



**Transport**  
Roads & Maritime  
Services

# PROSPECT HIGHWAY UPGRADE

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## Biodiversity Impact Assessment

Final



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Roads and Maritime Services

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Biodiversity Impact Assessment

Prepared by  
Sinclair Knight Merz  
February 2014

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## Glossary of terms and abbreviations

Term	Meaning
ANZECC	Australian and New Zealand Environment Conservation Council
AHD	Australian height datum
CMA	Catchment Management Authority
CEMP	Construction Environmental Management Plan
DBH	Diameter at breast height
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DPI	Department of Primary Industries
EIA	Environmental Impact Assessment
DoE	Federal Department of Environment
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FM Act	Fisheries Management Act 1994
GPS	Global positioning system
HBT	Hollow bearing trees
Km	Kilometre
m	Metre
m <sup>2</sup>	Metres squared
NES	National Environmental Significance
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service (now included under OEH)
NSW	New South Wales
OEH	Office of Environment and Heritage
Proposal footprint	Refers to the area of bridge replacement and includes any ancillary locations or drainage structures.
Riparian	Transition zone between land and watercourse
REF	Review of Environmental Factors
Roads and Maritime	NSW Roads Maritime Service
RTA	Roads Traffic Authority NSW (now known as the Roads and Maritime)
SEPP	State Environmental Planning Policy
SIS	Species impact Statement
SKM	Sinclair Knight Merz
Study area	Encompasses the proposal footprint and any adjoining or adjacent habitat where potential indirect impacts may



Term	Meaning
	occur.
Study region	The broader bioregional context defined by Thackway and Creswell (1995) as the Sydney Bioregion and occurs within a 10 kilometre radius of the proposal footprint.
TEC	Threatened Ecological Communities
TSC Act	Threatened Species Conservation Act 1995

# Executive Summary

Roads and Maritime Services (Roads and Maritime) are proposing to upgrade around 3.6 kilometres of Prospect Highway between Reservoir Road, Prospect and 200 metres north of St Martins Crescent, Blacktown (the proposal). The upgrade would deliver a minimum four lane divided road to the west of the existing carriageway.

This report describes the methods and results of a biodiversity assessment to identify potential impacts by the proposal on biodiversity. The assessment identifies relevant threatened species, populations and ecological communities in the study area. The purpose of the assessment is to assess the extent and magnitude of biodiversity impacts, and to address the requirements for a significance assessment under Part 5 of NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The report includes recommended mitigation measures to manage potential ecological impacts during construction and operation.

One remnant vegetation community (Shale Plains Woodland) and seven highly modified and/or planted and exotic vegetation types were identified. These have been described in the report as:

- Map Unit 1: Remnant Shale Plains Woodland (Cumberland Plain Woodland).
- Map Unit 2: Planted Shale Plains Woodland (Cumberland Plain Woodland).
- Map Unit 3: Regenerating Wattles.
- Map Unit 4: Freshwater Wetland.
- Map Unit 5: Mixed Plantings.
- Map Unit 6: Planted Casuarinas.
- Map Unit 7: Planted Pine Trees.
- Map Unit 8: Exotic vegetation.

Natural habitats for fauna have been extensively removed for commercial, industrial and residential development along the alignment of Prospect Highway. Habitats include a limited number of hollow-bearing trees. Other important habitats such as hollow logs, aquatic resources and rocky outcrops are generally absent. Remaining patches of habitat are small and fragmented and include:

- Small patches of remnant grassy woodland.
- Planted vegetation.
- Freshwater wetland
- Cleared and modified habitats.

Grassy woodland habitat is restricted to several small patches at the intersections of Prospect Highway and the Great Western Highway. There are also scattered remnant trees in the road reserve along Prospect Highway within maintained parkland. Although these native vegetation patches are fragmented, they are in relatively close proximity to Prospect Nature Reserve and the reservoir. These patches may be used as foraging habitat by microbats and threatened birds.

Areas of the critically endangered Cumberland Plain Woodland have been identified in the study area. These areas include low-moderate condition areas only listed

under the NSW Threatened Species Conservation Act 1995 (TSC Act) (Map Unit 1 and 2). A high condition remnant is also present adjacent to and within a Council reserve (Timbertop Reserve) and the Great Western Highway which is listed under both the TSC Act and the EPBC Act. Around 0.57 hectares of low-moderate condition and around 0.12 hectares of high condition Cumberland Plain Woodland would be directly and indirectly impacted by the proposal.

The high condition remnant of the critically endangered Cumberland Plain Woodland (Map Unit 1) listed under both the TSC Act and the EPBC Act is adjacent to the proposed widening of the two way link road between Prospect Highway and the Great Western Highway. The majority of the high condition remnant woodland extends over an area of land zoned for protection in Timbertop Reserve. Roads and Maritime has sought to avoid and minimise impact on this remnant woodland as much as possible. The proposed design minimised the direct and indirect impact of the proposal at the site to 0.12 hectares. The proposed design restricts the proposed clearing and indirect impacts to a narrow strip of vegetation around 25 metres by 100 metres between the residential subdivision and the road reserve while avoiding the remnant vegetation in Timbertop Reserve. This strip of vegetation is already indirectly impacted by the adjoining highway to the south and subdivision to the north.

The biodiversity assessment has identified that the proposal would involve:

- Impacts to 0.12 hectares of high condition Cumberland Plain Woodland listed as critically endangered under the EPBC Act. This consists of 0.08 hectares of direct impacts and 0.04 hectares of indirect impacts.
- Direct and indirect impacts to Cumberland Plain Woodland as listed under the TSC Act (0.69 hectares). This consists of high condition vegetation (0.12 hectares) listed under the EPBC Act (referred to above) and the TSC Act, and areas listed under the TSC Act only comprising moderate condition vegetation (0.11 hectares), isolated remnant trees (0.32 hectares) and planted vegetation (0.14 hectares) with affinities to native Cumberland Plain Woodland.
- One individual of the vulnerable species (TSC Act) Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*) was recorded in the study area. This was located in a highly modified area of Cumberland Plain Woodland that would not be affected by the proposal.
- Removal of habitat for threatened flora species in the study area is generally limited to intact patches of vegetation. Despite targeted surveys in these habitats none were recorded within the construction footprint, including targeted searches during the appropriate season for the cryptic Spiked Rice-flower (*Pimelea spicata*).
- The remnant and planted vegetation to be impacted provides limited but potential habitat for some threatened fauna species. Thirteen highly mobile species were identified in the background review as having a moderate potential to occur.
- The Cumberland Plain Land Snail has a high potential to occur in the study area based on local records and habitat preferences. Impacts would be limited to around 0.12 of habitat potentially available to this species, however suitable microhabitat elements in this area such as fallen timber and substantial areas of leaf litter are limited. No Cumberland Plain Land Snail were identified in the study area during targeted surveys in August and November 2013.

The proposal is unlikely to substantially contribute to further fragmentation of habitats and impacts to wildlife connectivity. This is due to existing high levels of fragmentation, which limits fauna species that would use the available habitats to

highly mobile species.

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

- Avoidance and minimisation of vegetation removal where possible.
- Pre-clearing surveys for Cumberland Plain Land Snail and Spiked Rice-flower.
- Staged habitat removal.
- Management of invasive weed species.
- Stormwater and water quality management

In accordance with Roads and Maritime offset policy (2011), offsets would be considered for the 0.69 hectares of CPW (TSC Act and EPBC Act listed) directly and indirectly impacted as part of the proposal. However offsets are not formally required as there is not a significant impact expected.

Based on the conclusions of the Assessment of Significance for threatened species and listed ecological communities a Species Impact Statement under the EP&A Act is not required and it is considered unlikely that the impact would trigger a controlled action under the EPBC Act.

# 1 Introduction

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## 1.1 Background

Roads and Maritime Services (Roads and Maritime) are proposing to upgrade approximately 3.6 kilometres of Prospect Highway between Reservoir Road, Prospect and 200 metres north of St Martins Crescent, Blacktown. The upgrade would deliver a minimum four lane divided road occurring to the west of the existing carriageway. The location of the study area is provided in **Figure 1–1**.

This report details the methods and results of a biodiversity assessment to identify threatened species, populations and ecological populations in the study area. The purpose of the assessment is to assess the extent and magnitude of impacts on biodiversity by the proposal.

The assessment addresses the requirements for assessment of significance under Part 5 of NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It includes recommended mitigation measures to ameliorate potential ecological impacts from the proposal.

## 1.2 Proposal description

The proposal involves upgrading Prospect Highway between Reservoir Road, Prospect and St Martins Crescent, Blacktown, a length of around 3.4 kilometres. The Prospect Highway, between Reservoir Road at Prospect and St Martins Crescent at Blacktown, forms the main road corridor connecting the city of Blacktown with the M4 Western Motorway. It is proposed to upgrade the corridor to meet future traffic demand, reduce travel times, and improve road safety. The upgrade will involve improvements to the existing route of the Prospect Highway.

The key features of the Prospect Highway upgrade are:

- Upgrading to two lanes in each direction.
- Duplicating the bridges over the M4 Western Motorway and the Great Western Highway.
- Providing a new two way road between the Great Western Highway and the Prospect Highway, with traffic lights at either end of the new road, to improve access.
- Providing new traffic lights at:
  - Stoddart Road.
  - M4 Western Motorway eastbound entry and exit ramp.
  - Reservoir Road.
- Changing access arrangements at:
  - Tudor Avenue.
  - Roger Place.
  - Vesuvius Street.
  - Ponds Road.

- Upgrading a shared path/cycleway on the western side of the Prospect Highway to connect existing paths.
- Improving bus priority.

### 1.3 Study area

The following areas are discussed throughout the report and are defined as:

- Proposal footprint: this area comprises the limits of the upgrade design.
- Construction footprint: this area comprises the limits of the upgrade design with a five metre buffer.
- Study area: includes the general location around the proposal footprint and includes adjacent lands potentially subject to indirect impacts and includes part of the M4 Western Motorway and Great Western Highway corridors.
- Study locality: this area comprises a 10 kilometre radius surrounding the proposal footprint.

The study area is located in the Sydney Basin bioregion as defined by Thackway and Cresswell (1995) and within the Hawkesbury-Nepean Catchment Management Area (CMA) and the Sydney Metro CMA in the Cumberland sub-region in both CMAs.

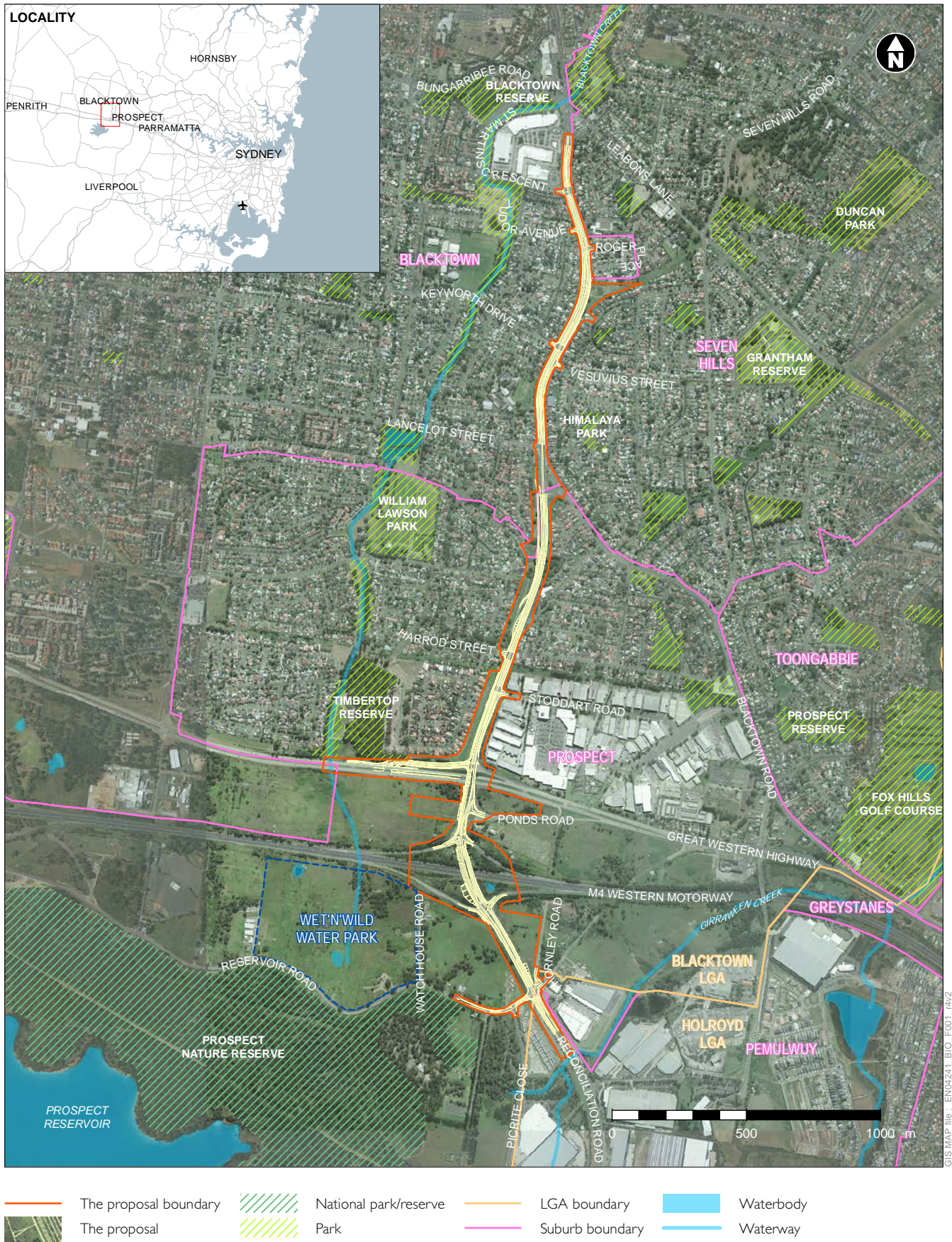


Figure I-1  
Overview of the proposal

## 1.4 Legislative context

The information presented in this report assesses the potential impacts on threatened species, populations, or ecological communities or their habitats in relation to State and Commonwealth environmental and threatened species legislation, namely the:

- *Environmental Planning and Assessment Act 1979* (EP&A Act).
- *Threatened Species Conservation Act, 1995* (TSC Act).
- *Fisheries Management Act 1994* (FM Act).
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

### 1.4.1 Environmental Planning and Assessment Act 1979

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

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

### 1.4.2 Threatened Species Conservation Act, 1995

The TSC Act identifies threatened species, populations and ecological communities, as listed under Schedules 1, 1A and 2 that are to be identified as potential subject species and therefore require a significance assessment under section 5A of the EP&A Act. The TSC Act also lists Key Threatening Processes, which comprise matters that threaten the survival or evolutionary development of a species, population or ecological community.

### 1.4.3 Fisheries Management Act, 1994

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

### 1.4.4 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act objective is to protect the environment, particularly Matters of National Environmental Significance (MNES), and to provide an environmental assessment pathway for development on Commonwealth land. It streamlines the national environmental



assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places. The EPBC Act identifies nine Matters of NES:

- World Heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).
- Great Barrier Reef.
- Protection of water resources from coal seam gas development or large coal mining development.

The EPBC Act is triggered by actions that would be likely to have a significant impact upon Matters of NES. Under the EPBC Act, such actions require approval from the Federal Environment Minister and should be referred to the Federal Department of the Environment (DoE) for consideration. Actions deemed by DoE to require Commonwealth approval would be 'controlled actions' which require an environmental assessment. The EPBC Act also lists Key Threatening Processes comprising matters that threaten the survival or evolutionary development of a native species or ecological community.

## 1.5 Study Aims

The aims of the biodiversity assessment are to:

- Describe the characteristics and ecological condition of the vegetation communities and habitats within the study area.
- Determine the occurrence, or likelihood of occurrence of threatened species, populations and ecological communities listed under the TSC Act, FM Act and EPBC Act within the study area.
- Assess the potential impacts on biodiversity in the study area from the proposal according to Section 5A of the EP&A Act, for species listed under the TSC Act and the FM Act, in addition to the guidelines of significance under the EPBC Act for any Matters of NES potentially impacted.
- Assess the potential impacts of the proposal on Matters of NES (refer to significant impact guidelines section 1.1 under the EPBC Act).
- Propose further investigations and/or mitigation measures to mitigate impacts on any conservation and significant biodiversity values identified in the study area.

## 2 Methodology

### 2.1 Personnel

SKM ecologists are licensed to conduct field surveys under the NPW Act (Scientific Research Permit SL100044) and maintain ethics approval to handle native fauna from the NSW Department of Primary Industries Animal Care and Ethics Committee (Animal Research Authority (09/1895)). The qualifications and role of personnel involved in the field and reporting assessment are provided in **Table 2-1**.

**Table 2-1 Qualifications and role of key personnel**

Personnel	Qualifications	Project tasks
Andrew Carty	BEnvSc; DipBushRegen; Accredited Biobanking Assessor	Biodiversity assessment report; flora and fauna surveys, vegetation mapping
Chris Thomson	BAppSc; GradCertNatRes	Practice review
Jonathan Carr	BEnvSc	Field assistant flora and fauna surveys

### 2.2 Database search and literature review

A review of existing reports and government maintained databases was undertaken as the first stage of the investigation. The following information was reviewed:

- NSW vegetation types database (OEH 2012). <http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm>
- NSW threatened species profile database (OEH 2013). <http://www.environment.nsw.gov.au/biobanking/biobankingtspd.htm>
- Native Vegetation of the Cumberland Plain - Final Edition (NPWS 2002).
- The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities (Tozer 2003).
- DPI Noxious Weed listings. <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed>
- Atlas of NSW Wildlife maintained by the NSW Office of Environment and Heritage (OEH April 2013).
- Atlas of Living Australia maintained by CSIRO.
- The Protected Matters Search Tool provided under the EPBC Act (August 2013).
- M4 Managed Motorway Biodiversity working paper (Roads and Maritime 2013).

The review focused on identifying and listing the threatened flora and fauna species, populations and ecological communities previously recorded within a 10 kilometre radius of the proposal. The background review also aimed to identify any sensitive ecological sites such as National Parks and other reserves, and areas protected by State Environment Planning Policies. Following collation of database records, species and community profiles a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the study area. This was further refined following field surveys and an assessment of habitat present. The list of threatened species recorded from the locality is provided as **Appendix A**.

## 2.3 Field survey

The following provides a description of the ecological surveys conducted in the study area which included terrestrial flora and fauna surveys. The survey was conducted over a single season during late August 2013. Weather conditions were clear and sunny with light south easterly winds and mild temperatures from 12-18°C. The study area was stratified into areas of ecological interest including intact patches of vegetation as well as isolated trees and planted vegetation, and targeted surveys were implemented relative to the quality and extent of these habitats. The main locations where field surveys were undertaken in the study area are indicated in **Figure 3-1a** to **Figure 3-1d**.

Further targeted surveys for cryptic flora species and Cumberland Plain Land Snail (*Meridolum corneovirens*) were undertaken on the 29 November 2013 in suitable areas of habitat. All potentially occurring cryptic flora species were targeted, with Spiked Rice-flower (*Pimelea spicata*) being the main species targeted. Known Spiked Rice-flower locations at Mount Annan Botanic Gardens were in flower at the time of the targeted surveys in November 2013. Higher levels of soil moisture were observed in November 2013 compared with the August 2013 surveys making conditions more optimal to detect threatened flora species and Cumberland Plain Land Snail, however conditions were still not completely optimal with below average rainfall proceeding surveys.

### 2.3.1 Vegetation and flora field survey

A combination of aerial photograph interpretation, broad-scale vegetation mapping (NPWS 2002) and elevation data was used to stratify the vegetation and habitats in the study area. The stratification of vegetation map units was based on a number of factors including the provenance (ie remnant or planted/landscaped), the vegetation structure, dominant species, soil types and landscape position. The location and number of sampling sites used in the field survey was determined according to the extent and condition of each vegetation type present to ensure they are adequately represented.

The flora survey aimed to provide baseline data for the presence of threatened plant species, populations and ecological communities to provide a basis for the prediction of impacts. It comprised the following steps:

- A thorough review of the broad-scale vegetation mapping, previous specialist reports conducted in close proximity (Roads and Maritime 2013), threatened species records, and other available literature and scientific databases. The purpose of this was to gain an appreciation of the diversity of flora including threatened species that could potentially occur in the study area.
- Stratified sampling techniques to classify and map vegetation communities, threatened species habitat and to develop an inventory of flora species specific to each vegetation association.
- Targeted searches for threatened flora species in areas of suitable habitat including Juniper-leaved Grevillea (*Grevillea juniperina subsp, juniperina*) and Spiked Rice-flower (*Pimelea spicata*).

### 2.3.2 Vegetation association classification and mapping

Transect sampling was used to identify vegetation community types and boundaries. The number of transects sampled was proportional to the size of the stratification units identified with a minimum of two 100 metre transects sampled per two to 50 hectares of each

stratification unit and three 100 metre transects sampled per 51 to 250 hectares of stratification unit in accordance with DEC (2004).

Digital mapping of vegetation communities was conducted using ArcGIS® software. A combination of current field data, previous field data (Roads and Maritime 2013) aerial photograph interpretation and biophysical data such as elevation and soil type was used to delineate community boundaries. Description of the vegetation communities was based on their structure and dominant canopy species (Specht 1981) and correlated with Keith (2004), Tozer (2003) and NPWS (2002). These were compared with final determinations and listing advice for threatened ecological communities.

Following field identification the vegetation communities in the study area were matched to relevant Biometric vegetation types as reported in OEH (2012) as well as broad-scale vegetation classification for the region produced by Tozer (2003).

### 2.3.3 Plot sampling

Standard quadrat based sampling was used in conjunction with general traverses of the study area, and in particular those areas associated with the proposal footprint. Quantitative data on plant species richness were collected from a series of 20 x 20 metre plots (400 m<sup>2</sup>) sampled within each remnant vegetation association. Data collected within each plot included:

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

### 2.3.4 Transects and traverses

General traverses comprised random searches throughout targeted areas to develop a plant list (**Appendix B**) and to complete searches for threatened species, as well as to opportunistically record the distribution of vegetation communities, significant habitat attributes and any other factors that may be of interest. The locations of all threatened species, vegetation community boundaries and any other ecological factors were recorded with a Geographic Positioning System (GPS).

### 2.3.5 Threatened Ecological Community assessment

Identification of Cumberland Plain Woodland as listed under the TSC Act and EPBC Act was delineated using the NSW final determination (NSW Scientific Committee 2009) and Federal listing advice (DEWHA 2010). Condition thresholds are not provided for the State-listed community. Condition thresholds for the federally listed community have been developed and these are detailed in **Table 2-2**.

**Table 2-2 Conditions thresholds for the federally listed Cumberland Plain Woodland and Shale-Gravel Transition Forest (DEWHA 2010)**

No	Category	Yes	No
1	Are diagnostic native tree species dominant ( <i>Eucalyptus fibrosa</i> , <i>E. tereticornis</i> , <i>E. moluccana</i> ) with a minimum projected foliage cover of 10%?	Go to 2	Not the listed ecological community
2	Is the patch size of the ecological community 0.5 ha or greater in size?	Go to 3	Not the listed ecological community
3	Of the perennial understorey vegetation cover present does greater than 50% consist of native species?	The listed ecological community is present	Go to 4
4	Is the patch 5 ha or greater in size?	Go to 7	Go to 5
5	Is the patch contiguous with a native vegetation patch 5 ha or greater in size?	Go to 7	Go to 6
6	Does the patch contain at least one tree per ha that is larger (>80 cm DBH) or has a hollow?	Go to 7	Not the listed ecological community
7	Of the perennial understorey vegetation cover present does greater than 30% consist of native species?	The listed ecological community is present	Not the listed ecological community

The area of vegetation patches was determined using Geographic Information System (GIS) software. The cover of perennial understory species was determined using the vegetation and condition assessment methods as specified in Section 2.3.6.

### 2.3.6 Vegetation and habitat condition assessment

A vegetation and habitat condition assessment was conducted using the Biobanking Assessment Methodology (DECC 2008). The assessment aimed to provide a measure of habitat condition for each of the remnant vegetation types impacted upon by the proposal. It also aimed to identify the floristic diversity, structure of the vegetation, the type and distribution of plant communities present and the density of fauna habitat features in the study area. Two condition assessment plots were undertaken in the study area, one in each remnant vegetation community. No formal habitat condition plots were undertaken in highly modified and planted vegetation communities due to the small patch sizes and lack of biodiversity values. Biodiversity values could readily be ascertained without the requirement for formal quadrat and transect assessment.

### 2.3.7 Fauna field survey

The fauna survey was targeted within the road reserves along the length of the study area

including proposed upgrade areas with notes taken from observations outside the corridor where adjoining habitat was present, particularly in relation to habitat condition and connectivity to the road reserve.

A combination of aerial photograph interpretation, broad-scale vegetation mapping (NPWS 2002) and elevation data was used to stratify the vegetation and habitats in the study area. The stratification of habitat types was primarily based on remnant planted habitat given the high prevalence of landscape plantings within the study area.

The fauna survey method adopted a habitat assessment approach focused on potential habitat for threatened species and identifying habitat usage by threatened fauna. This method was selected due to the predominance of planted and disturbed vegetation, the narrow linear nature of the habitat along the proposal footprint and adjoining urban landscape and therefore paucity of habitat for fauna. The location and number of sampling sites used in the field survey was determined according to the extent and condition of each vegetation type present to ensure they are adequately represented.

In addition to this, targeted searches were conducted for Cumberland Land Snail, diurnal birds and reptiles using the methods described below and in **Table 2-5**.

### 2.3.8 Fauna habitat assessment

Throughout the study area, details of the habitat type and condition were recorded. The details and habitat criteria assessed included:

- Type and structure of the vegetation, including an assessment of the 'naturalness' in terms of the presence of native remnant vegetation or planted and regrowth areas.
- Dominant flora species and a subjective assessment of the floristic diversity at different structural layers, flowering and fruiting resources.
- Tree species and height of canopy trees including the proportion of each species.
- Presence of significant keystone species and critical habitat elements for threatened fauna.
- Disturbance regimes including the presence of key threatening processes such as invasion and dominance of exotic species.
- The presence of tree hollows, dead stags or hollow logs providing potential shelter for hollow-dependent fauna, including microchiropteran bats and birds.
- The presence of artificial structures that may be used by roosting bats or nesting birds, such as concrete culverts or under bridges.
- The structure or the habitat in terms of complexity and presence of shelter and food resources for fauna, in particular threatened species.
- Presence and condition of wet areas or waterbodies, significant aquatic habitats where present.
- Size of remnant patches and extent of connectivity to habitats outside the road reserve.
- Site photographs and GPS coordinates.

The data was used in combination with the opportunistic fauna survey to identify habitats of conservation value for fauna, in particular threatened fauna known from the locality. Eight habitat assessment plots were undertaken in the study area, one in each area of remnant vegetation and six in areas of isolated trees and planted vegetation.

### 2.3.9 Searches for threatened fauna usage

An assessment was made on the potential presence of Cumberland Plain Snail (*Meridolum corneovirens*) (Endangered TSC Act) using the criteria described in **Table 2-3** to rate the value of the habitat for the species.

Targeted searches for the species were carried out at all sites that scored a moderate to high condition rating (n=2). This involved a time-based search of 20 minutes duration. The search involved a general traverse of the site and lifting any logs and building refuse when encountered and raking through patches of dense leaf litter. Opportunistic searches under logs and debris were also conducted whilst walking between habitat assessment sites. Targeted surveys for Cumberland Plain Land Snail were undertaken during the initial survey period in August 2013 and further survey during more favourable conditions was completed in November 2013.

**Table 2-3 Habitat condition criteria for Cumberland Plain Land Snail**

Condition	Sheltering habitat	Leaf litter	Naturalness	Patch size / Connectivity	Ground cover
High	Abundant logs and / or building refuse	Abundant	Remnant	Large patch or adjoins large remnant outside the road reserve	>10% open ground, low abundance of dense exotic grasses
Moderate	Low abundance of logs or building refuse	Moderate	Regrowth	Small patch in fragmented mosaic of woodland patches	<10% open ground, patchy mix of open ground and plant cover
Poor	Logs or building refuse absent	None	Planted	Small isolated patch	100% cover of tall exotic grasses, no open patches of leaf litter

The occurrence of specific habitat features appropriate for threatened fauna species known or potentially occurring at the site was evaluated as part of the habitat assessment. Features known to be used by threatened species were assessed such as hollow-bearing trees, nest trees, watercourses, specific food trees, wetland habitats, leaf litter and artificial structures suitable for roosting or denning purposes. Evidence of habitat use by fauna species was inspected such as:

- Regurgitation pellets and nest/roost sites for forest owls.
- Inspection for 'whitewash' and pellets under any potential owl roost sites.
- Diggings in the soil and scats attributed to the Long-nosed Bandicoot.
- Chewed cones beneath *Casuarina* trees indicating Glossy Black Cockatoo feeding.

### 2.3.10 Opportunistic surveys

Opportunistic fauna surveys were conducted during the survey period, and were based on direct observation, including the use of binoculars, identifying bird and frog calls as well as reptiles encountered during the surveys. A list of fauna species encountered was compiled and is presented as **Appendix C**.

