



# Upgrade of the Pacific Highway Ourimbah Street to Parsons Road, Lisarow

Roads and Maritime Services

## Species Impact Statement

Final

16 June 2016



**Upgrade of the Pacific Highway - Ourimbah Street to Parsons Road, Lisarow**

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#### **Appendix A. Director Generals Requirements**

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## Declaration

### Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow

#### Species Impact Statement

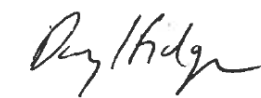
This Species Impact Statement (SIS) has been prepared in accordance with the specific requirements set out by the Director-General of the New South Wales Office of Environment and Heritage and notified to Roads and Maritime Services under Section 111 of the *Threatened Species Conservation Act 1995* (TSC Act). The specific requirements for the SIS (the Director General Requirements (DGR's)) include all the matters specified in Sections 109 and 110 of the *Threatened Species Conservation Act 1995* (TSC Act), with the exception of those matters that have been limited or modified by the DGR's. The form and content of this SIS follow that set out in the DGR's, unless specifically indicated in the text.



Chris Thomson  
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I, Daryl Fidge of Roads and Maritime, Level 17, 101 Miller Street, North Sydney 2060, being the applicant for the development consent for the upgrade of the Pacific Highway between Ourimbah Street and Parsons Road, Lisarow in Gosford Local Government Area (LGA), have read and understood this species impact statement. I understand the implications of the recommendations made in the statement and accept that they may be placed as conditions of consent or concurrence for the proposal.



Daryl Fidge  
Project Manager  
Roads and Maritime

## Acknowledgements

Jacobs Australia acknowledges the contribution of the following people in preparing this report:

- Scott Duncan (Senior Strategic Planner at Wyong Shire Council) with respect to information on population size and distribution of *Melaleuca biconvexa* in the Wyong Local Government Area.
- Geoff Sainty (Wetland Ecologist at Sainty and Associates) for peer review of the Wetland Management Plan and indirect impacts.

## Abbreviations

BVT	Biometric Vegetation Types
CEMP	Construction Environment Management Plan
CMA	Catchment Management Authority
CWR	Critical Weight Range
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEH	Department of Environment and Heritage
DEWHA	Department of the Environment, Water, Heritage and the Arts
DGRs	Director-General's Requirements
DoE	Department of the Environment
EEC	Endangered Ecological Community
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1995</i>
GPS	Global Positioning System
ISEPP	<i>State Environmental Planning Policy (Infrastructure) 2007</i>
KTP	Key Threatening Process
LEP	Local Environmental Plan
LGA	Local Government Area
NP&W Act	NSW <i>National Park and Wildlife Act 1974</i>
NPWS	National Park and Wildlife Service
NSW	New South Wales
NV Act	NSW <i>Native Vegetation Act 2003</i>
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Types
PMST	Protected Matters Search Tool
REF	Review of Environmental Factors
RMS	Roads and Maritime Services
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>
TSPD	Threatened Species Profile Database
TSSC	Threatened Species Scientific Committee

## Executive Summary

### Background

The Pacific Highway north of Gosford is the urban arterial road providing access to Gosford's northern suburbs and the Pacific Motorway (M1) at Ourimbah. The highway is currently a single lane in each direction from Manns Road, Wyoming to Glen Road at Ourimbah. This section of the Pacific Highway currently carries around 30,000 vehicles per day from regional and local areas. An upgrade of the highway is planned between Ourimbah Street and Parsons Road, Lisarow and forms the current proposed activity subject to this Species Impact Statement.

Roads and Maritime Services propose to upgrade this 1.6 kilometre section to a four-lane urban arterial road. A Review of Environmental Factors (REF) has been prepared for the project and identified the proposal would likely have a significant impact on the threatened flora species *Melaleuca biconvexa* (Biconvex Paperbark).

This species is listed as vulnerable under the Threatened Species *Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Consequently a request for Director General Requirements (DGRs) for a Species Impact Statement (SIS) under the TSC Act was submitted to the Office of Environment and Heritage (OEH) in March 2015. DGRs were provided by the OEH on the 26 March 2015 and outlined the requirements for the preparation of this SIS. The REF for the proposal has been completed in conjunction with this SIS and both documents are on public display for comments before submission to the OEH.

### Existing environment

The proposed upgrade is located around 150 metres south of the Gosford Local Government Area (LGA) northern boundary, in a modified urban landscape which includes a mix of residential, commercial / business, industrial and transport related land uses. The main features of the area include; the Lisarow Plaza Shopping Centre to the south of the proposal; industrial land to the west of the Pacific Highway and along Railway Crescent; and several rural and residential areas, including schools and sporting fields in proximity. The Main Northern Railway Line is located next to the proposal. The Lisarow Train Station is located to the north-west of the intersection of the Pacific Highway and The Ridgeway. The Lisarow Cemetery is located at the northern end of the proposal next to the northbound carriageway of the Pacific Highway between Railway Crescent and Ourimbah Street.

Vegetation surrounding the proposal includes remnant vegetation, roadside plantings, disturbed areas dominated by exotic vegetation and maintained grass. Two Endangered Ecological Communities (EECs) recognised as Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest) and Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands) occur as remnant vegetation adjoining the Pacific Highway. The distribution of *Melaleuca biconvexa* is mainly associated with the Swamp Sclerophyll Forest and margins of the Freshwater Wetlands. No other threatened flora species were identified in the study area.

Habitat for fauna is dominated by the periodically inundated swamp forest habitat, as well as open wetlands and small areas of moist open eucalypt forest in elevated land next to the cemetery. Habitat for fauna is fragmented into smaller habitat patches, with limited connectivity due to extensive fragmentation from the existing highway and rail corridor as well as industrial and residential development. This factor combined with a very low density of hollow-bearing trees would limit access and value of the habitats for populations of less mobile fauna species. This includes terrestrial and arboreal mammals, frogs and reptiles and limit opportunities for dispersal and colonisation. However, the forested habitats do provide foraging and prey resources for a range of nectivorous and carnivorous fauna, as well as refuge and shelter for highly mobile and disturbance tolerant fauna such as bats and birds. This suggests there is potential for several threatened fauna species to occur, in particular the Grey-headed Flying-fox, Powerful Owl and threatened hollow-roosting microbats. The Grey-headed Flying-fox was identified in the study area and the swamp forest habitats provide critical foraging habitat for this species; in accordance with the *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009). No other threatened fauna species were identified. However, eleven threatened fauna species were assessed as potentially being impacted by the proposal and assessed in further detail.



The open wetland habitats are utilised by a number of common amphibian and bird species, and provide locally important food resources for a range of nectivorous fauna, in particular the Grey-headed Flying-fox. This is due to the dominance of mature Swamp Mahogany (*Eucalyptus robusta*); an important keystone winter-flowering species productive during nectar resource bottlenecks. Such resources are also known to be utilised by nomadic threatened species such as Swift Parrot, Regent Honeyeater and Little Lorikeet.

The proximity to major infrastructure, isolation of habitat, high degree of disturbance from human activity including traffic with associated noise and light impacts, and lack of hollows may preclude the presence of the majority of threatened fauna species known from the region and that would normally be associated with these habitats. This includes the Koala, Squirrel Glider, and migratory wetland birds, none of these species were identified from surveys in the study area. The wetland and local creek habitats were also observed to exhibit very poor water quality as a result of influx of polluted stormwater water and heavy deposition of silt. These factors would also limit the suitability of the habitat for threatened frogs such as Green-thighed Frog and Green and Golden Bell Frog despite the apparent suitability of the habitat, and neither species was identified from the targeted surveys.

### Evaluation of impacts

The main impact of the proposal is associated with the loss of vegetation and habitat to accommodate the proposed upgrade footprint. This includes a reduction in the extent of two EECs as well as a significant portion of a population of the threatened species *Melaleuca biconvexa*. A range of direct and indirect impacts are predicted. An assessment of the likely significance of this impact on threatened subject species and ecological communities is provided. In general, the impacts to biodiversity likely to happen include:

- Loss of 3.84 hectares of native vegetation) including:
  - 0.35 hectares of *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions* (Endangered Ecological Community TSC Act).
  - 2.78 hectares of *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (Endangered Ecological Community TSC Act).
  - 0.71 hectares of coastal Narrabeen Moist Forest.
- Direct impact to 2.61 hectares of habitat occupied by *Melaleuca biconvexa* supporting up to an estimated 2,153 mature stems. A further possible indirect impact of 0.73 hectares is predicted and the total loss, approximately 2,575 individuals, is considered significant.
- Loss of 3.84 hectares of habitat for protected and threatened fauna (including food resources, shelter and refuge areas during non-breeding life-cycle events), with a particular impact to wide-ranging nectivorous fauna such as Grey-headed Flying-fox, Swift Parrot, Regent honeyeater and Little Lorikeet, in addition to foraging habitat for microbats and the Powerful Owl. The loss is not considered significant for these threatened fauna, due to the small and highly modified condition and the isolation of the habitats.
- Increased fragmentation of terrestrial and aquatic fauna habitat and indirect edge effects from road noise, increased light and wind turbulence reducing the value of the habitat for sedentary populations.
- Clearing and degradation of groundwater dependant ecosystems and wetlands.
- Alteration of existing hydrology regimes.
- Potential changes to water quality as a result of works in or adjacent to aquatic habitats.
- Potential for invasion and spread of weeds into areas disturbed by the construction as well as *in situ* habitats remaining adjacent to the road.
- Potential for spread of disease pathogens into remnant habitats during construction.
- A contribution to cumulative impacts associated with habitat loss in the locality affecting the long-term viability and survival of local flora and fauna populations, and ecological communities.

The Central Coast meta-population of *Melaleuca biconvexa* is the largest of four main known populations in NSW. This is occupying an estimated area greater than 400 hectares, across portions of the Gosford, Wyong

and Lake Macquarie LGAs. The populations mapped in the study area include a local population of 13.35 hectares. This includes all areas surrounding the proposal and no more than 500 metres distance from each patch. Within a 10 kilometre radius of the site around 258 hectares was identified. For the purposes of this assessment the local population is considered to be around 13.35 hectares and is defined and mapped in this report.

*Melaleuca biconvexa* is mainly associated with the low-lying swamp forest habitats in the study area, particularly in margins of the wetlands, although it also occurs on higher-elevated island pockets within the freshwater wetlands and low numbers occur along the ridge at the northern end of the project in Coastal Narrabeen Moist Forest. The upgrade would directly impact on around 19.5 per cent of the local population identified and mapped in the study area (i.e. 13.35 hectares). This includes a construction buffer area that may be minimised during construction activities.

The proposal will potentially result in alterations to existing hydrology regimes with further land reclamation and alterations to the existing drainage patterns from replacing and removing existing culverts. The current hydrology model for the 80 per cent road design indicates these changes will result in higher water levels within the freshwater wetlands and swamp sclerophyll forest habitats surrounding the proposal, following significant rainfall events. However, these water levels will recede at the current rate such that the duration of the inundation remains the same outside such events. Any indirect impacts from soil waterlogging may be experienced mostly in the margins of the freshwater wetlands. There is some scientific uncertainty around predicting the indirect impacts from this scenario on the *in situ Melaleuca biconvexa* population during operation of the proposal. It is likely a portion of the population will survive the temporary increased depths while others may decrease in health or reproductive ability. Using a precautionary approach, it is calculated a further 0.73 hectares of the residual *Melaleuca biconvexa* population may be indirectly impacted.

### Avoidance and mitigation approach

Considering the location of the upgrade, within a heavily urbanised landscape with a range of infrastructure, the potential to avoid impacts to biodiversity is constrained. While disturbance and clearing of vegetation as a result of the proposal would be unavoidable, there are opportunities to avoid and minimise the loss of native vegetation and fauna habitat during the detailed design and construction. This has been considered in the design. The following principles would be prioritised:

- Avoiding and minimising vegetation removal wherever possible, particularly in locations where *Melaleuca biconvexa* occurs.
- Construction compounds and stockpile sites would be sited in existing cleared areas to avoid unnecessary loss of and impacts to vegetation / habitat.
- Water quality basins and drainage structures will be designed to minimise vegetation removal, particularly where *Melaleuca biconvexa* occurs.

The direct impact area includes a construction buffer for the purposes of calculating impact areas. During detailed design and construction planning, the construction area will be minimised where possible reducing damage to adjacent vegetation, ensuring the works can be safely constructed and pollution is controlled.

A range of mitigation measures are planned and follow standard best practice measures for the protection of biodiversity; as documented in the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). In summary this includes:

- Pre-clearing process to identify fauna habitat.
- Management of unexpected species finds.
- Delineation of exclusion zones around protected vegetation.
- Weed management.
- Disease and pathogen management.
- Reestablishment of habitat post-construction.
- Management of water quality and hydrology.

In addition to the standard measures outlined, and given the identified impacts on the two EECs impacted by the proposal (Swamp Sclerophyll Forest and Freshwater Wetlands) and the threatened flora species *Melaleuca*

*biconvexa*, a Wetland Management Plan has been prepared. This documents specific pre-construction and construction mitigation measures. The plan includes a program to monitor the effectiveness of construction mitigation measures.

### **Biodiversity offsets**

Biodiversity impacts for threatened species and communities have been quantified using the BioBanking Assessment Methodology (BBAM). A total of 79 ecosystem credits are required to adequately offset the impacts from the proposed upgrade on EECs and 33,475 species credits are required to offset impacts for *Melaleuca biconvexa*. The ecosystem credits to be offset are considered to adequately compensate for the loss of habitat for threatened fauna species, in particular critical foraging habitat for the Grey-headed Flying-fox and important winter-flowering food resources for other nectivorous fauna.

A Biodiversity Offset Strategy has been prepared to investigate the availability of credits in the region to compensate for the loss of important habitat, associated with the proposal. The offset strategy focuses on identifying offsets containing a population of *Melaleuca biconvexa*, the endangered ecological communities (swamp sclerophyll forest and/or freshwater wetlands) and include potential habitat for threatened fauna species affected by the proposal. As there are no operational mitigation measures that can be implemented to ameliorate the potential indirect impacts, Roads and Maritime have calculated and will offset impacts from both direct and indirect impacts on *Melaleuca biconvexa*.

The offsets for this project are being delivered in two stages. Key activities for Stage 1 include:

- Identify if the ecosystem and species credits required for offset are available for purchase on the open market.
- Publishing an expression of interest on the BioBanking credits wanted register.
- Where credits are not available, identify a short-list of candidate offset sites based on desktop assessment with input from relevant stakeholders (such as OEH and local councils and the National Parks and Wildlife Service (NPWS)).
- Determine if land-based offsets will be achievable for the biodiversity values requiring offsetting. Where land-based offsets are not likely to be available, investigate indirect and supplementary offset options (noting that EPBC Act-listed biodiversity will require 'like for like' offsets with only a maximum of 10% of the offsets being provided by supplementary measures).
- Prioritise short-listed offset sites for further investigation as part of Stage 2.

The desktop assessment identifies 37 priority sites from 16 clusters of private properties that adequately compensate for the biodiversity impacts predicted in terms of land area and credit requirements. The short-list of potential offset properties identified in the offset strategy will be secured by Roads and Maritime as part of Stage 2. Roads and Maritime will continue to liaise with the NSW OEH while undertaking these further investigations. The key activities associated with Stage 2 are:

- Approach owners of priority sites to identify interest in offsetting.
- Undertake rapid field assessments on priority sites to confirm the ecological values and habitat condition, to ensure the offset areas provide equivalent or greater values to improve or maintain biodiversity values.
- Progress negotiations with owners and complete detailed BioBanking Assessment at priority sites.
- Identify site specific management actions for long-term management of the biodiversity offsets.
- Obtain agreement and approval from OEH for the proposed offset package.
- Secure offset properties under an appropriate conservation mechanism, when SIS concurrence is granted.

# 1. Introduction

## 1.1 Background

The Pacific Highway north of Gosford is the urban arterial road providing access to Gosford's northern suburbs and the Pacific Motorway (M1) at Ourimbah. The highway is currently a single lane in each direction from Manns Road, Wyoming to Glen Road at Ourimbah. This section of the Pacific Highway currently carries around 30,000 vehicles per day from regional and local areas. The study area is located between Ourimbah Street and Parsons Road within the GosfordLGA. The regional locality of the proposal is illustrated in Figure 1-1.

The NSW State Infrastructure Strategy outlines the progressive upgrading of the Pacific Highway to four-lane urban arterial road standard between North Gosford and the Pacific Motorway (M1). This was divided into three progressive stages by Roads and Maritime. Stages 1 and 2 of the upgrade between the Pacific Motorway (M1) and Glen Road at Ourimbah have been completed. Stage 1, which involved upgrading the Dog Trap Road intersection, was completed in July 2007. Stage 2, which involved widening the highway between Glen Road and Burns Road at Ourimbah, was completed in January 2010. Stage 3 has been broken down into two sub-stages, stages 3a and 3b. The design for stage 3a between Glen Road and Ourimbah Street has been completed and construction started in March 2016. The current proposal addressed by this Species Impact Statement (SIS) forms Stage 3b.

Roads and Maritime proposes to upgrade 1.6 kilometres of the Pacific Highway to a four-lane urban arterial road between Ourimbah Street to Parsons Road, Lisarow (the proposal). An overview of the proposal is provided in Figure 1-2 and a detailed description is provided in Section 2.1.

A Review of Environmental Factors (REF) is being completed by Roads and Maritime in conjunction with this SIS and both documents would be put on display together. A Biodiversity Assessment was completed as part of the REF. This assessment concluded the proposal would likely have a significant impact on a population of the threatened Biconvex Paperbark (*Melaleuca biconvexa*) as species listed as vulnerable under the *NSW Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A request for Director General Requirements (DGRs) for a Species Impact Statement (SIS) under the provisions of the TSC Act was submitted to the Office of Environment and Heritage (OEH) in March 2015. DGRs were provided by the OEH on the 26 March 2015 and outline the context for this SIS (refer Appendix A).

*Melaleuca biconvexa* is a matter of national environmental significance (MNES) under the EPBC Act. Roads and Maritime have negotiated an EPBC Act Strategic Assessment Approval (2015), which applies to this project so a referral and Federal approval is not required.

