenta Lilly Pilly)	Vulnerable	Endangered	Known
Eucalyptus scoparia (Wallangarra White Gum)	Vulnerable	Endangered	Moderate

THREATENED SPECIES CONSERVATION ACT 1995

Cumberland Plain Woodland in the Sydney Basin Bioregion

Cumberland Plain Woodland in the Sydney Basin Bioregion is listed as a critically endangered ecological community under the TSC Act.

The areas of Cumberland Plain Woodland (CPW) vegetation mapped in the study area include characteristic trees of this community, namely *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark). The trees are present as scattered individuals in a residential garden and in roadside areas, some under powerlines and subject to repeated lopping. The ground layer beneath these trees is highly modified and consists of slashed or mown exotic grasses. There were occasional herb and grass species typical of Cumberland Plain Woodland growing on road verges, but their occurrence was sparse.

The characteristic trees of CPW that are likely to be regrowth. Some of these trees have been repeatedly lopped for maintenance of clearance around overhead power lines. Given the lack of characteristic native understorey species beneath most of the trees, they are unlikely to meet the criteria for CPW as stated in the Final Determination for this community. For the purposes of impact assessment, however, the mapped areas of Disturbed regrowth Cumberland Plain Woodland are considered to form fragmented and degraded regrowth CPW.

The proposal will require removal of 0.190 hectares mapped as CPW, comprising small patches of characteristic trees in the west, centre and eastern parts of the study area.

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

Not applicable. Cumberland Plain Woodland is a threatened community.

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

Not applicable. Cumberland Plain Woodland is a threatened community.

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

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

The extent of the ecological community in the immediate locality is currently limited due to the highly modified, urban context of the study area. The extent of the ecological community within the broader locality is also limited. The extent of CPW (represented by the map units Shale Plains Woodland and Shale Hills Woodland) mapped within 10 kilometres of the study area by NPWS (2002, updated 2008) is as follows:

Vegetation map unit	Area mapped within 10 km of study area		Total area mapped within 10km of study area
	Greater than 10% canopy cover	Less than 10% canopy cover	
Shale Plains Woodland	935 ha	1612 ha	2547 ha
Shale Hills Woodland	56 ha	175 ha	231 ha
Total	991 ha	1787 ha	2778 ha

The removal of 0.190 hectares of poor condition CPW represents a reduction of 0.007% of the mapped extent of this community within 10 kilometres of the study area. It is however noted that the extent of this community in the locality has probably been reduced since the mapping was last updated in 2008, given the large amount of recent residential development in this region, particularly in the Sydney Growth Centres. Nevertheless, the impacts on CPW as a result of the proposal are not considered to substantially reduce the extent of the ecological community in the locality such that its local extent is likely to be placed as risk of extinction, given its small size. The areas of CPW to be cleared consist of some or all of several fragmented patches ranging in size from 0.03 ha to 0.1 ha.

The composition of the CPW in the study area is currently highly modified, comprising scattered trees with a largely absent midlayer and an understorey of mown or slashed exotic grasses. The proposal will not result in substantial modification of the composition of the remaining patches of CPW adjacent to the proposal, as they are in similarly poor condition.

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

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

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

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

The proposed action would result in clearing of approximately 0.190 hectares of CPW, comprising scattered characteristic trees over a largely exotic ground layer.

The proposed action would increase fragmentation of the community, however the CPW in the study area is already highly fragmented from other areas of CPW. The native vegetation in the vicinity of Memorial Avenue has been increasingly fragmented in recent years by residential and infrastructure development, including numerous residential estates and the NWRL, which intersects the western part of the study area. The proposal represents a small percentage of the cumulative impacts of these actions.

The CPW to be removed is not considered to be important to the long-term survival of the ecological community in the study area. Due to its small size, fragmentation, low native species diversity and the presence of invasive exotic species within and adjacent to mapped stands, the CPW in the study area could already fall outside the criteria for identification as this community, and is unlikely to be viable in the long term without assisted regeneration.

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

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for Cumberland Plain Woodland.

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

No recovery plan has been prepared specifically for Cumberland Plain Woodland. DECCW (2010) prepared the Cumberland Plain Recovery Plan, focusing on the threatened species, populations and ecological communities that are endemic to or primarily distributed on the Cumberland Plain. Cumberland Plain Woodland is one of the threatened ecological communities addressed in the recovery plan.