## 2.4 Survey effort

A summary of the flora survey effort with respect to the number of quadrats and transects sampled per habitat type are summarised in **Table 2-4**. Only map unit 1 was subject to plot/condition assessments due to the highly modified and planted nature of other map units and/or the very small patch size.

**Table 2-4 Flora survey effort per habitat stratification unit**

Habitat	Area in study area (ha)	Sampling effort plot / condition assessments	Sampling effort plot traverses (100 m+)
Map Unit 1: Remnant Shale Plains Woodland	1.83	2	2
Map Unit 2: Planted Shale Plains Woodland	1.31	0	2
Map Unit 3: Regenerating Wattles	0.25	0	1
Map Unit 4: Freshwater Wetland	0.08	0	1
Map Unit 5: Mixed Plantings	3.3	0	3
Map Unit 6: Planted Casuarinas	0.75	0	1
Map Unit 7: Planted Pine Trees	0.08	0	1
Map Unit 8: Exotic vegetation	1.17	0	1

The total terrestrial and fauna survey effort is summarised in **Table 2-5**.

**Table 2-5 Summary of fauna survey effort**

Technique	Methodology	Survey effort
Fauna habitat assessment	Habitat assessment data were collected at eight sites including remnant, modified and planted habitats to gather information on the type and condition of the fauna habitats within the road reserve. At each site details of the habitat type and condition were noted from variable plot sizes depending on the width of the road reserve and size of the vegetation patch. The assessment focused on identifying important features for threatened fauna species.	Four person hours
Cumberland Plain Land Snail	At each assessment site an assessment was made on the potential presence of habitat for Cumberland Plain Land Snail. Targeted searches for the species were carried out at all sites which had potential habitat features present. This involved a general traverse of the site and lifting any logs and building refuse when encountered and raking through patches of dense leaf litter.	Around two person hours
Diurnal bird census	Time-based survey (either 10-minute or 20-minute) was conducted at each of the habitat assessment sites. This involved a single observer moving along a random meander within the patch areas. The survey aimed to record all birds seen or heard. Birds were also recorded opportunistically throughout the study area.	Around two person hours



Technique	Methodology	Survey effort
Reptiles searches	Reptile surveys consisted of hand searches for active and resting individuals under rocks, logs, bark, leaves and timber and artificial debris. The survey was opportunistic during the targeted Cumberland Plain Land snail surveys.	Two person-hours
Scats, tracks and opportunistic records of threatened fauna	The species and location of mammal scats, scratches and other evidence of threatened fauna presence when encountered were noted to provide locality records.	Entire survey period
Inspection of culverts for microbats	Physical inspections were conducted in drainage structures and viaducts where access was available under the highway to search for roosting microchiropteran bats or potential roosting habitat.	0.5 person hours

## 2.5 Limitations

The list of flora and fauna species recorded from this study should not be seen to be fully comprehensive, but rather an indication of the species present at the time of the survey. A period of several seasons or years is often needed to identify all the species present in an area, especially as some species are only apparent at certain times of the year eg orchids or migratory birds and require specific weather conditions for optimum detection eg frogs. The conclusions of this report are therefore based upon available data and the field surveys and are therefore merely indicative of the environmental condition of the site at the time of the survey. It should be recognised that site conditions, including the presence of threatened species, can change with time. To address this limitation, the assessment has aimed to identify the presence and suitability of the habitat for threatened species as discussed in the following section.

Fauna trapping and nocturnal surveys for arboreal mammals, microbats and large forest owls were not considered necessary or suitable given the low likelihood of observing or detecting fauna in the high noise and artificial light conditions of the study area. Species with high to moderate potential to utilise habitats in the study area such as microbat species were assessed accordingly.

## 2.6 Threatened species assessment

### 2.6.1 Likelihood of occurrence

State and nationally listed threatened species identified from the background reviews were considered in terms of their likelihood to occur in the habitats present within the study area based on their identified habitat requirements. The results of this review are provided in **Appendix A**. The likelihood of occurrence was classified according to the criteria described in **Table 2-6**. The presence of all potentially occurring threatened species were targeted during the surveys with particular emphasis on those species with a high or moderate likelihood of occurrence. Species with a high or moderate likelihood of occurrence were subject to assessments of significance under the relevant legislation (TSC Act and/or EPBC Act).

**Table 2-6 Likelihood of occurrence includes one or more of the following criteria**

Likelihood of Occurrence	Criteria
Unlikely	<ul style="list-style-type: none"> <li>• Species highly restricted to certain geographical areas not within the proposal footprint.</li> <li>• Specific habitat requirements are not present in the study area.</li> </ul>
Low	<p>Species not recorded during field surveys and fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>• Have not been recorded previously in the study area/surrounds and for which the study area is beyond the current distribution range.</li> <li>• Use specific habitats or resources not present in the study area.</li> <li>• Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.</li> </ul>
Moderate	<p>Species not recorded during the field surveys that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>• Have infrequently been recorded previously in the study area/surrounds.</li> <li>• Use specific habitats or resources present in the study area but in a poor or modified condition.</li> <li>• Are unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration.</li> <li>• Are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.</li> </ul>
High	<p>Species recorded during the field surveys or species not recorded that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>• Have frequently been recorded previously in the study area/surrounds.</li> <li>• Use habitat types or resources that are present in the study area that are in abundance and/or in good condition within the study area.</li> <li>• Are known or likely to maintain resident populations surrounding the study area.</li> <li>• Are known or likely to visit the site during regular seasonal movements or migration.</li> </ul>

## 2.6.2 Significance assessments

Significance assessments were conducted for species, populations and communities that have been positively identified or that have a moderate or high potential to occur in the study area. Species with similar taxonomy or ecological requirements were assessed together, for example cave-roosting microchiropteran bats.

For threatened biodiversity listed under the TSC Act or FM Act, the assessment considers threatened species assessment detailed in the Department of Environment and Climate Change (2007) *Threatened species assessment guidelines: The assessment of significance*. The guidelines present methods to consider the impacts on biodiversity of proposals assessed under Section 5A of the EP&A Act. For threatened biodiversity listed under the EPBC Act significance assessments were completed in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DEWHA 2009). Impact assessment guidelines, listing advice (EPBC Act), recovery plans and other information for individual threatened species or species groups and ecological communities were also consulted to respond to the assessment criteria.

## 3 Existing environment

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### 3.1 Landscape context

The study area is located in the Sydney Basin bioregion (Thackway and Cresswell 1995) and within the Sydney Metro Catchment Management Area (CMA) in the Cumberland sub-region. The Cumberland Plain comprises gently undulating plains and low hills. The Cumberland Plain is formed on sediments derived from Wianamatta Shale comprising clay-based soils. On the fringes of the Cumberland Plain these clay soils grade into sandstone-derived soils.

The study area is contained within the Sydney Harbour and Parramatta River Catchment. The geology of the area is derived from the Wianamatta Group with the Ashfield Shale underlying most of the proposed expansion.

### 3.2 Land use

Land surrounding the Prospect Highway study area includes:

- Industrial estates.
- Densely populated residential suburbs.
- Public parklands including natural and vegetation and maintained landscapes.
- Local/State conservation estate: Prospect Nature Reserve, Timbertop Reserve
- Commercial properties.
- Narrow roadside landscapes, mostly planted native species and grassed drainage swales.

### 3.3 Vegetation communities and habitat

#### 3.3.1 Vegetation communities

Planted vegetation dominates the study area and includes a wide range of species, both exotic and non-indigenous, as well as species representative of the original local vegetation. Small patches of remnant vegetation occur (Timbertop Reserve) and scattered Grey Box (*Eucalyptus moluccana*) and Forest Red Gum (*Eucalyptus tereticornis*) trees along the Prospect Highway roadside reserve. Intact vegetation patches are dominated by Blackthorn (*Bursaria spinosa*) and Acacia species in the understorey. These have a moderate to high diversity of native grass and herb groundcovers, such as Three-awned Spear Grass (*Aristida ramosa*), Kangaroo Grass (*Themeda australis*), Weeping Grass (*Microlaena stipoides* var. *stipoides*), Pastel Flower (*Pseuderanthemum variabile*) and Kidney Weed (*Dichondra repens*).

The two prominent patches on the northern and southern sides of the Great Western Highway are considered to be moderate to high condition and seem to have a good regeneration potential where regrowth of juvenile Grey Box and Forest Red Gum were observed.

A high level of disturbance from urban development has altered the species composition and vegetation structure of remnant vegetation communities in the study area.

The remnant vegetation communities were classified according to the work by Tozer (2003),

threatened ecological communities and the Biometric Vegetation Types database (OEH 2012). These are described in **Table 3-1** including the conservation status and regional cleared estimate according to OEH (2012) and the approximate area for each type in the study area. Only one remnant vegetation community type (Map Unit 1) was identified in the study area. Seven additional map units consisting of highly modified and/or planted and exotic vegetation were identified during field work. These are described as:

- Map Unit 1: Remnant Shale Plains Woodland (Cumberland Plain Woodland).
- Map Unit 2: Planted Shale Plains Woodland (Cumberland Plain Woodland).
- Map Unit 3: Regenerating Wattles.
- Map Unit 4: Freshwater Wetland.
- Map Unit 5: Mixed Plantings.
- Map Unit 6: Planted Casuarinas.
- Map Unit 7: Planted Pine Trees.
- Map Unit 8: Exotic vegetation.

A summary of the vegetation community descriptions and corresponding fauna habitat types is provided in **Table 3-1**. The distribution of these communities in the study area is shown in **Figure 3-1a** to **Figure 3-1e**. A comprehensive list of the flora species present within the study area has been included as **Appendix B**.

The vegetation condition for remnant areas was assessed using the vegetation condition assessment plots according to the biobanking methodology (DECC 2009). The results of the condition assessments are summarised for each relevant map unit in **Table 3-1**. This includes corresponding threatened ecological communities and a description of each map unit including ecological condition.

**Table 3-1 Vegetation and fauna habitat types in the study area**

Map Unit	Biometric Vegetation Type	Description	Status	Condition	Area in study area (ha)	Cleared estimate <sup>#</sup>	Fauna habitat type and characteristics
Map Unit 1: Remnant Shale Plains Woodland (Cumberland Plain Woodland)	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin	<p>Shale Plains Woodland is the most widely distributed community on the Cumberland Plain. It predominantly occurs on soils derived from Wianamatta Shale, but also occurs on Holocene alluvium in well-drained areas.</p> <p>This community is dominated by Grey Box and Forest Red Gum. Other trees with other canopy species are generally absent except for some planted Narrow-leaved Ironbark (<i>Eucalyptus crebra</i>) in some areas of the Prospect Highway roadside reserve.</p> <p>The community includes high condition areas in Timbertop Reserve (refer to Plate 3-1), moderate condition patches on the southern side of the Great Western Highway and adjacent to Thornley Road south of the M4 Western Motorway. There are also low condition areas of this community, which comprises remnant trees of Grey Box and Forest Red Gum with a cleared and maintained understorey dominated by exotic species with no or very low abundance of native flora (refer to Plate 3-2).</p> <p><b>High and moderate condition patches</b></p> <p>The understorey is dominated by native flora species, which includes a sub-canopy with younger canopy species listed above as well as Cherry Ballart (<i>Exocarpos cupressiformis</i>) and Parramatta Wattle (<i>Acacia parramattensis</i> subsp. <i>parramattensis</i>). A shrub stratum dominated by Blackthorn and <i>Dillwynia sieberi</i> is present as well as several smaller shrub species in some areas, which include <i>Pultenaea microphylla</i> and <i>Phyllanthus virgatus</i>.</p> <p>Ground stratum species include a diversity of grass species such as Weeping Grass, Kangaroo Grass, Three-awned Spear Grass (<i>Aristida</i> spp.), Wallaby Grass (<i>Rytidosperma</i> spp.) and Shorthair Plumegrass (<i>Dichelachne micrantha</i>). Common herb species include Kidney Weed, Pastel Flower, Slender Tick Trefoil (<i>Desmodium varians</i>), <i>Opercularia diphylla</i>, Wattle Mat-rush (<i>Lomandra filiformis</i> subsp. <i>filiformis</i>), Fuzzweed (<i>Vittadinia cuneata</i>), Long-leaf Flax Lily (<i>Dianella longifolia</i> var. <i>longifolia</i>), Vanilla Lily (<i>Arthropodium milleflorum</i>) and Winter Apple (<i>Eremophila debilis</i>).</p> <p>This area provides potential habitat for several threatened flora species, however despite targeted searches no threatened flora species were identified in these areas.</p>	Critically endangered, TSC Act and EPBC Act (high condition only)	High	0.42	95%	<p><b>Grassy Woodland</b> in the study area is limited to several small isolated patches of habitat and isolated remnant trees surrounded by urban development.</p> <p>Moderate to high quality habitat is present as small fragmented habitat patches. Generally moderate to high structural diversity with large mature trees scattered throughout in medium density and occasional logs. Presence of mature trees provides food resources for nectivorous birds, bats and insects as well as occasional tree hollows for hollow dependent fauna.</p> <p>Density of native shrubs and groundcovers are present, which provide habitat for a range of smaller birds, including woodland bird species.</p> <p>Habitat high quality for Cumberland Plain Land Snail where dense exotic grass growth is sparse or absent.</p> <p>General habitat condition varies from moderate to high. This depends on the size of the patch and disturbance in the groundcover. Suitable resources exist for a range of threatened fauna, in particularly woodland birds, nectivorous species and insectivorous bats.</p>
				Moderate	0.65		
				Low	1.11		
				Total	2.18		

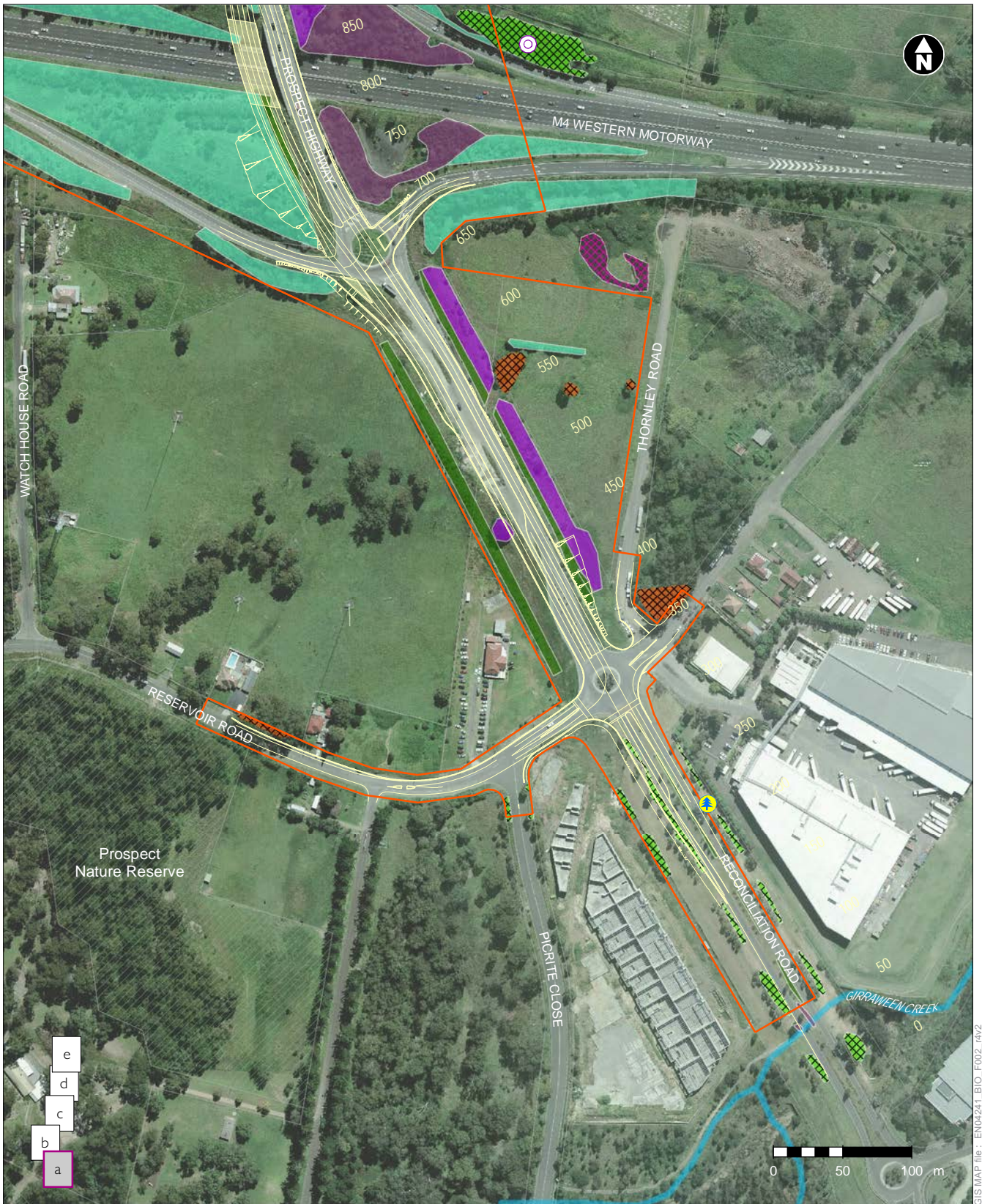
Map Unit	Biometric Vegetation Type	Description	Status	Condition	Area in study area (ha)	Cleared estimate <sup>#</sup>	Fauna habitat type and characteristics
		<p>The condition of this community varied depending on the degree of soil disturbance and vegetation modification. Intact vegetation in Timbertop Reserve is in a relatively high condition with a condition score of 82 out of 100. The vegetation patch on the southern side of the Great Western Highway is generally in a moderate condition with a condition score of around 69 out of 100.</p> <p><b>Low condition patches</b></p> <p>Low condition patches of this community generally consist of canopy species only with no native understorey within the Prospect Highway road reserve. The understorey includes areas of bare ground and maintained exotic grassland.</p> <p>There is a high diversity and abundance of exotic flora present in disturbed examples of this community, which include exotic grasses Rhodes Grass (<i>Chloris gayana</i>) and African Lovegrass (<i>Eragrostis curvula</i>), and shrubs African Olive (<i>Olea europaea</i> subsp. <i>cuspidata</i>), African Boxthorn (<i>Lycium ferocissimum</i>) and Paddy's Lucerne (<i>Sida rhombifolia</i>).</p> <p>These areas have a condition score of around 35 out of 100. These areas comprise only canopy species with an exotic dominated understorey, no ground habitats and no natural regeneration.</p>					
Map Unit 2: Planted Shale Plains Woodland (Cumberland Plain Woodland)	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin (restored example of)	<p>This community has been planted in the M4 Western motorway, the Great Western Highway and Prospect Highway road reserves. The age of the plantings varies throughout these areas. These areas rarely support any native groundcovers and often have a sparse planted shrub layer.</p> <p>Experience from rehabilitation projects on the Cumberland Plain Woodland suggests that sites with a history of soil disturbance will be extremely slow to recover. The majority of this community in the road reserve has been subject to significant soil disturbance from former land uses and/or by earth works and other disturbances from the construction of the M4 Western Motorway. Subsequently this map unit is dominated by exotic flora.</p> <p>Common tree species planted comprise Grey Box, Forest Red Gum and Narrow-leaved Ironbark. Other common planted species include Flax-leaved</p>	Critically endangered, TSC Act	Low	0.97	95%	<p>Low quality habitat. These areas rarely support any native groundcovers and often have a sparse planted shrub layer dominated by dense tall exotic grasses, such that there is little to no open patches in the ground cover and no leaf litter present.</p> <p>Common tree species planted comprise Grey Box, Forest Red Gum and Narrow-leaved Ironbark with tree height uniform throughout and generally ranging from only 5-10 metres in height.</p>

Map Unit	Biometric Vegetation Type	Description	Status	Condition	Area in study area (ha)	Cleared estimate#	Fauna habitat type and characteristics
		<p>Paperbark (<i>Melaleuca linariifolia</i>), Tick Bush (<i>Kunzea ambigua</i>), Blackthorn and Falcate Wattle (<i>Acacia falcata</i>).</p> <p>Some areas also include species not typical of Cumberland Plain Woodland such as Mugga Ironbark (<i>Eucalyptus sideroxylon</i>), Weeping Bottlebrush (<i>Callistemon viminalis</i>) and Fringed Wattle (<i>Acacia fimbriata</i>).</p> <p>This map unit was delineated from other map units based on the presence of a mixed planting dominated by Forest Red Gum and Grey Box. These areas support a limited cover of canopy and mid-storey species with an exotic dominated understorey, no ground habitats and no natural regeneration.</p>					<p>The habitat structure is simplistic and lacks structural maturity or important features such as hollows, timber on the ground and shrubs or tall canopy.</p> <p>Habitat for Cumberland Plain Snail is typically low to very low and influenced by the dense cover of exotic grasses; lack of microhabitat features, small patch size and lack of connectivity.</p> <p>Common fauna species include the introduced Spotted Turtle-dove (<i>Streptopelia chinensis</i>) and Common Myna (<i>Acridotheres tristis</i>) as well as Australian Magpie, and Garden Sunskink (<i>Lampropholis guichenoti</i>).</p>
Map Unit 3: Regenerating Wattles	N/A	<p>There is an area of regenerating wattles within one of the proposed compound sites between Ponds Road and the Great Western Highway. This area is dominated by regenerating Parramatta Wattle as well as some areas of Blackthorn and African Olive. The ground layer is dominated by exotic grass species including African Lovegrass and Rhodes Grass. No canopy species are present.</p>	N/A	Low	0.25	N/A	<p>This area of habitat consists of highly isolated areas of regenerating shrubs which provides limited value for native fauna species. When wattles are in flower these nectar and pollen resources are likely to be utilised by a range of nectivorous fauna species and insectivorous bats may also forage over this area.</p>
Map Unit 4: Freshwater Wetland	<i>Phragmites australis</i> and <i>Typha orientalis</i> coastal freshwater wetlands of the Sydney Basin	<p>There is an area of freshwater wetland community within one of the proposed compound site options between the Prospect Highway and Thornley Road. This community is dominated by a mix of species including Cumbungi (<i>Typha orientalis</i>), Common Rush (<i>Juncus usitatus</i>) and the exotic Spiny Rush (<i>Juncus acutus</i>).</p> <p>As this community is within one of the potential compound site options, this area can be readily avoided and potential direct or indirect impacts will be avoided.</p>	Endangered, TSC Act	Moderate	0.08	70%	<p>Low quality habitat. Occupies a natural drainage channel where there is continuous moisture in open situations. Dominated almost exclusively by Broadleaf Cumbungi and Spiky Rush. No native riparian vegetation present and no trees.</p> <p>Habitat for common frogs, such as Brown Toadlet (<i>Pseudophyrne bibroni</i>), Red-groined Toadlet (<i>Uperoleia laevigata</i>) and Common Eastern Froglet (<i>Crinia signifera</i>) and also the Eastern Water Skink (<i>Eulamprus quoyii</i>). Common birds</p>

Map Unit	Biometric Vegetation Type	Description	Status	Condition	Area in study area (ha)	Cleared estimate <sup>#</sup>	Fauna habitat type and characteristics
							in this habitat include the Superb Fairy-wren ( <i>Malurus cyaneus</i> ) and Red-browed Finch ( <i>Neochmia temporalis</i> ).
Map Unit 5: Mixed Plantings	N/A	<p>This map unit consists of mixed plantings of tree and shrub species including Eucalypt species such as Mugga Ironbark, She-oaks (<i>Casuarina</i> spp.) and various native shrub species including Tick Bush, Coastal Rosemary (<i>Westringia fruticosa</i>), Rosemary Grevillea (<i>Grevillea rosmarinifolia</i>), Wattles (<i>Acacia</i> spp.), Paperbarks (<i>Melaleuca</i> spp.) and Bottlebrush (<i>Callistemon</i> spp.). This map unit is the most dominant in the study area and includes a range of planted native species, exotic weeds and horticultural species.</p> <p>The understorey is dominated by exotic flora including a wide range of environmental and noxious weed species.</p> <p>This majority of this map unit is distributed around the intersection with the M4 Western Motorway and Prospect Highway interchange.</p>	N/A	Low	3.3	N/A	<p><b>Planted forest/woodland habitats</b> rarely support any native groundcovers and often have a sparse planted shrub layer. The understorey is dominated by dense tall exotic grasses, such that there is little to no open areas in the ground cover and minimal leaf litter present.</p> <p>The habitat structure is simplified and lacks structural maturity or important features such as hollows, timber on the ground and shrubs or tall canopy.</p> <p>Habitat for Cumberland Plain Snail is typically low to very low and influenced by the dense cover of exotic grasses; lack of microhabitat features, small patch size and lack of connectivity.</p> <p>Common fauna species include the introduced Spotted Turtle-dove (<i>Streptopelia chinensis</i>) and Common Myna (<i>Acridotheres tristis</i>) as well as Australian Magpie, Crested Pigeon (<i>Ocyphaps lophotes</i>) and Garden Sunskink (<i>Lampropholis guichenoti</i>).</p>
Map Unit 6: Planted Casuarina	N/A	<p>This map unit comprises monoculture plantings of Swamp Oak (<i>Casuarina glauca</i>) and River Oak (<i>Casuarina cunninghamii</i>).</p> <p>This map unit is mainly distributed around the M4 Western Motorway and Prospect Highway interchange. The understorey is dominated by exotic flora, which includes a wide range of environmental and noxious weed species.</p>	N/A	Low	0.75	N/A	
Map Unit 7: Planted Pine Trees	N/A	<p>This map unit includes roadside plantings at the southern end of the proposal. It comprises planted rows of Norfolk Island Pines (<i>Araucaria heterophylla</i>). Native understorey species are absent and exotic grasses generally dominate the understorey.</p>	N/A	Very Low	0.08	N/A	
Map Unit 8: Exotic Vegetation	N/A	<p>This map unit includes areas dominated by exotic trees and shrubs. Dominant species vary although common species include African Olive and Blackberry (<i>Rubus fruticosus</i>). Exotic groundcovers mainly include grass species such as Rhodes Grass and African Lovegrass.</p>	N/A	Very Low	1.17	N/A	<p>Exotic vegetation provides poor habitat value for fauna. These areas generally have a lack of food resources to attract foragers and limited nesting/roosting habitat. May be used by a range of introduced fauna and wide-ranging common fauna only.</p>

<sup>#</sup> Cleared estimate from the Biometric Vegetation Types database (DECC 2009a).