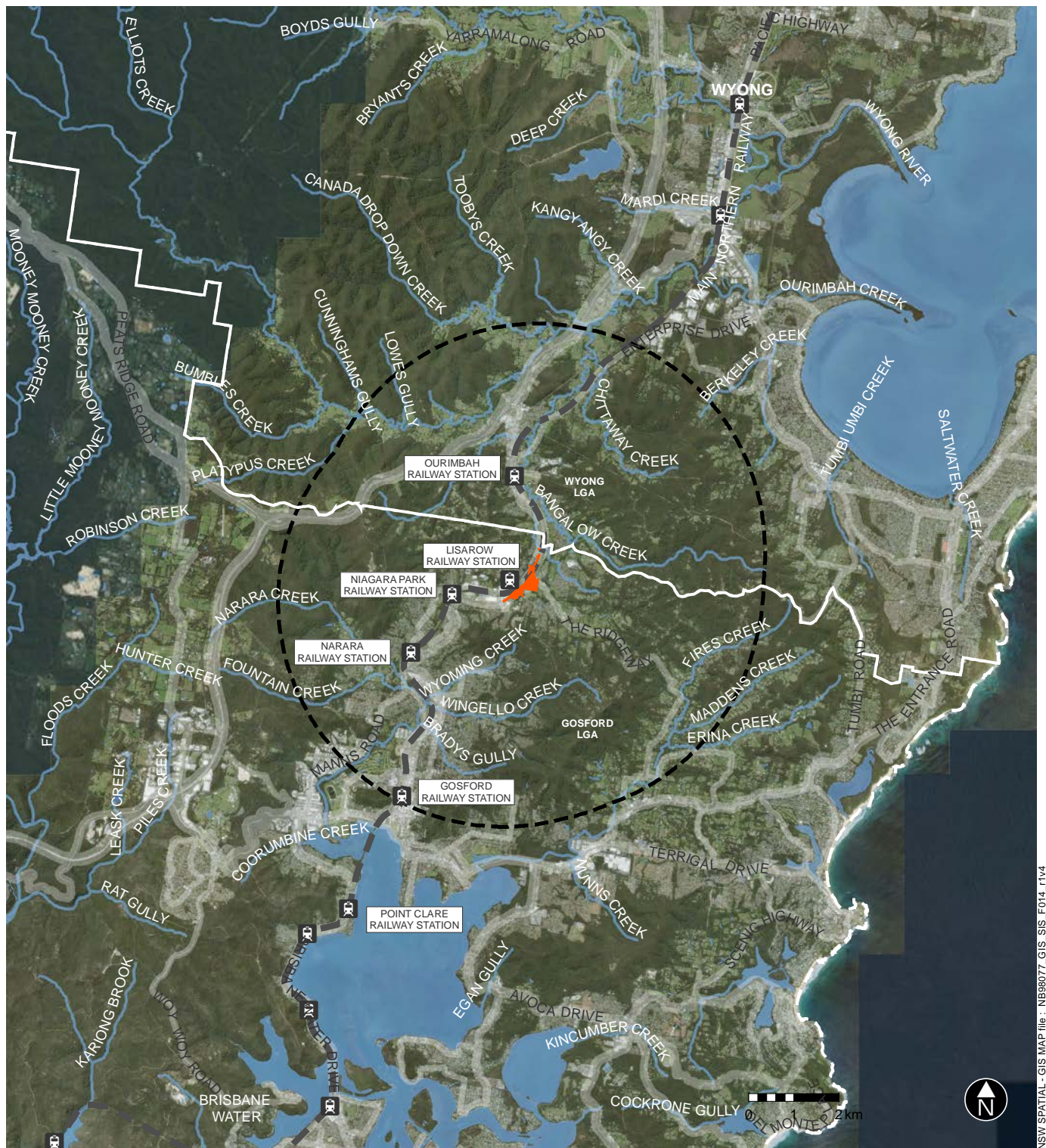
## 1.2 SIS purpose and objectives

The purpose of the SIS is to conduct targeted surveys and assessment of all potential threatened species, populations, and ecological communities that may be directly or indirectly impacted by the proposal. A list of threatened species, which are to be considered in the SIS, are listed in the DGRs and referred to in this SIS.

Following habitat assessment and targeted surveys this list of species was refined to a final list of subject species considered to potentially be impacted by the proposal. The area of habitat to be impacted for each of these subject species is identified and a brief description of the species and assessment of potential impacts provided. This information can be found in Chapter 5.

A revised assessment of significance (addressing Section 5a of the *Environmental Planning and Assessment Act 1979*) is completed for each subject species and detailed analysis of potential direct and indirect impacts, taking into consideration the extent of local populations and significance of the habitat being impacted for species in the study area. The assessment of significance is provided in Section 8. The final outcomes of the SIS are to determine if the proposal is likely to have a significant impact on subject threatened species or ecological communities, and to identify ameliorative measures to minimise impacts on threatened species as well as present a strategy to offset impacts that cannot be avoided.





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Figure 1-1 | Regional locality

### Legend

- Study area
- Study area 5 km radius

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Roads and Maritime Services 2014  
AUSIMAGE 2015  
LPI 2014, Jacobs 2014  
OEI 2014

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX,

## SPECIES IMPACT STATEMENT

Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow



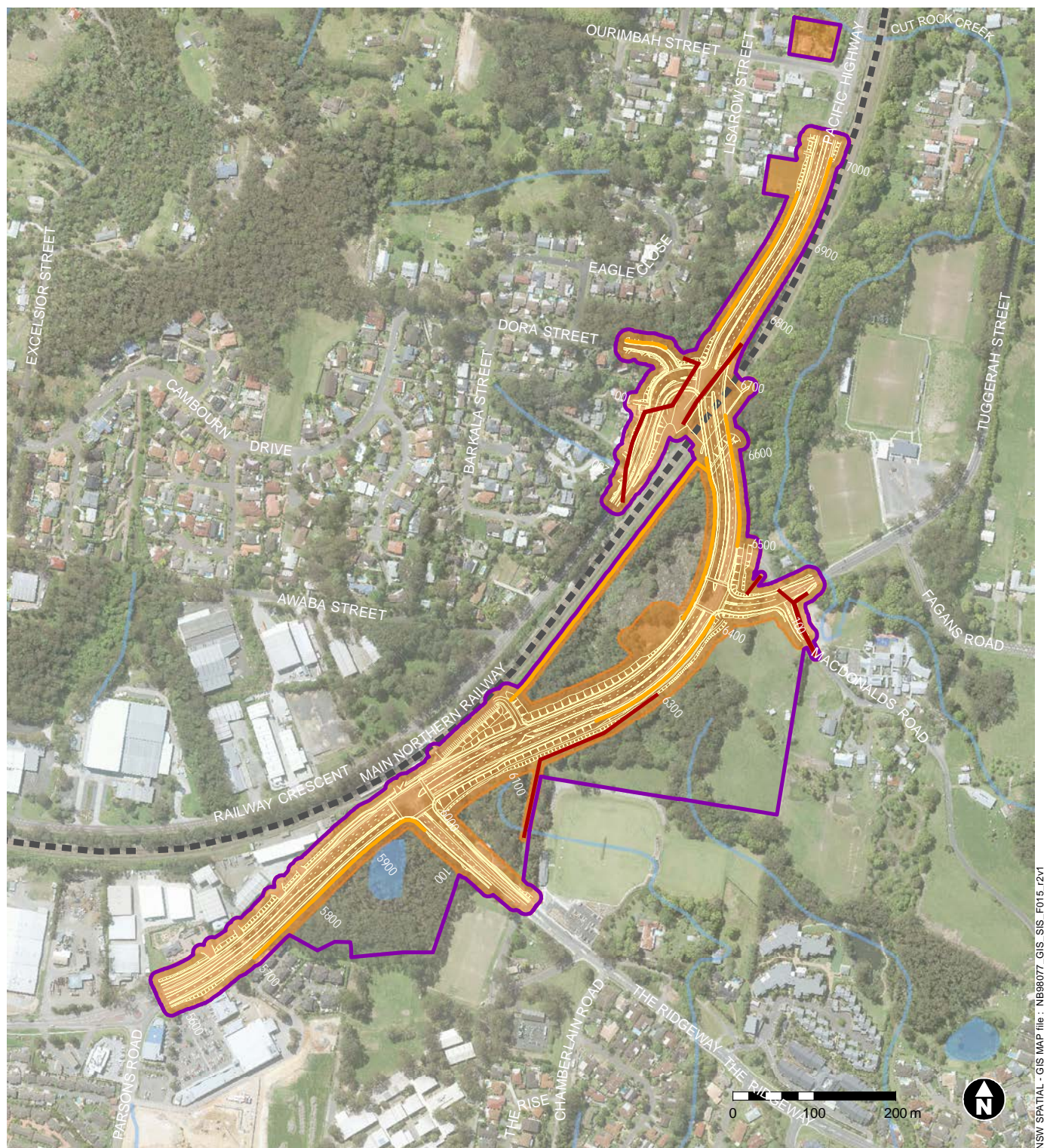








Figure 1-2 | Project site and study area

### Legend

- |  |  |
|--|--|
|  Concept design |  Study area   |
|  Retaining wall |  Subject site |
|  Power line     |  |
|  Watercourse    |  |

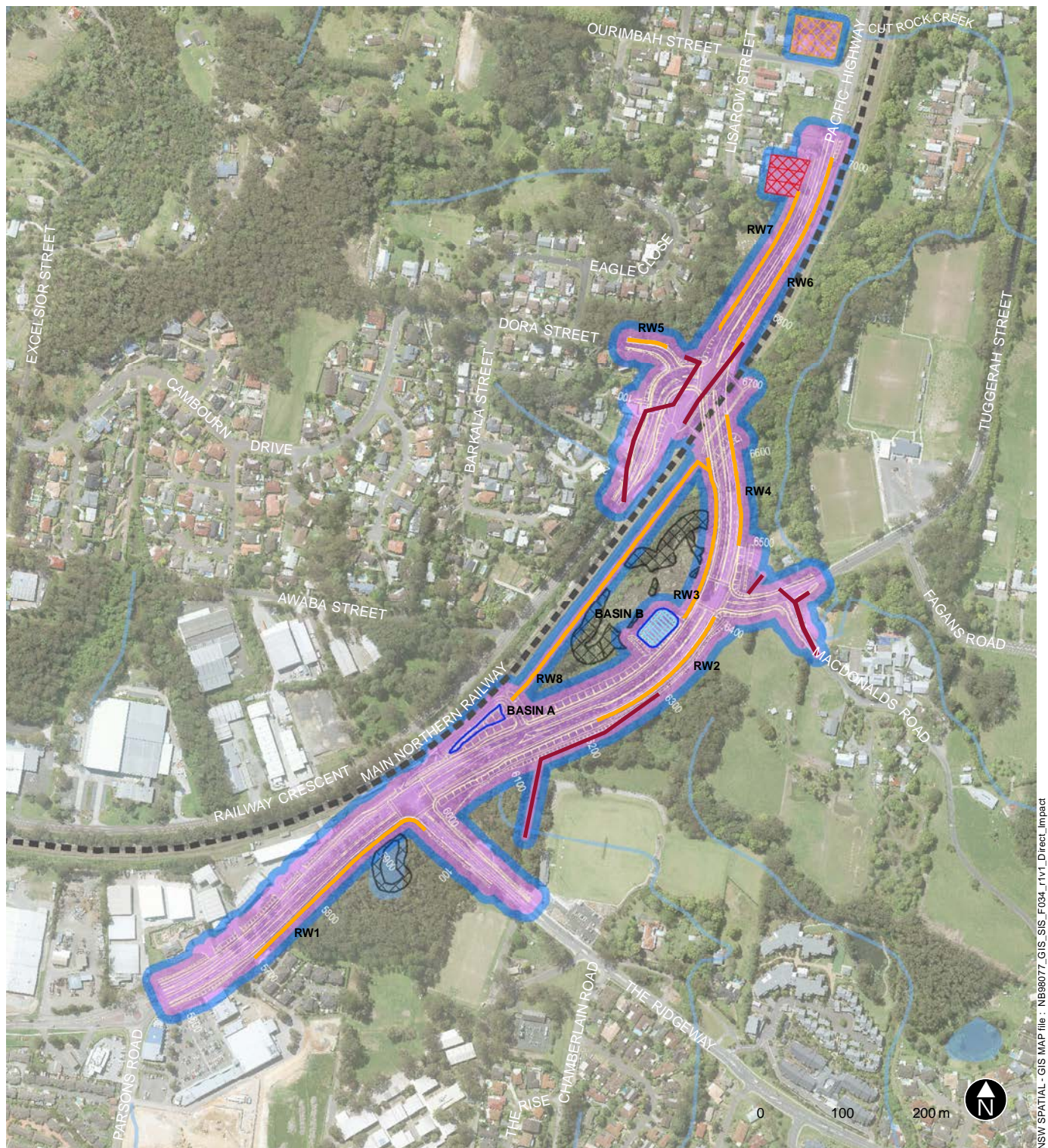
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 AUSIMAGE 2015  
 LPI 2014  
 Jacobs 2014

### 1.3 Definitions

The following definitions are used in the SIS:

- **Direct impacts** – based on a clearing footprint for the proposal which is determined as:
  - 80 per cent concept design with a 10 metre buffer for construction.
  - Sediment and operational water quality basins with a 10 metre buffer for construction.
  - Retaining wall along the railway corridor between Lisarow Railway Station and the Lisarow Rail Overbridge with a five metre buffer for construction.
  - Realigned utilities (power lines) with a five metre buffer for construction.
  - Ancillary facilities including the crane pad sites, stockpile sites and the compound site.
- **Indirect impacts** – defined as the direct impact footprint (defined above) with an additional 10 metre buffer; except in the area next to the retaining wall along the railway corridor between Lisarow Railway Station and the Lisarow rail over-bridge, where work will be restricted to the rail corridor.
- **Likely** – taken to be a real chance or possibility.
- **Local population (migratory or nomadic fauna)** – the population comprises those individuals likely to occur in the study area from time-to-time.
- **Local population (resident fauna)** – the population comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
- **Local population (threatened flora)** – the population comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous, with the study area that could reasonably be expected to be cross-pollinating with those in the study area. This is taken to be patches that are within 500 metres of each other.
- **Locality** – means the area within a 5 kilometre radius of the proposal.
- **Migratory species** – a species specified in the schedules of the EPBC Act.
- **Proposal** – the development, activity or action proposed as summarised in Section 2.1.
- **Subject site** – is the area which will be directly and indirectly affected by the construction of the proposal.
- **Subject species** – list of threatened species considered likely to be affected by the proposal. The list is identified from survey and assessment of the species listed in the DGRs in addition to other threatened species identified from a background search research and habitat assessment.
- **Study area** – encompasses the full extent of the subject site as well as surrounding properties supporting habitats contiguous with the subject site and are potentially subject to indirect impacts.
- **Threatened species, populations and ecological communities** – same meaning as in the TSC Act.





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Figure 1-3 | Areas of direct and indirect impacts associated with the proposal

### Legend

	Concept design		Construction sediment basin		Direct construction and operational impact
	Retaining wall		Construction sediment basin and operational water quality basin		Indirect construction impact
	Power line		Railway		Indirect operational impact
	Stockpile site				
	Compound site stage 3a				

Roads and Maritime Services 2016  
AUSIMAGE 2015  
LPI 2015  
Jacobs 2016

## SPECIES IMPACT STATEMENT

Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow

## 1.4 Matters which have been limited or modified

According to the DGRs the following section 110 matters in the TSC Act need only be addressed where relevant:

- All reference to threat abatement plans. A number of these are relevant to the species assessed and have been discussed in the species profiles in Section 5 and assessment of significance in Section 8.
- All reference to critical habitat under the TSC Act. At the time of printing, areas declared critical habitat under the Act are not relevant to this proposal.

## 1.5 Matters to be addressed

The TSC Act provides the SIS must meet all the matters specific in Sections 109 and 110 of the TSC Act, with the exception of those matters limited above. Previous surveys and assessments relevant to the locality may be used to assist in addressing these requirements.

Section 111 (1) of the TSC Act states an applicant must comply with the DGRs concerning the form, and content of the SIS. Failure to fully comply with the DGRs is a potential breach of the legislation, and may result in OEHL being unable to grant concurrence to a request by the consent authority to carry out the activity. Accordingly, this SIS has been structured to follow the sections and subsection headings provided in the DGRs.

The Director-General's Requirements for the proposal are summarised in Table 1-1 along with reference to where these issues are addressed in this report.

Table 1-1 Director-General's Requirements Species Impact Statement

DGRs (required SIS sections and subsections)	Where addressed in SIS
1 – Form of the Species Impact Statement	Section 1.6
2 – Contextual information	Section 2
2.1 – Description of the proposal, subject site and study area	Section 2.1
2.1.1 – Description of the proposal	Section 2.1
2.1.2 – Definition of the SIS study area	Section 2.2
2.1.3 – Description of the SIS study area	Section 2.3
2.2 – Provision of relevant plans and maps	Section 2.4
2.3 – Land tenure information	Section 2.5
3 – Initial assessment	Section 3
3.1 – Identifying subject species	Section 3.1
3.1.1 – Assessment of available information	Section 3.1.1
4 – Surveys	Section 4
4.1 – Requirement to survey	Section 4.1
4.2 – Documentation of survey effort and technique	Section 4.2
4.2.1 – Description of survey techniques and survey sites	Section 4.2
4.2.2 – Documenting survey effort	Section 4.2
4.3 – Survey results	Section 4.3 to 4.5
4.3.1 – Subject species survey results	Section 4.3
4.3.2 – General species survey results	Section 4.5



DGRs (required SIS sections and subsections)	Where addressed in SIS
4.4 – Subject species habitat mapping	Section 4.6
4.5 – General report structure	Whole document
<b>5 – Assessment of likely impacts on threatened species and populations</b>	Section 5
5.1 – Assessment of species likely to be affected	Section 5.2
5.2 – Discussion of conservation status	Section 5.2
5.3 – Discussion of local and regional abundance	Section 5.2
5.3.1 – Discussion of other known local populations	Section 5.2
5.3.2 – Discussion of habitat utilisation	Section 5.2
5.3.3 – Description of vegetation	Section 2.3.1
5.4 – Assessment of habitat	Section 2.3.1
5.4.1 – Description of habitat values	Section 2.3.2
5.4.2 – Extent of habitat removal	Section 5.1.1
5.4.3 – Consideration of corridors	Section 5.1.4
5.4.4 – Impacts of threatened species and/or populations in OEH estate	Section 5.2
5.5 – Description of feasible alternatives	Section 5.3
<b>6 – Assessment of likely impacts on ecological communities</b>	Section 6
6.1 – Assessment of likely impacts on ecological communities (endangered and critically endangered) likely to be affected	Section 6.1
6.2 – Discussion of conservation status	Section 6.5
6.2.1 – Significance within a local context	Section 6.5
6.2.2 – Discussion of corridor values	Section 2.3.3
6.2.3 – Discussion of regional significance	Section 2.3
6.2.4 Impacts on Ecological Communities in OEH estate	Section 5.1.1
6.3 – Assessment of habitat	Section 2.3.2
6.3.1 – Description of disturbance history	Section 2.3
6.3.2 – Extent of habitat removal	Section 5.1.1
6.4 – Description of feasible alternatives	Section 6.6
<b>7 – Ameliorative measures</b>	Section 7
7.1 – Description of ameliorative measures	Section 7.2
7.1.1 – Long term management strategies	Section 7.3
7.1.2 – Compensatory strategies	Section 7.4
7.1.3 – Ongoing monitoring	Section 7.5
<b>8 – Assessment of significance of likely effect of proposed action</b>	Section 8
<b>9 – Additional information</b>	Section 9
9.1 – Qualifications and experience	Section 9.1
9.2 – Other approvals required for the development or activity	Section 9.2



DGRs (required SIS sections and subsections)	Where addressed in SIS
9.3 – Licensing matters relating to flora and fauna surveys	Section 9.3
9.4 – Section 110 (5) reports	Section 9.4

## **1.6 Form of the Species Impact Statement**

This SIS is in writing and prepared in accordance with Section 109 (1) of the TSC Act. It has been signed by the principal author and by the applicant (refer to 'Declaration') in accordance with Section 109 (2) of the TSC Act and as specified in the DGRs.

## 2. Contextual Information

### 2.1 Description of the proposal

The NSW State Infrastructure Strategy outlines the progressive upgrading of the Pacific Highway to four-lane urban arterial road standard between North Gosford and the Pacific Motorway (M1). The upgrade of the Pacific Highway between North Gosford and the Pacific Motorway (M1) was broken down into four progressive stages by Roads and Maritime Services (Roads and Maritime), refer to Table 2-1. Stage 3 has been broken down into two sub-stages and includes stages 3a and 3b. The current proposal forms part of stage 3b and details of the proposal are described in Table 2-2.

Table 2-1: The Pacific Highway upgrade stages on the Central Coast.

Stage	Description	Status
Stage 1	Upgrade the Pacific Highway / Dog Trap Road intersection to improve safety, assist traffic flow during peak periods, and ease congestion outside the Ourimbah Primary School.	Completed 2007
Stage 2	Upgrade to widen the Pacific Highway between Glen Road and Burns Road, Ourimbah from one to two lanes in each direction.	Completed 2010
Stage 3a	Upgrade to Pacific Highway between Ourimbah Street at Lisarow and Glen Road at Ourimbah to provide two lanes in each direction.	Construction
<b>Stage 3b</b>	<b><i>The proposal - Upgrade of the Pacific Highway between Ourimbah Street and Parsons Road Lisarow to provide two lanes in each direction to improve traffic flow and safety for all road users.</i></b>	<b><i>In planning (subject to this SIS)</i></b>
Stage 4	Upgrade the Pacific Highway and Manns Road between Narara Creek Road at Narara and Parsons Road at Lisarow to provide two lanes in each direction to improve traffic flow and safety for all road uses.	In planning

Stage 3b has a concept design which is based on the available information and current design standards and criteria for the overall Pacific Highway upgrade program, which Roads and Maritime is currently progressively implementing. Elements of the concept design may be further refined during detailed design although the overall intent of the proposal will remain the same. The main features of the proposal are listed in Table 2-1 and described in detail in the REF.