DECCW (2010) has identified approximately 25,566 hectares of Priority Conservation Lands (PCLs), representing the best opportunities in the region to secure long-term viable conservation outcomes. The recovery plan identifies the current extent of CPW on the Cumberland Plain as approximately 10,612 hectares, of which 4,171 hectares is located within the Priority Conservation Lands.

The study area has not been mapped as part of the Priority Conservation Lands.

There are no objectives or actions in the recovery plan that specifically target Cumberland Plain Woodland. The objectives of the Cumberland Plain Recovery Plan are as follows:

1. To build a protected area network, comprising public and private lands, focused on the priority conservation lands.
2. To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation.
3. To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program.
4. To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The proposal is considered to be consistent with the recovery plan in respect to the recovery of Cumberland Plain Woodland.

(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.

Six key threatening processes (KTPs) are referred to in the Final Determination for Cumberland Plain Woodland as threats to this community:

- Clearing of native vegetation

The proposed action would include clearing of native vegetation, including a small area (0.190 hectares) of CPW.

- Loss of hollow-bearing trees

No hollow-bearing trees were identified in the mapped areas of CPW.

- Removal of dead wood and dead trees

There may be some dead wood or dead trees in the CPW to be cleared. Impacts to fauna habitat are likely to be minor as the ecological value of the study area is low. The CPW in the study area comprises small patches of vegetation set in a highly disturbed and fragmented urban landscape with little connectivity to any significant stands of vegetation. Short-term impacts to fauna could occur through injury and/or disturbance.

- Invasion of native plant communities by exotic perennial grasses

Several exotic perennial grass species included in the final determination for this KTP occur in the study area: *Chloris gayana* (Rhodes Grass), *Cortaderia selloana* (Pampas Grass), *Ehrharta erecta* (Panic Veld-grass), *Paspalum urvillei* (Vasey Grass) and *Pennisetum clandestinum* (Kikuyu). *Chloris gayana* and *Pennisetum clandestinum* are present in abundance within some of the patches mapped as CPW.

The proposal may exacerbate this KTP by facilitating the spread of seeds or fragments, via plant or contaminated topsoil; however it is unlikely that spread of these grasses would extend to any areas where the species are not already present.

- Invasion of exotic vines and scramblers

There are exotic vines and scrambler such as *Asparagus asparagoides* and *Araujia sericifera* in the study area. The proposal is unlikely to increase the extent of these species.

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

The proposed action is unlikely to result in the operation of, or increase the impact of high frequency fire.

Conclusion

The proposal will require removal of 0.190 hectares mapped as CPW, comprising small patches of characteristic trees in the west, centre and eastern parts of the study area. It is considered unlikely that the proposal represents a significant impact to this critically endangered ecological community as:

- The areas that would be impacted by the proposal do not comprise a significant area in the wider locality.
- The areas to be impacted are small, fragmented patches within a modified urban context.
- The areas to be impacted are in poor condition with very low native species diversity and high cover of exotic species.

A Species Impact Statement will not be required for this community.

Swamp Oak Floodplain Forest in the North Coast, Sydney Basin and South East Corner Bioregions

Swamp Oak Floodplain Forest in the North Coast, Sydney Basin and South East Corner Bioregions (SOFF) is listed as an endangered ecological community under the TSC Act.

A small stand of *Casuarina glauca* (Swamp Oak) with a mostly exotic understorey adjoins Elizabeth Macarthur Creek on the north side of Memorial Avenue. The mid layer in this patch is absent, except for occasional shrubs of *Ochna serrulata* (Mickey Mouse Plant). The ground layer is characterised by dense Swamp Oak leaf litter and patches of the exotics *Tradescantia fluminensis* (Wandering Jew), *Ehrharta erecta* (Panic Veld-grass). The exotic creepers *Passiflora caerulea* (Blue Passion Flower) and *Solanum seaforthianum* (Brazilian Nightshade) are abundant in the ground layer and climbing trees.

Although disturbed, the stand of Swamp Oak Forest in the study area is considered to meet the criteria in the Final Determination for this TEC. The proposal will require removal of 0.067 hectares mapped as SOFF, comprising the southern 28% of the small patch of disturbed forest adjoining Elizabeth Macarthur Creek.

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

Not applicable. Swamp Oak Floodplain Forest is a threatened community.