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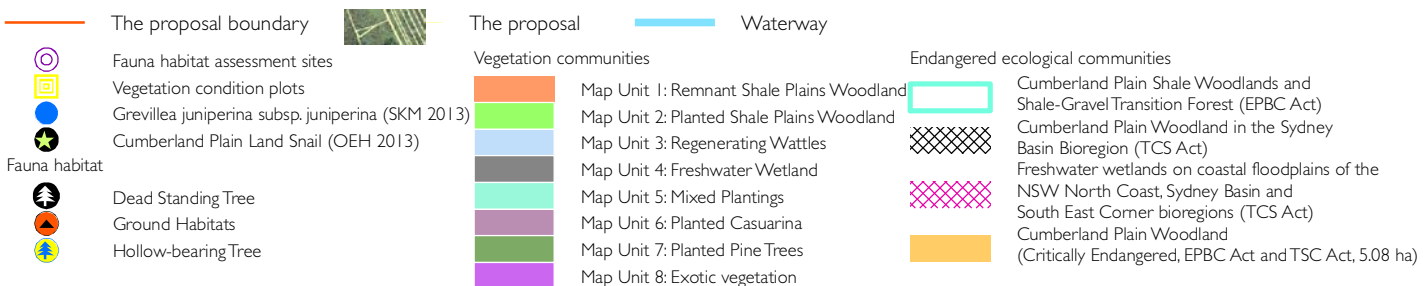
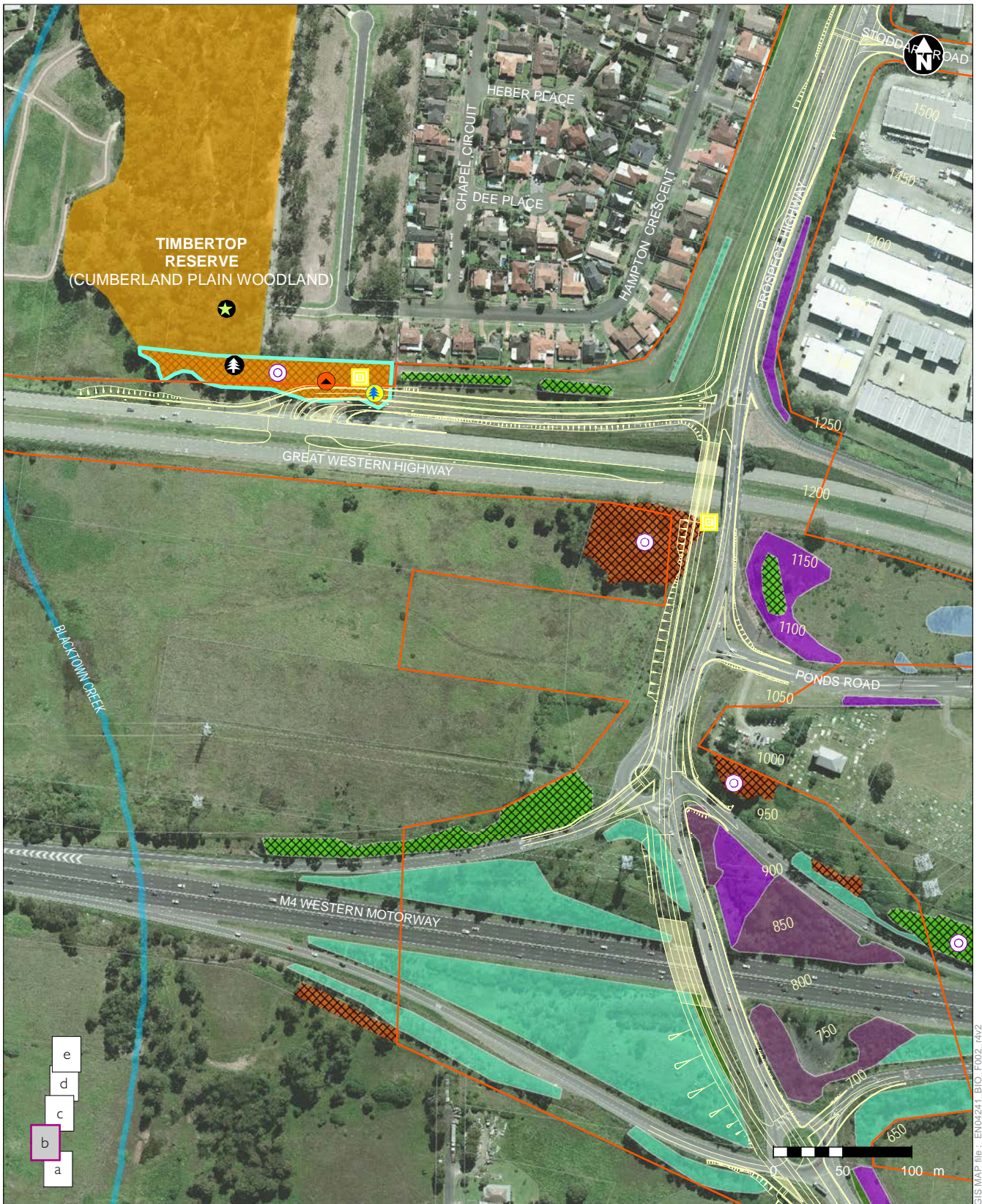


Figure 3-1a  
Distribution of Vegetation Communities, Fauna Habitats, Threatened Flora and Survey Locations



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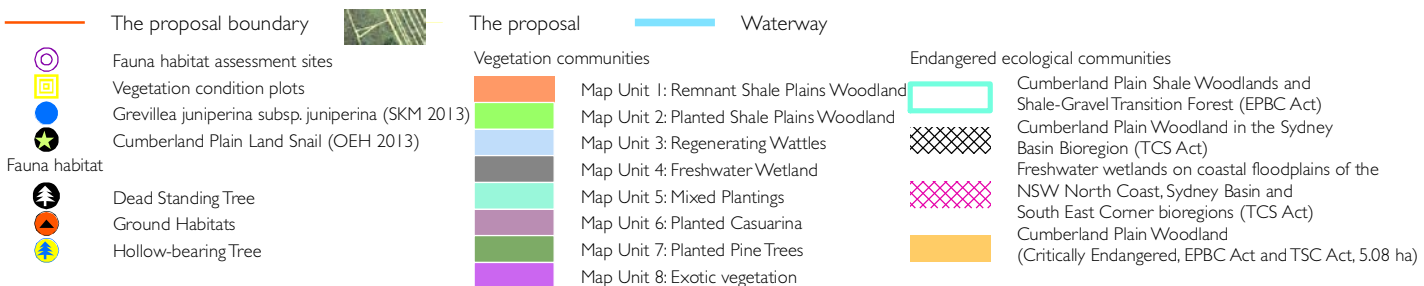


Figure 3-1b  
Distribution of Vegetation Communities, Fauna Habitats, Threatened Flora and Survey Locations



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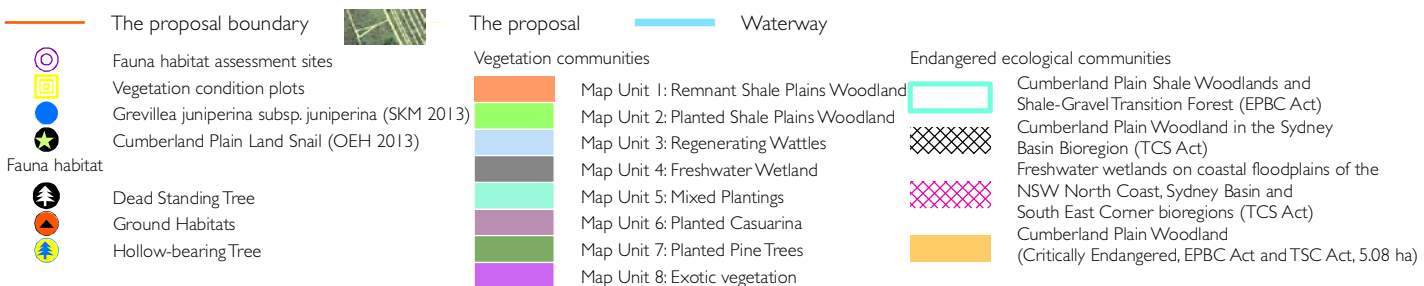


Figure 3-1c  
Distribution of Vegetation Communities, Fauna Habitats, Threatened Flora and Survey Locations

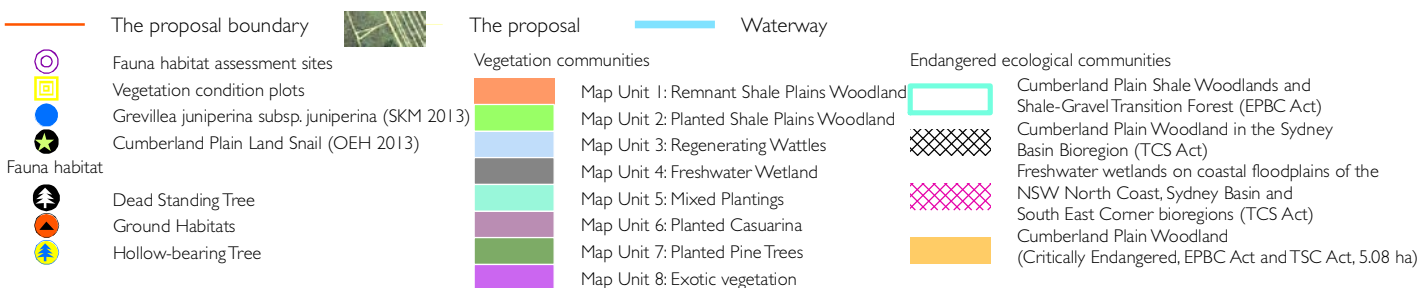


Figure 3-1d Prospect Highway Upgrade Biodiversity Impact Assessment  
 Distribution of Vegetation Communities, Fauna Habitats, Threatened Flora and Survey Locations

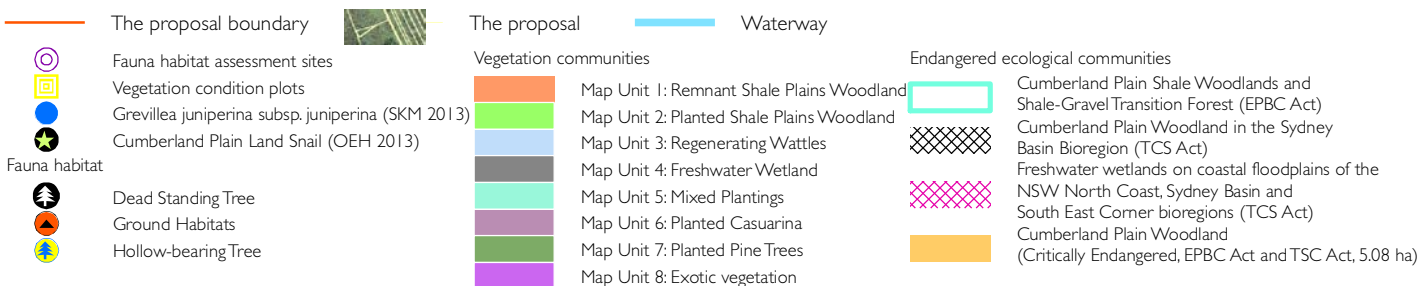
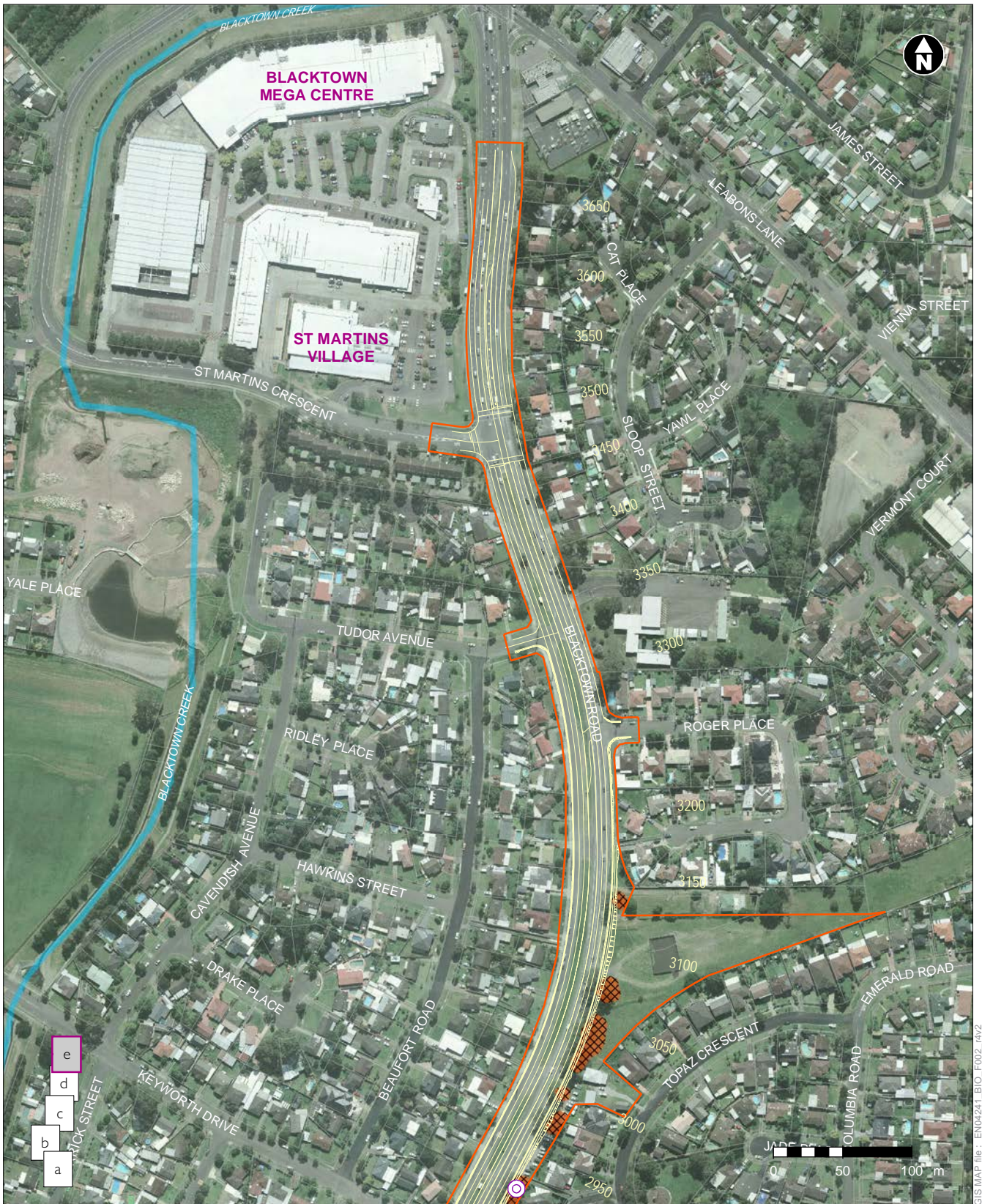


Figure 3-1e  
Distribution of Vegetation Communities, Fauna Habitats, Threatened Flora and Survey Locations



**Plate 3-1 High condition Cumberland Plain Woodland adjacent to Timbertop Reserve**



**Plate 3-2 Remnant trees in the Prospect Highway road reserve at the northern end of the proposal**

### 3.3.2 Fauna habitat

Natural habitats for fauna have been extensively removed for commercial, industrial and residential development. Fauna habitats are mapped in **Figure 3-1a** to **Figure 3-1e** including a small number of hollow-bearing trees and dead-standing trees. Remaining patches of habitat are relatively small and fragmented and comprise:

- Grassy woodland.
- Planted vegetation.
- Freshwater wetland.
- Cleared and modified habitats.

#### **Grassy woodland**

The woodland habitat type is restricted to several small patches at the intersection of Prospect Highway and the Great Western Highway. There are also scattered remnant trees in the road reserve along Prospect Highway. Although these native vegetation patches are fragmented, they are in close proximity to the Prospect Nature Reserve and the reservoir and may potentially be utilised by foraging micro bats, threatened woodland birds and owls.

One larger patch of vegetation in and surrounding Timbertop Reserve (around five hectares) is of high condition isolated between residential properties and the eastbound off-ramp from the Great Western Highway, which is around five hectares in area. This area is dominated by large remnant Grey Box (*Eucalyptus moluccana*) and a dense Blackthorn (*Bursaria spinosa*) mid-storey layer where a high diversity of ground herbs and native grasses occur. This habitat provides suitable foraging resources for threatened bird species, micro bats, Powerful Owl and Grey-headed Flying-fox. The large trees offer good refuge cover and nesting opportunities for woodland birds. This woodland has a high potential for Cumberland Plain Land Snail (*Meridolum corneovirens*) presence with a large quantity of leaf and bark ground litter around trees. There has also been a previous record of Cumberland Plain Land Snail in this patch.

A second patch of remnant vegetation around 0.4 hectares in area occurs adjacent to the westbound side of the Great Western Highway and the northbound side of Prospect Highway. Exotic vegetation has invaded the understory in some areas, but still retains mature trees. There is good canopy cover, which provides important fauna habitat and is considered to be in moderate condition. Although the habitat is isolated and affected by edge effects, it has potential Cumberland Plain Land Snail habitat and offers foraging opportunities for microbats and woodland birds.

Numerous remnant Grey Box (*E. moluccana*) occur scattered along the remaining roadside of the northern portion of Prospect Highway. The roadside is regularly maintained and also contains some exotic tree plantings. However, the relative habitat value of these is considered low in the context of the urban landscape and is potentially suitable only for common urbanised species. There are potential roost sites present for microbat species in the form of cavities located under concrete bridges beneath the existing bridges, as well as some culverts, which may provide roosting habitat.

Several hollow-bearing and dead standing trees were observed in areas of grassy woodland which provide limited habitat value for fauna species, with very small hollows and crevices generally suitable for smaller reptiles and amphibians. Some ground habitats were also observed, being limited to minor areas of fallen timber.

### **Planted vegetation**

The remaining vegetation around Prospect Highway and the M4 Western Motorway interchange comprises native and exotic planted vegetation. These areas rarely support any native groundcovers. They often have a sparse planted shrub layer dominated by exotic shrubs, grasses, herbs, vines and scramblers so there is little to no open patchiness in the ground cover and no leaf litter present. There is an absence of structural maturity and no tree hollows or logs, which reduces the value of the habitat as sheltering or refuge areas for larger or hollow dependent fauna. This mostly provides only foraging habitat for common urban species. Some sheltering habitat is provided for reptiles and invertebrates through rubbish dumping and dense groundcovers. The overall habitat condition was considered low.

### **Freshwater wetlands**

A small freshwater wetland is present at the southern end of the proposal outside of the construction footprint occupying a drainage channel dominated almost exclusively by Broadleaf Cumbungi (*Typha orientalis*) and Spiky Rush (*Juncus acutus*). No native riparian vegetation or overhanging trees were present. The area provides habitat for common frogs, such as Brown Toadlet (*Pseudophyrne bibroni*), Red-groined Toadlet (*Uperoleia laevigata*) and Common Eastern Froglet (*Crinia signifera*) and also the Eastern Water Skink (*Eulamprus quoyii*). Common birds in this habitat include the Superb Fairy-wren (*Malurus cyaneus*) and Red-browed Finch (*Neochmia temporalis*).

### **Cleared and modified habitats**

Cleared open grassland habitats are common throughout the study area including parkland areas in the easements along Prospect Highway. Grassland areas provide foraging habitat for a range of common bird species as well as microbats and reptiles.

Other modified habitats include dense growth of exotic shrubs and regenerating wattle shrubland in roadside areas and potential ancillary site locations.

### 3.4 Threatened ecological communities

#### 3.4.1 Literature and database review

Based on the background review a number of other potentially occurring Threatened Ecological Communities (TECs) are noted for the region as listed **Table A-3** of **Appendix A**. Targeted follow-up survey confirmed the presence or absence of these communities as identified in **Table 3-2**.

#### 3.4.2 Survey results

A brief description of the TECs recorded in the study area is provided in **Table 3-2** and these are mapped in **Figure 3-1a** to **Figure 3-1e**. Detailed descriptions of threatened ecological communities are provided in Final Determinations for state listed communities on the OEH website (OEH 2011) and federally listed communities can be found in the Commonwealth *Policy Statement 3.31* (DEWHA 2010).

**Table 3-2 Description threatened ecological communities recorded in the study area**

Threatened ecological community	Status	Description	Area in study area (ha)
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered, EPBC Act	This federally listed threatened ecological community is present in and adjacent to Timbertop Reserve on the northern side of the Great Western Highway, which comprises high condition areas of Map Unit 1. This area meets the condition thresholds for the federally listed community as it is greater than 0.5 hectares in area with a canopy cover greater than 10 per cent and an understorey dominated by native flora species.	0.42
Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered, TSC Act	The state-listed community occurs in several areas of the study area, which includes high condition areas of Map Unit 1 adjacent to Timbertop Reserve as described above (EPBC Act), a moderate condition patch of Map Unit 1 on the southern side of the Great Western Highway which is less than 0.5 hectares in area, isolated remnant trees in the road reserve (low condition areas of Map Unit 1) and areas planted with characteristic Cumberland Plain Woodland species (Map Unit 2). The areas of remnant trees and planted trees have been subject to significant disturbances as evidenced by the highly depleted floristic diversity and dominance of exotic flora in understorey.	3.15
Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Endangered, TSC Act	There is an area of freshwater wetland (Map Unit 4) within one of the proposed compound sites between the Prospect Highway and Thornley Road. This occupies a natural drainage channel where there is continuous moisture in open situations. Dominated almost exclusively by Broadleaf Cumbungi and Spiky Rush. No native riparian vegetation present and no trees.	0.08

### 3.5 Groundwater dependant ecosystems

The level of water dependence of vegetation communities on the Cumberland Plain has been identified in the Risk Assessment Guidelines for Groundwater Dependiant Ecosystems released by the NSW Department of Primary Industries (Kuginis *et al.* 2012). The level of groundwater dependence identified for ecological communities in



the study area is identified in **Table 3-3**.

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

Map Unit	Level of groundwater dependence (Kuginis <i>et al.</i> 2012)
Map Unit 1: Remnant Shale Plains Woodland	High
Map Unit 2: Planted Shale Plains Woodland	Unlikely
Map Unit 3: Regenerating Wattles	Unlikely
Map Unit 4: Freshwater Wetland	Obligate
Map Unit 5: Mixed Plantings	Unlikely
Map Unit 6: Planted Casuarina	Unlikely
Map Unit 7: Planted Pine Trees	Unlikely
Map Unit 8: Exotic vegetation	Unlikely

The remnant vegetation communities in the study area are considered to have a high level of potential groundwater dependence (refer to **Table 3-3**). Shale Plains Woodland (Map Unit 1 and 2) potentially has a high-level of groundwater dependence as identified by Kuginis *et al.* (2012). The remaining planted and exotic map units are considered unlikely to be dependent on groundwater.

## 3.6 Threatened flora species

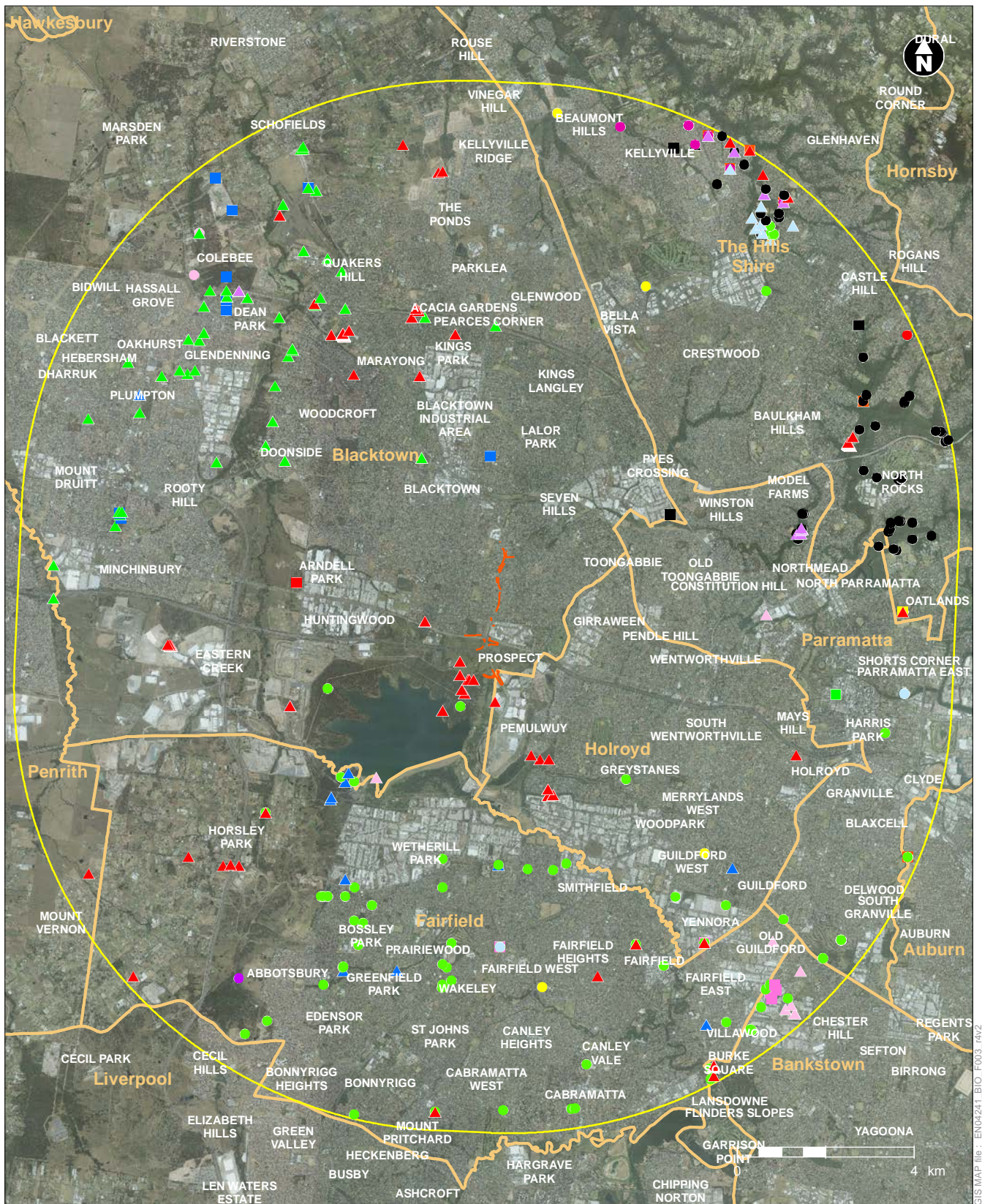
### 3.6.1 Literature and database review

On the basis of regional records and reports and the presence of suitable habitat, a total of 29 threatened flora species have been previously recorded or listed as having potential to occur in the locality. One species is considered to have a moderate chance of occurring in the study area comprising Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*) which is known to occur in high abundance along the M4 Western Motorway in rather disturbed environments. The remaining threatened flora species are considered to have a low or unlikely chance of occurring. The full list of flora species considered in this assessment is provided in **Table A-1** of **Appendix A**. The distribution of threatened flora species records in the study area is provided in **Figure 3-2**.

### 3.6.2 Survey results

The field surveys resulted in the identification of one individual Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*) a threatened flora species which is listed as vulnerable under the TSC Act. The individual was recorded in highly modified habitat of Cumberland Plain Woodland on the eastern side of Prospect Highway adjacent to the walkway underpass leading to Old Church Lane outside of the proposed construction footprint. There will be no direct or indirect impacts to this single Juniper-leaved Grevillea and therefore this species is considered to have a low potential to be present in the construction footprint. The location of this individual is mapped in **Figure 3-1c**.

Targeted searches for Spiked Rice-flower (*Pimelea spicata*) were undertaken in spring (29 November 2013) when plants were known to be flowering at Mount Annan Botanic Gardens. Despite targeted searches no individuals were identified and the species is therefore considered to have a low potential to be present in the construction footprint.



GIS MAP file: EN04241\_BIO\_F003\_14V2

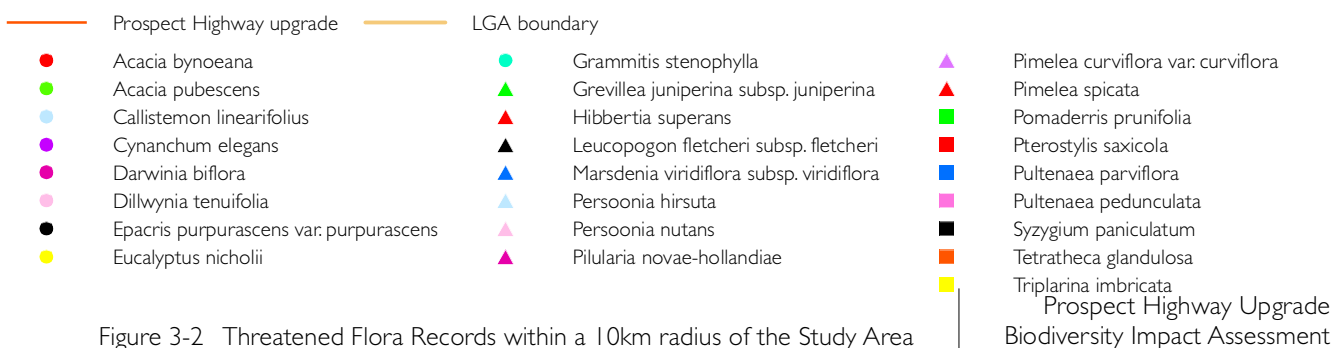


Figure 3-2 Threatened Flora Records within a 10km radius of the Study Area

## 3.7 Threatened fauna species

### 3.7.1 Literature and database review

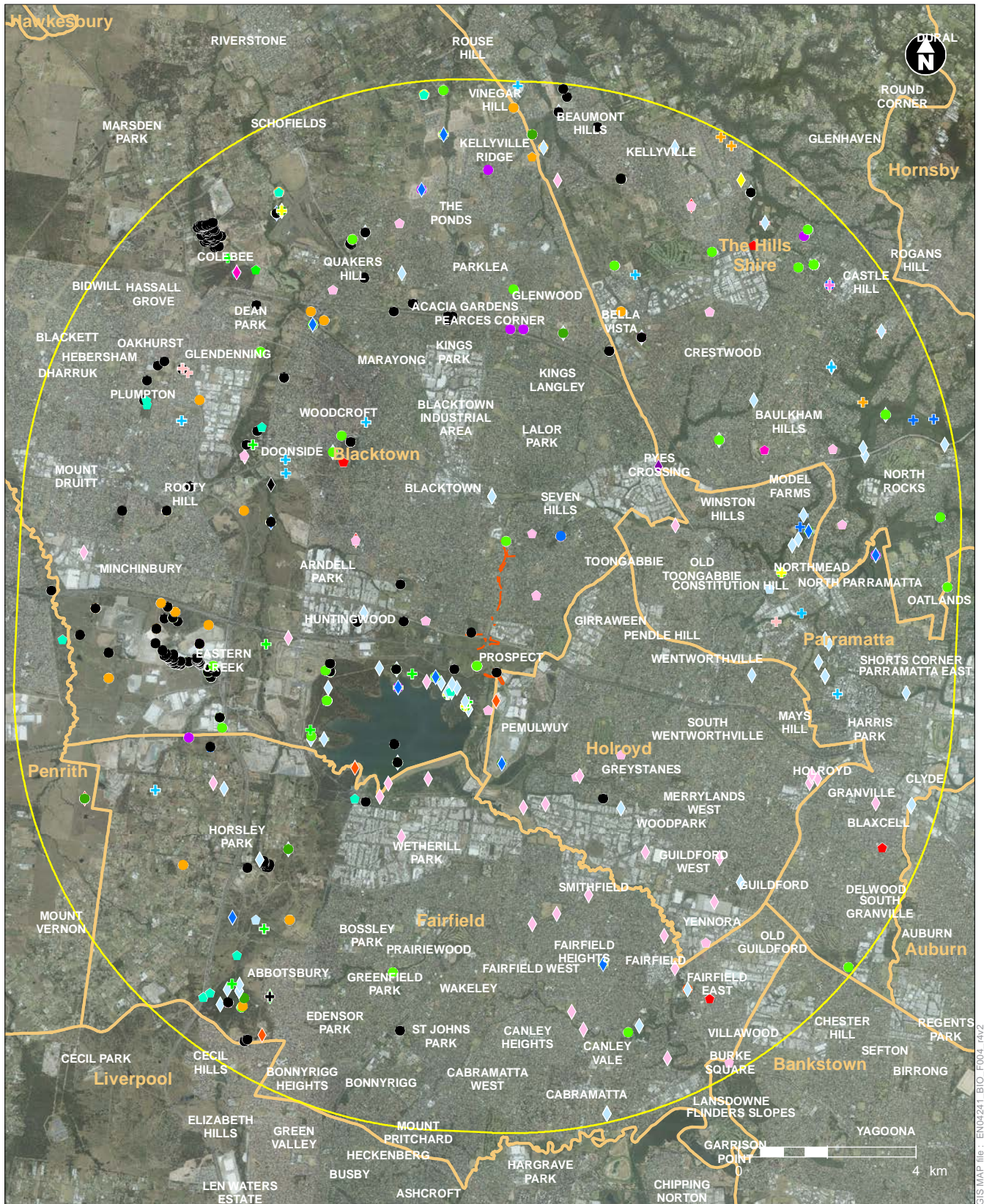
On the basis of regional records, reports and the presence of suitable habitat, a total of 47 threatened fauna species have been identified in the locality, within a 10 kilometre radius of the study area. These species are listed in **Table A-2** of **Appendix A** which presents an assessment of their likelihood of occurrence in the study area using the criteria described in Section 2.6.1. Many of these species favour habitats that are not represented in the study area and these were considered unlikely to occur (n=23) or have a low likelihood of occurring (n=9). From the review, 13 species were considered to have a moderate chance of occurring and one species, the Cumberland Plain Land Snail, was considered to have a high chance of occurring. All threatened fauna records within a 10 kilometre radius of the study area are graphically shown in **Figure 3-3**.