Table 2-2: Main features of the proposal

Main feature	Description
Design speed	<ul style="list-style-type: none"> <li>60 km/h design speed and posted speed limit along the length of the proposal.</li> </ul>
Road width	<ul style="list-style-type: none"> <li>An additional 3.3 m wide lane in both directions on the Pacific Highway.</li> <li>Widened shoulders by up to 2.0 m for consistent shoulder widths along the length of the proposal.</li> <li>Raised concrete median along the length of the proposal and traffic islands at the approaches to the Pacific Highway at Railway Crescent, MacDonald's Road and The Ridgeway.</li> </ul>
Lisarow rail overbridge	<ul style="list-style-type: none"> <li>Demolition of the of the existing bridge and replacement with a new rail overbridge over the Main Northern Railway Line immediately south of Railway Crescent on the Pacific Highway.</li> </ul>
Intersection upgrades	<ul style="list-style-type: none"> <li>Pacific Highway and The Ridgeway intersection: Line work and relocation of traffic lights.</li> <li>Pacific Highway and rail maintenance access road: Relocating the access road approximately 100 metres to the north-east, with all vehicle movements permitted at the intersection.</li> <li>Pacific Highway and MacDonald's Road intersection: Installing new traffic lights at the intersection.</li> <li>Railway Crescent and Pacific Highway intersection: Providing a wider radius of the curve approaching the Pacific Highway, and traffic lights at the intersection.</li> <li>Dora Street and Railway Crescent intersection: Adjusting the intersection to the south-west by approximately 30 metres and enforcing a no right turn from Dora Street to Railway Crescent.</li> </ul>

Main feature	Description
Retaining walls	<ul style="list-style-type: none"> <li>Eight retaining walls between 0.3 m and 10 m in height would be constructed to reduce environmental and property impacts at: <ul style="list-style-type: none"> <li>Pacific Highway, south west of The Ridgeway, next to the southbound lane.</li> <li>Pacific Highway, south west of MacDonald's Road, next to the southbound lane.</li> <li>Pacific Highway, south of the rail overbridge, on both sides of the road.</li> <li>Northern side of Dora Street and Railway Crescent.</li> <li>Pacific Highway, north of Railway Crescent, on both sides of the road.</li> <li>Along the eastern boundary of the rail corridor between the maintenance access road at Lisarow Railway Station and the new rail overbridge.</li> </ul> </li> </ul>
Property adjustments and acquisition	<ul style="list-style-type: none"> <li>About 13 properties would be partially acquired.</li> <li>About 10 properties would be wholly acquired.</li> <li>About 7 property accesses (residential and commercial) and the rail maintenance access road would be adjusted to fit in with the Pacific Highway. This would be determined during detail design.</li> <li>All existing property accesses would be reinstated for retained properties.</li> </ul>
Utility adjustments	<ul style="list-style-type: none"> <li>Relocation/protection of any utilities impacted by the proposal in consultation with the utility authorities.</li> </ul>
Compound and stockpile sites	<ul style="list-style-type: none"> <li>Two sites are proposed including: <ul style="list-style-type: none"> <li>Site 1 at 980 Pacific Highway, Lisarow (Lot 1, DP 567438) located on the corner of the Pacific Highway and Ourimbah Street. This site is the main site proposed for use for the Stage 3A proposal and is located just to the north of the end of the proposal. The total area of the site would be about 60 metres by 45 metres and would be used for the compound site, storage of culverts, pipes and off-street parking.</li> <li>Site 2 at 962, 964 and 966 Pacific Highway, Lisarow (Lot 1 DP 560299, Lot 25 DP 580016 and Lot 24 DP 580016 respectively). The site is located alongside the northbound carriageway of the Pacific Highway near the northern extent of the proposal to the north of Lisarow Cemetery. The total area of the site would be about 45 metres by 30 metres and would be used for the storage of equipment, machinery and materials.</li> </ul> </li> </ul>
Water quality measures	<ul style="list-style-type: none"> <li>Installation of one temporary water quality basin around 130 metres south of the Pacific Highway and MacDonald's Road intersection next to the northbound carriageway in areas of Lot 10 DP 838947 and Lot 1 DP 2417. This area is currently cleared in an area of fill but is next to areas of Swamp Sclerophyll Forest to the south and Freshwater Wetlands to the north.</li> <li>Kerb and guttering along the length of the proposal.</li> </ul>
Pedestrian and cyclist facilities	<ul style="list-style-type: none"> <li>Shared paths throughout the proposal area, with additional safety fencing for pedestrians in steep areas and along retaining walls.</li> </ul>
Bus facilities	<ul style="list-style-type: none"> <li>Retain the existing bus bays, with the exception of the bus bays on the Pacific Highway immediately north of the Railway Crescent intersection and both bus bays on MacDonald's Road.</li> </ul>
Other activities	<ul style="list-style-type: none"> <li>New pavement for the length of the proposal and tie-ins to existing roads.</li> <li>Safety furniture, including pedestrian fencing and guard rails, where required.</li> <li>Reinstating access into private properties impacted by the proposal.</li> </ul>

Construction of the proposal is anticipated to be undertaken in four stages to minimise impacts to road and rail traffic and property owners located next to the proposal.

## 2.2 Definition of the SIS study area

### Subject site and study area

The subject site is the area which will be directly and indirectly impacted by the construction of the proposal and based on the clearing footprint for direct impacts including an appropriate indirect impact buffer defined in Section 1-3.

The study area encompasses the extent of the subject site and surrounding properties that support habitats contiguous with the subject site and are potentially subject to indirect impacts. The extent of the study area is shown in Figure 1-2.

### Locality and region

The locality includes a 5 kilometre radius surrounding the subject site. The locality area is used as the basis for database searches, estimating the extent of vegetation / habitat in the locality, and assessing the likely wider abundance of subject species and ecological communities.

The region includes the land within the boundaries of both the Gosford and Wyong LGAs. An overview of the locality is provided in Figure 1-1.

### Discussion of direct and indirect impacts

The proposal will involve the clearing of vegetation and removal and damage to habitat. The footprint of direct and indirect impacts are shown in Figure 1-3 and based on the definition as included in Section 1.3. A detailed assessment and quantification of clearing and disturbance impacts on each habitat type in the project area, where appropriate, is included in Section 5.1 and follows the description of the environment and survey methods and results.

## 2.3 Description of the SIS study area

### 2.3.1 Vegetation communities and fauna habitats

Three vegetation communities are represented in the study area and are described in the following section with reference to regional vegetation classifications derived by Bell (2002) as well as the Plant Community Types (PCTs) and Biometric Vegetation Types (BVTs) described by Somerville (2009). Dense patches of exotic trees and shrubs are also present and have been mapped in the study area.

Each PCT was stratified into vegetation zones, based on assessment of the condition of the vegetation in the study area including the level of modification, weed invasion and other disturbances. Six vegetation zones are identified using two broad condition classes for each community. The six vegetation zones, biometric vegetation types, plant community types and threatened ecological communities are described in Table 2-3 and their distribution in the study area mapped on Figure 2-1. A flora species list including cover / abundance scores for each vegetation community is provided in Appendix B.

The three vegetation communities identified consist of the following plant community types (PCTs):

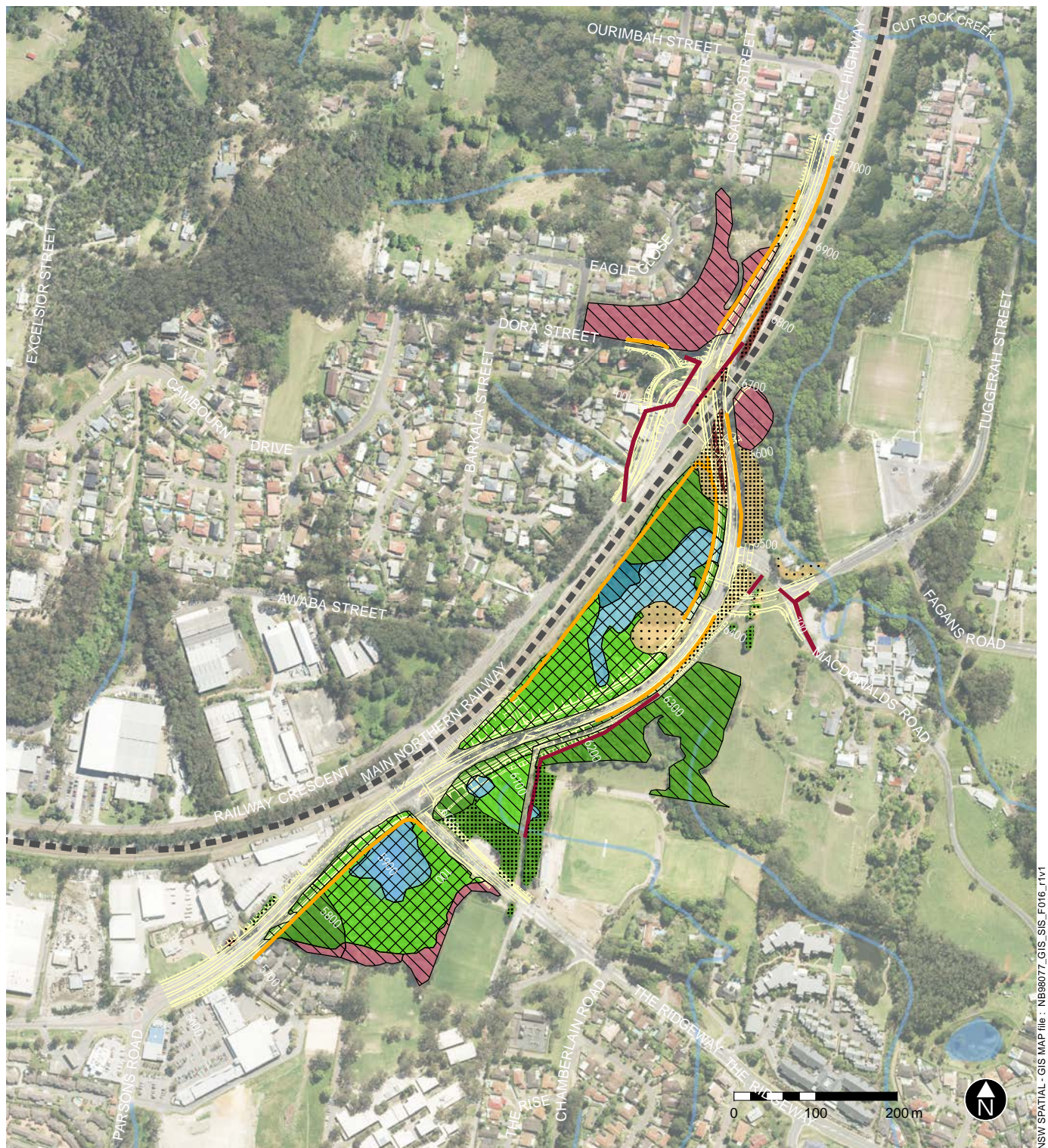
1. *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (PCT1723) (refer description Table 2-4).
2. Typha rushland (PCT1737) (refer description Table 2-5).
3. Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (PCT1568) (refer description Table 2-6).

Table 2-3: PCTs, vegetation zones, biometric vegetation types (BVT) and conservation status

Biometric vegetation type (BVT)	PCT ID	Vegetation zones	Status (TSC Act)	Fauna habitat type	Proportion of study area (ha)
Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	1723	1: Alluvial Paperbark Sedge Forest – moderate	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest)	Swamp forest	3.46 ha (30.81 %)
		2: Alluvial Paperbark Sedge Forest - poor			3.84 ha (34.19 %)

Biometric vegetation type (BVT)	PCT ID	Vegetation zones	Status (TSC Act)	Fauna habitat type	Proportion of study area (ha)
Typha rushland (HU951)	1737	3: Freshwater Wetland - Moderate	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands)	Open wetland	1.53 (13.62 %)
		4: Freshwater Wetland - Poor			0.16 (1.42 %)
Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (HU782)	1568	5: Coastal Narrabeen Moist Forest – moderate	Not listed	Moist/riparian forest	0.89 (7.92 %)
		6: Coastal Narrabeen Moist Forest - poor			0.24 (2.14 %)
n/a		Exotic Trees and Shrubs – Low Condition	Not listed	Modified habitats	1.11 (9.88 %)
				<b>TOTAL</b>	11.23 ha (100 %)









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Figure 2-1 | Vegetation zones and communities





### Legend

-  Concept design
-  Retaining wall
-  Power line
-  Watercourse

### Vegetation zones and communities

-  1: Alluvial Paperbark Sedge Forest
-  2: Alluvial Paperbark Sedge Forest - Poor Condition
-  3: Freshwater Wetland
-  4: Freshwater Wetland
-  5: Coastal Narrabeen Moist Forest
-  6: Coastal Narrabeen Moist Forest - Poor Condition
-  Exotic Trees and Shrubs - Low Condition

### Condition of vegetation

-  High
-  Moderate
-  Low
-  Very low

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Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014

## SPECIES IMPACT STATEMENT

Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow



### 2.3.2 General fauna habitat and condition

The habitats available for fauna in the study area are dominated by the low-lying and periodically inundated swamp forests making up 65 per cent of the study area. These surround open wetlands and drains and the naturally formed Cut Rock Creek, around 15 per cent. Moist open eucalypt forests occur on more elevated lands and make up 10 per cent of the study area, where this habitat occurs along Cut rock Creek, there is heavy weed infestation and growth of exotic trees and shrubs and the habitat is modified and degraded.

The study area is characterised by a landscape of small and disturbed patches of urban bushland that are heavily fragmented by the highway, rail corridor, and cleared industrial and residential development. These factors would limit the presence of less mobile fauna species and those intolerant of continual traffic noise and lights and general disturbance from weeds, and pollution. As a consequence the overall fauna diversity is low and dominated by mobile species that are capable of movements across a fragmented landscape and tolerant of disturbed habitats.

Despite the fragmentation and disturbance, the habitats present do provide food and shelter resources for mobile and resident fauna, including threatened fauna species, in particular the Grey-headed Flying-fox, Powerful Owl and threatened microbats. There is less likelihood stable breeding populations occur for threatened small mammals, gliders, Koala or the Eastern Pygmy Possum. The lack of tree hollows would further limit opportunities for hollow-dependent fauna.

The swamp forest habitats are dominated Swamp Mahogany (*E. robusta*), a keystone winter-flowering species, within these habitats. There is a diversity of tree sizes and ages and the presence of this species in abundance contributes to important food resources for the nectivorous birds and bats, including the Grey-headed Flying-fox, Swift Parrot, Regent Honeyeater and Little Lorikeet.

The most notable habitat in the study area for fauna is associated with the open wetland habitats, in which a number of common amphibian and bird species were recorded. Whilst likely to be have been modified and influenced by existing road, rail, development and constructed drainage adjacent to the study area, the wetland habitats are currently large, well established and densely vegetated and thus may provide temporary refuge, shelter and food for a diversity of waterfowl or wetland dependent birds, including threatened species such as the Black Bittern and Black-necked Stork.

The dense nature of the wetland vegetation and temporary inundation of the swamp forest habitat provides opportunities for frogs in terms of shelter, protection from predators, refuge during dry periods, and as sites for the deposition of eggs so a diversity of frog species could be expected.

There is potential for some migratory bird species to use the open wetland habitats for foraging and resting. However these areas are considered to provide only very marginal nesting habitat for migratory birds and would not constitute 'important habitat' as defined in the EPBC Act policy 3.21.

### 2.3.3 Local and regional wildlife corridors and connectivity

The study area is characterised by a landscape of small and disturbed patches of urban bushland that are heavily fragmented by the highway, rail corridor, and cleared industrial and residential development. The only vegetated corridor evident in the study area is the disturbed riparian vegetation retained along parts of Cut Rock Creek, next to the rail and road corridor. This would experience temporary disturbance during construction although it would not be compromised over the long-term.

Gosford City Council has recognised in the past, there has been minimal investigation and preservation of wildlife corridors in the LGA, and in 2002 implemented a pilot corridors project (Gosford City Council, 2004). Since the road to be upgraded already exists, it is not likely the road widening will adversely affect any wildlife corridors. However, two unnamed bushland reserves were identified by Gosford City Council, located on the southern boundary of the Pacific Highway – on either side of the Pacific Highway and The Ridgeway intersection. From this intersection northwards, the Pacific Highway traverses bushland, which has not specifically been identified as a bush reserve. These areas are likely to act as wildlife corridors.

The range of fauna species recorded in the ecological assessment for the REF is dominated by common urban-dwelling species, and highly mobile fauna species, such as birds and the Grey-headed Flying-fox. It is likely movements by less mobile fauna species across the road at this location are currently very restricted due to the

fenced barrier present along the northern side of the highway. This includes a concrete barrier and mesh fence, which separates pedestrians from the high traffic volumes along this section of the highway. The proposal will involve minimal further fragmentation. A map showing the existing barriers to fauna movements in the study area is shown as **Figure 2-2**.

#### 2.3.4 Wetlands and other water bodies

The natural hydrology regimes in the study area have likely been altered over decades of development associated with residential, commercial and industrial development and the associated network of roads, rail and artificial drainage structures. This is evident by the pooling of water in former ephemeral swamp forest communities and extent of tree stress and dieback in deeper wetland areas possibly associated with soil waterlogging.

The mosaic of natural drainage lines have been replaced by a network of pipes and drains both in the current road corridor and on external developments. These have redirected flows and modified discharges resulting in the creation of a series of water detection basins either side of the highway which have been allowed to colonise with aquatic vegetation and form relatively large open wetland type habitats, with some value for fauna, albeit disturbed. Subsequently there are now a number of waterways and wetlands in and around the study area that may be either directly or indirectly impacted by the proposal. Areas which will be directly affected are shown in **Figure 2-3** and include:

- **Wetland A:** A moderately deep wetland at the south-western end of the project located between Pacific Highway, The Ridgeway and Lisarow High School referred to locally as 'Lisarow Wetland'. The wetland is listed on the Lisarow High School website as the school currently has a bush regeneration program for areas of the EEC located near to the wetland. The wetland is part of a much larger key management site for the conservation of *Melaleuca biconvexa* under the Saving Our Species (SOS) program (OEH 2015).
- **Wetland B:** A low-lying area located within a 'D-shaped' parcel of land to the north of the highway between the road and the rail line. The low-lying area receives water from the south via a culvert below the highway and storm water from a culvert underneath the Main Northern Railway Line from Railway Crescent. Water from the wetland drains to the north via a culvert near the rail overbridge which drains into Cut Rock Creek. This wetland is dominated by Bulrushes (*Typha* spp) and appears ephemeral; being mostly dry around the edges, with very shallow standing water entering from culvert below the highway from the north.
- **Wetland C:** A shallow wetland directly opposite the Lisarow railway station on the south-eastern side of the Pacific Highway, fed by an unnamed creek running parallel to The Ridgeway and water from Wetland A. The wetland eventually drains to the north to join Cut Rock Creek via a series of natural and artificial drainage lines. A small portion of the wetland drains into Wetland B via two culverts located to the north of the Pacific Highway and The Ridgeway intersection.
- **Cut Rock Creek catchment:** Is the predominant waterway within the study area, refer to Figure 2-3. The Cut Rock Creek drainage area is around 10 square kilometres, flowing in a general south-north direction before converging with Bangalow Creek, Ourimbah Creek and eventually the estuarine reaches of Tuggerah Lakes. Upstream of this, some small ephemeral unnamed tributaries flow into Cut Rock Creek, both above and within the study area. Next to the proposal is an existing urban drain located to the east of the Pacific Highway extending from the north of The Ridgeway/Pacific Highway intersection to around 30 metres to the north of MacDonald's Road that drains into Cut Rock Creek. These urban drains are not considered key fish habitat and are classified as class 4 waterways according to the Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (Department of Primary Industries (DPI), 2013).
- **Narara Creek Catchment:** A very small part of the study area to the south of the Lisarow Railway Station also falls within the upper limit of the neighbouring Narara Creek Catchment. Only a very small portion of the proposal drains into this catchment.