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

Not applicable. Swamp Oak Floodplain Forest is a threatened community.

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

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

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

The extent of the ecological community in the immediate locality is currently limited due to the highly modified, urban context of the study area. The extent of the ecological community within the broader locality is also limited. The extent of SOFF (represented by the map unit Alluvial Woodland, which also includes the TEC River-flat Eucalypt Forest on Coastal Floodplains of the North Coast, Sydney Basin and South East Corner Bioregions) mapped within 10 kilometres of the study area by NPWS (2002, updated 2008) is as follows:

Vegetation map unit	Area mapped within 10 km of study area		Total area mapped within 10km of study area
	Greater than 10% canopy cover	Less than 10% canopy cover	
Alluvial Woodland	356 ha	286 ha	642 ha

The removal of 0.067 hectares of poor condition SOFF represents a reduction of 0.01% of the mapped extent of this community within 10 kilometres of the study area. It is however noted that the extent of this community in the locality has probably been reduced since the mapping was last updated in 2008, given the large amount of recent residential development in this region, particularly in the Sydney Growth Centres. Nevertheless, the impacts on SOFF as a result of the proposal are not considered to substantially reduce the extent of the ecological community in the locality such that its local extent is likely to be placed as risk of extinction, given its small size.

The composition of the SOFF in the study area is currently highly modified, comprising dense canopy of *Casuarina glauca* with no native midlayer and a sparse understorey dominated by weedy exotic species.The proposal will not result in substantial modification of the composition of the remaining patches of SOFF adjacent to the proposal, as they are in similarly poor condition.

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

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

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

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

The proposed action would result in clearing of approximately 0.067 hectares of SOFF, comprising characteristic trees over a largely exotic ground layer.

The proposed action would increase fragmentation of the community, however the SOFF in the study area is already highly fragmented from other areas of SOFF. The native vegetation in the vicinity of Memorial Avenue has been increasingly fragmented in recent years by residential and infrastructure development, including numerous residential estates and the NWRL, which intersects the western part of the study area. The proposal represents a small percentage of the cumulative impacts of these actions.

The SOFF to be removed is not considered to be important to the long-term survival of the ecological community in the study area. Due to its small size, fragmentation, low native species diversity and the presence of invasive exotic species within and adjacent to the mapped stand, the SOFF in the study area is unlikely to be viable in the long term without assisted regeneration.

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

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for Swamp Oak Floodplain Forest.

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

No recovery plan has been prepared for Swamp Oak Floodplain Forest. OEH is currently developing a targeted approach for managing Ecological Communities. In the interim, the following management actions have been identified for SOFF.

- Undertake research to determine minimum fire frequency.

- Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants.
- Prepare identification and impact assessment guidelines and distribute to consent and determining authorities.
- Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land.
- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
- Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.
- Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan and associated PAS actions.
- Implement appropriate fire management practices.
- Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT - all known provenances (conservation collection).
- Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).OEH has identified 12 management actions for this community.

The proposal is not inconsistent with these management actions, however the listed actions are aimed at threatened community management from a conservation agency perspective and are not directly relevant to the planning and design stage of the proposal.

(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.

Six key threatening processes (KTPs) are referred to in the Final Determination for SOFF as threats to this community:

- Clearing of native vegetation
- The proposed action would include clearing of native vegetation, including a small area (0.038 hectares) of SOFF.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands

The natural flow regime of Elizabeth Macarthur Creek has historically been substantially altered, with three square box culverts at the creek crossing below Memorial Avenue, upstream of the SOFF. The creek is highly degraded and modified with a muddy substrate, low turbidity and a moderate stream flow at the time of the site visit. Replacement and extension of the culvert at Elizabeth Macarthur Creek may alter flow patterns in this waterway. However, impacts are likely to be minor and would not result in any significant changes to aquatic habitat values.

- Invasion of native plant communities by exotic perennial grasses

Several exotic perennial grass species included in the final determination for this KTP occur in the study area: *Chloris gayana* (Rhodes Grass), *Cortaderia selloana* (Pampas Grass), *Ehrharta erecta* (Panic Veld-grass), *Paspalum urvillei* (Vasey Grass) and *Pennisetum clandestinum* (Kikuyu). *Ehrharta erecta* and *Pennisetum clandestinum* are present within and adjoining the patch of SOFF in the study area.