### 3.7.2 Survey results

There were no threatened fauna species observed during the surveys. However potential habitat for some woodland birds, microchiropteran bats and Cumberland Plain Land Snail was recorded in remnant woodland and in areas of planted/landscaped vegetation. The list of species with a moderate potential to occur is provided in **Chapter 4**. Potential habitat has been highly modified for threatened fauna species in the study area, being limited to planted vegetation and patches of remnant Cumberland Plain Woodland.

Habitat for Cumberland Plain Land Snail was limited to intact patches of habitat adjacent to Timbertop Reserve on the northern side of the Great Western Highway and a smaller patch adjoining the southern side of the Great Western Highway and western side of the Prospect Highway. These areas are considered to provide moderate condition habitat for the species, while remaining planted and highly modified habitats are considered to provide poor quality habitats. There is a record of Cumberland Plain Land Snail in Timbertop Reserve (refer to **Figure 3-1b**) from 1999, and a viable population may still persist within this patch. The other intact patch of vegetation on the southern side of the Great Western Highway is modified from clearing and weed invasion. This is isolated from other areas of potential habitat and so is considered unlikely to support a viable population. Ground conditions during the initial survey period (August 2013) were very dry which may have influenced the detectability of the species during the surveys, however further targeted surveys during November 2013 when ground conditions were more favourable also failed to locate any individuals within and surrounding the construction footprint.

Culverts under Prospect Highway were inspected where access was possible. No microbats were recorded and potential roosting habitats observed were considered to be marginal.



GIS MAP file: EN04241\_BIO\_F004\_14V2

- |  |   |  |
|--|---|--|
| <ul style="list-style-type: none"> <li><span style="color: orange;">—</span> Prospect Highway upgrade</li> <li><span style="color: orange;">—</span> LGA boundary</li> </ul> | <ul style="list-style-type: none"> <li><span style="color: blue;">●</span> Barking Owl</li> <li><span style="color: pink;">●</span> Black Bittern</li> <li><span style="color: red;">●</span> Black Falcon</li> <li><span style="color: yellow;">●</span> Black-chinned Honeyeater (eastern subspecies)</li> <li><span style="color: orange;">●</span> Cattle Egret</li> <li><span style="color: black;">●</span> Cumberland Plain Land Snail</li> <li><span style="color: green;">●</span> Eastern Bentwing-bat</li> <li><span style="color: lightgreen;">●</span> Eastern False Pipistrelle</li> <li><span style="color: purple;">●</span> Eastern Freetail-bat</li> <li><span style="color: red;">●</span> Eastern Pygmy-possum</li> <li><span style="color: black;">◆</span> Flame Robin</li> <li><span style="color: red;">◆</span> Fork-tailed Swift</li> <li><span style="color: green;">◆</span> Gang-gang Cockatoo</li> <li><span style="color: yellow;">◆</span> Glossy Black-Cockatoo</li> <li><span style="color: blue;">◆</span> Greater Broad-nosed Bat</li> <li><span style="color: pink;">◆</span> Green and Golden Bell Frog</li> <li><span style="color: lightblue;">◆</span> Grey-headed Flying-fox</li> <li><span style="color: black;">◆</span> Koala</li> <li><span style="color: purple;">◆</span> Large-eared Pied Bat</li> <li><span style="color: orange;">◆</span> Latham's Snipe</li> </ul> | <ul style="list-style-type: none"> <li><span style="color: green;">+</span> Little Eagle</li> <li><span style="color: red;">+</span> Little Lorikeet</li> <li><span style="color: green;">+</span> Masked Owl</li> <li><span style="color: pink;">+</span> Pink Robin</li> <li><span style="color: blue;">+</span> Powerful Owl</li> <li><span style="color: black;">+</span> Rainbow Bee-eater</li> <li><span style="color: orange;">+</span> Red-crowned Toadlet</li> <li><span style="color: lightblue;">+</span> Regent Honeyeater</li> <li><span style="color: red;">+</span> Scarlet Robin</li> <li><span style="color: yellow;">+</span> Southern Myotis</li> <li><span style="color: green;">●</span> Speckled Warbler</li> <li><span style="color: red;">●</span> Spotted-tailed Quoll</li> <li><span style="color: blue;">●</span> Square-tailed Kite</li> <li><span style="color: pink;">●</span> Superb Parrot</li> <li><span style="color: lightblue;">●</span> Swift Parrot</li> <li><span style="color: orange;">●</span> Turquoise Parrot</li> <li><span style="color: cyan;">●</span> Varied Sittella</li> <li><span style="color: lightblue;">●</span> White-bellied Sea-Eagle</li> <li><span style="color: purple;">●</span> White-throated Needletail</li> <li><span style="color: black;">●</span> Yellow-bellied Shearwater</li> </ul> |
|--|---|--|

Figure 3-3 Threatened Fauna Records within a 10km radius of the Study Area

### 3.8 Migratory species

A total of 13 migratory fauna species were identified in the EPBC Act Protected Matters Search Tool Report as potentially occurring in the locality based on the distributional range of the species. These migratory species, along with their preferred habitat requirements and an assessment of their likely presence in the study area are listed in **Table A-2** of **Appendix A**. From this review two migratory species are considered to have a moderate likelihood of occurring in the study area. These are the wide-ranging bird species Fork-tailed Swift (*Apus pacificus*) and White-throated Needletail (*Hirundapus caudacutus*). The main area of potential habitat for migratory species is moderate and high condition remnant grassy woodland habitats along the Great Western Highway.

Freshwater wetland habitats in the study area provide limited habitat value for migratory species such as overhanging trees for breeding and roosting. Freshwater wetlands are likely to be utilised for foraging by several listed migratory species commonly observed in the locality including Great Egret (*Ardea alba*) and Cattle Egret (*Ardea ibis*).

### 3.9 General flora and fauna

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

Native flora species richness was moderate within the naturally vegetated portions of the study area. The disturbed areas supporting plantings and open grassland areas were low in native species diversity and richness. This is primarily due to the long term effects of significant soil disturbance and removal of the native seed bank.

Of the total 133 species of flora recorded, 59 are introduced species including seven noxious weed species (refer to **Table 4-4**). Eight non-indigenous native flora were identified. Exotic species collectively represent around 44 per cent of the total species richness. The remaining 66 species include local native species which are naturally occurring in some areas of the study area. The total list of flora species recorded in the study area is provided in **Appendix B**.

A total of 13 vertebrate fauna species were recorded in the study area from this survey. This includes 10 bird species, one introduced mammal species and two reptile species. The list of fauna species recorded is provided in **Appendix C**. All species were directly seen or heard calling during the survey with the exception of the Red Fox which was observed through the presence of scats and trails.

### 3.10 Wildlife connectivity corridors

Landscape connectivity in the study area is very limited where vegetation patches are isolated between double carriage highways. Mammals, reptiles and amphibians would find it difficult to connect to remaining patches, an unidentified lizard was observed as roadkill on the Great Western Highway. Woodland birds and some micro bats would potentially forage from the Prospect Nature Reserve to vegetation patches in the study area. The patches of habitat in the study area could potentially be used as stepping stones for mobile fauna species dispersing throughout the landscape. Some minor connectivity has been maintained amongst urban suburbs between Timbertop Reserve and a wetland near William Lawson Park which may be

utilised by local native fauna species such as birds, possums, frogs and reptiles as well as feral species such as foxes.

### 3.11 Critical habitat

No areas of declared critical habitat under the TSC Act or EPBC Act are present in the study area.

## 4 Potential impacts

### 4.1 Loss of vegetation and habitat

The loss of vegetation communities and habitats in the study area is summarised in **Table 4-1**. The construction footprint would impact up to 1.15 hectares of planted and remnant native vegetation in various condition states with the remaining areas comprising exotic vegetation in cleared and modified lands. This total area of direct and indirect impact includes up to 0.55 hectares of remnant vegetation (Map Unit 1) including high condition (0.12 hectares), moderate condition (0.11 hectares) and isolated remnant trees (0.32 hectares). An area of likely indirect impact has been identified from a five metre buffer adjoining the proposal footprint. This is adjacent to areas of intact Cumberland Plain Woodland, and comprises 0.04 hectares (refer to **Table 4-1**).

The impacts are based on the design with a five metre buffer, however not all areas are likely to be impacted considering the majority of the design follows the existing road corridor with only minor widening affecting cleared and modified lands.

The proposed impacts include up to 0.55 hectares of remnant vegetation, 0.67 hectares of planted vegetation and 0.27 hectares of exotic vegetation including planted pine trees.

Impacts to threatened ecological communities comprise direct removal and indirect impacts of up to 0.69 hectares of vegetation (refer to Section 4.1.1).

**Table 4-1 Direct and indirect impacts on vegetation and fauna habitat**

Vegetation Community Type	Fauna Habitat Type	Biometric Vegetation Type	Conservation Status	Condition	Area of indirect impact (ha)	Area of direct impact (ha)
Map Unit 1: Remnant Shale Plains Woodland (Cumberland Plain Woodland)	Grassy Woodland	Grey Box - <i>Melaleuca decora</i> grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin	Critically endangered, TSC Act and EPBC Act (high condition only)	High	0.04	0.08
				Moderate	0.03	0.08
				Low	N/A	0.32
				Total	0.07	0.48
Map Unit 2: Planted Shale Plains Woodland (Cumberland Plain Woodland)	Grassy Woodland	Grey Box - <i>Melaleuca decora</i> grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin	Critically endangered, TSC Act	Low	N/A	0.14
Map Unit 3: Regenerating Wattles	Cleared and modified habitats	N/A	N/A	Low	N/A	0.0
Map Unit 4: Freshwater Wetland	Freshwater wetland	<i>Phragmites australis</i> and <i>Typha orientalis</i> coastal freshwater wetlands of the Sydney Basin	Endangered, TSC Act	Moderate	N/A	0.0
Map Unit 5: Mixed	Planted vegetation	N/A	N/A	Low	N/A	0.47

Vegetation Community Type	Fauna Habitat Type	Biometric Vegetation Type	Conservation Status	Condition	Area of indirect impact (ha)	Area of direct impact (ha)
Plantings						
Map Unit 6: Planted Casuarina	Planted vegetation	N/A	N/A	Low	N/A	0.06
Map Unit 7: Planted Pine Trees	Cleared and modified habitats	N/A	N/A	Very Low	N/A	0.13
Map Unit 8: Exotic vegetation	Cleared and modified habitats	N/A	N/A	Very Low	N/A	0.14
<b>TOTAL</b>					<b>0.07</b>	<b>1.42</b>

Several hollow-bearing and dead standing trees will be removed for the proposal, however these provide limited habitat value for fauna species, with small hollows and crevices generally suitable for smaller reptiles and amphibians. Some ground habitats were also observed, being limited to minor areas of fallen timber.

#### 4.1.1 Threatened ecological communities

Impacts to TECs are limited to a total of 0.69 hectares of Cumberland Plain Woodland listed under the TSC Act, of which 0.12 hectares is also listed under the EPBC Act. This comprises around 0.12 hectares of high condition vegetation (Map Unit 1) adjacent to Timbertop Reserve, 0.11 hectares of moderate condition vegetation on the southern side of the Great Western Highway (Map Unit 1) and 0.46 hectares of low condition habitat (Map Unit 1 and 2). Low condition areas comprise isolated trees and planted vegetation with affinities to this community. The direct and indirect impacts to threatened ecological communities are summarised in **Table 4-2**, comprising a collective impact to 0.69 hectares of Cumberland Plain Woodland.

Indirect impacts have been included in the calculations for areas of moderate and high condition vegetation. Indirect impacts in high condition vegetation will be limited to a strip of vegetation between the recently established residential subdivision at Hampton Crescent and the Great Western Highway which is unlikely to be viable in the long term due to ongoing edge effects and weed invasion.

**Table 4-2 Impacts on threatened ecological communities**

Vegetation Community Type	Threatened Ecological Community	Conservation Status	Condition	Area of direct and indirect impact (ha) *
Map Unit 1: Remnant Shale Plains Woodland	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest AND Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered, EPBC Act and TSC Act	High	0.12 (0.04 indirect)
	Cumberland Plain	Critically	Moderate	0.11 (0.03)



Vegetation Community Type	Threatened Ecological Community	Conservation Status	Condition	Area of direct and indirect impact (ha) *
	Woodland in the Sydney Basin Bioregion	Endangered, TSC Act		indirect)
			Low	0.32
Map Unit 2: Planted Shale Plains Woodland	Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered, TSC Act	Low	0.14
Map Unit 4: Freshwater Wetlands	Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Endangered, TSC Act	Moderate	0.0
<b>TOTAL</b>			<b>0.69 hectares</b>	

\*indirect impact indicated in brackets

Impacts to Cumberland Plain Woodland would remove several mature trees (up to 10) and an intact shrub and ground cover. This includes a remnant soil seed bank resource, particularly adjacent to Timbertop Reserve. Other impacts would be limited to several large remnant Grey Box trees which are within the proposal footprint along the road reserve. These trees are suspected to be remnant due to the size and position of these trees and occur within a maintained landscape including planted trees and parkland areas.

The removal of vegetation where widening of a two way link road between Prospect Highway and the Great Western Highway is proposed would directly impact on 0.08 hectares of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest as listed under the EPBC Act. A further 0.04 hectares would be indirectly impacted. This loss of native vegetation is a Key Threatening Process listed as 'Clearing of native vegetation' under Schedule 3 of the TSC Act and listed as 'Land Clearance' under the EPBC Act.

The area of freshwater wetland within one of the potential ancillary sites would be avoided including direct and indirect impacts, with any ancillary activities associated with construction sited greater than 50 metres from this area.

#### 4.1.2 Threatened species

Habitat for threatened flora species is generally absent from the majority of the study area, which is mainly limited to the two relatively intact patches of Cumberland Plain Woodland. Planted habitats, maintained parkland and highly disturbed areas of habitat are generally unsuitable for the large majority of threatened flora species. The vulnerable Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*) listed under the TSC Act was observed in the study area and occurs outside of the proposal footprint. Therefore, it would not be impacted by the construction and operation of the proposal and is unlikely to be present in other areas of the footprint.

Targeted searches for Spiked Rice-flower (*Pimelea spicata*) were undertaken during the flowering period for the species, however no individuals were observed and therefore the species is considered to have a low potential to be present and to be impacted by the proposal.

No threatened fauna species were directly observed during the surveys, however

potential habitat for several species was identified and these are listed below in **Table 4.3**. Potentially occurring threatened fauna include the Cumberland Plain Land Snail and highly mobile species which may forage in habitats of the study area. These include microbat species which potentially forage throughout the study area, woodland birds which potentially forage in Cumberland Plain Woodland such as Timbertop Reserve and nectar-feeding birds and bat species such as Little Lorikeet, Swift Parrot and Grey-headed Flying-fox. The Powerful Owl may potentially forage in and on the edge of grassy woodland habitats hunting prey such as arboreal mammals Common Ringtail Possum (*Pseudocheirus peregrinus*) and Common Brushtail Possums (*Trichosurus vulpecula*).

**Table 4-3 Threatened species considered to have a moderate to high likelihood of occurring in the construction footprint**

Species	Status		Habitat in study area (refer to Figure 3-1a to Figure 3-1e)	Likelihood of occurrence
	EPBC Act	TSC Act		
<b>FLORA</b>				
Juniper-leaved Grevillea ( <i>Grevillea juniperina</i> )	-	V	Map Unit 1 and 2	Moderate
Spiked Rice-flower ( <i>Pimelea spicata</i> )	E	E	Map Unit 1	Moderate
<b>MAMMALS</b>				
Eastern Bent-wing Bat ( <i>Miniopterus schreibersii oceanensis</i> )	-	V	All map units	Moderate
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )	-	V	All map units	Moderate
Eastern Freetail Bat ( <i>Mormopterus norfolkensis</i> )	-	V	All map units	Moderate
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )	-	V	All map units	Moderate
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	V	V	Map Unit 1 and 2	Moderate
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	V	V	All map units	Moderate
Southern Myotis ( <i>Myotis macropus</i> )	-	V	All map units	Moderate
Yellow-bellied Sheath-tail-bat ( <i>Saccolaimus flaviventris</i> )	-	V	All map units	Moderate
<b>BIRDS</b>				
Black-chinned Honeyeater ( <i>Melithreptus gularis</i> )	-	V	Map Unit 1 and 2	Moderate
Little Lorikeet ( <i>Glossopsitta pusilla</i> )	-	V	Map Unit 1 and 2	Moderate
Powerful Owl ( <i>Ninox strenua</i> )	-	V	Map Unit 1 and 2	Moderate
Speckled Warbler ( <i>Pyrrholaemus sagittatus</i> )	-	V	Map Unit 1 and 2	Moderate
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	-	V	Map Unit 1 and 2	Moderate
<b>INVERTEBRATE</b>				
Cumberland Land Snail ( <i>Meridolum corneovirens</i> )	-	E	High and moderate condition areas of Map Unit 1	High

V- vulnerable; E – endangered

## 4.2 Wildlife connectivity and habitat fragmentation

The study area is highly fragmented between roads and open spaces within the existing urban environment. The proposal is not likely to increase the amount of fragmented habitats but would impact the edge of existing vegetation patches (refer to Section 4.3.2) and remove single standing trees which may lead to minor increases in the extent of fragmentation.

## 4.3 Injury and mortality

Fauna injury or death can occur during the clearing phase of construction via the removal of habitat trees, and during operation of the road as a result of collision with vehicles. There is potential for increased fauna injury and mortality during construction.

### 4.3.1 Construction impacts

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

There is potential for injury and mortality to fauna species during vegetation clearing activities. The most vulnerable species are those taking refuge in trees (eg hollows, under bark, in nests, and in fallen logs) and in the ground, and/or have low agility. Mainly common species such as possums, reptiles, birds (particularly fledglings) and frogs are likely to be affected, however there is potential for threatened microbats to be sheltering in hollow and dead standing trees and Cumberland Plain Land Snails may also be present in grassy woodland. This considers the highly urbanised environment and limited sheltering opportunities such as hollow trees and fallen timber.

### 4.3.2 Operation impacts

Mortality due to vehicle strike during operation of the upgraded section of the Prospect Highway is considered to be rare. This is because there is a low abundance of fauna species prone to vehicle strike present in the study area. Impacts to mobile species such as bird species are not considered to be substantially increased from existing levels associated with the Prospect Highway.

Some indirect impacts to adjacent vegetation could be expected and typically involve weed invasion, which is common in all existing vegetated areas. Other areas of planted and remnant vegetation in the road corridor have a high proportion of weeds (50 per cent), which is indicative of existing edge effects. The potential indirect impacts from weeds are discussed further below.

## 4.4 Weeds

Of the total 133 species of flora recorded, 59 (44 per cent) are introduced species including seven noxious weed species (refer to **Table 4-4**).

**Table 4-4 Noxious weed species listed in the Blacktown control areas**

Species	Prevalence on Site	Noxious Class
African Boxthorn <i>Lycium ferocissimum</i>	Low abundance on the edges of remnant vegetation patches	Class 4: The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction Weed of national significance
African Olive <i>Olea europaea</i> subsp. <i>cuspidata</i>	Widespread in high to moderate abundance throughout the study area.	Class 4: The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed
Blackberry ( <i>Rubus fruticosus</i> agg)	High abundance in open paddock areas forming large thickets	Class 4: The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed
Bridal Creeper <i>Asparagus asparagoides</i>	Occurs in low abundance in areas of remnant vegetation	Class 4: The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed Weed of national significance
Lantana <i>Lantana camara</i>	Low abundance in areas of planted vegetation	Class 4: The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed. Weed of national significance
Privet species <i>Ligustrum sinense</i> <i>L. lucidum</i>	Low abundance on the edges of remnant vegetation patches	Class 4: The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its flowering and reproduction

There are currently six Key Threatening Processes listed under the TSC Act and EPBC Act that relate to the invasion and establishment of weeds. Each of these has potential to be exacerbated by construction and operation of the proposal, and includes the following:

- Invasion and establishment of exotic vines and scramblers (TSC Act).
- Invasion of native plant communities by Bitou Bush and Boneseed (TSC Act).
- Invasion of native plant communities by exotic perennial grasses.
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*) (TSC Act).
- Invasion, establishment and spread of Lantana (*Lantana camara*) (TSC Act).
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (EPBC Act).

The noxious species recorded in the study area are relatively common in roadside habitats throughout the study locality. During construction there is potential to disperse weed seeds and plant material into adjoining areas where weed species do not currently occur. The most likely causes of weed dispersal are associated with clearing of vegetation and the stockpiling of contaminated mulch and topsoil during earthworks. Further causes include the movement of soil and an attachment of seed (and other propagules) to construction vehicles and machinery.

There is a risk these species could be spread during construction of the proposal. However, in the event that the mitigation measures specified in the Roads and Maritime Biodiversity Guidelines (RTA, 2011) are implemented this would limit the spread and germination of noxious weeds (refer to Section 5.2.4). Further, landscaping of surrounding disturbed areas including weed management would limit the establishment and spread of weed species during operation.

## 4.5 Pests and pathogens

### 4.5.1 Pests

There are currently two Key Threatening Processes listed under the TSC Act and three under the EPBC Act that relate to the invasion and establishment of pests. Each of these has potential to be exacerbated by construction and operation of the proposal, which includes:

- Competition and grazing by the feral European Rabbit (TSC Act and EPBC Act).
- Predation by the European Red Fox (TSC Act and EPBC Act).

The proposal may contribute to increased levels of predation on native fauna from foxes, through habitat removal leading to the displacement of resident fauna. Evidence of European Red Fox (*Vulpes vulpes*) has been observed in the locality.

The clearing of vegetation may increase the value of the habitat for rabbits (*Oryctolagus cuniculus*) in the study area over the long-term. As rabbits tend to colonise more disturbed and modified open habitats, any increase in the population of this pest species is more likely to impact native fauna tolerant of modified habitats. Following construction of the proposal, revegetation of redundant sections would assist in reducing potential habitat for rabbits in the proposal area.

### 4.5.2 Pathogens

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

- Dieback caused by Phytophthora (Root Rot; EPBC Act and TSC Act).
- Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae (TSC Act).

While these pathogens were not observed or tested in the study area, the potential for pathogens to occur should be treated as a risk during construction (refer to **Table 4-5**).

**Table 4-5 Pathogens that may affect flora and fauna during construction**

Pathogen	Description	Potential disease transmission
Phytophthora ( <i>Phytophthora cinnamomi</i> )	A soil-borne fungus that causes tree death (dieback). Attacks the roots of a wide range of native plant species.	Spores can be dispersed over relatively large distances by surface and sub-surface water flows. Infected soil/root material may be dispersed by vehicles (eg earth moving equipment)
Myrtle rust	An introduced fungus that attacks	Myrtle rust is an air-borne fungus

Pathogen	Description	Potential disease transmission
( <i>Uredo rangelli</i> )	the young leaves, short tips and stems of Myrtaceous plants eventually killing the plant.	that may be spread by moving infected plant material, contaminated clothing, equipment and vehicles.

#### 4.6 Changed hydrology

Hydrology regimes are modified by surface water flows being directed to drainage channels and related control structures within the study area. The highly urbanised environment has large areas of impermeable ground conditions, modified slopes, flood storage areas and concentrated flows. A substantial proportion of surface water that flows within the study area is from road runoff. The proposal would increase the area of impermeable surfaces, while maintaining existing surface water controls and systems. Changes to hydrology are unlikely to result in a substantial modification to any areas of native vegetation in the study area.

#### 4.7 Groundwater-dependent ecosystems

The remnant vegetation communities in the proposal footprint are considered to have a high level of potential groundwater dependence (refer to **Table 3-3**) as identified by Kuginis *et al.* (2012). The remaining planted and exotic map units are considered unlikely to be dependent on groundwater.

Hydrological regimes including groundwater levels and flooding regimes are unlikely to be substantially altered by the proposal. Intersection of the water table on elevated lands is considered unlikely. It is considered unlikely there will be any groundwater drawdown from the proposal with required cuttings being relatively minor. These are unlikely to intersect groundwater. The potential for contamination of groundwater, should groundwater intersection occur during construction, would be low.

Considering groundwater levels are unlikely to be altered by the proposal, potential groundwater-dependant ecosystems are considered unlikely to be impacted.

#### 4.8 Noise, vibration and light

There are existing high levels of noise, vibration and artificial light (traffic-related light and street lighting) from Prospect Highway, the Great Western Highway and M4 Western Motorway and surrounding roads, industrial and commercial properties. It is unlikely that there would be any significant impacts to native fauna species from additional or altered noise, vibration and light spill resulting from the proposal. There is potential for impacts to local fauna from noise and vibration during construction, which may result in fauna temporarily avoiding habitats adjacent to the proposal.

The light levels beneath the proposed bridge structures (over the Great Western Highway and M4 Western Motorway) would be relatively low. This is similar to existing conditions beneath bridges over the M4 Western Motorway. This may limit the growth of any plantings associated with landscaping activities. The low light levels are not envisaged to substantially deter fauna movements or foraging activities in this area. It is considered unlikely there would be any additional impacts to native flora and fauna from any additional lighting installed as part of the proposal.

## 4.9 Impact on relevant key threatening processes

Key threatening processes listed under the TSC Act and EPBC Act and considered likely to be increased by the proposal are listed in **Table 4-6**. Key threatening processes identified as being a result of the proposal would comprise those associated with habitat degradation including vegetation clearing and removal of hollow-bearing trees. Mitigation measures would be implemented to minimise the extent of vegetation clearing and habitat disturbance (refer to Section 5.2), and relocate important fauna habitats. There is potential for other key threatening processes to be increased (eg weed invasion, introduction of pests and diseases, however, mitigation measures would be implemented to minimise their effect.

**Table 4-6 Enacting of key threatening processes**

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Bushrock removal	TSC Act	No	Section 5.2
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	TSC Act	No	
<b>Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Vertebrate Fauna</b>			
Predation by feral cats ( <i>Felis catus</i> )	EPBC Act, TSC Act	Unlikely	Section 5.2
Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs / Predation, habitat degradation, competition and disease transmission by feral pigs ( <i>Sus scrofa</i> )	EPBC Act, TSC Act	Unlikely	
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Unlikely	
Predation and hybridisation of feral dogs ( <i>Canis lupus familiaris</i> )	TSC Act	Unlikely	
Herbivory and environmental degradation caused by feral deer	TSC Act	Unlikely	
Predation by European red fox / Predation by the European red fox ( <i>Vulpes vulpes</i> )	EPBC Act, TSC Act	Unlikely	
Decline in woodland and forest birds due to aggressive exclusion by abundant Noisy Miners'	TSC Act	Unlikely	
<b>Hydrology and Riparian Zones</b>			
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act	Unlikely	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

#### 4.10 Cumulative impacts

The proposal would increase the existing area of disturbance created by the Prospect Highway as well as surrounding urban development. There would also be cumulative impacts from potential future upgrades, particularly around the M4 Western Motorway interchange.