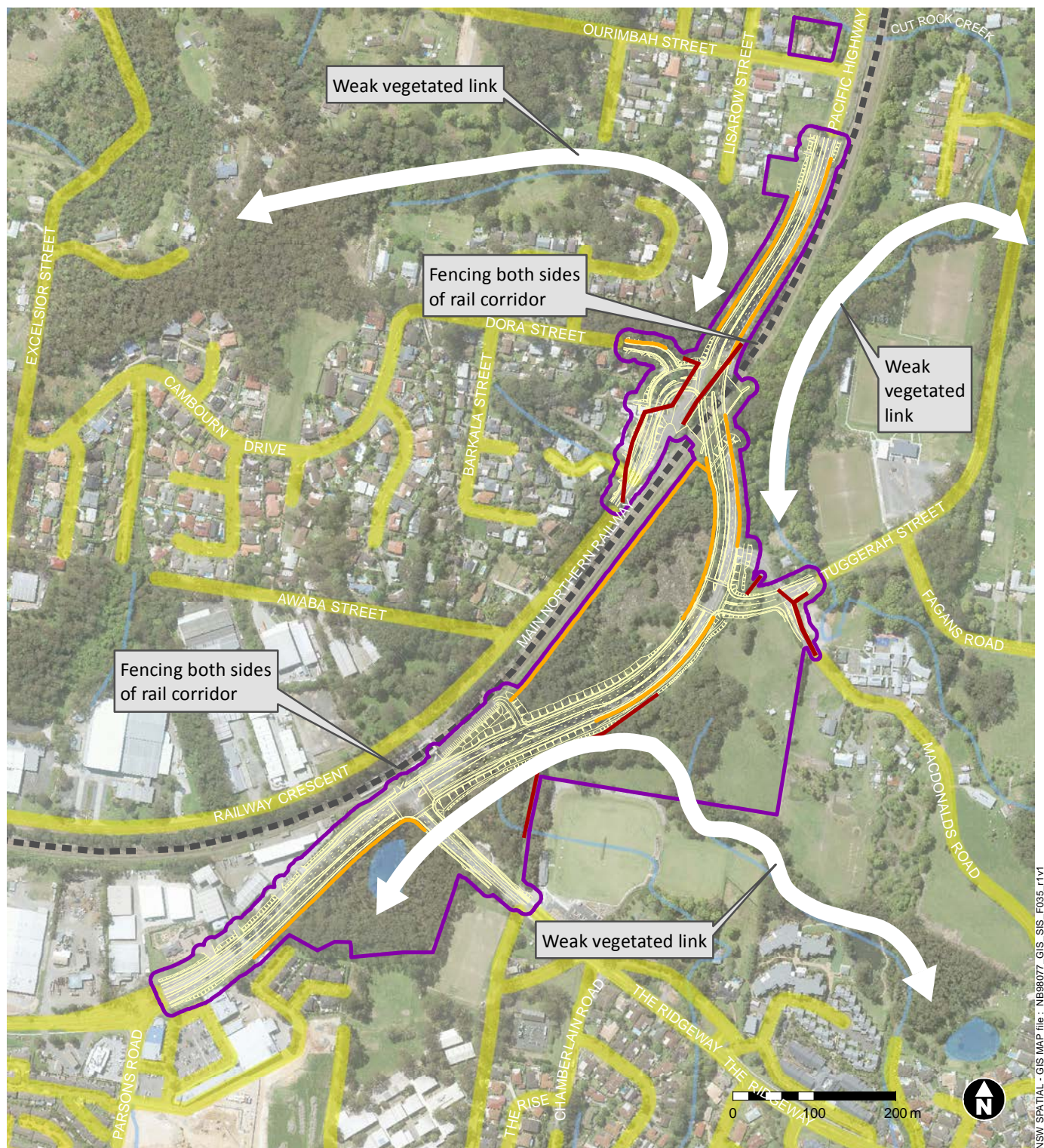


Figure 2-2 | Connectivity and barriers to fauna movement in the study area

### Legend

-  Concept design
-  Study area
-  Power line
-  Retaining wall
-  Watercourse
-  Road
-  Railway

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2015  
LPI 2014  
Jacobs 2014

### SPECIES IMPACT STATEMENT

Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow











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Figure 2-3 | Wetlands A, B, C and Cut Rock Creek

### Legend

- |   |                |   |  |
|---|----------------|---|--|
|  | Concept design |  | Cut Rock Creek   |
|  | Retaining wall |  | Wetland (comprised of Alluvial Paperbark Sedge Forest and Freshwater Wetlands) |
|  | Power line     |   |  |
|  | Watercourse    |   |  |

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



The areas surrounding these waterbodies are substantially urbanised and include residential, industrial, recreational areas, road and rail. The proximity of these waterbodies to these land uses has resulted in a high degree of degradation. In the studies conducted for the REF algae were reported in drainage areas next to the highway at the northern end and adjacent to The Ridgeway, and petro-chemical pollution was observed in the Lisarow wetland and at several locations throughout the forested wetlands, as evidenced by slicks on the surface of water in swamp forest areas.

There has also been considerable alteration of the surface hydrology in this location, historically associated with road and residential development and artificial drainage infrastructure. It is likely the Lisarow Wetlands (Wetlands A) and the large Typha wetland (Wetlands B) on the western side of the Pacific Highway have been substantially modified. This is evidenced by observations of stressed trees and dieback of trees and groundcovers observed during the REF and ponding around the fill embankments associated with the construction of the existing Pacific Highway, the railway and surrounding developments including sporting fields. The open water habitats are therefore likely associated with a long-term change in the structure of the vegetation from a forested wetland to an open wetland dominated by bulrushes (*Typha spp*) and sedges (*Phragmites spp*) and, in the case of the Lisarow Wetland, the permanent inundation has resulted in some tree dieback. These substantially modified aquatic habitats were observed to be impacted by large volumes of silt, rubbish, petro-chemical pollution and algae during the REF / SIS investigations.

There are a number of coastal wetlands identified under the State *Environmental Planning Policy No 14 – Coastal Wetlands* (SEPP 14) located to the south and north of the proposal and these occur in areas surrounding Brisbane Water and Tuggerah Lakes respectively. These SEPP 14 wetlands are outside the study area and the locality and at least 10 to 12 kilometres away from the proposal. Apart from the Lisarow Wetland area, the study area is not located on or close to any other important or listed wetlands either nationally or by local council.

### 2.3.5 Geology and soils

The 100,000 geological sheet (2009) for Gosford-Lake Macquarie, shows the study area is underlain by quaternary alluvium, comprising gravel and sands. These overlay the Triassic age (230 million years) sediments of the Terrigal Formation in the Narrabeen Group (Gosford subgroup), comprising interbedded laminite, shale, and quartz to lithic-quartz sandstone, with minor red claystone (north of the Hawkesbury River).

The Gosford – Lake Macquarie 1:100,000 soil landscape sheet shows the proposal is generally within the Yarramalong soil landscape with some smaller areas encroaching on areas described as Erina soil landscapes refer to Jacobs (*September 2014*), *Soil and Contamination Investigation Report* for further details.

The Yarramalong soil landscapes are composed of Quaternary sediments including gravels, sands, silts and clays. The Yarramalong landscapes are described as level to gently undulating alluvial plains. Soils in this landscape were originally covered by tall open-forest that has since been cleared. Soils are generally prone to flooding, may have foundation hazards, low fertility and be moderate to slightly acidic.

Erina soil landscapes are characterised by undulating to rolling rises and low hills on the Terrigal Formation of the Narrabeen Group which is typically composed of quartz sandstones and siltstone, claystone and conglomerates. Original vegetation was composed of tall open forest that has been extensively cleared. Soils in this landscape often have a high soil erosion hazard, strongly acid soils and low fertility.

These soil landscapes are consistent with the vegetation types in the study area, with wetlands and swamp forest on low elevated alluvial soils and wet sclerophyll forest on sheltered slopes underlain by Narrabeen sandstone.

Acid sulfate soils (ASS) are soils and sediments containing iron sulfides that, when disturbed and exposed to oxygen, generate sulfuric acid and toxic quantities of aluminium and other heavy metals. The sulfuric acid and heavy metals are produced in forms that can be readily released into the environment, with potentially adverse effects on the natural and built environment and human health.

The majority of ASS are formed by natural processes under specific environmental conditions. This generally limits the occurrence of acid sulfate soils to low lying sections of coastal floodplains, rivers and creeks where surface elevations are less than about five metres Australian Height Datum (AHD).

A review of the NSW Acid Sulfate Soils Risk Maps (NSW Department of Land and Water Conservation 1997), CSIRO Australian Soil Resource Information System (ASRIS) and the GCC Gosford Electronic Mapping System (GEMS) indicates that the proposal is outside of the identified ASS risk areas.

However, due to the limited confidence and reliability of information within the mapping tools, low lying areas of the proposal are expected to be underlain by saturated soils and consequently there is a considered risk of encountering ASS during construction of the proposal. The project REF recommended an investigation of ASS is targeted in low lying and saturated areas within the proposal's footprint. The targeted ASS investigation would be carried out in accordance with the *NSW Guidelines for the Management of Acid Sulfate Materials* (RTA, 2005).

### 2.3.6 Landscape

The study area is located within the Sydney Basin Bioregion. The south-western end of the proposal area is located within the Gosford Cooranbong Coastal Slopes (Gcs) (DECC 2002) and extends for approximately 200 metres from Parson Road north-east before the landscape transitions to Sydney-Newcastle Coastal Alluvial Plains (Sna), which covers the majority of the proposed area (refer to Figure 2-4).

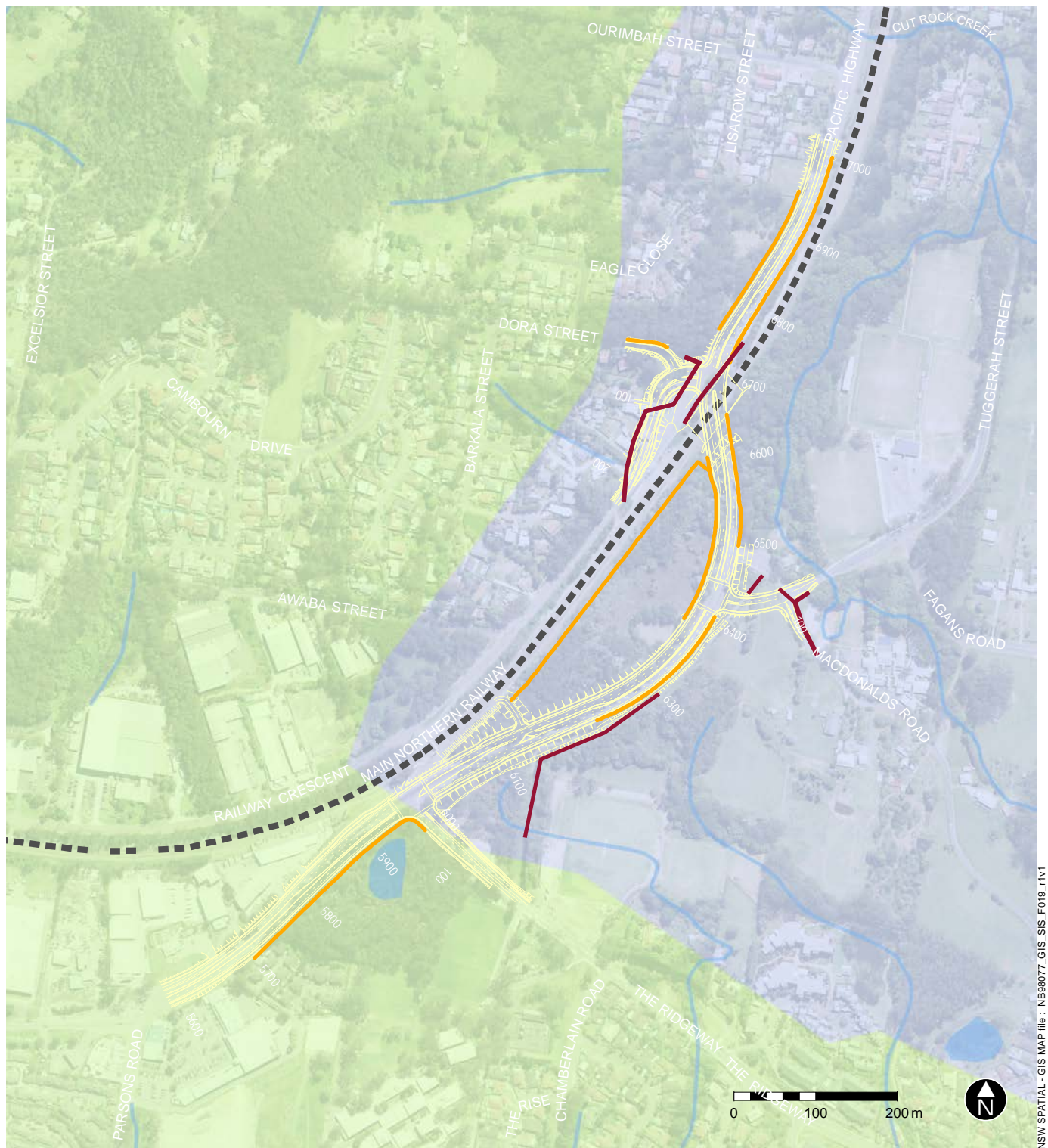
Gcs are characterised by rolling hills and sandstone plateau outliers of Triassic Narrabeen sandstones, extensive rock outcrops and low cliffs along ridge margins. These areas have textured contrast soils on lithic sandstones and shales; loamy sand alluvium along creeks; and organic sand and mud in lagoons and swamps. Elevations for these areas typically range from 0-75 metres (DECC, 2002).

Sna are characterised by undulating plains and low rises on Quaternary sand or Permian / Triassic sandstone or shale with swampy valley floors. The soil profiles are typically composed of siliceous uniform sand, deep podsol and yellow or brown texture-contrast soils on bedrock. Elevations for these areas typically range from 0-80 metres with a 20 metre local relief (DECC, 2002).

As stated the study area is characterised by a landscape of small and disturbed patches of urban bushland (1-5 hectares) that are heavily fragmented by the highway and the rail corridor, including Lisarow train station, along with cleared industrial and residential development.

The dominant character of the study area is defined by a low-lying alluvial plain, which runs from the southern extent of the proposal through to the rail crossing in the north where the proposal intersects a spur of the western valley edge. The elevation of this plain varies from 20 to 40 metres AHD. To the east, the valley floor and its low-lying land extends from 350 metres up to one kilometre from the road before the ground begins to rise.







A small but steep ridge defines the route to the west with the ground rising steeply from its edge to a high point of 100 metres (AHD). The Pacific Highway brushes against this ridge at the northern end of the corridor after crossing the railway line where a small cut is exposed.



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Figure 2-4 | Mitchell Landscapes

### Legend

	Concept design		Mitchell landscapes
	Retaining wall		Gosford - Cooranbong Coastal Slopes
	Power line		Sydney - Newcastle Coastal Alluvial Plains
	Watercourse		

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014

### 2.3.7 Fire history

There is limited evidence of fire in the last five to ten years within the habitats in the study area. Considering the highly mesic nature of the majority of vegetation communities (i.e. freshwater wetlands and swamp forest) these areas are not highly prone to bushfire and would be protected from fire to avoid impacts. Areas of Coastal Narrabeen Moist Forest are also relatively mesic, supporting an understorey of ferns and rainforest species with no evidence of recent fire. However, these areas are likely to be naturally subject to occasional wildfires.

### 2.3.8 Land uses and zoning

The locality as referred to in this report encompasses the area in a ten kilometre radius of the study area. All background searches were based on this area, which includes industrial, residential and public lands. The proposal is located within the Gosford City Council LGA. Consequently, the principal relevant local environmental planning instrument under the EP&A Act is the Gosford Local Environmental Plan 2014 (Gosford LEP 2014).

A substantial proportion of the proposal would be within the existing road corridor, with only minor impacts to other land uses within the proposal area. However, the land zonings (under the LEP) that would be affected by the proposal include:

- SP2 – Infrastructure.
- R1 – General Residential.
- R2 – Low Density Residential.
- RE1 – Public Recreation.
- RE2 – Private Recreation.
- IN1 – General Industrial.
- E2 – Environmental Conservation.
- B1 – Neighbourhood Centre.

Residential development along the corridor is located primarily to the west of the railway corridor and is dominated by R2 – Low Density Residential development typified by individual freestanding suburban development. This zoning offers limited protection to vegetation and threatened species.

A small section of R1 – General Residential, is located at the southern end of the proposal and consists of a two storey townhouse development, which backs onto the Pacific Highway.

A number of recreational areas adjoin the corridor. At The Ridgeway a large green space is located along the highway opposite the railway station. This is zoned RE1 Public Recreation being characterised by low lying lands dominated by Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest), which is listed as vulnerable under the Threatened Species Conservation (TCS) Act. This area of EEC also known to contains areas of the threatened flora species *Melaleuca biconvexa*, which is listed as vulnerable under the TSC Act and the *Environment Protection Biodiversity Conservation 1999* (EPBC Act). The margins of this area have been disturbed and are either cleared or grass. Behind this area is Lisarow High School. These public recreation areas currently provide protection to the floodplain TECs and a portion of the local *Melaleuca biconvexa* population.

Lisarow Station, zoned SP1, occurs at the southern end of the alignment some 500m from its commencement at Parsons Road opposite The Ridgeway. The station provides for commuters and includes off-street parking.

Heading north, the alignment becomes surrounded by densely vegetated areas of Swamp Sclerophyll Forest (EEC). This area is zoned E2 Environmental Conservation reflecting the flood prone nature of the land, and the conservation values of the vegetation community. The E2 zoned land currently provides protection to the floodplain TECs and a portion of the local *Melaleuca biconvexa* population.



Pluim Park occurs to the north east of the alignment just prior to the alignment crossing the rail corridor. This Private Recreation (RE2) space is separated / screened from the alignment by remnant vegetation and is defined by the Pacific Highway, MacDonald's Road and Tuggerah Street. The park consists of three playing fields, car park and associated support buildings.

Lisarow Public School is located to the east of the alignment at the intersection of Tuggerah Street and MacDonald's Road. The school is not visible from the current road corridor with a set-back distance of 100m.

Lisarow Anglican Cemetery is a listed heritage place under the Gosford LEP and located within the Low Density Residential area (R2 zoning). The first recorded burial in the cemetery is dated to 1841, which indicates the land was used as a cemetery before services were held on the site. Burials have consisted of marked and unmarked graves. Unmarked graves could occur between the current property boundary and the existing Pacific Highway.

A Neighbourhood Centre (B1 zoning) is located in Railway Crescent near its intersection with Dora Street and the project REF identifies a substantial impact on this area. There are three commercial / retail buildings here including; the Pryor Brothers shop (a former general store); a boat and lawn mower shop; and a coffee wholesaler. All four buildings lie fully or partly within the footprint of the proposal. The built form doesn't create this as a focus with the latter two buildings set back on their blocks. The Pryor Brothers building is also heritage listed under the Gosford LEP. A Development Application (DA) was obtained by Roads and Maritime to remove the building under Part 4 of the Environmental Planning and Assessment Act (EP&A Act).

A Local Centre (B2 zoning) known as Lisarow Plaza, is located at the southern end of the proposal, at the intersection of Parsons Road and the Pacific Highway. This is a small scale shopping plaza with at grade paved car parking. A landscaped margin also exists along the highway edge screening the parking largely from view. The proposal would not impact on this land use zone.

Opposite this shopping precinct are a number of industrial warehouses in zone IN1. These include self-storage, masonry sales and building product suppliers. All are warehouse structures with security fencing, landscaping, paved access and parking areas and setback from the road corridor.

The LEP zones are shown in Figure 2-5. Roads are permissible with development consent under all of the above zonings. However the *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) operates to remove the otherwise applicable consent requirement. Notwithstanding, the Roads and Maritime would endeavour to design the proposal in line with the broad intentions of the Gosford LEP 2014.