- Predation, habitat destruction, competition and disease transmission by feral pigs

Not relevant to the current assessment.

- Anthropogenic climate change

Not relevant to the current assessment.

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

The proposal is unlikely to result in the operation of, or increase the impact of high frequency fire.

Conclusion

The proposal will require removal of 0.067 hectares of SOFF, comprising the southern section of a small stand of *Casuarina glauca* (Swamp Oak) with a mostly exotic understorey adjoining Elizabeth Macarthur Creek. It is considered unlikely that the proposal represents a significant impact to this endangered ecological community as:

- The area that would be impacted by the proposal does not comprise a significant area in the wider locality.
- The area to be impacted is a small, isolated patch within a modified urban context.
- The area to be impacted is in poor condition with very low native species diversity and high cover of exotic species.

A Species Impact Statement will not be required for this community.

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

Grey-Headed Flying-Fox (*Pteropus poliocephalus*) is listed as Vulnerable under the TSC Act. In NSW, the Grey-Headed Flying-Fox occurs along the east coast, eastern slopes of the Great Dividing Range and the tablelands. The species may be found in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, while additional foraging is provided by urban gardens and cultivated fruit crops.

The Grey-Headed Flying-Fox was not recorded in the study area during the current survey. The study area contains potential foraging habitat for the species provided by a number of flowering native trees, predominantly eucalypts. This habitat is within an urban environment and is considered to be highly degraded and modified. There are 64 records of the species within a 10 kilometre radius of the study area, the closest record being 1.4 kilometres to the south-east (OEH 2014). The closest known camp is located approximately 11 kilometres south of the study area at Parramatta Park (DoE 2014). Due to the presence of potential foraging habitat in poor condition at the study area, and the abundance of local records, the species was considered to have a moderate likelihood of occurrence and could be impacted by the Proposal.

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

The Grey-Headed Flying-Fox is a highly mobile species with a nightly feeding range from a roosting camp of 20 to 50 kilometres. Their diet typically comprises a wide variety of flowering and fruiting plants, in particular, blossom from trees of the Myrtaceae family and native figs (Ficus sp.) (Churchill 1998). Foraging resources during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May) is important to this species (DECCW 2009). The study area contains several native flowering tree species that could be utilised across different seasons, including during the important times of the reproductive cycle.

Grey-Headed Flying-Foxes roost in large numbers, with up to tens of thousands of flying foxes using individual camps for mating, birth and rearing of young. Camps are typically located in gullies, close to water, in vegetation with a dense canopy, within 20 kilometres of a regular food source. Site fidelity to camps is high, with some camps being used for over 100 years (NPWS 2001).

There is no known maternity roosting camp of Grey-headed Flying-foxes within the study area. The study area provides a potential foraging resource for up to 25 camps that occur within a 50 kilometre radius, which is the maximum foraging distance of an adult Grey-headed Flying-fox (DECCW 2009). Potential foraging resources for the species are available at the study area during critical times of the reproductive cycle. Breeding individuals from nearby camps that utilise resources at the study area could be adversely impacted by the removal of foraging habitat. However, vegetation removal would be within a relatively small area and would not significantly diminish the foraging resources in the region that would support breeding females. Where feasible and reasonable, vegetation clearing for the proposal should be scheduled to avoid the times when the species gives birth and lactates (October to March) to minimise the impacts to the breeding cycle of this species.

The removal of seasonal foraging habitat as a result of the proposed action is highly unlikely to have an adverse effect on the life cycle of the Grey-Headed Flying-Fox such that a viable local population of the species is likely to be placed at risk of extinction.

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

Not applicable. The Grey-headed Flying-fox is a threatened species.

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

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

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

Not applicable. The Grey-Headed Flying-Fox is a threatened species.

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

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

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

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

Native trees across the study area provide a food resource for the Grey-Headed Flying-Fox, and include street trees and 0.65 hectares of native vegetation. However this foraging resource does not comprise a significant area of foraging habitat within the locality. The loss of potential foraging habitat within the study area is not likely to be significant to the species, nor would it fragment or isolate areas of habitat. However, the loss of foraging habitat is considered the primary threat to the species (DECCW 2009) and there has been an overall reduction in foraging habitat in the region and across the species' geographic range. Therefore the removal of a smaller area of habitat from the study area could contribute to cumulative impacts on the long-term stability of the population.