The recently established residential subdivision at Hampton Crescent adjacent to Timbertop Reserve has resulted in this patch of Cumberland Plain Woodland being reduced by around a third. The proposal would potentially result in direct and indirect impacts to around 2.4 per cent of the remaining patch area.



## 5 Avoidance and mitigation measures

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### 5.1 Avoid and minimise

All remnant and planted native vegetation would be avoided during construction where possible including hollow and dead standing trees.

The results of the biodiversity field survey identified a high condition remnant of the critically endangered Cumberland Plain Woodland in and adjacent to Timbertop Reserve where widening of a two way link road between Prospect Highway and the Great Western Highway is proposed. This remnant woodland extends over an area of land zoned for protection in Timbertop Reserve, and a recently established residential subdivision at Hampton Crescent which has reduced the remnant by around a third. Roads and Maritime subsequently sought to avoid and minimise further impact on this remnant woodland as much as possible. In achieving this, the design of the two way link road was subject to a number of revised options. The preferred option reduces the impact at the site and restricts the clearing to a narrow strip of vegetation between the residential subdivision and road reserve while avoiding the Council reserve. This strip of vegetation is indirectly impacted by vegetation clearing undertaken for the adjoining subdivision. The outcome of the redesign and proposed mitigation measures is considered to reduce the likely impact of the proposal on this remnant.

Water quality controls would be included in the proposal and all urban runoff would be directed away from adjacent areas of Cumberland Plain Woodland to avoid indirect impacts and the facilitation of weed species

### 5.2 Recommended construction mitigation measures

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

#### 5.2.1 Pre-clearing

- A construction environmental management plan (CEMP) would include details regarding pre-clearance surveys. The plan would include a clearing procedure, which in turn would specify the requirements for pre-clearing.
- Pre-clearing surveys would be undertaken by an experienced ecologist to identify potential nesting/roosting animals present in the overall proposal footprint.
- Pre-clearing surveys for Cumberland Plain Land Snail would be undertaken during suitable season/climatic conditions prior to construction in moderate and high condition areas of Map Unit 1.
- Pre-clearing surveys would also target potentially occurring threatened flora species such as Spiked Rice-flower (*Pimelea spicata*).
- The CEMP should specify the management measures required if Spiked Rice-flower and/or Cumberland Plain Land Snail are found during the pre-clearance surveys.
- Any major weed infestations that would require management during construction should also be identified in the pre-clearance surveys.

- The construction footprint would be identified and marked prior to construction and exclusion zones established in retained areas of habitat particularly in remnant vegetation areas.
- Identify nearby habitats on both sides of the existing highway along the length of the proposal suitable for the release of fauna that may be encountered during the pre-clearing process or habitat removal.
- Follow the unexpected threatened species finds procedure as outlined in the Roads and Maritime Biodiversity Guidelines (RTA 2011) if required.
- Woody debris and leaf litter would be relocated and pre-clearance surveys should identify areas of woody debris, leaf litter and other habitat features to be relocated to adjacent areas of habitat.
- Permanent fencing would be established along the edges of the high condition Cumberland Plain Woodland remnant adjacent to Timbertop Reserve to avoid incursions into this area during construction and operation.

### 5.2.2 Exclusion zones

The location of exclusion zones to be established would avoid damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Basic temporary fencing would be installed to indicate the limits of clearing. The location of exclusion fencing to be installed would be identified on plans in the CEMP and the function and importance of the exclusion zones communicated to construction personnel. Exclusion zones should be established around any remnant or planted vegetation to be retained to avoid accidental incursions. In particular, areas of high and moderate condition Cumberland Plain Woodland should be protected with exclusion fencing.

The construction boundary adjacent to the area of high condition Cumberland Plain Woodland adjacent to Timbertop Reserve would be minimised to an area around one metre from the edge of the proposal. Permanent chain-link fencing would be established along the construction boundary in this area to exclude machinery and personnel during construction, and to avoid encroachment from maintenance activities during operation.

An exclusion zone would be established around the area of Freshwater Wetland on the proposed ancillary site between the Prospect Highway and Thornley Road. A 50 metre buffer surrounding this community should be established as an exclusion zone if this ancillary site is to be utilised.

### 5.2.3 Minimising fauna injury and mortality

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

- Staged habitat removal for hollow-bearing trees and dead-standing trees.
- Allow fauna to leave an area without intervention as much as possible.
- In circumstances where the handling of fauna is completely unavoidable, best practice methods need to be followed as outlined in the Roads and Maritime Biodiversity Guidelines – Guide 9 Fauna Handling (RTA 2011).

- Include the procedures in project inductions for construction staff to implement if fauna is found or injured on site and also the importance of not feeding any wildlife that may be encountered on construction sites.
- Never deliberately kill a snake as all snakes are protected under the NSW *National Parks and Wildlife Act 1974*.
- Keep records of fauna captured and relocated.
- Report any injury to or death of a threatened species to the Roads and Maritime environmental staff.

#### 5.2.4 Weed management

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

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

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

Ongoing weed management along the road reserve in areas upgraded by the proposal should avoid the use of chemicals in the area adjoining the Timbertop Reserve to conserve the integrity of the remnant vegetation in this location.

#### 5.2.5 Pest and disease management

No pests and diseases are currently known within the proposal footprint but could potentially be present. Measures to prevent the introduction and/or spread of pests and disease causing agents such as bacteria and fungi need to be incorporated into the construction environmental management plan for the proposal.

Measures to confirm the presence of pathogens/disease causing agents such as bacteria and fungi may be undertaken prior to construction. This includes a background search of government-maintained websites for the most recent known locations of contamination and for the most up-to-date hygiene protocols for each pathogen. If risks are identified in the vicinity of the proposal, testing from a National Association of Testing Authorities (NATA) approved laboratory may be required to confirm the presence of pathogens in the soil and/or water.

If pathogens/disease causing agents are found to present, measures to prevent the introduction and/or spread of these pathogens/disease causing agents are to be incorporated into the CEMP for the proposal. If pathogens are identified exclusion zones with fencing and signage to restrict access into contaminated areas would be required. The pest and disease management plan should be developed in accordance with Guide 7 of the Biodiversity Guidelines (RTA 2011).

### 5.3 Re-establishment of native vegetation

A landscape management plan would be developed which provides specific details for the re-establishment of native vegetation on the roadside reserve, and other areas disturbed during construction.

Detailed guidelines for the re-establishment of native vegetation on road projects are provided in the Roads and Maritime Biodiversity Guidelines - Guide 3 (RTA 2011). Those of relevance to the proposal include the following:

- Use only local provenance seed sourced from the locality.
- Ensure areas to be revegetated have an appropriate level of natural drainage.
- Avoid compaction of soils in areas identified for revegetation and where compaction has occurred, the soil would be loosened.
- When planting consider seasonal risks of frost, drought, flooding and sun exposure to avoid damaging plants and to encourage growth.
- Adhere to relevant specifications and guidelines including but not limited to the RTA Landscape Planting QA Specification R179, RTA Seed Collection QA Specification R176, the Florabank Guidelines, Model Code of Practice and Construction Quality Technical Direction 007, Quality Alert 7 – Hydro-seeding, hydro-mulching and other slope stabilisation methods.
- Inspection, monitoring and maintenance of revegetated areas would be conducted biannually for a minimum of two years following the completion of construction in accordance with the landscape management plan. Outline the roles and responsibilities in landscape management and revegetation plans including the schedule for monitoring and maintenance activities.

### 5.4 Wildlife connectivity

Heavy pruning or pollarding of existing trees instead of complete removal of trees would maintain some cover and habitat structure for fauna.

### 5.5 Offsetting

The Roads and Maritime (2011) *Guideline for Biodiversity Offset* was considered to determine whether the proposal would trigger offset requirements under the guideline. The guideline identifies works involving clearing of native vegetation that is of very high conservation value which is defined in the guidelines as a vegetation

type that is more than 90 per cent cleared in NSW where the patch size of the impacted vegetation is greater than four hectares.

In accordance with Roads and Maritime offset policy (2011), offsets would be considered for the 0.69 hectares of CPW directly and indirectly impacted as part of the proposal. However, offsets are not formally required as there is not a significant impact expected.

## 6 Significance assessments

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

### 6.1 NSW Environmental Planning and Assessment Act, 1979

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

Species with similar taxonomy or ecological requirements have been assessed together, for example tree-roosting microchiropteran bats. Full details of the assessment of significance under the EP&A Act are presented in **Appendix D**. The conclusions of the EP&A Act are provided in **Table 6-1**, which indicates that a significant impact is considered unlikely on any biota listed under the TSC Act.

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

Species	Status (TSC Act)	Sect 5a EP&A Act							Likely significant impact	Potential to occur in the construction footprint
		a	b	c	d	e	f	g		
<b>Threatened Ecological Communities</b>										
Cumberland Plain Woodland	CE	X	X	Y	Y	X	N	Y	No	Confirmed in the study area
<b>Threatened Flora</b>										
Spiked Rice-flower ( <i>Pimelea spicata</i> )	E	N	X	X	N	X	N	Y	No	Moderate
Juniper-leaved Grevillea ( <i>Grevillea juniperina</i> )	V	N	X	X	N	X	N	Y	No	Moderate
<b>Threatened Fauna</b>										
Cumberland Plain Land Snail ( <i>Meridolum corneovirens</i> )	E	N	X	X	N	X	N	Y	No	High
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	V	N	X	X	N	X	N	Y	No	Moderate
Little Lorikeet ( <i>Glossopsitta pusilla</i> )	V	N	X	X	N	X	N	Y	No	Moderate
Powerful Owl ( <i>Ninox strenua</i> )	V	N	X	X	N	X	N	Y	No	Moderate
<b>Woodland Birds</b>										
Black-chinned Honeyeater ( <i>Melithreptus gularis</i> )	V	N	X	X	N	X	N	Y	No	Moderate
Speckled Warbler ( <i>Pyrrholaemus sagittatus</i> )	V	N	X	X	N	X	N	Y	No	Moderate
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	V	N	X	X	N	X	N	Y	No	Moderate
<b>Cave-roosting microbats</b>										
Eastern Bent-wing Bat ( <i>Miniopterus schreibersii oceanensis</i> )	V	N	X	X	N	X	X	Y	No	Moderate
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	V									Moderate
Southern Myotis	V									Moderate

Species	Status (TSC Act)	Sect 5a EP&A Act							Likely significant impact	Potential to occur in the construction footprint
		a	b	c	d	e	f	g		
<i>(Myotis macropus)</i>										
<b>Tree-roosting microbats</b>										
Eastern False Pipistrelle <i>(Falsistrellus tasmaniensis)</i>	V	N	X	X	N	X	X	Y	No	Moderate
Eastern Freetail-bat <i>(Mormopterus norfolkensis)</i>	V									Moderate
Yellow-bellied Sheath-tail-bat <i>(Saccolaimus flaviventris)</i>	V									Moderate
Greater Broad-nosed Bat <i>(Scoteanax rueppellii)</i>	V									Moderate
<p>* Y= Yes (negative impact), N = No (no or positive impact), X = not applicable,</p> <p>Significance Assessment Questions (heads of consideration) as detailed in S.5a of the EP&amp;A Act</p> <p>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.</p> <p>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.</p> <p>c in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:</p> <p>(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</p> <p>(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.</p> <p>d in relation to the habitat of a threatened species, population or ecological community:</p> <p>(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and</p> <p>(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</p> <p>(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.</p> <p>e whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).</p> <p>f whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.</p> <p>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.</p>										

## 6.2 Commonwealth Environmental Protection and Biodiversity Conservation Act 1999

### 6.2.1 Threatened species

Full details of the assessment of significance for threatened species under the EPBC Act are presented in **Appendix D**. The conclusions of the EPBC Act assessment of significance are provided in **Table 6-2** which indicates that a significant impact is considered unlikely for any Matter of National Environmental Significance (MNES).

**Table 6-2 Summary of Commonwealth EPBC Act assessments of significance**

Species/Ecological Community	Assessment of significance questions (EPBC Act)									Likely Significant Impact	Important Population +
	1	2	3	4	5	6	7	8	9		
<b>Critically Endangered Ecological Community</b>											
Cumberland Plain Shale Woodlands	Y	Y	N	Y	X	Y	Y	N	N	No	N/A
<b>Endangered Flora</b>											
Spiked Rice-flower ( <i>Pimelea spicata</i> )	N	N	N	N	N	N	N	N	N	No	N/A
<b>Vulnerable fauna</b>											
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	N	N	N	N	N	N	N	N	N	No	No
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	N	N	N	N	N	N	N	N	N	No	No
+ Important Population as determined by the EPBC Act is a population of a vulnerable species that: is likely to be key source populations either for breeding or dispersal. is likely to be necessary for maintaining genetic diversity. is at or near the limit of the species range.											

### 6.2.2 Migratory species

Full details of the assessment of significance under the EPBC Act are presented in **Appendix D**. The conclusions of the assessments of significance on migratory species are provided in **Table 6-3** and indicate that the proposal is considered unlikely to significantly impact on migratory birds.



**Table 6-3 Summary of Commonwealth significance assessment for migratory species**

<b>Migratory species</b>	<b>EPBC Act status</b>	<b>Important population* in study area</b>	<b>Likely significant impact</b>
Black-faced Monarch ( <i>Monarcha melanopsis</i> )	Marine; Migratory (BONN)	No	No
Cattle Egret ( <i>Ardea ibis</i> )	Marine; Migratory (CAMBA, JAMBA)	No	No
Fork-tailed Swift ( <i>Apus pacificus</i> )	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
Great Egret ( <i>Egretta alba</i> )	Marine; Migratory (CAMBA, JAMBA)	No	No
Latham's Snipe ( <i>Gallinago hardwickii</i> )	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
Eastern Osprey ( <i>Pandion haliaetus</i> )	Marine; Migratory (BONN)	No	No
Rainbow Bee-eater ( <i>Merops ornatus</i> )	Marine; Migratory (JAMBA)	No	No
Rufous Fantail ( <i>Rhipidura rufifrons</i> )	Marine; Migratory (BONN)	No	No
Satin Flycatcher ( <i>Myiagra cyanoleuca</i> )	Marine; Migratory (BONN)	No	No
White-bellied Sea-Eagle ( <i>Haliaeetus leucogaster</i> )	Marine; Migratory (CAMBA)	No	No
White Throated Needletail ( <i>Hirundapus caudacutus</i> )	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
<p>* Important Population as determined by the EPBC Act, is for a migratory species:</p> <ul style="list-style-type: none"> <li>a Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or</li> <li>b Habitat that is of critical importance to the species at particular life-cycle stages, and/or</li> <li>c Habitat used by a migratory species which is at the limit of the species range, and/or</li> <li>d Habitat within an area where the species is declining.</li> </ul>			

## 7 Conclusion

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The biodiversity assessment has identified that the proposal would involve:

- Impacts to 0.12 hectares of high condition Cumberland Plain Woodland listed as critically endangered under the EPBC Act. This consists of 0.08 hectares of direct impacts and 0.04 hectares of indirect impacts.
- Direct and indirect impacts to Cumberland Plain Woodland as listed under the TSC Act (0.69 hectares). This consists of high condition vegetation (0.12 hectares) listed under the EPBC Act and the TSC Act, and listed under the TSC Act only. There is also moderate condition vegetation (0.11 hectares), isolated remnant trees (0.32 hectares) and planted vegetation (0.14 hectares) with affinities to native Cumberland Plain Woodland.
- One individual of the vulnerable species (TSC Act) Juniper-leaved Grevillea (*Grevillea juniperina subsp. juniperina*) was recorded in the study area. This was located in a highly modified area of Cumberland Plain Woodland that would not be affected by the proposal.
- Habitat for threatened flora species in the study area is generally limited to intact patches of vegetation. Despite targeted surveys in these habitats none were recorded. The remnant and planted vegetation to be impacted provides limited but potential habitat for some threatened fauna species. Thirteen highly mobile species were identified in the background review as having a moderate potential to occur.
- The Cumberland Plain Land Snail has a high potential to occur in the study area based on local records and habitat preferences. Impacts would be limited to around 0.12 hectares of potential habitat potentially available to this species, however suitable microhabitat elements in this area such as fallen timber and substantial areas of leaf litter are limited.
- The proposal is unlikely to substantially contribute to further fragmentation of habitats and impacts to wildlife connectivity. This is due to existing high levels of fragmentation, which limits fauna species to highly mobile species.

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

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

In accordance with Roads and Maritime offset policy (2011), offsets would be considered for the 0.69 hectares of CPW directly and indirectly impacted as part of the proposal. However offsets are not formally required as there is not a significant impact expected

Provided the mitigation measures described in Chapter 5 are adequately implemented, the proposal is unlikely to have a significant impact on any threatened species, populations or ecological communities listed under the TSC Act and EPBC Act. Four matters of national environmental significance have been identified in the study area as being directly impacted or potentially impacted. These comprise one

ecological community and three threatened species. The assessment has concluded there would not be a significant impact.

The high condition remnant of the critically endangered Cumberland Plain Woodland (Map Unit 1) listed under both the TSC Act and the EPBC Act is adjacent to the proposed widening of the proposed two way link road between Prospect Highway and the Great Western Highway. This high condition remnant woodland extends over an area of land zoned for protection within Timbertop Reserve and recently established residential subdivision at Hampton Crescent which has reduced the remnant woodland by around a third. Roads and Maritime subsequently sought to avoid and minimise further impact on this remnant woodland as much as possible. The proposed design reduces the direct and indirect impact at the site by 56 per cent from 0.27 hectares to 0.12 hectares. It restricts the proposed clearing and indirect impacts to a narrow strip of vegetation around 25 metres by 100 metres in an area between the residential subdivision and road reserve while avoiding the remaining remnant in Timbertop Reserve. This strip of vegetation is indirectly impacted by the adjoining subdivision.

Based on the conclusions of the Assessment of Significance for threatened species and listed ecological communities a Species Impact Statement under the EP&A Act is not required and it is considered unlikely that the impact would trigger a controlled action under the EPBC Act.

## 8 References

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## Appendix A Threatened subject likelihood of occurrence

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

Likelihood of Occurrence	Criteria
Unlikely	<ul style="list-style-type: none"> <li>Species highly restricted to certain geographical areas not within the proposal footprint.</li> <li>Specific habitat requirements are not present in the study area.</li> </ul>
Low	<p>Species not recorded during field surveys and fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>Have not been recorded previously in the study area/surrounds and for which the study area is beyond the current distribution range.</li> <li>Use specific habitats or resources not present in the study area.</li> <li>Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.</li> </ul>
Moderate	<p>Species not recorded during the field surveys that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>Have infrequently been recorded previously in the study area/surrounds.</li> <li>Use specific habitats or resources present in the study area but in a poor or modified condition.</li> <li>Are unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration.</li> <li>Are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.</li> </ul>
High	<p>Species recorded during the field surveys or species not recorded that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> <li>Have frequently been recorded previously in the study area/surrounds.</li> <li>Use habitat types or resources that are present in the study area that are in abundance and/or in good condition within the study area.</li> <li>Are known or likely to maintain resident populations surrounding the study area.</li> <li>Are known or likely to visit the site during regular seasonal movements or migration.</li> </ul>

**Table A-1 Known or potentially occurring threatened flora species**

Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
Bynoe's Wattles <i>Acacia bynoeana</i>	V	E	Found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood ( <i>Corymbia gummifera</i> ), Scribbly Gum ( <i>Eucalyptus haemastoma</i> ), Drooping Red Gum ( <i>E. parramattensis</i> ), Old Man Banksia ( <i>Banksia serrata</i> ) and Small-leaved Apple ( <i>Angophora bakeri</i> ).	2	Absent	Unlikely
Downy Wattle <i>Acacia pubescens</i>	V	V	Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravelly soils, often with ironstone.	92 PMST	Map Unit 1	Low – not recorded (non-cryptic species)
<i>Allocasuarina glareicola</i>	E	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil. Found in open woodland with <i>Eucalyptus parramattensis</i> , <i>Eucalyptus fibrosa</i> , <i>Angophora bakeri</i> , <i>Eucalyptus sclerophylla</i> and <i>Melaleuca decora</i> . Common associated understorey species include <i>Melaleuca nodosa</i> , <i>Hakea dactyloides</i> , <i>Hakea sericea</i> , <i>Dillwynia tenuifolia</i> , <i>Micromyrtus minutiflora</i> , <i>Acacia elongata</i> , <i>Acacia brownei</i> , <i>Themeda australis</i> and <i>Xanthorrhoea minor</i> .	0 PMST	Absent	Low
Netted Bottlebrush <i>Callistemon linearifolius</i>	-	V	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Was more widespread across its distribution in the past. Some populations are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve, and Spectacle Island Nature Reserve. Further north it has been recorded from Yengo National Park and Werakata National Park. Grows in dry sclerophyll forest on the coast and adjacent ranges.	4	Map Unit 1	Low – not recorded (non-cryptic species)
White-flowered Wax Plant <i>Cynanchum elegans</i>	E	E	Occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree ( <i>Leptospermum laevigatum</i> ) – Coastal Banksia ( <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> ) coastal scrub; Forest Red Gum ( <i>Eucalyptus tereticornis</i> ) aligned open forest and woodland; Spotted Gum ( <i>Corymbia maculata</i> ) aligned open forest and woodland; and Bracelet Honeymyrtle ( <i>Melaleuca armillaris</i> ) scrub	1	Absent	Low

Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
			to open scrub.			
<i>Darwinia biflora</i>	V	V	Occurs at 129 sites in the northern and north-western suburbs of Sydney, in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai Local Government Areas (LGAs). Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include <i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i> and/or <i>E. squamosa</i> . The vegetation structure is usually woodland, open forest or scrub-heath.	8	Absent	Unlikely
<i>Dillwynia tenuifolia</i>	V	V	Core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in western Sydney are recorded at Voyager Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include the Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains. In western Sydney, it may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	6	Map Unit 1	Low – not recorded (non-cryptic species)
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-	V	Recorded from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the south. Found in a range of habitat types, most of which have a strong shale soil influence.	70	Map Unit 1	Low – not recorded (non-cryptic species)
Narrow-leaved Black Peppermint <i>Eucalyptus nicholii</i>	V	V	This species is sparsely distributed but widespread on the New England Tablelands from Nundle to north of Tenterfield, being most common in central portions of its range. Found largely on private property and roadsides, and occasionally conservation reserves. Planted as urban trees, windbreaks and corridors. Typically grows in dry grassy woodland, on shallow soils of slopes and ridges. Found primarily on infertile soils derived from granite or meta sedimentary rock. This species has been planted in the locality.	4	Natural habitat absent. Potentially planted in the study area	Low
Narrow-leaf Finger Fern <i>Grammitis stenophylla</i>	-	E	In NSW it has been found on the south, central and north coasts and as far west as Mount Kaputar National Park near Narrabrai. Inhabits moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest.	1	Absent	Unlikely



Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
Juniper-leaf Grevillea <i>Grevillea juniperina</i> subsp. <i>juniperina</i>	-	V	Endemic to western Sydney, centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium often with a shale influence, typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest. Associated canopy species within Cumberland Plain Woodland and Shale/Gravel Transition Forest include Forest Red Gum ( <i>Eucalyptus tereticornis</i> ), Grey Box ( <i>E. moluccana</i> ), Narrow-leaved Ironbark ( <i>E. crebra</i> ), Broad-leaved Ironbark ( <i>E. fibrosa</i> ) and Thin-leaved Stringybark ( <i>E. eugenioides</i> ). Understorey species include Sweet Bursaria ( <i>Bursaria spinosa</i> ), Prickly parrot pea ( <i>Dillwynia sieberi</i> ), White Dogwood ( <i>Ozothamnus diosmifolius</i> ), Gorse Bitter Pea ( <i>Daviesia ulicifolia</i> ), Sickie Wattle ( <i>Acacia falcata</i> ), Parramatta Wattle ( <i>Acacia parramattensis</i> ), Kangaroo Grass ( <i>Themeda australis</i> ), Purple Wiregrass ( <i>Aristida ramosa</i> ), Barbwire Grass ( <i>Cymbopogon refractus</i> ), Brown's Lovegrass ( <i>Eragrostis brownie</i> ), Rock Fern ( <i>Cheilanthes sieberi</i> ), Blue Flax Lily ( <i>Dianella revolute</i> ) and Ivy Goodenia ( <i>Goodenia hederacea</i> ). In Castlereagh Woodland on more sandy soils the dominant canopy species are Broad-leaved Ironbark ( <i>Eucalyptus fibrosa</i> ), Scibbly Gum ( <i>E. sclerophylla</i> ), Small-leaved Apple ( <i>Angophora bakeri</i> ) and Honey Myrtle ( <i>Melaleuca decora</i> ). Understorey species include Prickly-leaved Paperbark ( <i>Melaleuca nodosa</i> ), Needlebush ( <i>Hakea sericea</i> ), <i>Cryptandra spinescens</i> , Slender Wattle ( <i>Acacia elongate</i> ), Forest Raspwort ( <i>Gonocarpus teucroides</i> ), Spiny-headed Mat Rush ( <i>Lomandra longifolia</i> ) and the threatened species <i>Dillwynia tenuifolia</i> , Prickly-bush Pea ( <i>Pultenaea parviflora</i> ), <i>Micromyrtus minutiflora</i> and <i>Allocasuarina glareicola</i> .	53	Map Unit 1	Present – recorded in study area outside of the construction footprint and there will be no direct or indirect impacts to this species
Small-flower Grevillea <i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	V	Sporadically distributed throughout the Sydney Basin with the main occurrence centred around Picton, Appin and Bargo. Separate populations are also known further north from Putty to Wyong and Lake Macquarie on the Central Coast, and Cessnock and Kurri Kurri in the Lower Hunter. Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	0 PMST	Absent	Unlikely
<i>Hibbertia superans</i>	-	E	Occurs from Baulkham Hills to South Maroota in the northern outskirts of Sydney and at one locality at Mount Boss inland from Kempsey. Occurs in both open woodland and heathland, and appears to prefer open disturbed areas, such as tracksides. Known to occur on Sandstone Gully Forest.	47	Absent	Unlikely

Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
<i>Leucopogon fletcheri</i> subsp. <i>fletcheri</i>	-	E	Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the LGAs of Hawkesbury, Baulkham Hills and Blue Mountains. Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs.	1	Absent	Unlikely
<i>Marsdenia viridifolia</i> subsp. <i>viridifolia</i> (endangered population)	-	EP	Endangered population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas. Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Grows in vine thickets and open shale woodland.	16	Potential habitat widespread	Low – not recorded (non-cryptic species)
Hairy Geebung <i>Persoonia hirsuta</i>	E	E	The Hairy Geebung has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	10	Absent	Unlikely
Nodding Geebung <i>Persoonia nutans</i>	E	E	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith, and to a lesser extent, Hawkesbury LGAs, with isolated and relatively small populations also occurring in the Liverpool, Campbelltown, Bankstown and Blacktown LGAs. Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	10	Map Unit 1	Low – not recorded (non-cryptic species)
Austral Pillwort <i>Pilularia novae-hollandiae</i>	-	E	The Austral Pillwort is a sub-aquatic fern species has records in western Sydney and south central NSW. It grows in shallow swamps and waterways amongst grasses and sedges. It is most conspicuous in drying mud.	1	Absent	Unlikely
Slender Curved Rice Flowers <i>Pimelea curviflora</i> var. <i>curviflora</i>	V	V	Confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	11 PMST	Absent	Unlikely
Spiked-rice Flower <i>Pimelea spicata</i>	E	E	Broad distribution in western Sydney, occurring on the Cumberland Plain (Narellan, Marayong, Prospect Reservoir areas). Another smaller population is recorded in districts (Landsdowne to Shellharbour to northern Kiama) Illawarra. It grows on well-structured clay soils. On the inland Cumberland Plain sites it is associated with Grey Box and Ironbark. In the coastal Illawarra it occurs commonly in Coastal Banksia open woodland with a more well developed shrub and grass understorey.	121 PMST	Map Unit 1	Moderate – not recorded during targeted surveys during November 2013, however

Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
						still regarded as having some potential to occur
<i>Pomaderris prunifolia</i> (endangered population)	-	EP	Endangered population in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas. Known from only three sites within the listed local government areas, at Rydalmere, within Rookwood Cemetery and at The Crest of Bankstown. At Rydalmere it occurs along a road reserve near a creek, among grass species on sandstone. At Rookwood Cemetery it occurs in a small gully of degraded Cooks River / Castlereagh Ironbark Forest on shale soils.	1	Absent	Unlikely
Illawarra Greenhood <i>Pterostylis gibbosa</i>	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark ( <i>Eucalyptus crebra</i> ), Forest Red Gum ( <i>Eucalyptus tereticornis</i> ) and Black Cypress Pine ( <i>Callitris endlicheri</i> ).	0 PMST	Absent	Low
Sydney Plains Greenhood <i>Pterostylis saxicola</i>	E	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. There are very few known populations and they are all very small and isolated. Only one population occurs within a conservation reserve at Georges River National Park. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where it occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	1 PMST	Absent	Unlikely
Sydney-bush Pea <i>Pultenaea parviflora</i>	E	E	Endemic to the Cumberland Plain the core distribution is from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. May be locally abundant, particularly within scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. <i>Eucalyptus fibrosa</i> is usually the dominant canopy species. <i>Eucalyptus globoidea</i> , <i>E. longifolia</i> , <i>E. parramattensis</i> , <i>E. sclerophylla</i> and <i>E. sideroxylon</i> may also be present or co-dominant, with <i>Melaleuca decora</i> frequently forming a secondary canopy layer. Associated species may include <i>Allocasuarina littoralis</i> , <i>Angophora bakeri</i> , <i>Aristida</i>	2	Map Unit 1	Low – not recorded

Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
			spp. <i>Banksia spinulosa</i> , <i>Cryptandra</i> spp., <i>Daviesia ulicifolia</i> , <i>Entolasia stricta</i> , <i>Hakea sericea</i> , <i>Lissanthe strigosa</i> , <i>Melaleuca nodosa</i> , <i>Ozothamnus diosmifolius</i> and <i>Themeda australis</i> .			
Matted Bush-pea <i>Pultenaea pedunculata</i>	-	V	Widespread in Victoria, Tasmania, and south-eastern South Australia, However in NSW it is represented by just three disjunct populations on the Cumberland Plains in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn. NSW populations are generally among woodland vegetation but plants have also been found on road batters and coastal cliffs. It is largely confined to loamy soils in dry gullies in populations in the Windellama area.	12	Absent	Low
Whalebone Tree <i>Streblus brunonianus</i> (syn. <i>Streblus pendulinus</i> )	E	-	In warmer rainforest, chiefly along watercourses, north from Milton.	0 PMST	Absent	Unlikely
Magenta Lilly Pilly <i>Syzygium paniculatum</i>	V	V	The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	3 PMST	Absent	Unlikely
Glandular-pink Bell <i>Tetradlea glandulosa</i>	V	V	Endemic to NSW, with around about 150 populations from Yengo National Park to Lane Cove National Park. Associates in areas with shale cappings over sandstone. Occurs in heath, scrublands to woodlands and open forest. Common woodland tree species include: <i>Corymbia gummifera</i> , <i>C. eximia</i> , <i>Eucalyptus haemastoma</i> , <i>E. punctata</i> , <i>E. racemosa</i> , and/or <i>E. sparsifolia</i> , with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae.	6 PMST	Absent	Unlikely
Creek Triplarina <i>Triplarina imbricata</i>	E	E	Found only in a few locations in the ranges south-west of Glenreagh and near Tabulam in north-east NSW. Along watercourses in low open forest with Water Gum ( <i>Tristaniopsis laurina</i> ).	4	Absent	Unlikely
<p>^ E – endangered, EP – endangered population, V – vulnerable</p> <p>* Distribution and habitat requirement information adapted from:</p> <ul style="list-style-type: none"> <li>Australian Government Department of Sustainability, Environment, Water, Populations and Community <a href="http://www.environment.gov.au/biodiversity/threatened/index.html">http://www.environment.gov.au/biodiversity/threatened/index.html</a></li> </ul>						

Species	Status^		Distribution and habitat requirements*	Data source and no. of records+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act				
<ul style="list-style-type: none"> <li>NSW Office of Environment and Heritage <a href="http://www.environment.nsw.gov.au/threatenedspecies/">http://www.environment.nsw.gov.au/threatenedspecies/</a></li> </ul>						
+ Data source includes						
<ul style="list-style-type: none"> <li>Number of records from the NSW Office of Environment and Heritage Wildlife Atlas record data (Accessed November 2012); and</li> <li>Identified from the Protected Matters Search Tool (PMST) Australian Government Department of Sustainability, Environment, Water, Populations and Community <a href="http://www.environment.gov.au/epbc/pmst/index.html">http://www.environment.gov.au/epbc/pmst/index.html</a></li> </ul>						

**Table A-2 Known or potentially occurring threatened and migratory fauna species**

Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
<b>MAMMALS</b>						
Brush-tailed Rock Wallaby ( <i>Petrogale penicillata</i> )	E	E	Open forest habitats on steep terrain with exposed rocks, rock overhangs and platforms.	0 PMST	Absent	Unlikely
Eastern Bent-wing Bat ( <i>Miniopterus schreibersii oceanensis</i> )	-	V	Occurs on east and north west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	70	Potential habitat widespread	Moderate
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )	-	V	Occurs in a variety of open forest and woodland habitats with hollow-bearing trees. Requires hollows for roosting. May forage in re-growth and modified environments.	17	Potential habitat widespread	Moderate
Eastern Freetail Bat ( <i>Mormopterus norfolkensis</i> )	-	V	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in human-made structures.	30	Potential habitat widespread	Moderate
Eastern Pygmy Possum ( <i>Cercartetus nanus</i> )	-	V	Found in a broad range of habitats from rainforest through to wet and dry sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred.	1	Absent	Unlikely
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )	-	V	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall	14	Potential habitat	Moderate

Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
			wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.		widespread	
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	V	V	Forages on nectar and pollen in sclerophyll forests and on rainforest fruits and vines, orchards, gardens.	117 PMST	Potential habitat widespread	Moderate
Koala ( <i>Phascolarctos cinereus</i> )	V	V	Open forests and woodlands with favoured food tree species.	1 PMST	Absent	Unlikely
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	V	V	Forages over a broad range of open forest and woodland habitats, this species is a cave roosting bat which favours sandstone escarpment habitats for roosting, in the form of shallow overhangs, crevices and caves.	3 PMST	Potential habitat widespread	Moderate
Long-nosed Potoroo ( <i>Potorous tridactylus</i> )	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.	0 PMST	Absent	Unlikely
New Holland Mouse ( <i>Psuedomys novaehollandiae</i> )	V	-	Distribution is fragmented across all eastern states of Australia, where it inhabits open heath lands, open woodlands with heath understorey and vegetated sand dunes.	0 PMST	Absent	Unlikely
Southern Myotis ( <i>Myotis macropus</i> )	-	V	Generally roost in groups close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools catching insects and small fish.	13	Potential habitat widespread	Moderate
Spotted-tailed Quoll ( <i>Dasyurus maculatus</i> )	E	V	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated with large expansive areas of habitat to sustain territory size. Requires hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	9 PMST	Potential habitat widespread	Unlikely
Yellow-bellied Sheath-tail-bat ( <i>Saccolaimus flaviventris</i> )	-	V	Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Roost in tree hollows and buildings.	2	Potential habitat widespread	Moderate
<b>BIRDS</b>						
Australasian Bittern	E	E	They are widespread but uncommon over south-eastern Australia. It	0	Absent	Unlikely

Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
<i>(Botaurus poiciloptilus)</i>			extends mainly along the coasts of eastern Australia and is found all over NSW except for the far north west. It inhabits freshwater wetlands with tall dense vegetation where it feeds in shallow waters.	PMST		
Australian Painted Snipe ( <i>Rostratula benghalensis australis</i> )	V, M	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	0 PMST	Absent	Unlikely
Barking Owl ( <i>Ninox connivens</i> )	-	V	Forest and woodland habitats, particularly drier western slopes and riverine areas, hunts for birds and small mammals.	3	Absent	Unlikely
Black-chinned Honeyeater ( <i>Melithreptus gularis</i> )	-	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	1	Potential habitat widespread	Moderate
Black Bittern ( <i>Ixobrychus flavicollis</i> )	-	V	Occurs from south NSW to Cape York, and extends to the Kimberley region. Inhabits terrestrial and estuarine wetlands, preferring permanent water and dense vegetation.	3	Absent	Unlikely
Black Falcon ( <i>Falco subniger</i> )	-	V	Is found on the south east, northern and central inland regions of Australia. Usually occurs along vegetated watercourses and scattered woodlands.	1	Potential habitat widespread	Unlikely – fly over only
Eastern Bristlebird ( <i>Dasyornis brachypterus</i> )	E	E	Habitat is characterised by dense, low vegetation including heath and open woodland with a heathy understorey; in northern NSW occurs in open forest with tussocky grass understorey; all of these vegetation types are fire prone.	0 PMST	Absent	Unlikely
Eastern Osprey ( <i>Pandion haliaetus</i> )	M	V	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes	PMST	Absent	Low
Flame Robin ( <i>Petroica phoenicea</i> )	-	V	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with an open understorey.	1	Absent	Unlikely
Gang-gang Cockatoo ( <i>Callocephalon fimbriatum</i> )	-	V, EP	Occurs within a variety of forest and woodland types. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes.	2	Absent	Low
Glossy Black-Cockatoo ( <i>Calyptorhynchus lathamii</i> )	-	V	Open forest habitats with She-oak species ( <i>Allocasuarina</i> spp.) required for food.	1	Absent	Low
Little Eagle	-	V	Occupies open eucalypt forest, woodland or open woodland. Sheoak or	15	Map Unit 1	Low

Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
<i>(Hieraetus morphnoides)</i>			<i>Acacia</i> woodlands and riparian woodlands of interior NSW are also used.			
Little Lorikeet ( <i>Glossopsitta pusilla</i> )	-	V	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in apples ( <i>Angophora</i> sp.), paperbarks ( <i>melaleuca</i> sp.) and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country (e.g. paddocks, roadside remnants) and urban trees also help sustain viable populations of the species.	3	Map Unit 1 and 2	Moderate
Masked Owl ( <i>Tyto novaehollandiae</i> )	-	V	Dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting	2	Absent	Low
Pink Robin ( <i>Petroica rodinogaster</i> )	-	V	The Pink Robin is found in Tasmania and the uplands of eastern Victoria and far south-eastern NSW, almost as far north as Bombala. On the mainland, the species disperses north and west and into more open habitats in winter, regularly as far north as the ACT area, and sometimes being found as far north as the central coast of NSW. Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies.	1	Absent	Unlikely
Powerful Owl ( <i>Ninox strenua</i> )	-	V	Open forests with dense wet gullies and creek areas, requires large mature trees with hollows for breeding and dense areas of vegetation for prey and roosting	7	Map Unit 1	Moderate
Red Goshawk ( <i>Erythrorichis radiatus</i> )	V	CE	This unique Australian endemic raptor is distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. The species is very rare in NSW, extending south to about 30°S, with most records north of this, in the Clarence River Catchment, and a few around the lower Richmond and Tweed Rivers. Formerly, it was at least occasionally reported as far south as Port Stephens. Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	0 PMST	Absent	Unlikely
Regent Honeyeater	E, M	E	A nomadic species typically associated with forest and woodland habitats	13	Absent	Low



Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
<i>(Xanthomyza phrygia)</i>			with the presence of suitable foraging species such as Yellow Box ( <i>Eucalyptus melliodora</i> ) and Red Ironbark ( <i>Eucalyptus sideroxylon</i> ).	PMST		
Scarlet Robin ( <i>Petroica boodang</i> )	-	V	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and re-growth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.	3	Absent	Low
Speckled Warbler ( <i>Pyrrholaemus sagittatus</i> )	-	V	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt re-growth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	1	Map Unit 1	Moderate
Square-tailed Kite ( <i>Lophoictinia isura</i> )	-	V	It is widely distributed to the coastal and sub-coastal area of Australia. Migrates to NSW in September for breeding. Occurs in dry woodlands and open forests, and timbered watercourses.	1	Map Unit 1	Low – fly over only
Superb Parrot ( <i>Polytelis swainsonii</i> )	V	V	Occurs in eastern inland NSW. Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest	2	Absent	Unlikely
Swift Parrot ( <i>Lathamus discolor</i> )	E, M	E	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany ( <i>Eucalyptus robusta</i> ), Spotted Gum ( <i>Corymbia maculate</i> ), Red Bloodwood ( <i>C. gummifera</i> ), Red Ironbark ( <i>E. sideroxylon</i> ), and White Box ( <i>E. albens</i> ).	26 PMST	Absent	Low
Turquoise Parrot ( <i>Neophema pulchella</i> )	-	V	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	1	Absent	Low
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	-	V	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and acacia woodland.	14	Map Unit 1 and 2	Moderate
<b>REPTILES</b>						
Broad-headed Snake ( <i>Hoplocephalus</i> )	V	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks	0 PMST	Absent	Unlikely

Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
<i>bungaroides</i> )			to shelters in hollows in large trees within 200 metres of escarpments in summer.			
<b>AMPHIBIANS</b>						
Southern Barred Frog ( <i>Mixophyes iteratus</i> )	E	E	Forages and lives amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 metres. They breed around shallow, flowing rocky streams from late spring to summer.	0 PMST	Absent	Unlikely
Giant Burrowing Frog ( <i>Heleioporus australiacus</i> )	V	V	Found in heath, woodland and open forest with sandy soils.	0 PMST	Absent	Unlikely
Green and Golden Bell Frog ( <i>Litoria aurea</i> )	E	E	Ephemeral and permanent freshwater wetlands, ponds, dams with an open aspect and fringed by Typha and other aquatics, free from predatory fish.	30 PMST	Absent	Unlikely
Red-crowned Toadlet ( <i>Pseudophryne australis</i> )	-	V	It has restricted distribution from Pokolbin to Nowra and west to Mount Victoria. Occurs in open forests and wet drainage lines below sandstone ridges that often have shale lenses or cappings in the Hawkesbury and Narrabeen Sandstones.	5	Absent	Unlikely
Southern Bell Frog ( <i>Litoria raniformis</i> )	V	E	In NSW the species was once distributed along the Murray and Murrumbidgee Rivers and their tributaries, the southern slopes of the Monaro district and the central southern tablelands as far north as Tarana, near Bathurst. Currently, the species is known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. A few yet unconfirmed records have also been made in the Murray Irrigation Area in recent years. The species is also found in Victoria, Tasmania and South Australia, where it has also become endangered. Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat.	0 PMST	Absent	Unlikely
<b>INVERTEBRATE</b>						
Cumberland Plain Land Snail	-	E	Primarily inhabits Cumberland Plain Woodland (an endangered ecological community). This community is grassy, open woodland with	162	Map Unit 1	High

Species	Status^		Distribution and habitat requirements*	Source+	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
<i>(Meridolum corneovirens)</i>			occasional dense patches of shrubs. Lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish.			
<b>FISH</b>						
Macquarie Perch <i>(Macquaria australasica)</i>	E	E (FM Act)	Macquarie Perch has been recorded within the upper Reaches of the Hawkesbury –Nepean System.	0 PMST	Absent	Unlikely
<b>MIGRATORY MARINE SPECIES</b>						
Fork-tailed Swift <i>(Apus pacificus)</i>	M	-	The species breeds in Asia and migrate to Australia in the summer from which they spend their entire life-cycle on the wing, hunting, resting and sleeping.	4 PMST	Potential habitat widespread	Moderate
Cattle Egret <i>(Ardea ibis)</i>	M	-	Grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Often seen with cattle.	29 PMST	Potential habitat widespread	Low
<b>MIGRATORY TERRESTRIAL SPECIES</b>						
Black-faced Monarch <i>(Monarcha melanopsis)</i>	M	-	Rainforests, moist eucalypt forests and coastal scrubs.	PMST	Absent	Low
Rainbow Bee-eater <i>(Merops ornatus)</i>	M	-	Predominantly woodland and timbered plains.	1 PMST	Absent	Low
Rufous Fantail <i>(Rhipidura rufifrons)</i>	M	-	Predominantly rainforests and wetter forests.	PMST	Absent	Low
Satin Flycatcher <i>(Myagra cyanoleuca)</i>	M	-	Predominantly forests, in particular thick vegetation in gullies.	PMST	Absent	Low
White-bellied Sea-eagle <i>(Haliaeetus leucogaster)</i>	M	-	Predominantly ocean shores and estuaries, occasionally inland rivers and streams.	4 PMST	Absent	Low
White-throated Needletail <i>(Hirundapus caudacutus)</i>	M	-	An aerial foraging species which occupies a range of habitats from open modified landscapes to woodland and forest.	5 PMST	Potential habitat widespread	Moderate
<b>MIGRATORY WETLAND SPECIES</b>						
Great Egret ( <i>Ardea alba</i> )	M	-	Grasslands and wetlands such as pastures and croplands, especially	PMST	Potential	Low

Species	Status <sup>^</sup>		Distribution and habitat requirements*	Source <sup>+</sup>	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act / FM Act				
			where drainage is poor.		habitat widespread	
Latham's snipe ( <i>Gallinago hardwickii</i> )	M	-	Wetlands, wet meadows, flooded grassy paddocks, open grassland and drainage areas.	6 PMST	Potential habitat widespread	Low
<sup>^</sup> CE – critically endangered, E – endangered, EP – endangered population, V – vulnerable, M – Migratory/Marine <sup>*</sup> Distribution and habitat requirement information adapted from: <ul style="list-style-type: none"> <li>Australian Government Department of Sustainability, Environment, Water, Populations and Community <a href="http://www.environment.gov.au/biodiversity/threatened/index.html">http://www.environment.gov.au/biodiversity/threatened/index.html</a></li> <li>NSW Office of Environment and Heritage <a href="http://www.environment.nsw.gov.au/threatenedspecies/">http://www.environment.nsw.gov.au/threatenedspecies/</a></li> <li>Department of Primary Industries – Threatened Fish and Marine Vegetation <a href="http://pas.dpi.nsw.gov.au/Species/All_Species.aspx">http://pas.dpi.nsw.gov.au/Species/All_Species.aspx</a></li> </ul> <sup>+</sup> Data source includes <ul style="list-style-type: none"> <li>Number of records from the NSW Office of Environment and Heritage Wildlife Atlas record data (Accessed November 2012); and</li> <li>Identified from the Protected Matters Search Tool (PMST) Australian Government Department of Sustainability, Environment, Water, Populations and Community <a href="http://www.environment.gov.au/epbc/pmst/index.html">http://www.environment.gov.au/epbc/pmst/index.html</a></li> </ul>						

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

TSC Act Listed Community	EPBC Act Listed Community	Confirmed occurrence in the study area
Castlereagh Swamp Woodland Community (Endangered)	-	No
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	No
Cooks River/ Castlereagh Ironbark Forest in the Sydney Basin Bioregion (Endangered)	-	No
Cumberland Plain Woodland in the Sydney basin Bioregion (Critically Endangered)	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered)	Present
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast,	-	Present

<b>TSC Act Listed Community</b>	<b>EPBC Act Listed Community</b>	<b>Confirmed occurrence in the study area</b>
Sydney Basin and South East Corner Bioregions (Endangered)		
Moist Shale Woodland in the Sydney Basin Bioregion (Endangered)	-	No
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	No
Shale Gravel Transition Forest in the Sydney Basin Bioregion (Endangered)	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered)	No
Shale Sandstone Transition Forest in the Sydney Basin Bioregion (Endangered)	Shale/Sandstone Transition Forest (Endangered)	No
Sydney Turpentine-Ironbark Forest (Endangered)	Turpentine-Ironbark Forest in the Sydney Basin Bioregion (Critically Endangered)	
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	-	No

# Appendix B Flora species list

## Abbreviations

i = introduced (i.e. not indigenous to Australia)

ix = Noxious species listed under the *Noxious Weeds Act 1993*.

n = native Australian species not considered to be indigenous to the site

t = threatened species

## Notes

A sample flora assemblage obtained from a short term survey, such as the present one, cannot be considered to be comprehensive, but rather indicative of the actual flora assemblage. It can take many years of flora surveys to record all of the plant species occurring within any area, especially species that are only apparent in some seasons. Not all species can be accurately identified in a 'snapshot' survey due to absence of flowering or fruiting material, etc.

FAMILY	Scientific Name	Common Name	
<b>Flowering Plants - Dicotyledons</b>			
ACANTHACEAE	<i>Pseuderanthemum variabile</i>	Pastel Flower	
AIZOACEAE	<i>Aptenia cordifolia</i>	Baby Sun Rose	i
AIZOACEAE	<i>Galenia pubescens</i>	Galenia	i
AMYGDALACEAE	<i>Pyrus ussuriensis</i>	Manchurian Pear	i
APIACEAE	<i>Foeniculum vulgare</i>	Fennell	i
APOCYNACEAE	<i>Araujia hortorum</i>	Moth Vine	i
APOCYNACEAE	<i>Vinca major</i>	Greater Periwinkle	i
ASTERACEAE	<i>Arctotheca calendula</i>	Cape Dandelion	i
ASTERACEAE	<i>Bidens pilosa</i>	Cobblers Peg	i
ASTERACEAE	<i>Cirsium vulgare</i>	Spear Thistle	i
ASTERACEAE	<i>Conyza spp.</i>	Fleabane	i
ASTERACEAE	<i>Coreopsis lanceolata</i>	Coreopsis	i
ASTERACEAE	<i>Euchiton sphaericus</i>		
ASTERACEAE	<i>Gamochaeta purpurea</i>	Cudweed	i
ASTERACEAE	<i>Hypochaeris microcephala var. albiflora</i>	White Flatweed	i
ASTERACEAE	<i>Hypochaeris radicata</i>	Flatweed	i
ASTERACEAE	<i>Lactuca serriola</i>	Prickly Lettuce	i
ASTERACEAE	<i>Senecio linearifolius</i>	Fireweed Grounel	
ASTERACEAE	<i>Senecio madagascariensis</i>	Fireweed	i
ASTERACEAE	<i>Soliva sessilis</i>	Bindyi	i
ASTERACEAE	<i>Sonchus oleraceus</i>	Common Sow-thistle	i
ASTERACEAE	<i>Taraxacum officinale</i>	Dandelion	i
ASTERACEAE	<i>Vernonia cinerea var. cinerea</i>	Vernonia	
ASTERACEAE	<i>Vittadinia cuneata</i>	Fuzzweed	
BRASSICACEAE	<i>Capsella bursa-pastoris</i>	Shepherds Purse	i
CACTACEAE	<i>Opuntia ficus-indica</i>	Indian Fig	i

<b>FAMILY</b>	<b>Scientific Name</b>	<b>Common Name</b>	
CARYOPHYLLACEAE	<i>Cerastium glomeratum</i>	Mouse-ear Chickweed	i
CASUARINACEAE	<i>Casuarina cunninghamiana</i>	River Oak	
CASUARINACEAE	<i>Casuarina glauca</i>	Swamp Oak	
CHENOPODIACEAE	<i>Einadia hastata</i>	Shrubby Berry-saltbush	
CONVOLVULACEAE	<i>Dichondra repens</i>	Kidney Weed	
FABACEAE- CAESALPINIOIDEAE	<i>Senna pendula</i> var. <i>glabrata</i>	Cassia	i
FABACEAE- FABOIDEAE	<i>Daviesia ulicifolia</i>	Gorse Bitter-pea	
FABACEAE- FABOIDEAE	<i>Desmodium brachypodum</i>	Large Tick-trefoil	
FABACEAE- FABOIDEAE	<i>Desmodium varians</i>	Slender Tick-trefoil	
FABACEAE- FABOIDEAE	<i>Dillwynia sieberi</i>	Prickly Parrot-pea	
FABACEAE- FABOIDEAE	<i>Erythrina cristi-galli</i>	Cockspur Coral Tree	i
FABACEAE- FABOIDEAE	<i>Glycine clandestina</i> agg.	Twining Glycine	
FABACEAE- FABOIDEAE	<i>Glycine tabacina</i> agg.		
FABACEAE- FABOIDEAE	<i>Glycine tomentella</i>	Wooly Glycine	
FABACEAE- FABOIDEAE	<i>Medicago polymorpha</i>	Burr Medic	i
FABACEAE- FABOIDEAE	<i>Pultenaea microphylla</i>		
FABACEAE- FABOIDEAE	<i>Trifolium campestre</i>	Hop Clover	
FABACEAE- FABOIDEAE	<i>Trifolium repens</i>	White Clover	i
FABACEAE- FABOIDEAE	<i>Vicia sativa</i> subsp. <i>sativa</i>	Common Vetch	i
FABACEAE- MIMOSOIDEAE	<i>Acacia baileyana</i>	Cootamundra Wattle	n
FABACEAE- MIMOSOIDEAE	<i>Acacia falcata</i>	Sickle Wattle	
FABACEAE- MIMOSOIDEAE	<i>Acacia fimbriata</i>	Fringed Wattle	
FABACEAE- MIMOSOIDEAE	<i>Acacia floribunda</i>	Sally Wattle	
FABACEAE- MIMOSOIDEAE	<i>Acacia implexa</i>	Hickory	
FABACEAE- MIMOSOIDEAE	<i>Acacia parramattensis</i>	Sydney Green Wattle	
GOODENIACEAE	<i>Goodenia hederacea</i> subsp. <i>hederacea</i>	Ivy-leaf Goodenia	
LAMIACEAE	<i>Mentha satureioides</i>	Creeping Mint	
LAMIACEAE	<i>Plectranthus parviflorus</i>	Cockspur Flower	
LAMIACEAE	<i>Stachys arvensis</i>	Stagger Weed	i
LAMIACEAE	<i>Westringia fruticosa</i>	Coast Rosemary	n
LINACEAE	<i>Linum marginale</i>	Native Flax	
LINACEAE	<i>Linum trigynum</i>	French Flax	i
LORANTHACEAE	<i>Amyema pendulum</i> subsp. <i>pendulum</i>	Pendulous Mistletoe	

<b>FAMILY</b>	<b>Scientific Name</b>	<b>Common Name</b>	
LYTHRACEAE	<i>Lagerstroemia indica</i>	Crepe Myrtle	i
MALVACEAE	<i>Modiola caroliniana</i>	Red-flowered Mallow	i
MALVACEAE	<i>Pavonia hastata</i>	Pavonia	i
MALVACEAE	<i>Sida rhombifolia</i>	Paddys Lucerene	i
MORACEAE	<i>Ficus macrophylla</i>	Moreton Bay Fig	
MYOPORACEAE	<i>Eremophila debilis</i>	Winter Apple	
MYOPORACEAE	<i>Myoporum acuminatum</i>	Boobialla	
MYRSINACEAE	<i>Anagallis arvensis</i>	Scarlet Pimpernell	i
MYRTACEAE	<i>Callistemon citrinus</i>	Crimson Bottlebrush	n
MYRTACEAE	<i>Callistemon viminalis</i>	Weeping Bottlebrush	n
MYRTACEAE	<i>Eucalyptus bosistoana</i>	Coast Grey Box	
MYRTACEAE	<i>Eucalyptus crebra</i>	Narrow-leaf Ironbark	
MYRTACEAE	<i>Eucalyptus moluccana</i>	Grey Box	
MYRTACEAE	<i>Eucalyptus sideroxylon</i>	Mugga Ironbark	n
MYRTACEAE	<i>Eucalyptus tereticornis</i>	Forest Red Gum	
MYRTACEAE	<i>Kunzea ambigua</i>	Tick Bush	
MYRTACEAE	<i>Melaleuca linariifolia</i>	Snow-in-Summer	
OLEACEAE	<i>Ligustrum lucidum</i>	Large-leaf Privet	ix
OLEACEAE	<i>Ligustrum sinense</i>	Small-leaf Privet	ix
OLEACEAE	<i>Olea europaea</i> subsp. <i>africana</i>	African Olive	ix
OXALIDACEAE	<i>Oxalis exilis</i>	Yellow Oxalis	
PHYLLANTHACEAE	<i>Phyllanthus virgatus</i>	Small-leaf Spurge	
PITTOSPORACEAE	<i>Bursaria spinosa</i>	Blackthorn	
PLANTAGINACEAE	<i>Plantago lanceolata</i>	Plantain	i
PROTEACEAE	<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	t
PROTEACEAE	<i>Grevillea robusta</i>	Silky Oak	n
PROTEACEAE	<i>Grevillea rosmarinifolia</i> subsp. <i>rosmarinifolia</i>	Rosemary Grevillea	n
RUBIACEAE	<i>Opercularia diphylla</i>	Stinkweed	
SANTALACEAE	<i>Exocarpos cupressiformis</i>	Cherry Ballart	
SAPINDACEAE	<i>Dodonaea viscosa</i> subsp. <i>cuneata</i>	Wedge-leaf Hop-bush	
PLANTAGINACEAE	<i>Veronica arvensis</i>	Wall Speedwell	i
SOLANACEAE	<i>Lycium ferocissimum</i>	African Boxthorn	ix
SOLANACEAE	<i>Solanum nigrum</i>	Black Nightshade	i
SOLANACEAE	<i>Solanum pseudocapsicum</i>	Jerusalem Cherry	i
SOLANACEAE	<i>Solanum sisymbriifolium</i>		i
STACKHOUSIACEAE	<i>Stackhousia viminea</i>	Slender Stackhousia	
VERBENACEAE	<i>Lantana camara</i>	Lantana	ix
VERBENACEAE	<i>Verbena bonariensis</i>	Purple Top	i
VERBENACEAE	<i>Verbena rigidus</i>	Creeping Verbena	i
<b>Flowering Plants - Monocotyledons</b>			
ANTHERICACEAE	<i>Arthropodium milleflorum</i>	Vanilla Lily	



<b>FAMILY</b>	<b>Scientific Name</b>	<b>Common Name</b>	
ASPARAGACEAE	<i>Asparagus aethiopicus</i>	Asparagus Fern	ix
ASPARAGACEAE	<i>Asparagus asparagoides</i>	Bridal Creeper	ix
JUNCACEAE	<i>Juncus acutus</i>	Spiny Rush	i
JUNCACEAE	<i>Juncus usitatus</i>	Common Rush	
LOMANDRACEAE	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	Wattle Mat-rush	
PHORMIACEAE	<i>Dianella longifolia</i> var. <i>longifolia</i>	Long-leaf Flax Lily	
POACEAE	<i>Aristida ramosa</i>	Three-awned Spear Grass	
POACEAE	<i>Aristida vagans</i>	Three-awned Spear Grass	
POACEAE	<i>Austrostipa rudis</i>	Spear Grass	
POACEAE	<i>Avena fatua</i>	Common Oat	i
POACEAE	<i>Bothriochloa macra</i>	Red-leg Grass	
POACEAE	<i>Briza subaristata</i>		i
POACEAE	<i>Chloris gayana</i>	Rhodes Grass	i
POACEAE	<i>Cymbopogon refractus</i>	Barbed Wire Grass	
POACEAE	<i>Cynodon dactylon</i>	Common Couch	n
POACEAE	<i>Dichelachne micrantha</i>	Short-hair Plume Grass	
POACEAE	<i>Echinopogon ovatus</i>	Hedgehog Grass	
POACEAE	<i>Ehrharta erecta</i>	Panic Veldtgrass	i
POACEAE	<i>Enteropogon acicularis</i>		
POACEAE	<i>Eragrostis curvula</i>	African Lovegrass	i
POACEAE	<i>Eragrostis leptostachya</i>	Paddock Lovegrass	
POACEAE	<i>Melinis repens</i>	Red Natal Grass	i
POACEAE	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass	
POACEAE	<i>Panicum effusum</i>	Hairy Panic	
POACEAE	<i>Paspalidium distans</i>	Paspalidium	
POACEAE	<i>Paspalum dilatatum</i>	Paspalum	i
POACEAE	<i>Pennisetum clandestinum</i>	Kikuyu	i
POACEAE	<i>Phalaris aquatica</i>	Canary Grass	i
POACEAE	<i>Rytidosperma pilosum</i>	Smooth-flower Wallaby Grass	
POACEAE	<i>Rytidosperma tenuius</i>	Wallaby Grass	
POACEAE	<i>Setaria gracilis</i>	Slender Pigeon Grass	i
POACEAE	<i>Sporobolus elongatus</i>	Slender Rats Tail Grass	
POACEAE	<i>Themeda australis</i>	Kangaroo Grass	
TYPHACEAE	<i>Typha orientalis</i>	Broad-leaf Cumbungi	

## Appendix C Fauna species

### NOTES ON SYMBOLS USED IN THE TABLE

V = Vulnerable species  
M = Migratory species listed in the EPBC Act  
P = Protected species  
U = Introduced species

Family / Scientific name	Common name	Status
<b>BIRDS</b>		
<b>Columbidae</b>		
<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	U
<b>Psittacidae</b>		
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	P
<i>Platycercus adscitus eximius</i>	Eastern Rosella	P
<b>Maluridae</b>		
<i>Malurus cyaneus</i>	Superb Fairy-wren	P
<b>Meliphagidae</b>		
<i>Manorina melanocephala</i>	Noisy Miner	P
<b>Artamidae</b>		
<i>Strepera graculina</i>	Pied Currawong	P
<i>Cracticus tibicen</i>	Australian Magpie	P
<b>Corvidae</b>		
<i>Corvus coronoides</i>	Australian Raven	P
<b>Sturnidae</b>		
<i>Acridotheres tristis</i>	Common Myna	U
<b>Estrildidae</b>		
<i>Neochmia temporalis</i>	Red-browed Finch	P
<b>Canidae</b>		
<b>MAMMALS</b>		
<i>Vulpes vulpes</i>	Red Fox	U
<b>REPTILES</b>		
<b>Elapidae</b>		
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	P
<b>Scincidae</b>		
<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink	P
<i>Lampropholis guichenoti</i>	Pale-flecked Garden Sunskink	P
<i>Tiliqua scincoides</i>	Eastern Blue-tongue	P

## Appendix D Assessments of significance

Significance assessments have been conducted for species, populations and communities that were identified as having a moderate or high potential to occur in the study area. These species are listed in **Table 6-1** for states listed species, **Table 6-2** for federal listed species and **Table 6-3** for federally listed migratory species.