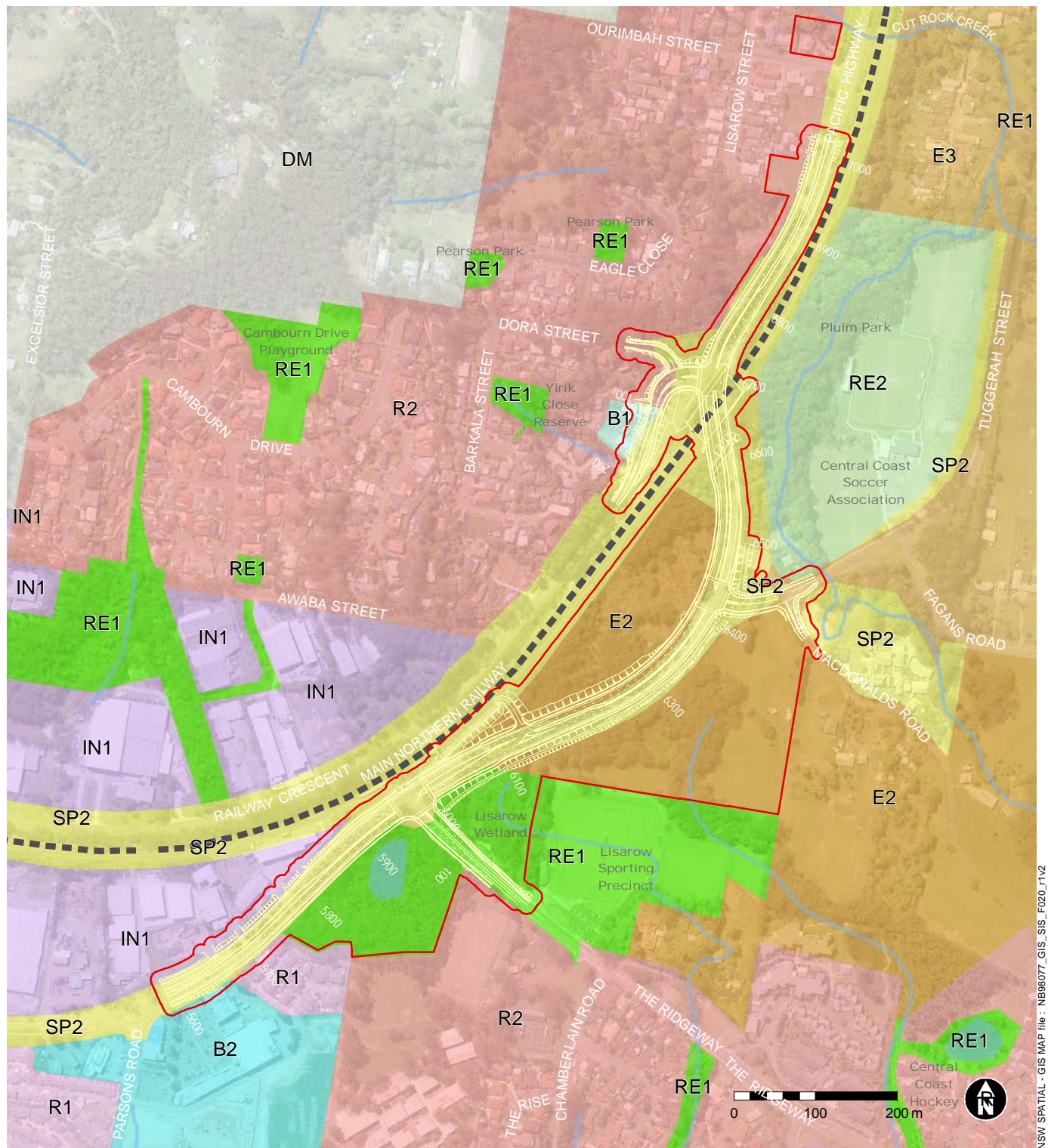
### 2.3.9 State Environmental Planning Policies (SEPP)

#### State Environmental Planning Policy (Infrastructure) 2007

*State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) aims to facilitate the effective delivery of infrastructure across the State. Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. As the proposal is for a road and is to be carried out on behalf of Roads and Maritime, it can be assessed under Part 5 of the EP&A Act. Development consent from council is not required.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and does not affect land or development regulated by *State Environmental Planning Policy No. 14 – Coastal Wetlands*, *State Environmental Planning Policy No. 26 - Littoral Rainforests*, *State Environmental Planning Policy (State and Regional Development) 2011* or *State Environmental Planning Policy (Transitional Major Projects) 2005*.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities before the start of certain types of development. Roads and Maritime has consulted Gosford City Council under ISEPP, about potential impacts of the proposal on locally listed heritage items, flood liable land and council related infrastructure and property. Details of this consultation are provided in Chapter 5 of the Project REF. The ISEPP does not afford any protection to vegetation or habitat for threatened species on the site.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F020\_r1v2

Figure 2-5 | Local Environment Plan Zonings

### Legend

	Concept design		Study area		R1 General Residential
	Retaining wall		Land zoning		R2 Low Density Residential
	Power line		B1 Neighbourhood Centre		RE1 Public Recreation
	Watercourse		B2 Local Centre		RE2 Private Recreation
			E2 Environmental Conservation		SP2 Infrastructure
			E3 Environmental Management		DM Deferred Matter
			IN1 General Industrial		

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Roads and Maritime Services 2014  
AUSIMAGE 2015  
LPI 2014  
Jacobs 2014  
DPE 2015

**State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP No 14)**

*State Environmental Planning Policy No. 14 – Coastal Wetlands* aims to ensure the coastal wetlands are preserved and protected in the environmental and economic interests of the State. It requires development consent for works within areas mapped as being coastal wetlands. This policy is in force under the *Environmental Planning and Assessment Act 1979*.

There are a number of SEPP 14 coastal wetlands located to the south and north of the proposal and these occur in areas surrounding Brisbane Water and Tuggerah Lakes respectively. These SEPP 14 wetlands are at least 10 to 12 kilometres away from the proposal. There would be no direct impacts to SEPP 14 wetlands. There is potential for indirect impacts to SEPP 14 coastal wetlands including sediment laden water and other pollutants entering local waterways which flow into SEPP 14 coastal wetlands surrounding Brisbane Water and Tuggerah Lake during construction. Mitigation measures have been included in the REF to manage these impacts (refer to Section 6.5 and 6.8 of the project REF). The proposal is not located on or close to any other important or listed wetlands.

**State Environmental Planning Policy No. 26 – Littoral Rainforests**

*State Environmental Planning Policy No. 26 – Littoral Rainforests* aims to provide a mechanism for the consideration of applications for development likely to damage or destroy littoral rainforest areas with a view to the preservation of those areas in their natural state. This policy is in force under the *Environmental Planning and Assessment Act 1979*. The proposal would not impact on any areas of littoral rainforest identified under SEPP 26.

**State Environmental Planning Policy No. 19 – Bushland in Urban Areas (SEPP No 19)**

*State Environmental Planning Policy No 19 - Bushland in Urban Areas* (SEPP 19) aims to protect and preserve bushland within urban areas due to its value to the community as part of the natural heritage, its aesthetic value and its value as a recreational, educational and scientific resource. Clause 4 of SEPP 19 defines bushland as 'land on which there is vegetation which is either a remnant of the natural vegetation or, if altered, is still representative of the structure and floristics of the natural vegetation'.

SEPP 19 applies to bushland within the urban areas listed in Schedule 1 of the SEPP, which includes Gosford LGA. SEPP 19 applies to land affected by the proposal. Clause 6(4) of SEPP 19 provides a consent authority must not consent to development affecting bushland zoned or reserved for public open space purposes unless:

- It has made an assessment of the need to protect and preserve the bushland having regard to the aims of this Policy.
- Is satisfied the disturbance of the bushland is essential for a purpose in the public interest and no reasonable alternative is available to the disturbance of that bushland.
- Is satisfied the amount of bushland proposed to be disturbed is as little as possible and, where bushland is disturbed to allow construction work to be carried out, the bushland will be reinstated upon completion of that work as far as is possible.

Vegetation clearing would be required in Environmental Conservation (E2) and Public Recreation (RE1) zoning under the *Gosford Environmental Plan 2014*. These zones could be considered to equivalent to the zoning of which SEPP 19 applies, ie bushland zoned or reserved for public open space purposes.

The vegetation that would be cleared during the construction of the proposal is consistent with the definition of bushland, as defined under Clause 4 of SEPP 19. According to the Infrastructure SEPP discussed previously. However, a trigger for consent under SEPP 19 does not apply for this proposal but the objectives of the SEPP, to preserve local bushland as much as possible is still addressed in the project REF.



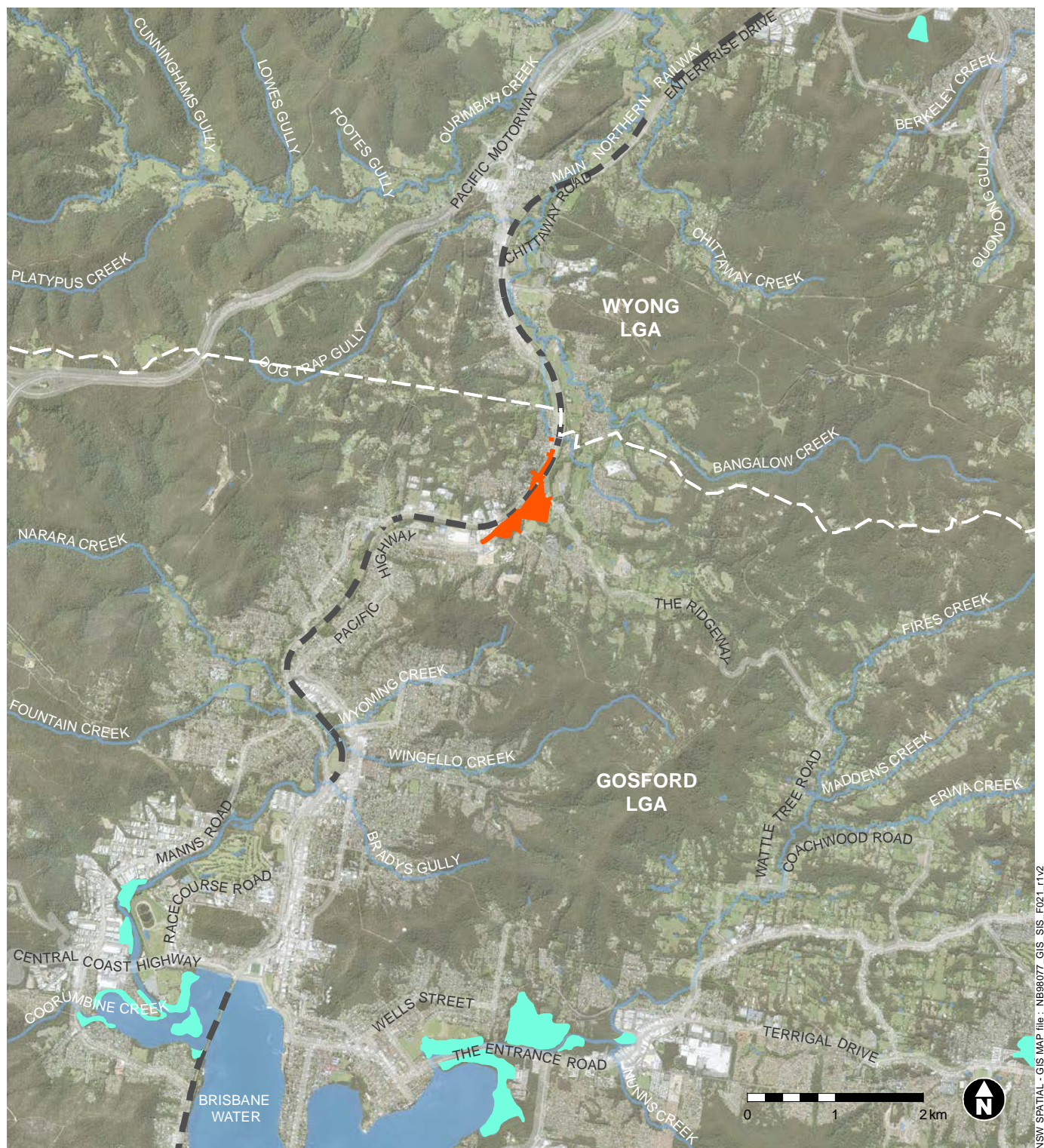


Figure 2-6 | Location of SEPP 14 Wetlands

#### Legend

Study area  SEPP 14 Coastal wetlands

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Roads and Maritime Services 2014  
AUSIMAGE 2015  
LPI 2014, Jacobs 2014  
OEI 2014



**State Environmental Planning Policy No. 55 - Remediation of Land (SEPP 55)**

The objective of *State Environmental Planning Policy No. 55 - Remediation of Land* (SEPP 55) is to provide a state-wide approach to the remediation of contaminated land, for the purpose of minimising the risk of harm to the health of humans and the environment. In accordance with Clause 7(1) of SEPP 55, a consent authority must not consent to the carrying out of any development on land unless it has considered whether the land is contaminated.

A number of potential areas of concern have been identified in the proposal area. These include:

- Industrial Properties.
- Rail Corridor.
- Two areas of imported fill.
- Potential workshop areas associated with commercial properties.

The *Upgrade of Pacific Highway HW10, Ourimbah Street to Parsons Road, Lisarow Soils and Contamination Investigation Report* (Jacobs 2014) (refer to Appendix L of the project REF) has recommended that a Phase 2 Contamination Assessment is completed in accordance with the NSW RTA Contaminated Land Management Guideline (2005), to quantify risk at the properties identified to hold increased contamination risk. The Phase 2 assessment was carried in 11 August 2014 and 7 October 2014 and the results are summarised in Appendix F of the project REF Submissions report.

The *Soil and Contamination Investigation – Phase 2 Report* (Jacobs 2015) made the following conclusions based on the review of available information, site inspections, analytical results at the locations tested and the Qualitative Risk Assessment:

- Concentrations of contaminants within soil samples were detected at levels in excess of the adopted assessment criteria for the following two contaminant categories:
  - The PAH – benzo(a)pyrene exceeded the National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (National Environment Protection Council's (NEPC), 1999), amended 2013 (NEPC, 2013), ecological screening levels within the rail corridor next to the Lisarow rail overpass (at depths of 0.5 metres, 0.9 metres and 1.9 metres) and within the workshop area (at depths of 0.5 metres and 0.9 metres).
  - Chrysotile, Amosite and Crocidolite asbestos was detected within fill materials (at a depth of 1.8 metres) to the north of The Ridgeway.
- The remainder of samples and analytes were either below the laboratories limit of detection, or below the adopted assessment criteria for the respective analytes. Additional contaminants may be present at locations that were not tested as part of the Phase 2 Soils and Contamination Investigation undertaken by Jacobs.
- Additional contamination investigations will be undertaken in the area identified as workshops to determine the extent of PAH contamination. Additional testing will inform the Contaminated Land Management Plan, specifically:
  - The interaction of the construction work with contaminated materials.
  - Workplace, health and safety requirements to ensure the safety of site personnel (including hygiene practices) and local communities during construction.
  - Waste classification for any material that is to be removed from site or managed on site.
  - Provide details on the management of any residual contamination in relation to the final land use and whether a remediation action plan is required to validate the site.
  - Procedures to deal with unexpected contamination (eg stained or odorous soil and / or waters encountered during construction).

## 2.4 Provision of relevant plans and maps

The provision of relevant plans and maps in this Species Impact Statement is summarised below in Table 2-4 including the relevant section and figure number where each map or plan can be located.

Table 2-4: Provision of relevant plans and maps

Figure no.	Relevant plans and maps	Section
1-1	Regional locality	1-1
1-2	The proposal	1.2
1-3	Study area and project footprint	1.3
2-1	Vegetation zones and communities	2.3.1
2-2	Connectivity and barriers to fauna movement in the study area	2.3.3
2-3	Wetlands A, B C and Cut Rock Creek	2.3.4
2-4	Mitchell Landscapes	2.3.6
2-5	Local Environment Plan Zonings	2.3.8
2-6	SEPP 14 Coastal Wetlands	2.3.9
4-1	Location of flora survey traverses and plots	4.2.4
4-2	Location of fauna survey sites and techniques	4.2.5
4-3	Melaleuca biconvexa in the study area	4.3.1
4-4	Regional distribution of Melaleuca biconvexa	4.3.1
4-5	Fauna habitats and threatened fauna records in the study area	4.3.2
4-6	Threatened ecological communities	4.4
5-1 to 5-8	Threatened species habitat mapping	5.5

## 2.5 Land tenure information

The proposal would require partial acquisition of 13 properties and full acquisition of ten properties. Table 2-5 lists the 23 properties would be acquired.

Roads and Maritime has undertaken consultation with affected landowners about the area of acquisition required as a result of the proposal. Final areas of acquisition would be finalised during detailed design in consultation with these affected landowners.

All property acquisitions would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, the *Roads Act 1993* and Roads and Maritime's *Land Acquisition Information Guide February 2012* (Roads and Maritime, 2012c).

Table 2-5: Properties where land would be acquired

Lot	DP	Acquisition area (square metres)	Type of acquisition	Status
102	1172179	503	Partial acquisition	To be acquired
4	815279	389	Partial acquisition	To be acquired
5	815279	375	Partial acquisition	To be acquired
0	SP83883	195	Partial acquisition	To be acquired
1	553146	4,574	Partial acquisition	To be acquired
1 SEC 17	2417	28,229	Partial acquisition comprised of: <ul style="list-style-type: none"> <li>23,812 square metres to the West of the Pacific Highway</li> </ul>	To be acquired

Lot	DP	Acquisition area (square metres)	Type of acquisition	Status
			<ul style="list-style-type: none"> <li>4,417 square metres to the east of the Pacific Highway</li> </ul>	
10	838947	9,722	Partial acquisition <ul style="list-style-type: none"> <li>9,092 square metres to the west of the Pacific Highway</li> <li>630 square metres to the east of the Pacific Highway</li> </ul>	To be acquired
11	838947	303	Full acquisition	To be acquired
7	1120209	617	Full acquisition	To be acquired
120	844315	1,429	Full acquisition	Acquired
1	590606	604	Full acquisition	Acquired
2	590606	1,141	Full acquisition	To be acquired
1	300669	332	Full acquisition	To be acquired
4	232680	302	Partial acquisition	To be acquired
3	232680	657	Full acquisition	Acquired
2	232680	533	Full acquisition	To be acquired
1	784504	553	Full acquisition	To be acquired
2	1059717	1,876	Partial acquisition	To be acquired
1	1059717	1,479	Partial acquisition	To be acquired
33	1022683	564	Full acquisition	Acquired
10	1047882	171	Partial acquisition	To be acquired
5	809307	2,672	Partial acquisition	To be acquired
6	237537	1,256	Partial acquisition	To be acquired

The proposal would also impact on areas of existing road reserve and rail corridor zoned SP2 Infrastructure according to the Gosford LEP. Road reserve includes areas of the existing Pacific Highway managed by Roads and Maritime and areas of road reserve for the local roads identified as Railway Crescent, Dora Street, Tuggerah Street, MacDonald's Road and The Ridgeway which are managed by Gosford City Council. Rail corridor includes direct and indirect impacts to areas of the Main Northern Railway Line near the Lisarow Rail Overbridge. The proposal would also have potential for direct impacts to an area of RE2 – Private recreation in the vicinity of Plum Park to the north of Tuggerah Street however no property acquisition is required.