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

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for the Grey-Headed Flying-Fox.

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

There is currently no approved Recovery Plan in place for the Grey-Headed Flying-Fox. A Draft National Recovery Plan for the Grey-headed Flying-fox was prepared in July 2009 (DECCW 2009).The Draft National Recovery Plan lists 13 specific objectives for the five-year timeframe of the Plan. Of these, two could be considered relevant to the proposal:

- Objective 1: To identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range.
- Objective 2: To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes.

The Grey-headed Flying-fox has been assigned to the Landscape species management stream under the NSW OEH Saving Our Species program. Threatened species in this management stream are distributed across large areas, or are highly mobile and threatened across the landscape by habitat loss and degradation. They are managed using measures such as broadscale vegetation and habitat management programs, land clearing controls, water

management plans and management of national parks and reserves. A number of management actions have been identified for the species that also include measures to protect foraging habitat for the species.

Whilst the Proposal would result in the removal of potential foraging habitat, this habitat is not likely to be key foraging habitat or habitat critical to the survival of this 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.

Of the key threatening processes listed in Schedule 3 of the TSC Act, one is relevant to the potential impacts of the Proposal on Grey-Headed Flying-Fox:

- Clearing of native vegetation – Approximately 0.65 hectares of native vegetation that contains foraging habitat would be cleared. This does not represent a significant area of foraging habitat for Grey-Headed Flying-Fox in the locality.

Conclusion

The Proposal would require the removal of native and exotic vegetation which provides potential seasonal foraging habitat for this species. There is no known maternity roosting camp of Grey-headed Flying-foxes within the study area, but there are 25 camps known to occur within a 50 kilometre radius, for which the trees on the study area may provide a potential foraging resource.

Potential foraging habitat to be cleared is not considered to be a significant area of habitat or of importance to the long-term survival of Grey-headed Flying-fox in the locality. As a result, it is considered unlikely that the proposal represents a significant impact to the vulnerable species Grey-headed Flying-fox, particularly if the proposed mitigation measures are implemented. A Species Impact Statement is not required for this species.

Microchiropteran Bats

Impacts to microchiropteran bats (microbats) have been considered in one seven-part test due to the similarity in habitat requirements and potential impacts. The following microbats have the potential to be impacted by the Proposal:

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (OEH 2014b). It prefers moist habitats, with trees taller than 20 metres and generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It breeds between late spring and early summer (Churchill 1998).

The Study Area provides suboptimal foraging habitat within woodland areas and riparian habitat. Hollow-bearing trees and exfoliating bark of eucalypts within the Study Area may offer potential roosting habitat. The Eastern False Pipistrelle has been recorded 20 times within 10 kilometres of the Study Area (OEH 2014b) and a potential call was recorded at Strangers Creek.

Little Bentwing-bat (*Miniopterus australis*)

Little Bentwing-bat (*Miniopterus australis*) occurs along the east coast of NSW and ranges from the northern border south to Wollongong. The species is found in moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub; it is generally found in well-timbered areas. It roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges (OEH 2014c).

The Study Area does not provide preferred vegetation for this species however, culverts may offer roosting habitat. The Little Bentwing-bat has been recorded six times within 10 kilometres of the Study Area (OEH 2014), however it was not recorded during Anabat surveys.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) occurs along the east coast of Australia. The species forages in forested areas and primarily roosts in caves, but will also use a range of man-made structures (Churchill 1998).

The Study Area does not provide preferred vegetation for this species however, culverts may offer roosting habitat. The Eastern Bentwing-bat has been recorded 63 times within 10 kilometres of the Study Area (OEH 2014), and a potential call was recorded during Anabat surveys.

Eastern Freetail-bat *(Mormopterus norfolkensis)*

The Eastern Freetail-bat is listed as Vulnerable under the TSC Act. The Eastern Freetail-bat is found east of the Great Dividing Range, from Brisbane in south-east Queensland to Sydney in NSW, where it is most commonly recorded in dry eucalypt forest and woodland, and shows a preference for open spaces in woodland or forest. The species has also been recorded in swamp forests and mangrove forests. The Eastern Freetail-bat forages in openings and gaps in the forest including over larger waterways (Churchill 2008). The Eastern Freetail-bat roost mainly in tree hollows; usually in hollow spouts of large mature trees, but will also roost under exfoliating bark or in man-made structures and buildings (Churchill 2008).