Significance assessments have been divided into:

- State listed species (under the *Threatened Species Conservation Act 1995* or the *Fisheries Management Act 1994*) (refer to Appendix D.1).
- Commonwealth listed species (under the *Environmental Protection and Biodiversity Assessment Act 1999*) (refer to Appendix D.2).

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

For threatened biodiversity listed under the *Environment Protection and Biodiversity Conservation Act 1999* significance assessments have been completed in accordance with the Matters of National Environmental Significance Significant Impact Guidelines 1.1 (Department of the Environment, Water, Heritage and the Arts 2009).

Species with similar taxonomy or ecological requirements have been assessed together, for example wetland birds, tree-roosting microchiropteran bats and cave-roosting microchiropteran bats.

### ***Environmental Planning & Assessment Act, 1979***

#### **Threatened ecological communities**

##### **Cumberland Plain Woodland**

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

N/A

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

N/A

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

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

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

The proposal would directly impact around 0.62 hectares of Cumberland Plain Woodland comprising a high condition patch (0.08 hectares), a moderate condition patch (0.08 hectares), areas of isolated remnant trees (0.32 hectares) and planted vegetation with affinities to the community (0.14 hectares). An additional 0.07 hectares of intact Cumberland Plain Woodland within five metres of the construction footprint has been identified as potentially being indirectly impacted from the proposal from edge effects such as weed invasion from altered physical attributes. The potential impact represents a small proportion of the overall distribution within around 1,616 hectares of the community with greater than 10 per cent canopy cover mapped within a 10 kilometre radius of the proposal by NPWS (2002). The proposed direct and indirect impact to this community represents around 0.007 per cent of the local distribution and is unlikely to result in the local occurrence being placed at risk of extinction. The remaining areas of Cumberland Plain Woodland greater than 10 metres from the proposal are considered unlikely to be substantially modified from indirect impacts such as edge effects and altered hydrology.

The extent of Cumberland Plain Woodland in and surrounding Timbertop Reserve has been reduced by a recently established residential development from around seven hectares to around five hectares.

The results of the biodiversity field survey identified areas of high condition remnant in the location of the proposed widening of the two way link road between Prospect Highway and the Great Western Highway. This high condition remnant woodland extends over an area of land zoned for protection within Timbertop Reserve and a recently established residential subdivision which has reduced the remnant woodland by around a third. Roads and Maritime subsequently sought to avoid and minimise further impact on this remnant woodland as much as possible. The original design has been refined to include a preferred option that reduces the direct and indirect impact at the site by 56 per cent from 0.27 hectares to 0.12 hectares. The proposed design restricts the proposed clearing and indirect impacts to a narrow strip of vegetation around 25 metres by 100 metres in area between the residential subdivision and road reserve. The proposed design avoids the remaining remnant woodland in Timbertop Reserve. This strip of vegetation is indirectly impacted by the adjoining subdivision.

The other intact patch on the southern side of the Great Western Highway is in moderate condition and currently isolated and small in size (0.4 hectares) with a modified or degraded understorey. The upgrade is not expected to substantially modify the composition of the remaining small areas of the listed ecological community.

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

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

A total of 0.62 hectares of Cumberland Plain Woodland would be directly impacted by the proposal, and there is a high potential for an additional 0.07 hectares to be indirectly impacted from edge effects including weed invasion, altered light levels and hydrology regimes. This impact constitutes around 0.05% of the better quality examples (ie greater than 10 per cent canopy) of this community in the locality (10 kilometre radius).

The community is currently highly fragmented in the study area, comprising two intact relatively small patches of isolated remnant trees and planted vegetation. The largest patch (Timbertop Reserve) is around five hectares, where the proposal would remove around 0.08 hectares from the edge of this patch and indirectly impact an additional 0.04 hectares, impacts would be restricted to a narrow linear strip adjacent to the recently established residential subdivision. The reserve in its current condition is considered important for survival of Cumberland Plain Woodland in the locality, and although the residential subdivision has removed around 2.4 hectares this patch is still considered to be viable. The proposed two way link road between Prospect Highway and the Great Western Highway was specifically designed to avoid the council reserve and restrict clearing to the edge of the subdivision and therefore the extent of habitat removal is considered minor and not important for the survival of the community within the reserve or the locality.

Indirect impacts in high condition vegetation would be limited to a strip of vegetation (25 metres by 100 metres) between the recently established residential subdivision and the Great Western Highway which is unlikely to be viable in the long term due to ongoing edge effects and weed invasion.

The other intact patch on the southern side of the Great Western Highway and adjacent to the western side of the Prospect Highway would be reduced by around 23 per cent of its current area (including direct and indirect impacts). Considering the small and isolated nature of this remnant and degraded condition it is not considered highly important for the long-term survival of the Cumberland Plain Woodland in the locality.

Considering the highly fragmented nature of the remaining areas of Cumberland Plain Woodland, the proposal would not result in further fragmentation or isolation of areas of habitat as a result of the proposed action. The larger higher condition patch of vegetation within and adjacent to Timbertop Reserve would not be substantially fragmented by the proposal and the current viability of the patch is expected to be retained.

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

Critical habitat has not been declared for this community.

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

A recovery plan was approved for the Cumberland Plain in January 2011 (DECCW, 2010). It is a multi-entity recovery plan which covers seven threatened species, four endangered populations and nine endangered ecological communities that reside on the Plain. The plan identifies 17 priority conservation lands (PCLs) which best represent cost-effective biodiversity protection on the Plain. The nearest PCL

identified in the plan is to the south of the study area, which comprises patches surrounding Prospect Reservoir. The proposal footprint does not fall into a PCL and the proposed action is not inconsistent with the objectives or actions of the recovery plan.

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

Key threatening processes that are relevant to this community are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Unlikely	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Cumberland Plain Woodland

Considering the small proportion of Cumberland Plain Woodland being impacted by the proposal relative to the local distribution and the substantial modification of the majority of the these habitats in the construction footprint, the proposal is unlikely to result in a significant impact to Cumberland Plain Woodland.

## Threatened Flora

### Spiked Rice-flower (*Pimelea spicata*)

(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.*

Surveys were undertaken during the flowering period for this cryptic species (November 2013) however no individuals were recorded. There is potential for it to be present in the intact areas of habitat in the study area including the remnant in and surrounding Timbertop Reserve and a smaller patch on the southern side of the Great Western Highway and adjacent to the western side of the Prospect Highway. Impacts to potential habitat for this species are limited to direct impacts to around 0.16 hectares and indirect impacts to an additional 0.07 hectares.

Targeted surveys for Spiked Rice-flower would be undertaken during pre-clearance surveys prior to construction in moderate and high condition areas of Map Unit 1. There is some potential for the proposal 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 if found to be present. Further assessment and mitigation may be required if the species is found to be present in or adjacent to the construction footprint.

Very little is known of what constitutes a viable population of the species, and therefore all known populations are considered viable. A population is known to be present in Prospect Nature Reserve with records of the species around 900 metres to the south of Timbertop Reserve. Spiked Rice-flower has restricted pollination and seed dispersal mechanisms.

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

N/A

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

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

N/A

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

- *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and*

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

Impacts to potential habitat for this species are limited to direct and indirect impacts to around 0.23 hectares. There is potential for this area of habitat to be important for long-term survival of the species if it is found to be present in the construction footprint, as all populations are considered to be viable.

Considering impacts to potential habitat for this species is limited to edges of existing patches, it is unlikely the proposal would result in a population of *Pimelea spicata* being fragmented by the proposal.

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

No areas of critical habitat have been gazetted for Spiked Rice-flower.

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

A recovery plan was approved for the Cumberland Plain in January 2011 (DECCW, 2010). It is a multi-entity recovery plan which covers seven threatened species, four endangered populations and nine endangered ecological communities that reside on the Plain. The plan identifies 17 priority conservation lands (PCLs) which best represent cost-effective biodiversity protection on the Plain. The nearest PCL identified in the plan is to the south of the study area, which comprises patches surrounding Prospect Reservoir. The proposal footprint does not fall into a PCL and the proposed action is not inconsistent with the objectives or actions of the recovery plan.

There is also a national and NSW recovery plan for *Pimelea spicata* (DEC 2005). The recovery actions of this plan include protection of existing populations, survey and monitoring of existing populations and potentially occurring populations, research of the life cycle attributes of the species, potential impacts and threats and habitat mapping. The proposal will aim to be consistent with these objectives if the species is found to be present.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	



Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Spiked Rice-flower

There is potential for the proposal to have a significant impact on a population of Spiked Rice-flower if present in the habitats within or adjacent to the construction footprint. Considering the small proportion of potential habitat being impacted by the proposal and the substantially modified nature of these habitats, and targeted searches having been undertaken, a large population is considered unlikely to be present.

### Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*)

(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 field surveys resulted in the identification of one individual Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*). The individual was recorded in highly modified habitat of Cumberland Plain Woodland on the eastern side of Prospect Highway adjacent to the walkway underpass leading to Old Church Lane outside of the proposed construction footprint. There would be no direct or indirect impacts to this single individual. Considering the non-cryptic nature of the species it is considered to have a low potential to be present in the construction footprint.

Habitat for this species will be impacted comprising direct impacts to around 0.48 hectares of Cumberland Plain Woodland in various states of condition as well as areas of planted Cumberland Plain Woodland comprising 0.14 hectares. Targeted surveys have been carried out for this species in the study area and it is considered unlikely to be directly impacted. Impacts to potential habitat would be limited to 0.62 hectares of which around 0.46 hectares is considered to be in low condition.

Considering the low potential for direct and indirect impacts to the species and the small area of potential habitat being removed the action proposed is unlikely 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.*

N/A

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

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

N/A

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

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

Impacts to potential habitat for this species are limited to direct and indirect impacts to around 0.69 hectares including planted and low condition habitats where the species could potentially occur. There is potential for this area of habitat to be important for the long-term survival of the species if it is found to be present in the construction footprint, as all populations are considered to be viable.

Considering impacts to potential habitat for this species is limited to the edges of existing patches, it is unlikely the proposal would result in a population of Juniper-leaved Grevillea being fragmented by the proposal.

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

No areas of critical habitat have been gazetted for Juniper-leaved Grevillea.

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

A recovery plan was approved for the Cumberland Plain in January 2011 (DECCW, 2010). It is a multi-entity recovery plan which covers seven threatened species, four endangered populations and nine endangered ecological communities that reside on the Plain. The plan identifies 17 priority conservation lands (PCLs) which best

represent cost-effective biodiversity protection on the Plain. The nearest PCL identified in the plan is to the south of the study area, which comprises patches surrounding Prospect Reservoir. The proposal footprint does not fall into a PCL and the proposed action is not inconsistent with the objectives or actions of the recovery plan.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Juniper-leaved Grevillea

It is unlikely the proposal would have a significant impact on a population of Juniper-leaved Grevillea or potential habitats within or adjacent to the construction footprint. Considering the small proportion of potential habitat being impacted by the proposal and the substantially modified nature of these habitats, and targeted searches having been undertaken, a large population is considered unlikely to be present.

## Threatened Fauna

### Cumberland Plain Land Snail (*Meridolum corneovirens*)

(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.*

Very little of the biology and ecology of the Cumberland Plain Land Snail is understood (NPWS 2000b). The species is a fungus specialist that primarily occupies Cumberland Plain Woodland in western Sydney, living under bark, leaf litter, leaves and logs, and occasionally rubbish items (DECC 2009a). The Cumberland Plain Land Snail is a hermaphrodite and lays clutches of between 20 and 25 eggs in moist, dark areas such as under logs which take between two and three weeks to hatch (NPWS 2000b). No further details regarding its biology are known.

Potential habitat for the species in the study area comprises areas of woody debris and leaf litter within intact areas of Cumberland Plain Woodland. Where possible woody debris, leaf litter and other habitat features for the species would be relocated. Pre-clearing inspections would identify the presence of any individuals and these would be relocated to adjacent areas of suitable habitat outside of the construction footprint.

Impacts to Cumberland Plain Land Snail habitat would be limited to around 0.12 hectares of Cumberland Plain Woodland adjacent to Timbertop Reserve. Habitats on the southern side of the Great Western Highway were considered to be too modified and isolated for the species and therefore this area is not assessed as potential habitat. Woody debris and leaf litter are present in low abundance in areas of potential habitat for Cumberland Plain Land Snail adjacent to Timbertop Reserve with no substantial areas of microhabitat attributes present.

In view of the relatively small area of habitat being impacted which provides limited habitat value and the proposed mitigation measures to relocate habitats (ie woody debris and leaf litter) and individuals, where present, the proposal is considered unlikely to have an adverse effect on the life cycle of the species. Therefore, a viable local population of the species is unlikely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

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

Impacts to Cumberland Plain Land Snail habitat would be limited to around 0.12 hectares of Cumberland Plain Woodland adjacent to Timbertop Reserve. These habitats have been modified from edge effects and are unlikely to be optimal for the species with a general lack of suitable microhabitat features.

Habitats on the southern side of the Great Western Highway were considered to be too modified and isolated for the species. These were considered not to provide potential habitat for the species. Woody debris and leaf litter are present in low abundance in this area of habitat with no substantial areas of microhabitat attributes present. These areas of habitat impacted by the proposal are not considered to be important for the long-term survival of the species.

Cumberland Plain Land Snail has been previously recorded in Timbertop Reserve (OEH 2013). The remaining areas of habitat in Timbertop Reserve would continue to provide habitat for the species.

Considering the highly fragmented nature of the remaining areas of Cumberland Plain Woodland in the study area, the proposal would not result in further fragmentation or isolation of areas of habitat as a result of the proposal.

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

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

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

A recovery plan was approved for the Cumberland Plain in January 2011 (DECCW, 2010). It is a multi-entity recovery plan which covers seven threatened species, four endangered populations and nine endangered ecological communities that reside on the Plain. The plan identifies 17 priority conservation lands (PCLs) which best represent cost-effective biodiversity protection on the Plain. The nearest PCL identified in the plan is to the south of the study area, which comprises patches surrounding Prospect Reservoir. The proposal footprint does not fall into a PCL and the proposal is not inconsistent with the objectives or actions of the recovery plan.

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

Key threatening processes that are relevant to this species are listed below, including reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Cumberland Plain Land Snail

In view of the small area of suitable habitat for Cumberland Plain Land Snail impacted by the proposal relative to the local distribution including areas of retained habitat in Timbertop Reserve, and proposed mitigation measures the proposal is unlikely to result in a significant impact.

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

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

There have been no roost camps identified in the proposal footprint to date and the proposal's construction would not directly impact on any known breeding / maternity site.

Therefore it is likely that the impacts of construction and operation of the proposal would be confined to loss of feeding habitat caused by 1) direct clearing or damage to native vegetation during the construction phase and 2) edge effects during operation related to degradation of foraging habitat.

The proposal would directly remove up to 1.09 hectares of foraging habitat, which

comprises remnant and planted grassy woodland and mixed plantings including Eucalypt species, however vegetation would be avoided where possible. Foraging habitat mainly comprises nectar resources from planted native trees and shrubs as well as fruit resources from planted fig trees and some exotic trees. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the proposal footprint. Given the relative widespread nature of similar planted vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of regional populations such as swamp forest in coastal areas and habitats in Prospect Nature Reserve, the proposal is not expected to significantly affect the life cycle of the species.

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

N/A

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

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

N/A

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

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

The proposal would directly remove up to 1.09 hectares of foraging habitat however vegetation would be avoided where possible. Foraging habitat mainly comprises nectar resources from planted native trees and shrubs and some exotic trees. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the proposal boundary. Given the relative widespread nature of similar planted vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of regional populations, the proposal is not expected to significantly affect the life cycle of the species.

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

The main disturbance regimes affecting habitats in the study area are weed invasion, fragmentation and edge effects and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes such as weed management, avoidance of tree removal during construction, water quality controls and landscaping with native species.

There is currently a high degree of habitat fragmentation across the study area. These highly mobile species are adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the road.

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

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

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

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

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

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

Key threatening processes that are relevant to this species are listed below. These include reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora</i> )	EPBC Act,	Potential	Section 5.2



Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<i>cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	TSC Act		
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Grey-headed Flying-fox

Considering the small proportion of foraging habitat for Grey-headed Flying-fox being impacted by the proposal relative to the local distribution and the absence of any roost camps, the proposal is unlikely to result in a significant impact to Grey-headed Flying-fox.

### Little Lorikeet (*Glossopsitta pusilla*)

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

Little lorikeets are known to occupy a diversity of forest and woodland habitats, including old-growth and logged forests, and remnant woodland patches and roadside vegetation (Pizzey & Knight 1997, DECC 2008). The species is generally considered to be nomadic, with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability (DECC 2008). However, they do exhibit some site fidelity, with breeding pairs resident from April to December, and even during their non-resident period some individuals will return to the nest area for short periods if there is some tree-flowering in the vicinity.

They feed in small flocks, often with other species of lorikeet, primarily on nectar and pollen in the tree canopy. They prefer profusely flowering eucalypts but will also feed in other species such as melaleucas and mistletoes. The species breeds in tree hollows in living trees, during May to September, raising clutches of three to five eggs (DECC 2008). They likely commence breeding at one year, and live for around 10 years in the wild.

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

The study area would constitute non-breeding habitat for the species as no trees supporting suitably-sized hollows would be impacted. The loss of feed trees would directly affect the species opportunity to feed and breed in the area, however, the study area is not considered a critical area for the Little Lorikeet as extensive areas of suitable habitat occur elsewhere in the region such as Prospect Nature Reserve.

The current potential for the species to occur based on the presence of potential foraging habitat is expected to remain following construction of the proposal such that foraging, movement and other life-cycle attributes would not be impacted.

The proposal would remove up to 1.09 hectares of potential foraging habitat including a mix of nectar-producing native shrubs and trees. The large majority of this potentially impacted foraging habitat comprises planted vegetation and potential impacts would be avoided where possible during construction.

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

N/A

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

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

N/A

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

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

The distribution of the little lorikeet extends from just north of Cairns, around the east of Australia, to Adelaide (DECC 2008). In NSW the species is distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range. Hence, the study area is not at the limit of the species known distribution.

The main disturbance regimes affecting habitats in the study area are weed invasion, fragmentation and edge effects and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes such as weed management, avoidance of tree removal during construction, water quality controls and landscaping with native species.

Potential impacts to habitat condition associated with altering disturbance regimes within the road corridor (eg roadside maintenance) is considered minor due to the species ability to move widely throughout the landscape and access disturbed and fragmented habitats.

There is currently a high degree of habitat fragmentation across the study area. These highly mobile species are adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly

impacted by the barrier effect of the road.

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

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

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

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

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

Threats to the survival of the species include:

- The depletion of food resources as a result of clearing of woodlands for agriculture, thus reducing survival and reproduction. Small scale clearing, such as during roadworks and fence construction, continues to destroy habitat and it would be decades before revegetated areas supply adequate forage sites.
- The loss of old hollow bearing trees has reduced nest sites, and increased competition with other native and exotic species that need large hollows with small entrances to avoid predation. Felling of hollow trees for firewood collection or other human demands increases this competition. Hollow trees potentially impacted by the proposal are considered unsuitable for Little Lorikeet due to the small and possibly shallow nature of the hollows in these trees.

Key threatening processes that are relevant to this species are listed below. These include reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Little Lorikeet

Considering the small proportion of foraging habitat for Little Lorikeet being impacted by the proposal relative to the local distribution and the absence of any suitable breeding habitat, the proposal is unlikely to result in a significant impact to Little Lorikeet.

### Powerful Owl (*Ninox strenua*)

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

Powerful Owls occupy a range of vegetation types including woodland, forests and rainforests and have large home ranges including fragmented landscapes such as those in the locality. Major threats to Powerful Owl are loss of breeding sites and food resources from ongoing land clearing.

The habitats in the study area would constitute non-breeding habitat for the species as no trees supporting suitably-sized hollows for nesting would be impacted. The loss of habitat for prey species (arboreal mammals) will be minimal and prey numbers are unlikely to be substantially reduced. There are no areas of suitable roosting habitat present in the study area, such as gully areas with dense vegetation.

The proposal would remove up to 1.09 hectares of potential foraging habitat including areas of remnant (0.48 hectares) and planted vegetation (0.61 hectares). The large majority of this potentially impacted foraging habitat comprises planted vegetation and isolated remnant trees and potential impacts would be avoided where possible during construction.

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

N/A

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

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

N/A

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

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

The proposal would remove up to 1.09 hectares of potential foraging habitat including areas of remnant (0.48 hectares) and planted vegetation (0.61 hectares). The large majority of this potentially impacted foraging habitat comprises planted vegetation and isolated remnant trees and potential impacts would be avoided where possible during construction.

The habitats in the study area would constitute non-breeding habitat for the species as no trees supporting suitably-sized hollows for nesting would be impacted. The loss of habitat for prey species (arboreal mammals) will be minimal and prey numbers are unlikely to be substantially reduced. There are no areas of suitable roosting habitat present in the study area, such as gully areas with dense vegetation.

There is currently a high degree of habitat fragmentation across the study area. These highly mobile species are adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the road.

The main disturbance regimes affecting habitats in the study area are weed invasion, fragmentation and edge effects and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes such as weed management, avoidance of tree removal during construction, water quality controls and landscaping with native species.

Potential impacts to habitat condition associated with altering disturbance regimes within the road corridor (eg roadside maintenance) is considered minor due to the species ability to move widely throughout the landscape and access disturbed and fragmented habitats.

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

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

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

There is a recovery plan for Large Forest Owls. Considering the low potential impact to habitat for this species and the minimisation of habitat removal, the proposal is consistent with the objectives of the recovery plan.

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

Threats to the survival of the species include:

- The depletion of food resources (prey) as a result of clearing of woodlands and forest habitat thus reducing survival and reproduction. Small scale clearing, such as during roadworks and fence construction, continues to destroy habitat and it would be decades before revegetated areas supply adequate habitat for prey species.
- The loss of old hollow bearing trees has reduced nest sites. Felling of hollow trees for firewood collection or other human demands increases this competition. Hollow trees potentially impacted by the proposal are considered unsuitable for Powerful Owl.

Key threatening processes that are relevant to this species are listed below. These include reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	potential	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Unlikely	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Powerful Owl

Considering the small proportion of foraging habitat for Powerful Owl being impacted by the proposal relative to the local distribution and the absence of any suitable breeding habitat, the proposal is unlikely to result in a significant impact to Powerful Owl.

### Woodland Birds

Species	Status – TSC Act
Black-chinned Honeyeater ( <i>Melithreptus g. gularis</i> )	V
Speckled Warbler ( <i>Pytholaemus sagittatus</i> )	V
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	V

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

### Black-chinned Honeyeater (*Melithreptus g. gularis*)

The Black-chinned Honeyeater has two subspecies, with only the nominate (*gularis*) occurring in NSW. The other subspecies (*laetior*) was formerly considered a separate species (Golden-backed Honeyeater) and is found in northern Australia between central Queensland west to the Pilbara in Western Australia. The eastern subspecies extends south from central Queensland, through NSW, Victoria into south eastern South Australia, though it is very rare in the last state. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions, though it is very rare in the latter (OEH 2014).

Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts (OEH 2014). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees. A gregarious species usually seen in pairs and small groups of up to 12 birds. Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least five hectares. Nectar is taken from flowers, and honeydew is gleaned from foliage. The nest is placed high in the crown of a tree, in the uppermost lateral branches, hidden by foliage. It is a compact, suspended, cup-shaped nest. Two or three eggs are laid and both parents and occasionally helpers feed the young (OEH 2014).

### **Speckled Warbler (*Pytholaemus sagittatus*)**

The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies (OEH 2014). Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area (OEH 2014).

The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter (OEH 2014).

### **Varied Sittella (*Daphoenositta chrysoptera*)**

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (OEH 2014).

Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland (OEH 2014). Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (OEH 2014). Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (OEH 2014). Generation length is estimated to be 5 years.

Varied Sittellas occupy a range of vegetation types including woodland, forests and rainforests and have large home ranges including fragmented landscapes such as those in the locality. Major threats to Varied Sittella are loss of breeding sites and food resources from ongoing land clearing.

The habitats in the study area would constitute non-breeding habitat for the species as no trees supporting suitably-sized hollows for nesting would be impacted. The loss of habitat for prey species (arboreal mammals) will be minimal and prey numbers are unlikely to be substantially reduced. There are no areas of suitable roosting habitat present in the study area, such as gully areas with dense vegetation.

The proposal would remove up to 1.09 hectares of potential foraging habitat including areas of remnant (0.48 hectares) and planted vegetation (0.61 hectares). The large majority of this potentially impacted foraging habitat comprises planted vegetation and isolated remnant trees and potential impacts would be avoided where possible during construction.

The remnant woodland habitats on the site provide suitable habitat for these species however planted vegetation provides only sub-optimal habitat for woodland birds particularly by nature of the younger growth stage and relative dense low canopy and mid and ground-cover vegetation structure. The proposal will remove around 1.15 hectares of habitat for these species comprising around 0.48 hectares of remnant vegetation including isolated trees, and around 0.67 hectares of planted vegetation.