### 3. Initial Assessment

#### 3.1 Identifying subject species and ecological communities

##### 3.1.1 Review of available information and data

The list of potential subject species was provided in the DGRs and from a review of existing information and government maintained databases. The following sources were reviewed for information of threatened flora and fauna and endangered ecological communities previously recorded in the locality:

- Gosford City Council Local Environmental Plan (LEP) (2014).
- Gosford City Council Significant Vegetation Map (Accessed April 2014).
- Atlas of NSW Wildlife, maintained by the NSW Office of Environment and Heritage.
- NSW BioNet (OEH Accessed July 2015).
- The Protected Matters Search Tool (PMST) provided under the EPBC Act (Accessed April 2014).
- The Natural Vegetation of the Gosford Local Government Area, Vegetation Mapping (Bell 2004).
- The Natural Vegetation of the Wyong Local Government Area, Vegetation Mapping (Bell 2002).
- Hunter, Central and Lower North Coast Vegetation Classification and Mapping Project (Somerville 2009).
- Risk assessment guidelines for groundwater dependent ecosystems, Volume 3 – Identification of high probability groundwater dependent ecosystems on the coastal plains of NSW and their ecological value, (Kuginis L., Byrne G., Serov P, Williams J.P., 2012).

A number of ecological studies have been prepared for RMS prior to the SIS to investigate the potential ecological values and impacts associated with upgrade of the Pacific Highway at this location. These reports were reviewed for context in the SIS with regard to potential impacts and additional accounts of threatened species and communities and included:

- Preliminary Ecological Investigation. Pacific Highway Improvements Stage 4 – Manns Road Narara to Railway Crescent Lisarow (Hyder 2009).
- Pacific Highway Upgrade Narara to Lisarow Biodiversity Assessment (Parsons Brinckerhoff 2012).
- Pacific Highway and Wyong Road Intersection Ecological Survey Report (Parsons Brinckerhoff 2013).

The background review confirmed the list of potential candidate species identified in the DGRs for further investigation.

##### 3.1.2 Spatial data and imagery

The following spatial data sources were used in the initial assessment and preliminary investigations:

- Wyong Shire Council (2015) *Melaleuca biconvexa* - polygon spatial data layer
- OEH (2015) Atlas data records - *Melaleuca biconvexa*.
- Broad-scale vegetation mapping (Somerville 2009; Bell 2002; Bell 2004).
- Cadastral and property data.
- Local Environment Plans – Wyong Shire Council and Gosford City Council.

#### 3.2 Identification of targeted threatened flora species

A total of four threatened flora species have been identified in the DGRs as requiring consideration and each of these species were confirmed in the locality from the database searches as potential subject species in the study area. Table 3-1 further lists the species and assesses their suitability as subject species. Each species is considered to potentially occur in the study area. No other threatened flora species were considered to have potential to occur based on database records and habitat suitability.



Table 3-1: Threatened flora target species

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Known habitat preference / comments	Subject species
Biconvex Paperbark ( <i>Melaleuca biconvexa</i> )	V	V	383	Occurs in damp areas, often near watercourses, on alluvium soils over shale. The species may form a dense stand in a narrow strip adjacent to a watercourse.	Yes
Magenta Lilly Pilly ( <i>Syzygium paniculatum</i> )	E	V	61	This species is found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas. Rainforests are often remnant stands of littoral or gallery rainforest.	Yes
Spider Orchid ( <i>Dendrobium melaleucaphilum</i> )	E	-	1	Occurs in coastal districts and nearby ranges. Grows frequently on <i>Melaleuca styphelioides</i> , less commonly on rainforest trees or on rocks.	Yes
Tranquil Mintbush ( <i>Prostanthera askania</i> )	E	E	97	Occurs adjacent to, but not immediately in, drainage lines on flat to moderately steep slopes formed on Narrabeen sandstone and alluvial soils derived from it.	Yes

E = Endangered, V = Vulnerable

### 3.3 Identification of targeted threatened fauna species

A total of 41 threatened fauna species listed under the TSC Act have been identified in the DGRs and by database searches as requiring consideration and / or confirmed from database records as potential subject species. Table 3-2 further lists the species and assesses their suitability as subject species. The potential for these species to occur has been assessed based on the habitat types present in the study area and their condition and patch size, and the known and characteristic habitat preferences of the subject species being assessed. From the list of 41 species assessed 24 of these are considered to have potential to occur in the study area and were targeted in fauna surveys for the REF and SIS.

Table 3-2: Threatened fauna target species

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
<b>BIRDS</b>					
Barking Owl ( <i>Ninox connivens</i> )	V	-	10	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Suitable habitat would include the swamp forest and moist forest communities	Yes
Black Bittern ( <i>Ixobrychus flavicollis</i> )	V	-	17	Inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation. The open wetland habitats, particularly on the intersection of Pacific Highway and The Ridgeway provide permanent water and dense vegetation and are considered suitable	Yes

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
Black-necked Stork ( <i>Ephippiorhynchus asiaticus</i> )	E	-	10	The species is a vagrant in the study area and past records are associated with larger open wetlands and floodplain habitats in the region. Floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers are the key habitat in NSW for the Black-necked Stork. Secondary habitat includes minor floodplains, coastal sand plain wetlands and estuaries. There is a low chance of occurring, although the open vegetated wetland does provide suitable habitat.	Yes
Eastern Osprey ( <i>Pandion cristatus</i> )	V	-	14	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. There are no suitable foraging areas for this species in the study area despite the number of records in the region, which are associated with lakes and near coastal areas, considered unlikely to occur.	No
Gang-gang Cockatoo ( <i>Callocephalon fimbriatum</i> )	V	-	13	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box ironbark assemblages, or in dry forest in coastal areas. Records of this species are associated with the taller wet sclerophyll forests known in the locality. A small area of potential habitat occurs in the northern end of the study area.	Yes
Glossy Black-cockatoo ( <i>Calyptorhynchus lathami</i> )	V	-	101	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak ( <i>Allocasuarina littoralis</i> ) and Forest Sheoak ( <i>A. torulosa</i> ) are important foods. Despite the abundance of records in the wider study locality, there are no important food tree species for the Glossy Black-Cockatoo in the study area and the species is considered unlikely to utilise the habitat in the study area.	No
Grey-crowned Babbler ( <i>Pomatostomus temporalis</i> )	V	-	2	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. The low-lying swamp forest and wetland habitats in the study area are not suited to this species.	No
Little Eagle ( <i>Hieraaetus morphnoides</i> )	V	-	5	Occupies open eucalypt forest, woodland or open woodland. She-oak or Acacia woodlands and riparian woodlands of interior NSW are also used. The habitat preferences of this species are broad, and individuals may occupy a diversity of habitats over relatively large areas, and should be considered to potentially occur.	Yes
Little Lorikeet ( <i>Glossopsitta pusilla</i> )	V	-	26	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in apples ( <i>angophora</i> sp.), paperbarks	Yes

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
				(melaleuca sp.) and other tree species. Riparian habitats are particularly used. The species could visit the swamp forest and moist forest habitats in the study area particularly during the winter when the abundance of Swamp Mahogany present in the study area.	
Masked Owl ( <i>Tyto novaehollandiae</i> )	V	-	21	Dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting. The habitat is marginal for this wide-ranging species, there is potential to frequent the edges of the cleared land and eucalyptus forest to the east of the Pacific Highway.	Yes
Painted Honeyeater ( <i>Grantiella picta</i> )	V	-	21	Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> . Feeding resources are absent or very limited in the study area, and the dominant wet low-lying habitats are not suitable.	No
Powerful Owl ( <i>Ninox strenua</i> )	V	-	120	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. This wide-ranging species could utilise all forest areas of the site, for hunting and prey species were identified in the survey. Large hollows are absent.	Yes
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	CE	CE	11	The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak. In coastal areas on NSW, the species has been reported in low-lying swamp forest habitats dominated by Swamp Mahogany and therefore has potential to occur in the study area.	Yes
Sooty Owl ( <i>Tyto tenebricosa</i> )	V	-	144	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. There is no rainforest in the study area. Two small areas of moist forest occur at the northern end of the study area, both areas are very small patches and heavily disturbed, in particularly the gully habitat which has a high density of Camphor Laurel and privet. The species is not expected to utilise the habitats adjoining the highway at this location despite a high number of records in the wider locality.	No

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
Square-tailed Kite ( <i>Lophoictinia isura</i> )	V	-	5	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests. The species occupies a wide range of habitats and may utilise the forested wetlands and moist forests in the study area on occasion.	Yes
Superb Fruit-dove ( <i>Ptilinopus superbus</i> )	V	-	3	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. The habitat is not considered suitable and there is a lack of food resources to attract this species.	No
Swift Parrot ( <i>Lathamus discolour</i> )	E	E	47	On the mainland they occur in areas abundant with winter-flowering eucalypts or where there are abundant lerp (from sap-sucking bugs) infestations. This species is known to visit Swamp Mahogany forests in the central coast area of NSW and may visit the site during the winter.	Yes
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	V	-	14	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Rough-barked Eucalypts are present and the species has a low likelihood of occurring.	Yes
Wompoo Fruit-dove ( <i>Ptilinopus magnificus</i> )	V	-	2	Occurs in, or near rainforest, low elevation moist eucalypt forest and brush box forests. The habitat is not considered suitable and there is a lack of food resources to attract this species.	No
<b>MAMMALS</b>					
Eastern Bentwing-bat ( <i>Miniopterus schreibersii oceanensis</i> )	V	-	75	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 manmade structures. Will utilise a range of forest and urban bushland remnants for foraging.	Yes
Eastern Chestnut Mouse ( <i>Pseudomys gracilicaudatus</i> )	V	-	1	Mostly found, in low numbers, in heathland and is most common in dense, wet heath and swampy heath. The tall flooded swamp forests, wetlands and moist forests with limited ground cover are not suited to this species. The habitat is too degraded and isolated to support populations of this species and the nearest record is from coastal heath.	No
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )	V	-	23	Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Yes
Eastern Freetail-bat ( <i>Mormopterus norfolkensis</i> )	V	-	21	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.	Yes



Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
Eastern Pygmy-possum ( <i>Cercartetus nanus</i> )	V	-	15	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. The habitat lacks important food resources and is too degraded and isolated to support populations of this species. Regional records are associated with coastal forests, and heaths to the east of Lisarow	No
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )	V	-	29	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.	Yes
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	V	V	3629	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Important winter food resources are present and there are known roost sites within 50 km of the study area indicating the species is likely to utilise the habitat in the study area for foraging.	Yes
Koala ( <i>Phascolarctos cinereus</i> )	V	V	17	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. A known food tree species is present, the Swamp Mahogany ( <i>E.robusta</i> ) and dominates the swamp forest habitats. Despite a lack of evidence to support a population in the study locality, the habitat is considered suitable.	Yes
Little Bentwing-bat ( <i>Miniopterus australis</i> )	V	-	68	Roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	Yes
Large-footed Myotis ( <i>Myotis macropus</i> ) – now Southern Myotis	V	-	15	Generally roost in groups close to water in caves, mine shafts, hollow-bearing trees, and storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools catching insects and small fish.	Yes
Spotted-tailed Quoll ( <i>Dasyurus maculatus</i> )	V	E	64	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. The habitat in the study area is too small, degraded and fragmented to support populations of this species.	No

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
Squirrel Glider ( <i>Petaurus norfolcensis</i> )	V	-	17	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. The habitat appears suitable for the species and therefore is considered to potentially occur, although is likely too small in size and fragmented.	Yes
Yellow-bellied Glider ( <i>Petaurus australis</i> )	V	-	103	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. There are no records in close proximity to the site, and populations are known from the larger mature moist and dry forests in the region. The habitat is not suited to this species and there is a high degree of fragmentation.	No
Yellow-bellied Sheath-tail-bat ( <i>Saccolaimus flaviventris</i> )	V	-	3	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	Yes
<b>REPTILES</b>					
Pale-headed Snake ( <i>Hoplocephalus bitorquatus</i> )	V	-	1	Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. The main prey is tree frogs although lizards and small mammals are also taken.	No
Rosenberg's Goanna ( <i>Varanus rosenbergi</i> )	V	-	1	Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Found in drier forest types in larger remnants, there are no terrestrial termite mounds in the study area.	No
Stephens' banded snake ( <i>Hoplocephalus stephensii</i> )	V	-	2	Inhabits rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Shelters in tree hollows, rock crevices or rock slabs. The habitat is not suitable for this species	No
<b>AMPHIBIANS</b>					
Giant Barred Frog ( <i>Mixophyes iteratus</i> )	E	E	1	Forages and lives amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. Cut Rock Creek is the only flowing stream in the study area and is in very poor condition, in terms of water quality, siltation and dense weed infestations, and it is not considered suitable for the species.	No

Species	TSC Act	EPBC Act	No. Atlas records within 10 km of proposal	Habitat requirements / comments	Subject species
Giant Burrowing Frog ( <i>Heleioporus australiacus</i> )	V	V	44	Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. The inundated swamp forest and open wetlands are not considered suitable for this species.	No
Green and Golden Bell Frog ( <i>Litoria aurea</i> )	E	V	11	Inhabits ephemeral and permanent freshwater wetlands, ponds, dams with an open aspect and fringed by Typha and other aquatics, free from predatory fish. The open wetlands, particularly on the western side of the highway provide potential habitat, although there are no populations known from this location	Yes
Green-thighed Frog ( <i>Litoria brevipalmata</i> )	E	-	10	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. The swamp forest and shall wetlands provide potential habitat, although there are no populations known from this location.	Yes
Stuttering Frog ( <i>Mixophyes balbus</i> )	E	V	32	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Cut Rock Creek is the only flowing stream in the study area and is in very poor condition, in terms of water quality, siltation and dense weed infestations, and it is not considered suitable for the species.	No

### 3.4 Identification of endangered ecological communities

Six endangered ecological communities (TSC Act) have been identified in the DGRS and database searches of the locality (Table 3-3), of which two have been confirmed as occurring during field surveys in the study area.

Table 3-3 Endangered ecological communities (TSC Act)

Threatened Ecological community	Confirmed presence or expected in the study area
Freshwater Wetlands on Coastal Floodplains of the New South Wales Coast, Sydney Basin and South East Corner	Yes. Confirmed in the study area including three separate wetlands.
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Yes. Confirmed across a large proportion of the study area.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion	No
River Flat Eucalypt Forest in Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner	No
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin Bioregion and South East Corner Bioregions	No
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	No

### **3.5 Identification of endangered populations**

There are no endangered populations that have been identified during the initial assessment.

### **3.6 Preliminary listed species**

The list of preliminary listed threatened species and ecological communities under the TSC Act (last updated 18 Dec 2015) was reviewed. Of this list the Dusky Woodswallow (*Artamus cyanopterus*) is the only species with a distributional range that includes the study locality.

The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats. The habitat types in the study area are not considered suitable for this species and the likelihood of this species occurring in the study area is considered low and it is not considered further.



## 4. Survey

### 4.1 Requirement to survey

Chapter 4 describes the field survey methods and results and the qualifications and experience of the project team (refer also to Appendix G for a full Curricula Vitae). The field surveys aimed to provide a consistent and systematic approach to the survey and assessment of the threatened subject species identified in Section 3.

Surveys were designed for consistency where possible with the *Draft Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation 2004) and reference to these guidelines is made throughout this section and other relevant survey guidelines from the OEH, for example *Threatened species survey and assessment guidelines: field survey methods for fauna – amphibians* (DECC 2009). The assessment has made reference to the *Threatened Species Assessment Guidelines: the assessment of significance* (DECC 2007). The qualifications and experience of the project team is summarised in Table 4-1.

Table 4-1: Qualifications and experience of project team

Personnel	Qualifications	Experience
Chris Thomson	B App Sc; Grad Cert Nat Res	20 years fauna survey experience throughout New South Wales including 10+ years bat call analysis
Andrew Carty	B Env Sc; Dip Bush Regen	12 years flora survey experience throughout New South Wales including vegetation community classification and mapping
Brenton Hays	B Env Sc & Mgmt	3 years flora and fauna survey experience throughout NSW

### 4.2 Survey methods

#### 4.2.1 Stratification and preliminary site visits

Preliminary site visits were used in combination with analysis of aerial photographs, and a review of existing vegetation mapping, and topographic data to stratify the vegetation and habitats in the study area for further targeted survey effort.

Flora and fauna surveys aimed to sample the variation in vegetation, slope and elevation in the study area. Habitat in the study area is dominated by forested and open wetlands in low-elevation areas broadly separated into swamp sclerophyll habitats (65 % of the study area) and open freshwater wetlands (15 % of the study area). The remaining 20 % of the habitat present is the moist open eucalypt forest located on the higher elevated western end of the project adjoining the cemetery. The hills slope to the north and east.

The surveys aimed to replicate effort across these three habitats types, described further in the following sections.

#### 4.2.2 Flora / vegetation survey and mapping

##### Timing

The flora surveys undertaken for both the REF and SIS are summarised in Table 4-2, both surveys contribute to the knowledge of species distribution and abundance in the study area. In total ten days were spent surveying the flora of the study area over winter and spring in 2014 and 2015. Additional surveys have been conducted for baseline wetland monitoring and are described in Appendix D

Table 4-2: Timing and survey type for flora surveys

Assessment	Survey dates	Survey type	Season
Review of Environmental Factors	10-11 April 2014	Targeted surveys for threatened flora species in particular the distribution and abundance of <i>Melaleuca biconvexa</i> including stem counts.	Autumn
	18 August 2014	Floristic plots and targeted surveys for threatened flora species.	Winter
Species Impact Statement	19-21 August 2015	Targeted surveys for <i>Melaleuca biconvexa</i> and broader population assessment.	Winter/early spring
	28 August 2015	Floristic plots and targeted surveys for <i>Melaleuca biconvexa</i> and broader population assessment.	Winter/early spring
	9 September 2015	Floristic plots and targeted threatened flora surveys <i>Syzygium paniculatum</i> , <i>Prostanthera askania</i> and <i>Dendrobium melaleucaphilum</i> .	Spring
	15 September 2015	Floristic plots and targeted threatened flora surveys <i>Syzygium paniculatum</i> , <i>Prostanthera askania</i> and <i>Dendrobium melaleucaphilum</i> .	Spring
	16 October 2015	Floristic plots and targeted threatened flora surveys <i>Syzygium paniculatum</i> , <i>Prostanthera askania</i> and <i>Dendrobium melaleucaphilum</i> .	Spring

### Vegetation community mapping

Data from general traverses and transects were used to identify vegetation community boundaries and plot data was used to record the species composition, vegetation structure and habitat condition. Digital mapping of vegetation communities was conducted using ArcGIS® software. A combination of field data, aerial photograph interpretation and biophysical data such as elevation and soil type were used to delineate community boundaries.

Vegetation mapping and classification projects have previously been undertaken across the study area by Bell (2004) and Somerville (2009), and forms the basis of the vegetation classification used in the study area for consistency with regional classifications. These existing vegetation layers were ground-truthed and polygon boundaries were modified based on recent aerial photography and field data. Vegetation communities were compared with final determinations and listing advice under the TSC Act and EPBC Act to identify threatened ecological communities.

### Plot and transect sampling

Plot sampling (20 x 20 metre) was used to identify the vegetation structure and floristic composition of vegetation communities, determine ecological condition and record the cover/abundance of threatened flora species, namely *Melaleuca biconvexa*.