The Study Area provides potential foraging habitat within woodland areas and riparian habitat. Hollow-bearing trees and exfoliating bark of eucalypts within the Study Area may offer potential roosting habitat. The Eastern Freetail-bat has been recorded 34 times within 10 kilometres of the Study Area, and was recorded in the study area during Anabat surveys.

Southern Myotis *(Myotis macropus)*

The Southern Myotis is listed as Vulnerable under the TSC Act. The Southern Myotis occurs across the northern and eastern coasts of Australia (from the Kimberley to Victoria) and is rarely found more than 100 kilometres inland (OEH 2014d). The species is found in vegetated habitats associated with streams and permanent waterways, most commonly at low elevations in flat or undulating terrain (Churchill 1998). Habitats include riparian vegetation and also in mangroves, paperbark swamps, rainforest, wet and dry sclerophyll forest and open woodland. Southern Myotis roosts near water in caves, mine shafts, tree hollows, under bridges and in buildings, stormwater drains, culverts and amongst dense vegetation fringing watercourses (Churchill 1998).

The Study Area provides potential foraging habitat within woodland areas and riparian habitat. Culverts within the Study Area may offer potential roosting habitat. The Southern Myotis has been recorded 21 times within 10 kilometres of the Study Area (OEH 2014) and a potential call was recorded during Anabat surveys.

Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)

The Yellow-bellied Sheathtail-bat is listed as Vulnerable under the TSC Act. It occurs throughout tropical and south-east of Australia, excluding Tasmania. It is found in a variety of habitat types including wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grassland and desert. It roost in tree hollows, abandoned sugar glider nests or animals burrows (OEH 2014e).

The Study Area provides suboptimal foraging habitat within woodland areas and riparian habitat. Hollow-bearing trees within the Study Area may offer potential roosting habitat. The Yellow-bellied Sheathtail Bat has been recorded seven times within 10 kilometres of the Study Area (OEH 2014) however it was not recorded during Anabat surveys.

Greater Broad-nosed Bat (*Scoteanax rueppellii*)

The Greater Broad-nosed Bat is listed as Vulnerable under the TSC Act. The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland (OEH 2014f). GBB extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 metres. It utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. The Greater Broad-nosed Bat forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 to 6 metres. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.

The Study Area provides suboptimal foraging habitat within woodland areas and riparian habitat. Hollow-bearing trees within the Study Area may offer potential roosting habitat. The Greater Broad-nosed Bat has been recorded 14 times within 10 kilometres of the Study Area (OEH 2014) however it was not recorded during Anabat surveys.

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

The *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC 2007) defines local population as the “population that occurs in the Study Area”. The local population can be extended to include individuals beyond the Study Area if it can be clearly demonstrated that the populations extends beyond the Study Area in adjoining areas (contiguous or otherwise).

Microbats are a wide-ranging, highly mobile species and any microbats roosting at the Study Area are likely to be part of local populations that extend beyond the Study Area, in remnant vegetation in the locality.

Up to one potential hollow-bearing tree could be removed for the Proposal. As such, potential roosting habitat of the Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat, Eastern False Pipistrelle and Eastern Freetail-bat could be impacted. Furthermore, the removal of culverts at the three creek crossings could temporarily remove roosting habitat for the Little Bentwing-bat, Eastern Bentwing-bat and Southern Myotis. Both species of Bentwing Bat breed in maternity colonies and therefore would not breed in the study area. As such, the life cycle of these two species would not be impacted by the Proposal.

Impacts to the breeding cycle of the remaining five microbats could include displacement of females with young or pregnant females. Whether these impacts occur is dependent on the timing of vegetation removal. Vegetation and culvert removal timing is unknown and therefore could occur during hibernation and/ breeding times. Nevertheless, the Proposal would impact a small proportion, if any, of microbat populations that occur in the wider locality (i.e. recorded within 10 kilometres). The Proposal is unlikely to lead to the extinction of these populations.

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

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, or

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

Not applicable.