The preferred habitat for these species often includes habitat patches greater than 100 hectares in order to maintain variable populations, so if present, the core habitat



for these species would occur in surrounding areas such as Prospect Nature Reserve to the south. In general, important habitat resources necessary for the life cycle of these three species are unlikely to be significantly affected by the proposal, and is therefore unlikely to place a viable local population at risk of extinction.

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

N/A

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

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

N/A

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

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

The remnant woodland habitats on the site provide suitable habitat for these species however planted vegetation provides only sub-optimal habitat for woodland birds particularly by nature of the younger growth stage and relative dense low canopy and mid and ground-cover vegetation structure. The proposal will remove around 1.15 hectares of habitat for these species comprising approximately 0.48 hectares of remnant vegetation including isolated trees, and around 0.67 hectares of planted vegetation.

The main disturbance regimes affecting habitats in the study area are weed invasion, fragmentation and edge effects and maintenance regimes such as slashing and pruning. Mitigation measures would be implemented to limit the exacerbation of these current disturbance regimes such as weed management, avoidance of tree removal during construction, water quality controls and landscaping with native species. Potential impacts to habitat condition associated with altering disturbance regimes within the road corridor (eg roadside maintenance) is considered minor due to the species ability to move widely throughout the landscape and access disturbed and fragmented habitats.

There is currently a high degree of habitat fragmentation across the study area. These highly mobile species are adapted to moving across forest clearings such as

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

The preferred habitat for these species often includes habitat patches greater than 100 hectares in order to maintain variable populations, so if present, the core habitat for these species would occur in surrounding areas such as Prospect Nature Reserve to the south. In general, important habitat resources necessary for the life cycle of these three species are unlikely to be significantly affected by the proposal.

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

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

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

There are no recovery plans for these species. There are priority action statements for each of these species related to scientific research, community awareness and protection of these species. Considering the low potential impact to habitat for these species and the proposed mitigation measures to minimise habitat removal and improve connectivity, the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to these species are listed below. These include reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to this community that are directly enacted by the proposal are those associated with clearance and degradation of listed vegetation.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Unlikely	
Removal of dead wood and dead trees	TSC Act	Potential	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Woodland Birds

Considering the small proportion of foraging habitat for Woodland Birds being impacted by the proposal relative to the local distribution and the absence of any suitable breeding habitat, the proposal is unlikely to result in a significant impact to Woodland bird species.

### Tree-roosting microbats

Species	Status – TSC Act
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )	✓
Eastern Freetail-bat ( <i>Mormopterus norfolkensis</i> )	✓
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )	✓
Yellow-bellied Sheath-tail-bat ( <i>Saccolaimus flaviventris</i> )	✓

(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.*

Vegetation in the study area provides potential foraging and roosting habitat for the assessed species. These bat species frequent a variety of habitat types including disturbed habitats, forests and woodlands. Important life-cycle activities include roosting and breeding. Roosting and breeding are typically associated with tree hollows as well as foraging for insect prey which occurs in a variety of habitat types. Breeding habitat for insect prey includes a very diverse range of wetlands, swamps and open modified and artificial landscapes.

The size of local populations is not known, although it is not expected to be large considering the highly urbanised and modified habitats in the locality and limited tree hollows. Potential foraging habitat in the study area is generally widespread including natural habitats such as remnant woodland, as well as planted vegetation and exotic dominated vegetation. Impacts to these habitats would impact on the potential breeding habitat for prey species (invertebrates), however, any potential overall reductions to the abundance of prey species is likely to be minimal, considering the widespread nature of these habitats in the locality.

The proposal would have some level of impact to up 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts and removal of vegetation where required, however, foraging attributes are unlikely to be substantially modified throughout much of this 1.42

hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area.

Potential impacts to the life-cycle activities of these bat species mainly relate to a disruption of breeding activities and shelter or dormancy activities and the removal of roosting habitats. This could lead to increased competition for hollows. Potential roost sites are limited in the study area to several small hollows and fissures, and decorticated bark observed in several trees in the study area. These potential roosting habitats are considered to have relatively limited habitat value, however, in a landscape of limited roosting resources may be utilised by these species on occasion.

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

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

N/A

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

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

N/A

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

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

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and removal of vegetation where required, however foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area.

Potential roost sites are limited in the study area to several small hollows and fissures, and decorticated bark observed in several trees in the study area. These potential roosting habitats are considered to have relatively limited habitat value, however, in a landscape of limited roosting, resources may be utilised by these

species on occasion. There is also some potential for these species to utilise other habitats for roosting in the study area.

The range of disturbance regimes that currently exists in the study area, and the evolutionary adaptation of species to these disturbances, has been influenced by the historical and current land-uses. For example, processes such as seasonal weed invasions, interruption to surface and groundwater flow, nutrient inputs into aquatic systems can result in the creation of habitat for insect prey species. This could create potential foraging habitat resources for microbat species. The proposal has potential to affect these current disturbance regimes, however, considering the existing high levels of human disturbance in the locality, the proposal is unlikely to substantially exacerbate these disturbance regimes.

Insectivorous bats are wide-ranging species adapted to moving across fragmented landscapes to find prey. Any impacts from a change of habitat condition associated with altering disturbance regimes in proximity to the proposal may be compensated by their ability to move widely throughout the landscape and access disturbed and fragmented habitats.

None of these tree roosting threatened bat species are at the limit of their distribution in the study area. Habitats are widespread throughout the region particularly further south and west of the study area in Prospect Nature Reserve.

There is currently a high degree of habitat fragmentation across the study area. These highly mobile species are adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the proposal.

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

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

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

There is no recovery plan for these species. There are 16-21 priority action statements for each of species related to scientific research, community awareness and protection of these species. There is a low potential impact to habitat for these species. Management measures include avoidance and mitigation measures to minimise habitat removal. These measures include appropriate design of the infrastructure to minimise ecological impacts, such as minimising the size of fill batters where appropriate, avoiding hollow tree removal where possible during construction, and the re-establishment of native vegetation. Therefore, the proposal is consistent with these priority actions.

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

Key threatening processes that are relevant to these species are listed below. These include reference to direct impacts and potential indirect impacts from key threatening processes and how each of these would be mitigated by the proposal. The main key threatening processes relevant to these species that are directly related to the proposal are those associated with clearance and degradation of

foraging and roosting habitat. Potential indirect impacts include the introduction or spread of pathogens and weeds which may alter habitat quality, and habitat degradation from feral herbivores. It is considered unlikely that the proposal would increase the likelihood of predation on this species by feral carnivores.

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	
<b>Climate Change</b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### Conclusion – Tree-roosting microbats

Considering the small proportion of habitat being impacted by the proposal relative to the local distribution and the substantial modification of the majority of these habitats in the construction footprint, the proposal is unlikely to result in a significant impact to any tree-roosting microbat species.

### Cave-roosting microbats

Species	Status – TSC Act
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	V
Eastern Bent-wing Bat ( <i>Miniopterus schreibersii oceanensis</i> )	V
Southern Myotis ( <i>Myotis macropus</i> )	V

*(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.*

Vegetation in the study area provides potential foraging habitat for the assessed species. Some potential roosting habitats are also present including cavities in the existing bridge structures of the M4 Western Motorway and Great Western Highway, culverts, buildings, and other structures.

These bat species frequent a variety of habitat types including, disturbed habitats, forests and woodlands. Important life-cycle activities include roosting and breeding and both are typically associated with caves, as well as foraging for insect prey which occurs in a variety of habitat types. Breeding habitat for insect prey includes a very diverse range of wetlands, swamps and open modified and artificial landscapes.

The size of local populations is not known, although it is not expected to be large as the area is highly urbanised and there are modified habitats in the locality. Potential foraging habitat in the study area is generally widespread, which include natural habitats such as woodland, as well as planted vegetation and exotic dominated vegetation. Impacts to these habitats would impact on the potential breeding habitat for prey species (invertebrates). However, any potential overall reductions to the abundance of prey species is likely to be minimal, considering the widespread nature of these habitats in the locality.

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and removal of vegetation where required, however foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area.

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

Mitigation measures would include avoiding disturbance of potential roosting habitats and pre-clearance surveys. A microbat management plan may be required if microbats are found roosting in any structures that would be disturbed during construction to avoid impacts. Considering the limited potential impact to preferred roosting habitats and the proposed mitigation measures the proposal is unlikely to result in a negative impact to the life cycle of these species.

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

N/A

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

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

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

N/A

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

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

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and the removal of vegetation where required, however foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area.

Potential roost sites include cavities in the existing viaduct and bridge structures of the M4 Western Motorway, culverts, buildings and other structures. Impacts to these potential roosting habitats are not expected and any potential impacts to these impacts from construction would be identified during the pre-clearance surveys.

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

Insectivorous bats are wide-ranging species adapted to moving across fragmented landscapes to find prey. Any impacts from a change of habitat condition associated with altering disturbance regimes in proximity to the proposal may be compensated by their ability to move widely throughout the landscape and access disturbed and fragmented habitats.

None of these threatened bat species are at the limit of their distribution in the study area. Habitats are widespread throughout the region particularly further south and west of the study area in Prospect Nature Reserve.

There is currently a high degree of habitat fragmentation across the study area. These highly mobile species are adapted to moving across forest clearings such as roads to access foraging and roosting habitat and are unlikely to be significantly impacted by the barrier effect of the road.

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

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



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

There is no recovery plan for these species. There are 15-25 priority action statements for each of these species related to scientific research, community awareness and protection of these species.

There is a low potential impact to habitat for these species. Management measures include avoidance and mitigation measures to minimise habitat removal. These measures include appropriate design of the infrastructure to avoid ecological impacts and the re-establishment of native vegetation and relocation of habitats. Therefore, the proposal is consistent with these priority actions.

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

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

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b>Habitat Degradation</b>			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5.2
Loss of hollow-bearing trees	TSC Act	Potential	
Removal of dead wood and dead trees	TSC Act	Yes	
<b>Feral Invertebrate Fauna</b>			
Competition from feral honey bees ( <i>Apis mellifera</i> )	TSC Act	Unlikely	
<b>Feral Vertebrate Fauna</b>			
Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> )	EPBC Act, TSC Act	Potential	Section 5.2
<b>Pathogens</b>			
Dieback caused by the root-rot fungus ( <i>Phytophthora cinnamomi</i> )/Infection of native plants by <i>Phytophthora cinnamomi</i>	EPBC Act, TSC Act	Potential	Section 5.2
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
<b>Weeds</b>			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5.2
Invasion and establishment of exotic vines and scramblers	TSC Act	Potential	
Invasion of native plant communities by African Olive ( <i>Olea europaea</i> L. subsp. <i>cuspidata</i> )	TSC Act	Potential	
Invasion, establishment and spread of <i>Lantana camara</i>	TSC Act	Potential	

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
<b><i>Climate Change</i></b>			
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	Potential	n/a
Anthropogenic climate change	TSC Act	Potential	n/a

### **Conclusion – Cave-roosting microbats**

Considering the small proportion of habitat being impacted by the proposal relative to the local distribution and the substantial modification of the majority of these habitats in the construction footprint, the proposal is unlikely to result in a significant impact to any cave-roosting microbat species.

## ***Environment Protection and Biodiversity Conservation Act, 1999***

### **Critically Endangered Ecological Community**

#### **Cumberland Plain Shale Woodlands**

##### *Reduce the area of occupancy of the community*

The high condition remnant of the critically endangered Cumberland Plain Woodland (Map Unit 1) listed under both the TSC Act and the EPBC Act is adjacent to the proposed widening of the two way link road between Prospect Highway and the Great Western Highway. This high condition remnant woodland extends over an area of land zoned for protection within Timbertop Reserve and recently established residential subdivision at Hampton Crescent which has reduced the remnant woodland from around seven hectares to five hectares. Roads and Maritime subsequently sought to avoid and minimise further impact on this remnant woodland as much as possible. The preferred option reduces the direct and indirect impact at the site by 56 per cent from 0.27 hectares to 0.12 hectares. It restricts the proposed clearing and indirect impacts to a narrow strip of vegetation around 25 metres by 100 metres in area between the residential subdivision and the road reserve while avoiding the remaining remnant in Timbertop Reserve. This strip of vegetation is indirectly impacted by the adjoining subdivision.

The proposal would directly impact around 0.08 hectares of Cumberland Plain Woodland, which comprises a high condition patch adjacent to Timbertop Reserve. There is also a high potential for indirect impacts to an additional 0.04 hectares of Cumberland Plain Woodland. This comprises a five metre buffer surrounding the proposal footprint. This is considered to be a very minor reduction to the extent of the woodland in this location which would be restricted to the narrow strip of vegetation that is between the recently established residential subdivision and the road reserve. The redesign in this location would avoid direct and indirect impacts to vegetation conserved in the council reserve.

The potential impact represents a small proportion of the overall distribution with around 1,616 hectares of the community with greater than 10 per cent canopy cover mapped within a 10 kilometre radius of the proposal by NPWS (2002), however some of these areas are likely to not conform to the condition criteria for the federally-listed community. The proposed direct and indirect impact to this community represents as small as 0.01 per cent of the local distribution, however considering the condition thresholds this proportion is likely to be higher.

##### *Fragment or increase fragmentation of an ecological community*

Impacts to this community from the proposal would be limited to the edge of a single patch adjoining a recently established residential subdivision at Hampton Crescent. The narrow clearing would occur between the existing road reserve and residential development and would not lead to fragmentation of vegetation. The area to be impacted is already fragmented.

Indirect impacts would be limited to a strip of vegetation between the recently established residential subdivision and the Great Western Highway which is unlikely to be viable in the long term due to ongoing edge effects and weed invasion.

##### *Adversely affect habitat critical to the survival of an ecological community*

The proposal would directly impact around 0.08 hectares of habitat and there is a high potential for an additional 0.04 hectares to be indirectly impacted.

The area to be impacted would be restricted to a narrow linear strip situated between the recently established residential subdivision and the road reserve, which is likely to be subject to ongoing edge effects such as weed invasion. The road design in this location has been specifically positioned to avoid the adjoining Council reserve.

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

It is considered unlikely for the proposal to substantially alter the habitat attributes of the surrounding remnant beyond five metres of the proposal footprint through indirect impacts such as altered hydrological and nutrient regimes and weed invasion. The existing abiotic conditions at this site are expected to already be substantially modified by the long isolation of the remnant and surrounding urban developments.

Hydrological regimes including groundwater levels and flooding regimes are unlikely to be substantially altered by the proposal. Intersection of the water table on elevated lands is considered unlikely. It is considered unlikely there would be any groundwater drawdown from the proposal with required cuttings being relatively minor. These are unlikely to intersect groundwater. Potential for contamination of groundwater if groundwater intersection occurs during construction would be low

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

There is potential for indirect impacts such as edge effects and further weed invasion. It is likely there would be indirect impacts to adjacent areas up to five metres from the proposal to areas of intact vegetation from edge effects. This could increase light availability which may result in altered understorey floristics. These indirect impacts could result in increases in weed abundance and altered species composition.

Roads and Maritime subsequently sought to avoid and minimise further impact on this remnant woodland as much as possible. The preferred option reduces the direct and indirect impact at the site by 56 per cent from 0.27 hectares to 0.12 hectares. It restricts the proposed clearing and indirect impacts to a narrow strip of vegetation around 25 metres by 100 metres in area between the residential subdivision and road reserve while avoiding the remaining remnant in Timbertop Reserve. This strip of vegetation is indirectly impacted by the adjoining subdivision.

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

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

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

The position of the impact is to be located in a narrow strip between the residential subdivision and road reserve on the edge of the patch. The strip would be impacted

by the road on one side and the subdivision and associated fire break on the other side. The residential subdivision has resulted in a substantial reduction in the quality and integrity of the vegetation in this narrow strip. For this reason, the widening of the road was deliberately designed to impact on this area and not adjoining areas of the Council reserve. The strip indirectly impacted by the proposal is unlikely to be viable in the long term as it is likely to be impacted by existing maintenance regimes and weed invasion. However, the proposal is likely to exacerbate the degradation of this area.

Future weed maintenance along the road reserve would avoid the use of chemical sprays near the council reserve. Other mitigation measures to minimise indirect impacts include weed management measures, management of urban runoff and minimising vegetation removal during construction.

*Interfere with the recovery of an ecological community.*

A recovery plan was approved for the Cumberland Plain in January 2011 (DECCW, 2010). It is a multi-entity recovery plan which covers seven threatened species, four endangered populations and nine endangered ecological communities that reside on the Plain. The plan identifies 17 priority conservation lands (PCLs) which best represent cost-effective biodiversity protection on the Plain. The nearest PCL identified in the plan is to the south of the study area, which comprises patches surrounding Prospect Reservoir. The proposal footprint does not fall into a PCL and the proposed action is not inconsistent with the objectives or actions of the recovery plan.

## **Endangered Flora**

### **Spiked Rice-flower (*Pimelea spicata*)**

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

Surveys were undertaken during the flowering period for this cryptic species (November 2013) however no individuals were recorded. There is potential for it to be present in the intact areas of habitat in the study area including the remnant in and surrounding Timbertop Reserve and a smaller patch on the southern side of the Great Western Highway and adjacent to the western side of the Prospect Highway. Impacts to potential habitat for this species are limited to direct impacts to around 0.16 hectares and indirect impacts to an additional 0.07 hectares.

Targeted surveys for Spiked Rice-flower would be undertaken during pre-clearance surveys prior to construction in moderate and high condition areas of Map Unit 1. There is some potential for the proposal to lead to a long-term decrease in the size of the local population if found to be present. Further assessment and mitigation may be required if the species is found to be present in or adjacent to the construction footprint.

*Reduce the area of occupancy of the species*

Targeted surveys for Spiked Rice-flower would be carried out during pre-clearance surveys prior to construction in moderate and high condition areas of Map Unit 1. There is some potential for the proposal to reduce the area of occupancy of the species if found to be present. Further assessment and mitigation may be required if the species is found to be present in or adjacent to the construction footprint.

*Fragment an existing population into two or more populations*

Considering impacts to potential habitat for this species is limited to the edges of existing patches, it is unlikely the proposal would result in a population of *Pimelea spicata* being fragmented by the proposal.

*Adversely affect habitat critical to the survival of a species*

Impacts to potential habitat for this species are limited to direct impacts to around 0.16 hectares and indirect impacts to an additional 0.07 hectares. Considering the small area of habitat being impacted and the proposed mitigation measures to minimise indirect impacts, habitat is unlikely to be adversely affected by the proposal.

*Disrupt the breeding cycle of a population*

Very little is known of what constitutes a viable population of the species, and therefore all known populations are considered viable. A population is known to be present in Prospect Nature Reserve with records of the species around 900 metres to the south of Timbertop Reserve. Spiked Rice-flower has restricted pollination and seed dispersal mechanisms. There is potential for the breeding cycle of a local population to be disrupted if found to be present in the study area.

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

Impacts to potential habitat for this species are limited to direct impacts to around 0.16 hectares and indirect impacts to an additional 0.07 hectares. Considering the small area of habitat being impacted and the proposed mitigation measures to minimise indirect impacts, habitat quality and availability is unlikely to be substantially modified by the proposal.

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

The potential for weed invasion was considered possible with a proposal of this nature and appropriate controls are required during construction and operation of the proposal to manage urban runoff. The management of invasive species would be managed under the construction environmental management plan and during operation of the highway using best practice methods as outlined in RTA (2011) biodiversity guidelines.

Urban runoff from the proposal would be directed away from potential habitat for this species, which would minimise the potential for weed invasion and modification of habitat.

*Introduce disease that may cause the species to decline*

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. Although no pests and diseases are currently known within the proposal footprint these could potentially be present. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat near the proposal. This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. Current best

practice hygiene protocols would be implemented as detailed in RTA (2011) guidelines as part of the CEMP to prevent the introduction or spread of pathogens.

*Interfere with the recovery of the species*

A recovery plan was approved for the Cumberland Plain in January 2011 (DECCW, 2010). It is a multi-entity recovery plan which covers seven threatened species, four endangered populations and nine endangered ecological communities that reside on the Plain. The plan identifies 17 priority conservation lands (PCLs) which best represent cost-effective biodiversity protection on the Plain. The nearest PCL identified in the plan is to the south of the study area, which comprises patches surrounding Prospect Reservoir. The proposal footprint does not fall into a PCL and the proposed action is not inconsistent with the objectives or actions of the recovery plan.

There is also a national and NSW recovery plan for *Pimelea spicata* (DEC 2005). The recovery actions of this plan include protection of existing populations, survey and monitoring of existing populations and potentially occurring populations, research of the life cycle attributes of the species, potential impacts and threats and habitat mapping. The proposal would aim to be consistent with these objectives if the species is found to be present.

## **Vulnerable Fauna**

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

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

There have been no roost camps identified in the proposal footprint to date and the proposal's construction would not directly impact on any known breeding / maternity site.

Therefore it is likely that the impacts of construction and operation of the proposal would be confined to loss of feeding habitat caused by 1) direct clearing or damage to native vegetation during the construction phase and 2) edge effects during operation related to degradation of foraging habitat from shading.

The proposal would directly remove up to 1.09 hectares of foraging habitat, however, vegetation would be avoided where possible. Foraging habitat mainly comprises nectar resources from planted native trees and shrubs as well as some exotic trees. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the proposal footprint. Given the relatively widespread nature of similar planted vegetation in the locality and the abundance of higher quality foraging habitat within the feeding range of regional populations, the proposal is not expected to lead to a long-term decrease in the size of an important population.

*Reduce the area of occupancy of an important population*

The proposal would directly remove up to 1.09 hectares of foraging habitat however vegetation would be avoided where possible. Foraging habitat mainly comprises nectar resources from planted native trees and shrubs as well as some exotic trees. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The proposal would reduce the area of habitat available to the species.

*Fragment an existing important population into two or more populations*

There is currently a high degree of habitat fragmentation across the study area. Highly mobile species such as bats are expected to be less impacted by fragmentation and the Grey-headed Flying-fox is particularly well adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal fruits and blossom. The proposal would not fragment an important population of the Grey-headed Flying-fox.

*Adversely affect habitat critical to the survival of the species*

Habitat critical to the survival of a species refers to areas that are necessary for activities such as:

- Foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.
- To maintain genetic diversity and long-term evolutionary development.
- For the reintroduction of populations or recovery of the species.

Habitat loss from the proposal represents a small percentage of the potential foraging habitat for the Grey-headed Flying-fox. This considers habitat that is located within a 50 kilometre radius of the proposal footprint and known roost camps in the region. This species typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). No evidence of a camp site has been identified in the proposal footprint.

The draft recovery plan for the Grey-headed Flying-fox (DECCW 2009) identifies critical foraging habitat for this species as:

- Productive during winter and spring, when food bottlenecks have been identified.
- Known to support populations of >30,000 individuals, within an area of 50 kilometre radius.
- Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (Sept-May).
- Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes.
- Known to be continuously occupied as a camp site.

The proposal would directly remove up to 1.09 hectares of foraging habitat however vegetation would be avoided where possible. Foraging habitat mainly comprises nectar resources from planted native trees and shrubs as well as fruit resources from planted fig trees and some exotic trees. This area of habitat may be defined as a portion of the potential area of occupancy for feeding life-cycle attributes of the population. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the proposal boundary. Given the relatively widespread nature of similar planted vegetation in the locality and the abundance of higher quality foraging habitat within the feeding range of regional populations, the proposal is not expected to adversely affect habitat critical to the survival of the species.



*Disrupt the breeding cycle of an important population*

As stated above there would be a minor impact on critical habitat identified as important during the breeding cycle of the species. The proposal would not directly impact on a known roost camp / breeding or maternity site.

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

No evidence of a roost camp has been identified in the proposal footprint. There would be a relatively minor impact on critical foraging habitat associated with the proposal and habitat contained within a 50 kilometre radius of known camp sites. This impact is not expected to lead to a decline in the species in this region.

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

The potential for weed invasion was considered possible with a proposal of this nature and appropriate controls are required during construction and operation of the road to manage urban runoff. The management of invasive species would be managed under the construction environmental management plan and during operation of the highway using best practice methods as outlined in RTA (2011) biodiversity guidelines.

Urban runoff from the proposal would be directed away from potential habitat for this species, which would minimise the potential for weed invasion and modification of habitat.

*Introduce disease that may cause the species to decline*

There are no known disease issues affecting this species in relation to the proposal. The proposal would be unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. Although no pests and diseases are currently known within the proposal footprint these could potentially be present. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat near the road. This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. It is the intention to use current best practice hygiene protocols as detailed in RTA (2011) guidelines for this proposal as part of the CEMP to prevent the introduction or spread of pathogens.

*Interferes substantially with the recovery of the species*

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

Given the relative widespread nature of similar planted vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of regional populations, the proposal is not expected to interfere substantially with the recovery of the species.

### **Large-eared Pied Bat (*Chalinolobus dwyeri*)**

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

Vegetation in the study area provides potential foraging habitat for this species. Some potential roosting habitats are also present, which include cavities in the existing viaduct and bridge structures of the M4 Western Motorway and Great Western Highway, culverts, buildings, and other structures.

This species frequently uses a variety of habitat types including disturbed habitats, forests and woodlands. Important life-cycle activities include roosting and breeding and both are typically associated with caves, as well as foraging for insect prey which occurs in a variety of habitat types. Breeding habitat for insect prey includes a very diverse range of wetlands, swamps and open modified and artificial landscapes.

The size of the local population is not known, although it is not expected to be large considering the highly urbanised and modified habitats in the locality and absence of caves. Potential foraging habitat in the study area is generally widespread and includes natural habitats such as remnant woodlands, as well as planted vegetation and exotic dominated vegetation. Impacts to these habitats would impact on the potential breeding habitat for prey species (invertebrates), however any potential overall reductions to the abundance of prey species is likely to be minimal, considering the widespread nature of these habitats in the locality.

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and the removal of vegetation where required, however, foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area.

Potential impacts to the life-cycle activities of this species mainly relates to disruption of breeding activities and shelter or dormancy activities. Impacts to these potential roosting habitats are not expected and any potential impacts from construction would be identified during pre-clearance surveys.

Mitigation measures would include avoiding disturbance of potential roosting habitats, pre-clearance surveys and staged habitat removal. Considering the limited potential impact to preferred roosting habitats, and the proposed mitigation measures, the proposal is unlikely to lead to a long-term decrease in the size of an important population.

#### *Reduce the area of occupancy of an important population*

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and removal of vegetation where required, however foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area. The proposal would reduce the area of habitat available to the species.

#### *Fragment an existing important population into two or more populations*

There is currently a high degree of habitat fragmentation across the study area. Highly mobile species such as bats are expected to be less impacted by fragmentation. The proposal would not fragment an important population of this

species.

*Adversely affect habitat critical to the survival of the species*

Habitat critical to the survival of a species refers to areas that are necessary for activities such as:

- Foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.
- To maintain genetic diversity and long-term evolutionary development.
- For the reintroduction of populations or recovery of the species.

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and the removal of vegetation where required, however foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area.

The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the Large-eared Pied-bat. Impacts to areas of roosting habitat are not anticipated. The proposal is unlikely to impact habitat critical to the survival of the species.

*Disrupt the breeding cycle of an important population*

The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the Large-eared Pied-bat. The proposal would not directly impact on a known roost or maternity site and is unlikely to disrupt the breeding cycle of this species.

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

The proposal would have some level of impact to up to 1.42 hectares of foraging habitat, which comprises a combination of all identified map units. This includes indirect impacts from shading and removal of vegetation where required. However, foraging attributes are unlikely to be substantially modified throughout much of this 1.42 hectare area. Maintained lawns and various structures throughout the study area also provide potential foraging opportunities, which have not been delineated and quantified throughout the study area. The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the Large-eared Pied-bat, and it is considered unlikely the species would decline as a result of the proposal.

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

The potential for weed invasion was considered possible with a proposal of this nature and appropriate controls are required during construction and operation of the proposal to reduce this threat. The management of invasive species would be managed under the construction environmental management plan and during operation of the highway using best practice methods as outlined in RTA (2011).

*Introduce disease that may cause the species to decline*

There are no known disease issues affecting this species in relation to the proposal. The proposal would be unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction of the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat near the proposal. This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. It is the intention to use current best practice hygiene protocols as detailed in RTA (2011) guidelines for this proposal as part of the CEMP to prevent the introduction or spread of pathogens.

*Interferes substantially with the recovery of the species*

Given the relative widespread nature of similar planted vegetation in the locality and the abundance of higher quality foraging habitat in the region and locality, the proposal is not expected to interfere substantially with the recovery of the species.

## **Migratory species**

***An area of 'important habitat' for a migratory species is:***

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

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species. Some factors that would be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates). These factors have been considered in the assessment.

The study area does not support any important populations of migratory species.

*Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species*

There is no evidence to suggest that an ecologically significant proportion of the population of any identified migratory species exists within the proposal footprint.

*Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species*

The potential for weed invasion has been considered highly likely with a proposal of this nature and appropriate controls have been provided for during the construction and operation of the proposal to reduce this threat as it may have long term implications for the habitat of threatened and migratory species. The management of invasive species would be managed under the construction environmental management plan.

*Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

As discussed there is no evidence to suggest that an ecologically significant proportion of the population of a migratory species exists within the proposal footprint.