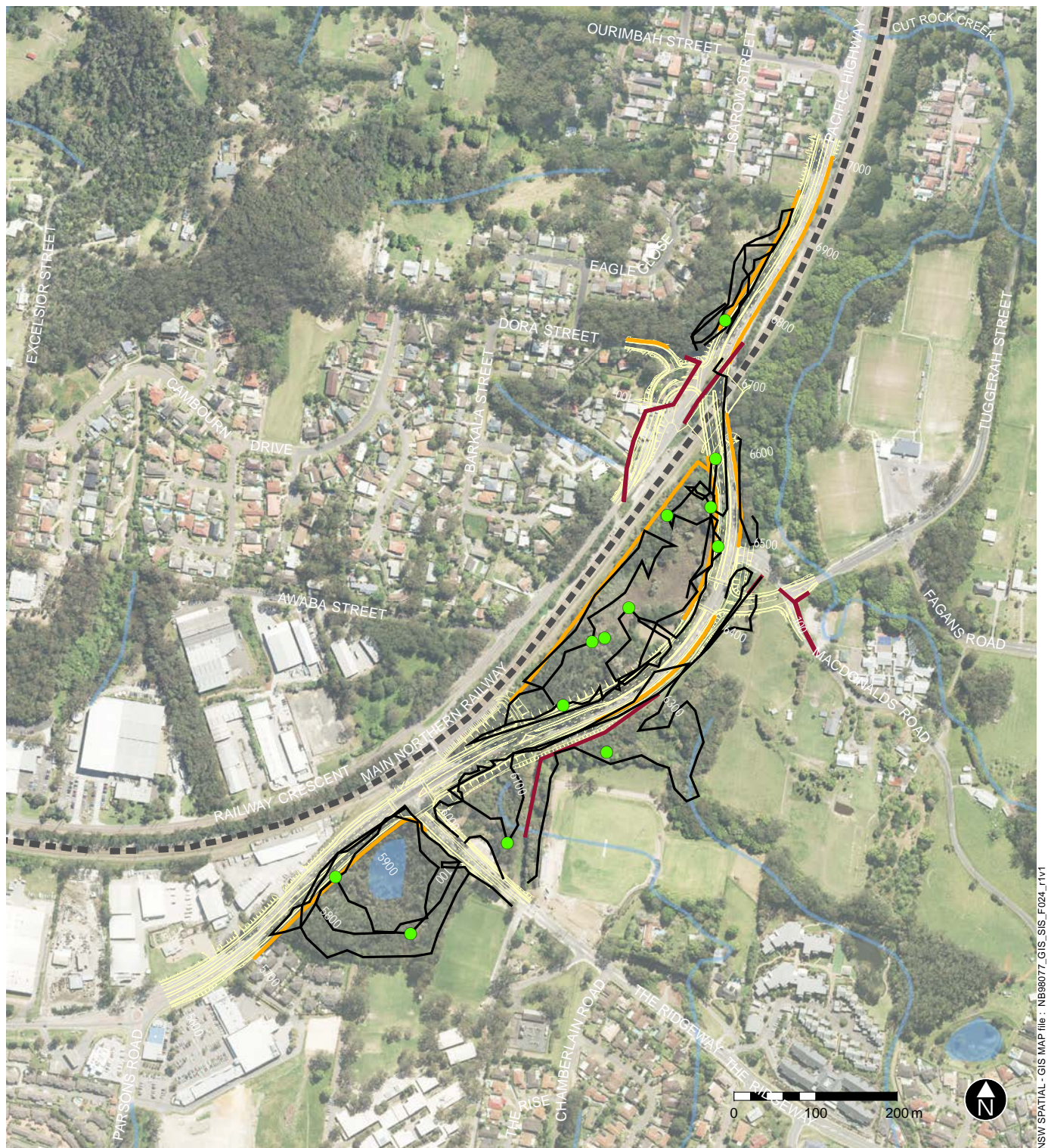
Biobanking condition assessment plots were undertaken which included sampling 20 x 20 metre quadrats for recording floristic diversity, combined with a 50 metre transect adjacent to each quadrat for recording vegetation cover and five 20 x 50 metre quadrats for recording fauna habitat and regeneration. 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 2-50 hectares of each stratification unit and three 100 metre transects sampled per 51-250 hectares of stratification unit in accordance with DEC (2004).

The location of floristic plots / biobanking condition assessment plots is mapped in Figure 4-1.

Data collected within each plot / transect included:

- Flora diversity and composition.
- Projected foliage cover for each flora species.
- Stem counts of larger trees and shrubs.
- Groundcover composition and abundance.
- Approximate heights of structural layers (i.e. canopy, sub-canopy, shrub and groundcovers).
- Fauna habitats (i.e. hollow trees, fallen timber).











NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F024\_r1v1

Figure 4-1 | Location of flora survey traverses and plots

### Legend

- |   |                |   |                       |
|---|----------------|---|-----------------------|
|  | Concept design |  | Flora survey plot     |
|  | Retaining wall |  | Flora survey traverse |
|  | Power line     |   |                       |
|  | Watercourse    |   |                       |

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- Regeneration of canopy species.
- Landscape features (e.g. slope, gully, and aspect).
- Soil features (e.g. soil type, rocks, organic matter).
- Geographical coordinates and a photographic record.

### Random traverses

General traverses comprised random searches throughout stratified areas to develop an inventory of all flora present and search for threatened plant species, identify significant habitat attributes and record any other factors that may be of interest. The location of all threatened species, vegetation community boundaries and any other ecological factors were recorded using a Trimble handheld GPS with ArcPad software.

### Determining Biometric Vegetation Types (BVT)

Considering the previous ecological assessments undertaken in the study area as well as broad-scale vegetation mapping and technical reports available for the Gosford LGA, the biometric vegetation types (BVTs) could be readily determined. Vegetation communities as described by Somerville (2009) were compared with field survey data and equivalent communities were determined which are directly comparable to these regional biometric vegetation types.

### Habitat condition

Habitat condition was broadly assessed within each of the vegetation communities in the study area and also within occupied habitat of *Melaleuca biconvexa* in the study area and region. Habitat condition was based on the degree of modification and disturbance observed in areas of habitat.

A vegetation and habitat condition assessment was conducted using the Biobanking Assessment Methodology (BBAM) (DECC 2008). The assessment aimed to provide a measure of habitat condition for each of the remnant vegetation types impacted by the proposal, as well as identifying floristic diversity, vegetation structure and composition, and the density of fauna habitat features in the study area.

A basic scale was established to quantify the condition of each patch of native vegetation. The scale for vegetation condition is defined in Table 4-3.

Table 4-3: Habitat condition classes

Condition class	Description	Criteria			
		Flora diversity	Canopy cover	Mid-storey	Weed abundance
Good/moderate	Vegetation still retains the majority of native species and structural characteristics of the pre-European equivalent. Such vegetation is usually in a near natural state and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers and lack of soil disturbance. Some limited weed cover is present in edge habitats.	High	Intact	Intact	Low
Poor	Vegetation generally still retains most of its structural integrity but has been partially disturbed and has lost some component of its original species complement. Weed invasion varies from slight to high.	Moderate	Intact	Partial - Intact	Moderate - High
Low	Modified areas where most of the native diversity and vegetation structure has been lost. Environmental weeds are often co-dominant with the original indigenous species. Includes cleared paddock areas and roadside clearings dominated by exotic species including noxious weeds.	Low	Partial	Absent - Sparse	High - Moderate

### Targeted threatened flora surveys

Targeted surveys for known and potentially occurring threatened flora species were undertaken during suitable survey periods to detect the target species, comprising:

- Targeted survey and local and regional population assessment of *Melaleuca biconvexa* to build upon data collected for the REF.
- Targeted surveys for Spider Orchid (*Dendrobium melaleucaphilum*) during September/October. Targeted searches on the trunks and branches of any Prickly-leaved Tea Tree (*Melaleuca styphelioides*) encountered were undertaken from the ground using binoculars.
- Targeted surveys for Tranquillity Mintbush (*Prostanthera askania*) were undertaken in areas of Coastal Narrabeen Forest north of the railway bridge as well as elevated areas of vegetation including disturbed areas surrounding swamp habitats.
- Targeted surveys for Magenta Lilly Pilly (*Syzygium paniculatum*) were undertaken in all habitats in the study area including planted and disturbed habitats.

### *Melaleuca biconvexa* – local population assessment

A large population of *Melaleuca biconvexa* was confirmed in the study area. Targeted surveys aimed to identify the distribution and abundance of the species within the study area (local population) in addition to the surrounding 5 km radius to identify the wider local distribution and determine the importance of the local population impacted by the project.

This species can grow from aerial shoots arising from low-lying roots, making assessment of individual plants difficult. Stem counts and estimates of projected foliage cover were used to provide a quantified measure of abundance. Data were conducted from 15 plots (20 x 20 metre) located randomly within the study area, and a further 47 plots located within the wider 5 km radius of the study area. The location of sample plots in the study area is mapped in Figure 4-1, and plots undertaken in the wider locality are mapped in Figure 4-4.

The visual assessment and stem count methods were modified from an approach by Duncan (2001) to determine local abundance in Wyong Shire. Stem counts involved counting the number of above ground stems within the following age class criteria:

- Mature/intermediate: Stems with Diameter at Breast Height (DBH) of greater than 200 mm and greater than two metres in height.
- Immature: Stems DBH less than 200 mm and less than two metres in height.
- Juvenile: The presence of saplings and suckers below two metres in height were recorded.

### *Melaleuca biconvexa* – desktop review and survey of regional population

The regional population of *Melaleuca biconvexa* was reviewed and assessed using data for the Wyong and Gosford Local Government Areas (LGAs) based on a combination of existing spatial data and ground-truthing where data gaps existed. Spatial data layers analysed included:

- Wyong Shire Council (2015) *Melaleuca biconvexa* - polygon spatial data layer.
- OEH (2015) Atlas data records - *Melaleuca biconvexa*.
- Broad-scale vegetation mapping (Somerville 2009; Bell 2002; Bell 2004).
- Cadastral and property data.
- Local Environment Plans – Wyong Shire Council and Gosford City Council.

From the above data sources accessible lands with known records of *Melaleuca biconvexa* or suitable habitat were targeted for ground-truthing. Ground-truthing involved traverses through suitable habitat on accessible lands plot sampling (20 x 20 metre) using the stem count and cover / abundance assessments described above as well as recording vegetation condition and any other notable attributes. Habitat condition was assessed within habitats occupied by *Melaleuca biconvexa* based on a basic scale of condition as specified in Table 4-3.

The Wyong LGA spatial layer of *Melaleuca biconvexa* was ground-truthed in the Wyong LGA and existing polygons were modified where applicable based on a mix of ground-truth data points and aerial photography, and new polygons were created where additional individuals were recorded. In the Gosford LGA existing records were targeted on accessible lands and the abundance and distribution of plants were ground-truthed and new polygons created across the distribution. Aerial photograph interpretation was used to modify some polygons from the Wyong LGA spatial data layer using recent ortho-rectified aerial imagery as well as other spatial layers including vegetation communities and topography. A confidence level was assigned to each polygon based on the quality of the existing and collected data. The three confidence levels assigned to polygons comprise:

- **High:** Generally comprises areas where there was sufficient access for surveys and individuals have been confirmed throughout the majority of the polygon. Plot-based stem counts and cover / abundance assessments were undertaken within these patches.
- **Moderate:** Generally includes areas where individuals have been confirmed but the ground-truthing surveys were limited to a portion of existing polygons from the Wyong LGA spatial layer and/or there are numerous recent records within the polygon. Plot-based stem counts and cover/abundance assessments were undertaken within some of these patches.
- **Low:** Existing polygons from the Wyong LGA spatial where there has been no ground-truthing surveys undertaken. These polygons are from the Wyong LGA spatial data layer, however around one third of these polygons have been modified based on recent aerial imagery and are likely to more accurately reflect the distribution of *Melaleuca biconvexa* at these locations. Taking a precautionary approach these polygons have been assumed to have an overall low abundance of *Melaleuca biconvexa* (ie 250 stems / ha).

Population numbers were then attributed to each polygon based on stem counts and cover / abundance assessments undertaken, or where formal counts were not undertaken a basic scale was used to gauge the abundance of *Melaleuca biconvexa* particularly where access was limited. The basic scale for gauging the abundance of *Melaleuca biconvexa* was adapted from Duncan (2001) and included the following categories:

- **Low:** 1-10 per cent cover / abundance and / or less than 500 stems per hectare.
- **Moderate:** 10-30 per cent cover / abundance and between 500 and up to 1,250 stems per hectare.
- **High:** Greater than 30 per cent cover / abundance and greater than 1,250 stems per hectare.

Population estimates were undertaken across the mapped distribution including populations confirmed from the ground-truthing surveys and unconfirmed polygons from the Wyong LGA spatial dataset. Estimates of the regional population for *Melaleuca biconvexa* in the Wyong and Gosford LGA were extrapolated from the mapped area of occurrence and average densities determined from the plot data and general assessments of cover / abundance.

### Summary of flora survey effort

A summary of the flora survey effort with respect to the number of plots sampled per habitat type in the study area and wider locality for *Melaleuca biconvexa* surveys are provided in Table 4-4.

Table 4-4: Flora survey effort (2014/15)

Vegetation zone / habitat type / condition	Approximate habitat in study area (ha)	Sampling effort		
		Floristic plots	<i>Melaleuca biconvexa</i> stem count plots	Traverses (m)
1: Alluvial Paperbark Sedge Forest – moderate	3.46	5	8	1,200
2: Alluvial Paperbark Sedge Forest - Poor	3.84	2	4	2,900
3: Freshwater Wetland - moderate	1.53	3	1	600
4: Freshwater Wetland - poor	0.16	0	0	950
5: Coastal Narrabeen Moist Forest – moderate	0.89	1	0	400



Vegetation zone / habitat type / condition	Approximate habitat in study area (ha)	Sampling effort		
		Floristic plots	<i>Melaleuca biconvexa</i> stem count plots	Traverses (m)
6: Coastal Narrabeen Moist Forest - poor	0.24	1	1	150
Exotic Trees and Shrubs – Low Condition	1.11	1	1	1,200
Survey of local population of <i>M.biconvexa</i>	13.35 ha	n/a	47	10,000
		13 plots	62 plots	17,400 m,

### 4.2.3 Fauna survey

#### Stratification and site selection

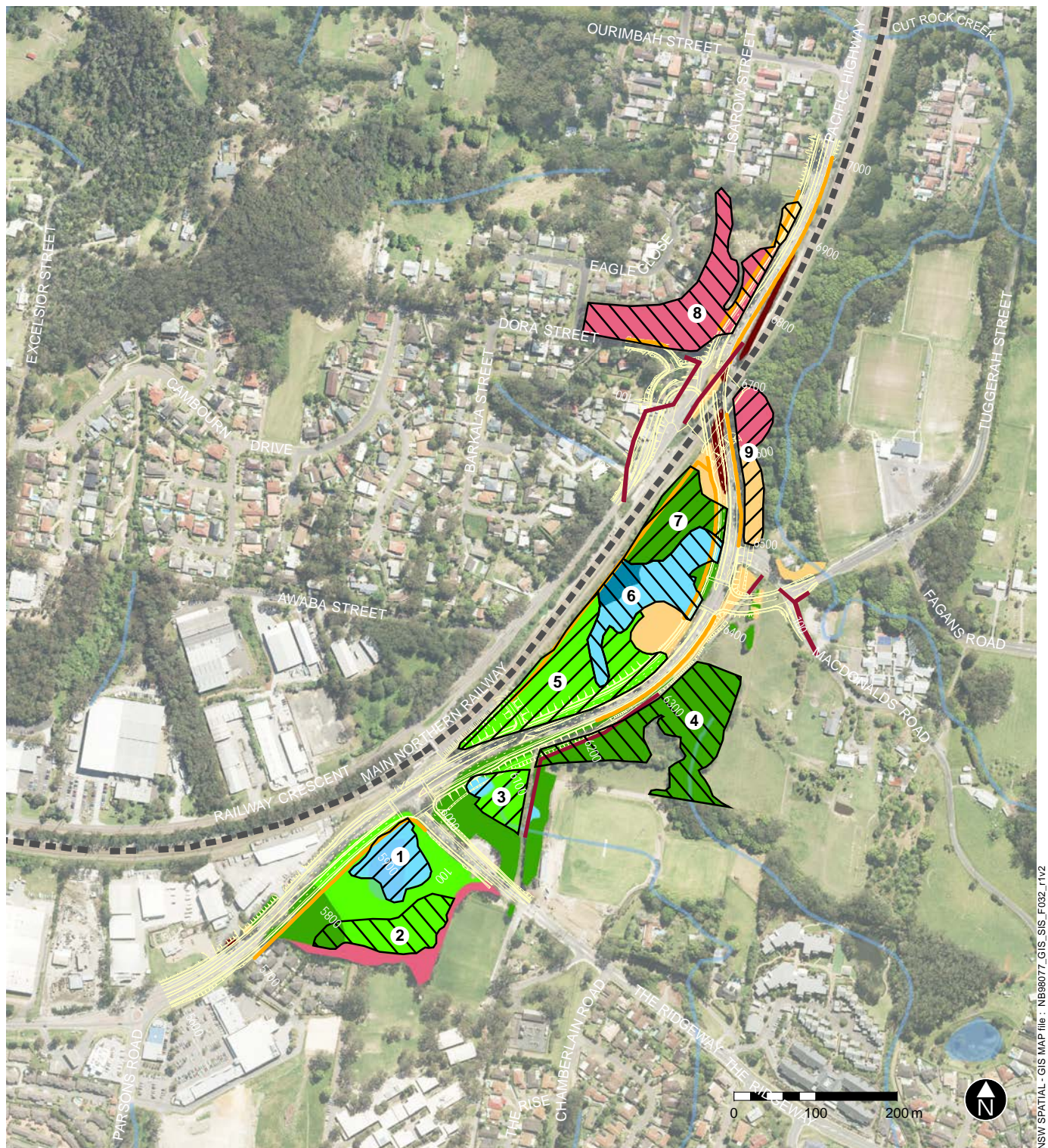
The fauna survey methods and results presented describe the survey effort undertaken for the REF and SIS as both survey data contribute to the species knowledge in the study area. Preliminary site visits, aerial photographs and vegetation mapping were used to stratify habitat types and identify survey sites, which aimed to sample the variation in habitat. Four habitat types were subsequently identified; open wetlands; swamp forest; moist forest; and disturbed modified habitat – these are all represented by relatively small patches typically less than 2.0 hectares with the exception of the swamp forest habitats around 7.0 hectares in area (refer to Table 4-5).

At least one site was surveyed per habitat type with greater effort in the dominant swamp forest. Surrounding disturbed habitats (exotic grassland, cleared easements, regrowth and weed infestations) provided incidental observational data. Fauna sampling was conducted at nine sites (Sites 1-9) described in **Table 4-5** and illustrated on **Figure 4-2**. A combination of sampling techniques was employed at all nine sites which included diurnal and nocturnal surveys and opportunistic observations over four seasons associated with the REF (April to Sept 2014) and the SIS (Aug 2015 to March 2016). Details of survey techniques and effort are provided below.

Table 4-5: Fauna survey sites (2014/15/16)

Stratification unit	Equivalent MU / Vegetation type	Area in study area (ha)	Fauna survey sites	Description
Open wetlands	MU2: Freshwater Wetlands	1.69 ha	1, 3, 6	Site 1: Large open wetland at corner of The Ridgeway and Pacific Highway on south-western side of the transect (Wetland A) Site 3: Small wetland on north-eastern side of The Ridgeway and south of Pacific Highway (Wetland C) Site 6: large shallow Typha wetland between Pacific Highway and rail line (Wetland B)
Swamp forests	MU1: Alluvial Paperbark Sedge Forest	7.30 ha	2, 4, 5, 7	Site 2: South of The Ridgeway, Pacific Highway intersection at southern end of the study area surrounding open Wetland A Site 4: North of The Ridgeway, and east of Pacific Highway Site 5: North of Pacific Highway and south of rail line, isolated by the road and rail line Site 7: north of Typha wetland and isolated between the Pacific Highway and rail line
Moist/riparian forest	MU3: Coastal Narrabeen Moist Forest	1.13 ha	8	Site 8: moist open forest on slope south of cemetery
Modified habitat	Exotic Trees and Shrubs – Low Condition	1.11 ha	9	Site 9: Dense weed infested creekline north of MacDonald's Road and east of the Pacific Highway










NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F032\_r1v2

Figure 4-2 | Location of fauna survey sites

### Legend

-  Concept design
-  Retaining wall
-  Power line
-  Watercourse
-  Fauna survey site

### Vegetation zones and communities

-  1: Alluvial Paperbark Sedge Forest
-  2: Alluvial Paperbark Sedge Forest - Poor Condition
-  3: Freshwater Wetland
-  4: Freshwater Wetland
-  5: Coastal Narrabeen Moist Forest
-  6: Coastal Narrabeen Moist Forest - Poor Condition
-  Exotic Trees and Shrubs - Low Condition

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### SPECIES IMPACT STATEMENT

Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow



### Timing and weather details

Fauna surveys were conducted over four seasons from April to September 2014 and August 2015 to March 2016 for a total of 14 days. Details of the field survey times, maximum and minimum ambient air temperature and daily rainfall conditions experienced during the surveys are provided in Table 4-6. Climate records are taken from Gosford (Narara Research Station). The range of survey times and conditions were considered suitable for detection of the majority of fauna groups and targeted threatened species.