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

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

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

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

The Proposal would require the removal of potential roosting and foraging habitat for threatened microbat species. Approximately 0.236 hectares of riparian and aquatic habitat would be impacted by the Proposal which would provide foraging habitat for all microbat species. Furthermore, street trees and 0.65 hectares of native vegetation would be removed for the Proposal which provide potential roosting habitat for two species that are known to roost under bark: Eastern False Pipistrelle and Eastern Freetail-bat. The removal of a potential hollow-bearing tree could also impact roosting habitat for these species and Yellow-bellied Sheathtail-bat and Greater Broad-nosed Bat.

Three culverts would be removed for the Proposal which have the potential to provide roosting habitat for three threatened microbats: Little Bentwing-bat, Eastern Bentwing-bat and Southern Myotis. Culverts would be replaced at Elizabeth Macarthur Creek and the unnamed tributary. A bridge would replace the culvert at Strangers Creek. Culverts and the bridge have the potential to provide roosting habitat to these microbats in future.

The amount of potential microbat habitat to be impacted does not represent a significant area for any of the seven threatened species in the wider locality.

Habitat removal would further fragment the landscape which is highly affected by fragmentation in its current state. Habitat is unlikely to become isolated within the Study Area for highly mobile fauna such as microbats.

Microbat habitat within the Study Area is unlikely to be particular important for the long-term survival of any of the microbat species with the potential to occur or known within the Study Area.

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

No area has been designated as 'critical habitat' under Part 3 of the TSC Act 1995 for the any microchiropteran bat species.

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

There are currently no Recovery Plans or Threat Abatement Plans in operation for any of the seven microbat species.

Four of the threatened microbat species have been assigned to the Landscape species management stream under the NSW OEH Saving Our Species program: Eastern False Pipistrelle, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat and Southern Myotis. Threatened species in this management stream are distributed across large areas, or are highly mobile and threatened across the landscape by habitat loss and degradation. They are managed using measures such as broadscale vegetation and habitat management programs, land clearing controls, water management plans and management of national parks and reserves.

A number of management actions have been identified for each species, with a number common to all four. One management action listed for all four species which is relevant to the proposal is:

- Prepare EIA guidelines which address retention of hollow bearing trees maintaining diversity of age groups, species diversity & structural diversity, giving priority to largest hollow bearing trees.

Although the proposal will potentially remove one hollow-bearing tree which represent potential roosting and breeding habitat for the species, there are opportunities to retain habitat (including hollow bearing trees) and implement some of the other listed management actions.

Two of the threatened microbat species have been assigned to the Site-managed species management stream under the NSW OEH Saving Our Species program: Little Bentwing-bat and Eastern Bentwing-bat. It is considered that site-managed species can be successfully secured by carrying out targeted conservation projects on specific sites around NSW.

OEH has established four management sites for the Eastern Bentwing-bat and one management site for the Little Bentwing-bat, at the maternity colony at Willi Willi Caves (as for

the Eastern Bentwing-bat). None of these management sites are within the greater Sydney region.

The Eastern Freetail-bat has been assigned to the Data-deficient species management stream under the NSW OEH Saving Our Species program. There is insufficient information on these species to allocate them to another management stream. Species action statements have been prepared outlining research and survey actions to be undertaken before an appropriate management approach can be developed. Once detailed information is available, an expert panel will consider which management stream each species should be placed in. One action has been identified for the Eastern Freetail-bat: conduct targeted survey of the species' known habitat and census all populations.

(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 TSC Act defines a 'key threatening process' as 'a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities'. Schedule 3 of the TSC Act provides a list of the 'key threatening processes' (KTP). Of the KTPs listed in Schedule 3 of the TSC Act the following would occur as a result of the Proposal relevant to microbats:

- Clearing of native vegetation – Approximately 0.65 hectares of native vegetation that contains potential habitat for the four microbat species would be cleared.
- Loss of hollow-bearing trees – A maximum of one hollow-bearing tree could be cleared which could provide roosting habitat for microbats.

Conclusion

Though the Proposal could result in the extinction of a local viable population, it is unlikely to impact known populations of microbats in the locality. The Proposal would not remove, modify or further fragment or isolate a significant area of habitat for the species. Therefore the Proposal is unlikely to have a significant impact on Eastern Freetail-bat, Eastern False Pipistrelle, Little Bentwing-bat, Greater Broad-nosed Bat, Yellow-bellied Sheathtail-bat or Southern Myotis.

Consequently, a Species Impact Statement is not required to be prepared.

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

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

Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act. Due to the presence of potential foraging habitat in poor condition in the study area, and the abundance of local records, the species was considered to have a moderate likelihood of occurrence and could be impacted by the Proposal. .

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

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

Important populations are those that may be identified as such in recovery plans, and/or that are:

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

The Grey-headed Flying-fox has no separate or distinct populations (DoE 2014a). The species constantly exchanges genetic information between camps throughout its geographic range. The study area is located close to a large roosting camp at Parramatta Park and several other colonies in the Greater Sydney region such as Clyde, Wetherill Park and Gordon camps. The study area could be utilised by individuals from these camps for foraging however, they do not currently use the study area for permanent roosting or as a maternity camp. Native trees across the study area provide a food resource for the Grey-Headed Flying-Fox, however this foraging resource does not comprise a significant area of foraging habitat within the locality. However, the loss of foraging habitat is considered the primary threat to the species (DECCW 2009) and there has been an overall reduction in foraging habitat in the region and across the species geographic range. Therefore the development could have a cumulative impact on the long-term stability of the population.

Reduce the area of occupancy of an important population

Twenty-five roosting camps of the Grey-headed Flying-fox are known within 50 kilometres of the study area (DoE 2014). Individuals from these camps could utilise foraging resources within the study area however potential usage would fluctuate seasonally and year-by-year according to changes in food availability. The removal of a relatively small portion of potential foraging habitat from the study area would not significantly reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

The removal of potential foraging habitat from the study area would not fragment the population of the Grey-Headed Flying-Fox into two or more populations.

Adversely affect habitat critical to the survival of a species

Whilst the Proposal would result in the removal of potential foraging habitat, this habitat is not likely to be habitat critical to the survival of this species.

Disrupt the breeding cycle of an important population

There is no known maternity roosting camp of Grey-headed Flying-foxes within the study area. The study area provides a potential foraging resource for up to 25 camps that occur within a 50 kilometre radius which is the maximum foraging distance of an adult Grey-headed Flying-fox

(DECCW 2009). Potential foraging resources for the species are available at the study area during critical times of the reproductive cycle. Breeding individuals from the 11 nearby camps that utilise resources at the study area could be adversely impacted by the removal of foraging habitat. However, vegetation removal would be over a relatively small area and would not significantly diminish the foraging resources elsewhere in the study area and in the region that would support breeding females. Nevertheless, vegetation clearing for the proposal should be scheduled to avoid the times when the species gives birth and lactates (October to March) to minimise the impacts to the breeding cycle of this species.

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

The proposal would involve the removal of potential foraging habitat for the Grey-Headed Flying-Fox. This foraging resource does not comprise a significant area of foraging habitat within the study area or the locality. The loss of street trees and 0.65 hectares of native vegetation that provide potential foraging habitat is not likely to be significant to the species such that it is likely to decline.

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

The action is unlikely to result in the establishment of an invasive species that is harmful to the Grey-Headed Flying-Fox. Known predators of the species include native reptiles and birds; no invasive exotic fauna species are known to predate upon Grey-Headed Flying-Foxes. The action is highly unlikely to result in the establishment of invasive flora species that are harmful to the Grey-Headed Flying-Fox.

Introduce disease that may cause the species to decline, or

The action is highly unlikely to introduce disease that may cause the Grey-Headed Flying-Fox to decline.

Interfere with the recovery of the species

There is currently no approved Recovery Plan in place for the Grey-Headed Flying-Fox. A Draft National Recovery Plan for the Grey-headed Flying-fox was prepared in July 2009 (DECCW 2009).The Draft National Recovery Plan lists 13 specific objectives for the five-year timeframe of the Plan. Of these, two could be considered relevant to the proposal:

- Objective 1: To identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range.
- Objective 2: To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes.

Whilst the Proposal would result in the removal of potential foraging habitat, this habitat is not likely to be key foraging habitat or habitat critical to the survival of this species.

Conclusion

Under the EPBC Act an action requires approval from the Australian Government Minister for the Environment (DoE) if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance such as the Grey-Headed Flying-Fox. Based on the above assessment, it is concluded that the action would not have a significant impact on the Grey-Headed Flying-Fox as it would result in the removal of a relatively small amount of potential foraging habitat which is not likely to be critical to the survival of the species. It is unlikely to introduce diseases or invasive species that would impact this species. As such the action does not require referral to DoE.