Table 4-6: Timing, weather and rainfall conditions for fauna surveys

Survey dates	Season / Survey Period	Mean ambient air temperature ( °C )		Wind speed and direction	Cloud cover	Moon phase	Rainfall each 24 hour period (mm)	Total rainfall 7 days preceding survey date
		Min	Max					
10 April 2014	Autumn / day	13.7	28.0	Slight 9km/hr SE	50 %	First quarter	0.0 mm	37.0 mm
11 April 2014	Autumn / day	15.3	22.7	Slight to moderate 10km/hr increasing to 40km/hr in the afternoon NE	80 %	First quarter	3.0 mm	37.0 mm
24 April 2014	Autumn / day and night	12.7	29.0	Moderate 33km/hr WNW	25 %	First quarter	16.8 mm	30.0 mm
9 Sept 2014	Autumn / day and night	10.0	24.0	Slight 13km/hr S	50 %	Full	0.2 mm	50.0 mm
12 August 2015	Winter / morning	2.1	17.8	Slight 13km/hr WNW	0 %	Last Quarter	0 mm	0 mm
20 August 2015	Winter / morning	4.4	20.3	Slight 11km/hr E	0 %	First quarter	0 mm	0 mm
19 October 2015	Spring / day	18.2	25.3	Moderate 20km/hr ENE	0 %	Second quarter	0.2 mm	10 mm
20 October 2015	Spring / morning	15.1	30.9	Slight 11km/hr ENE	20 %	Second quarter	0.4 mm	4.4 mm
21 October 2015	Spring / morning	16	30.8	Slight 9km/hr SW	50 %	Half full	1.2 mm	2 mm
22 October 2015	Spring / morning	17.1	23.3	Slight 11km/hr ENE	80 %	Third quarter	3.8 mm	1.6 mm
23 October 2016	Spring / day	14.3	20.7	Slight 11km/hr S	80%	Third quarter	16.8 mm	4.2 mm
29 December 2015	Summer / night	15.6	23.1	Slight to moderate 15km/hr ESE	90%	Fourth quarter	3.6 mm	96.4 mm
30 December 2015	Summer / night	12.1	24.4	Slight 11km/hr ESE	90%	Third quarter	3.2 mm	103.2. mm
24 March 2016	Autumn / night	13.6	26.9	Slight 9km/hr	10%	Fourth quarter	0.0	71.8 mm



## Non-flying mammals

The survey targeted threatened arboreal mammal species considered to potentially occur. No threatened ground-dwelling mammal species were expected to occur.

**Target species:** Squirrel Glider (*Petaurus norfolcensis*) and Koala (*Phascolarctos cinereus*).

**Methods:** Live trapping was undertaken for arboreal mammals over four nights between the 19 and 23 October 2015 at sites 2, 4, 5 and 8. At each site a transect of Elliot traps (Type B 15 x 16 x 45 cm aluminium folding traps) were positioned approximately 50 metres apart along a transect line, with transects being up to 300 m in length, however this was subject to the size of the habitat. Traps were mounted on trees with a platform positioned 3-4 metres above the ground using a ladder. Each trap was baited with rolled oats, peanut butter and honey. Trees and close surrounding foliage were sprayed with honey dissolved in water once the traps were installed and again every morning after traps were checked to act as an attractant. Traps were checked every morning within two hours of sunrise. Animals caught were identified and released immediately. Each trap site was active for four consecutive trap nights. Table 4-7 details the trapping effort for arboreal mammals. The total trapping effort for the swamp forest habitats (i.e. 7.3 ha) was 64 trap nights and the moist forest (i.e. 0.77 ha) was 24 trap nights (refer to Table 4-7). Trapping was not conducted in the open wetlands or disturbed and weed infested riparian habitat due to lack of suitable habitat for the target species.

Scat searches were conducted to target koala at the swamp forest and moist forest habitats (Sites 2, 4, 5 and 8) in spring (19-23 Oct 2015), this involved sampling a radial plot randomly placed at the site and searching for scats, starting at a central tree and continuing until 20 trees were searched. A total of five plots and 100 trees were sampled.

Spotlighting for arboreal mammals was conducted at each trap site 2, 4, 5, and 8 over four nights in autumn (24 April 2014), spring (9 Sept 2014), and summer (29 and 30 Dec 2015). Spotlighting was foot-based and comprised of a general traverse of the site, utilising Lightforce 50W hand-held spotlights powered by 12 V batteries. One or two persons conducted the survey for a minimum period of 30 minutes per site. Spotlighting was also conducted while moving between sites and all fauna heard or observed over the two hour period were recorded. Notes were also taken on the location and relative abundance of fauna.

Table 4-7 Survey effort for arboreal mammals

Site	Stratification unit / area	Number of tree traps	Number of nights	Total trap nights	Cumulative total	Spotlighting / person hours
2	Swamp forest / (7.3 ha)	6	4	24	64 trap nights	1.0
4		6	4	24		1.0
5		4	4	16		0.5
8	Moist forest / 1.13 ha	6	4	24	24 trap nights	1.0

## Flying mammals

**Target species:** Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Little Bentwing-bat (*Miniopterus australis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail Bat (*Mormopterus norfolcensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Southern Myotis (*Myotis macropus*), Grey-headed Flying-fox (*Pteropus poliocephalus*).

**Methods:** A standard two-bank 4.2m<sup>2</sup> harp trap was used to sample for microchiropteran bats at one location (site 4). The siting of suitable trap sites was limited by the high degree of public access and visibility over the study area and lack of suitable positions. As a result only one site was able to be sampled in the swamp forest habitat on the edge of the wetland. The trap was set for two nights in a narrow fly-way on the edge of the forest. Captured bats were collected early the following morning, identified and measured then soft-released at the capture point using a bat release box.

Two stationary ultrasonic bat call detectors (Anabat II, Titley Electronics) were used with a storage ZCAIM unit to record bat calls at sites 3 and 6 in autumn (10 April 2014), and sites 4, 6 and 8 in spring (20-23 Oct 2015). Calls were recorded continuously between 1900 and 0500 hours on each occasion for one night during the autumn survey and for two nights during the spring survey. Calls were identified to genus or species level where possible using computer frequency analysis software (i.e. Analook v.4.0).

A number of small culverts take drainage under the existing highway in this location. These were inspected in the April survey using a spotlight. These culverts were found to have a high proportion of built up sediment, with some up to 80 per cent full due to the low-lying nature of the site and therefore considered to present very poor opportunities for roosting bats (see Photo 4-1 – 4.3). Visibility within these culverts was very limited

Spotlighting was used to target Grey-headed Flying-fox (*P. poliocephalus*) at sites 2, 4, 5 and 8 in autumn (24 April 2014), spring (9 Sept 2014) and summer (29- 30 Dec 2015). Spotlighting was foot-based and comprised of a general traverse across the site, utilising Lightforce 50W hand-held spotlights powered by 12-Volt batteries. One or two observers conducted the survey for a minimum period of 30 minutes per site. Spotlighting was also conducted while moving between sites with a focus on flowering tree and shrub species.



Photo 4-1 Example of a culvert



Photo 4-2 Drainage line crossing The Ridgeway



Photo 4-3 Twin drainage line under the railway line, not impacted by the proposal

## Birds

**Target species:** Black Bittern (*Ixobrychus flavicollis*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Gang-Gang Cockatoo (*Callocephalon fimbriatum*), Little Eagle (*Hieraaetus morphnoides*), Little Lorikeet (*Glossopsitta pusilla*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Square-tailed Kite

(*Lophoictinia isura*), Varied Sitella (*Daphoenisitta chrysoptera*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Barking Owl (*Ninox connivens*).

**Methods:** A time-based bird survey was conducted at each of the nine survey sites within four hour of sunrise in autumn (11 and 24 April 2014), winter (12 and 24 Aug), and spring (20-23 Oct). This involved replicated 10-20 minute surveys at each site depending on the size of the habitat. The survey was conducted by one observer using a random meander within the habitat patch and recording all birds seen and heard during the survey period. Ten minute searches were conducted in small patches and disturbed areas (<0.5 ha) and the longer 20-minute survey was conducted in larger habitat patches (>0.5 ha) and habitat continuous with other habitat outside the study area. Surveys at the freshwater open wetland sites (sites 1, 3 and 6) targeted the wetland birds and used an initial stationary point method following by a general traverse around the margins of the wetland.

All bird species heard or observed were recorded including those outside the habitat node (i.e. flying over the sample site). Birds were also recorded opportunistically during all other site visits and field surveys activities. Binoculars were carried in the field at all times to assist in identification.

The surveys conducted in winter on the 12 and 20 August 2015 aimed to sample the winter flowering period of the dominant Swamp Mahogany (*Eucalyptus robusta*) in the swamp forest habitat to target the Swift Parrot and Regent Honeyeater. The survey consisted of 20 minute area-based survey of each of the forested wetland sites (1, 2, 3, 4, 5 and 7) for a total of two person hours.

Nocturnal surveys were conducted and targeted the Powerful Owl, Masked Owl, Sooty Owl and Barking Owl as well as Black Bittern. Call playback of the target species was utilised over four nights during the spotlighting surveys in autumn (24 April), spring (9 September) and summer (29-30 Dec). Owl playback was used at three sites (site 2, 3 and 8) on each of the four occasions and calls of the Black Bittern were played at the open wetland habitats (site 1 and 3) on each of the four occasions. Pre-recorded calls were broadcast via a portable MP3 player and megaphone for a period of five minutes each, followed by a five minute listening period. Spotlighting was conducted following completion of the call playback series. Quiet listening for dusk calls of each large forest owl species was also undertaken whilst conducting other field activities such as spotlight searches. Locations for playing call playback were very limited and the success of the technique was likely compromised by the constant noise and lights from highway traffic and trains.

## Reptiles and Amphibians

**Target species:** Green and Golden Bell Frog (*Litoria aurea*) and Green-thighed Frog (*Litoria brevipalmata*).

**Method:** Both nocturnal and diurnal herpetological surveys were conducted at each site (1-9).

Surveys were carried out with regard to the significant impact guidelines for the Green and Golden Bell Frog (DEWHA 2009) and the State and Commonwealth and survey guidelines for threatened frogs (DECC, 2009; DEWHA 2010). Systematic area-based frog searches were carried out at the open wetland sites (1, 3, and 6) and forested wetland sites (2 and 5) over four nights in spring (9 Sept), summer (29-30 Dec) and early autumn (24 Mar). Moderate to heavy rainfall was experienced during and prior to all survey periods, which included 50 mm of rain in the seven days preceeding the spring survey, 103.2 mm in the seven days before the summer survey and 71.8 mm in the seven days preceeding the autumn survey. The surveys also targeted warm and windless nights and these conditions were considered optimum for the detection of the target species.

Each survey was conducted by one or two persons using Lightforce spotlights (50W) and battery powered head torches to survey along the margins of the open wetlands and around flooded sections of the swamp forest habitats. The survey included the broadcast of recorded calls of the target species, calls were played for a total of 15 minutes at each site on each occasion. Frogs were identified by call, and/ or visual characteristics. All active frogs were captured, where possible, identified and immediately released.

The diurnal component of the herpetofauna surveys consisted of hand searches for frogs and reptiles under rocks, logs, bark, timber and other debris when encountered. Specific reptile census was conducted for one person hour at each site. Opportunistic observations were also recorded during the carrying out of other survey.



## Fauna survey effort

A summary of the survey effort for target fauna species is presented in Table 4-8.

Table 4-8 Summary of fauna survey effort

Survey method & target group	Season / survey dates	Habitat strata / survey effort			
		Moist Forest 0.11 ha (site 8)	Swamp forest 7.30 ha (site 2, 4, 5, and 7)	Wetlands 1.67 ha (site 1 and 6)	Modified 1.0 ha (site 9)
<i>Tree-based Elliott traps (arboreal mammals)</i>	Spring 19-23 October	1 trap site 6 tree traps for 4 nights (24 trap nights)	3 trap sites 16 tree traps for 4 nights (64 trap nights)		
<i>Harp-trap (microchiropteran bats)</i>	Spring, 21-22 October		2 trap nights		
<i>Ultrasonic call recording (microchiropteran bats)</i>	Spring (9 Sept), summer (29-30 Dec)	1 detector for 2 nights (24 hours recording)	1 detector for 2 hours + 1 detector for 2 nights (26 hours recording)	1 detector for 2 nights (24 hours recording)	
<i>Bird survey (winter)</i>	Winter (12 and 20 Aug)		12 x 20 minute targeted surveys (4 person hours)		
<i>Bird survey (spring)</i>	Spring, (20-22 October)	1 x 20 minute survey	5 x 20 minute surveys	2 x 20 minute surveys	
<i>Bird survey (autumn)</i>	Autumn (11 April)	1 x 20 minute survey	4 x 20 minute surveys	2 x 20 minute surveys	1 x 10 minute survey
<i>Call playback (nocturnal birds)</i>	Autumn (24 April), spring (9 Sept), summer (29-30 Dec)	4 nights	4 nights	4 nights	
<i>Spotlighting (nocturnal birds and mammals)</i>	Autumn (24 April), spring (9 Sept), summer (29-30 Dec)	4 nights	4 nights	4 nights	
<i>Area based nocturnal searches (frogs) and call playback (frogs)</i>	Spring (9 Sept), summer (29-30 Dec) and autumn (24 March)		4 nights	4 nights	
<i>Timed diurnal active searches (reptiles)</i>	Spring 19-23 October	1 x 30 minute search	4 x 30 minute searches		1 x 30 minute search
<i>Area searches (Spot Assessment Technique for koala)</i>	Autumn (10-11 April), spring (20-23 Oct)	1 plot (20 trees)	4 plots (80 trees)		

### 4.2.4 Limitations

Ecological surveys are often subject to false absences and imperfect detection. Although some species may be able to be readily confirmed in an area, it is highly difficult to absolutely confirm a species is absent from an area, and non-detection does not confirm the absence of a species. Habitats in the study area are positioned adjacent to the existing Pacific Highway and main northern railway and include three busy intersections, traffic lights and Lisarow train station. Subsequently, there is a high degree of human activity, and constant noise and lights at all hours, and this activity is likely to have compromised the success of the fauna survey, in particular the use of call playback for nocturnal birds and frogs. Whilst all efforts have been made to detect all of the subject species in the study area there is potential for false absences, and therefore a precautionary approach has been taken for identifying species that are potentially present or absent.

The siting of suitable bat trap sites was limited by the high degree of public access and visibility over the study area and lack of suitable positions. As a result only one site was able to be sampled in the swamp forest habitat on the edge of the wetland.

Restricted access to private land for the purposes of ecological surveys in this SIS was encountered over the summer period from November 2015 to February 2016. Access was reinstated by March 2016 and follow up surveys completed in early autumn.


## 4.3 Survey results- subject species and TECs

### 4.3.1 Vegetation community descriptions

A broad description and mapping of vegetation communities in the study area is detailed in Section 2.3.1 of the SIS. The following information provides a detailed description of each community based on the results of floristic surveys (Table 4-9-Table 4-11). The identification of the three main biometric vegetation types could be readily determined through the presence of dominant species, vegetation structure and landscape position, as follows:

1. **Alluvial Paperbark Sedge Forest (HU937):** This community occurs in low elevated flats surrounding the Pacific Highway and is dominated by a canopy of Swamp Mahogany (*Eucalyptus robusta*) and with a sub-canopy dominated by paperbark species and the understorey is dominated by sedges.
2. **Freshwater Wetlands Typha (HU951):** These areas are in low elevated depressions and have limited canopy cover with dense cover of Cumbungi (*Typha orientalis*) and other aquatic flora such as Knotweeds (*Persicaria* species) and *Carex* species.
3. **Coastal Narrabeen Moist Forest (HU782):** This community occurs on higher elevated is dominated by a canopy of Sydney Blue Gum (*Eucalyptus saligna*), Blackbutt and Turpentine (*Syncarpia glomulifera*) with a mesic understorey including rainforest trees and shrubs, ferns and vines.

Table 4-9 *Melaleuca biconvexa* - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast

Description of the vegetation community: <i>Melaleuca biconvexa</i> - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (1723)	
<p>Vegetation zones: 1; 2 (Poor condition)</p> <p>PCT Code: 1723</p> <p>BVT Code: HU937</p> <p>Vegetation formation: Forested Wetlands</p> <p>Vegetation class: Coastal Swamp Forests</p> <p>Conservation status: Endangered, TSC Act</p> <p>Estimate of percent cleared: 92%</p> <p>Condition: Good/Moderate</p> <p>Extent in the study area: 7.3 hectares (3.46 hectares good to moderate; 3.84 hectares poor condition)</p> <p>Plots completed in vegetation zone: 3, 4, 10, 12 (veg zone 1), 5, 6, 7, 9 (veg zone 2)</p>	 <p>Photograph 1: <i>Melaleuca biconvexa</i> - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937), vegetation zone 1 (Plot 4).</p>
<p><b>Description:</b> This community occurs on low elevated flats of alluvial soils surrounding the Pacific Highway. This community is a forested wetland dominated by a canopy of Swamp Mahogany (<i>Eucalyptus robusta</i>) to 20 metres high and with a sub-canopy dominated by Biconvex Paperbark (<i>Melaleuca biconvexa</i>) up to 10 metres high. Other small tree species in this community include Cheese Tree (<i>Glochidion ferdinandi</i>), Cabbage Tree Palm (<i>Livistona australis</i>) and Snow-in-summer (<i>Melaleuca linariifolia</i>). The ground layer is dominated by sedges and ferns including Tall Saw-sedge (<i>Gahnia clarkii</i>), Tall Sedge (<i>Carex appressa</i>), Tassel Sedge (<i>Carex fascicularis</i>), Harsh Ground Fern (<i>Hypolepis muelleri</i>) and Swamp Water Fern (<i>Blechnum indicum</i>).</p> <p>Many areas of this community is in a disturbed condition resulting from weed invasion, urban runoff and altered hydrology from surrounding development, with a moderate to high abundance of Small-leaved Privet (<i>Ligustrum sinense</i>) and Camphor Laurel</p>	

**Description of the vegetation community: Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (1723)**

(*Cinnamomum camphora*).

**Landscape features:** This community occurs on low elevated flats of alluvial soils surrounding the Pacific Highway. The substrate is most commonly unconsolidated sands although some sites occur on sandstone substrates. Elevation is less than 30 metres.

**Distribution:** The community occurs as three main patches surrounding the Pacific Highway in the study area. This community is found in the Central Coast hinterlands from Copacabana to Tuggerah, so the study area is generally in the central region of the main distribution of this community.

**Diagnostic features:** This community is distinguished by the canopy dominated by Swamp Mahogany (*Eucalyptus robusta*) and with a sub-canopy dominated by paperbark species with an understorey dominated by sedges and ferns.

**Threatened flora species:** Large populations of *Melaleuca biconvexa* occur in this community being the dominant mid-storey species. No other threatened flora species were recorded.

**Threatened ecological community:** Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

**Fauna habitat features:** comprises the winter-flowering Eucalypt Swamp Mahogany, which is an important food resource at a time when food bottlenecks may occur for nectivorous fauna such as the Grey-headed Flying-fox, and Squirrel Glider and birds such as Swift Parrot. The habitat exhibits standing water which fluctuates in depth forming small persistent pools and temporary flooded depressions which are important for life-cycle activities (feeding/breeding) of frogs and waterfowl. The density of the mid-storey and ground-cover vegetation (sedges and rushes) provides shelter for ground-dwelling mammals, frogs and reptiles. There is a very low abundance of tree hollow and logs in this habitat, although dead trees do occur in the deeper water sections and adjoin open wetlands formed by permanent inundation and tree dieback.

**Condition:** There are two condition classes of this PCT in the study area. Lower elevated wetland areas in the study area have been indirectly impacted from surrounding developments such as sporting fields, roads and associated drainage which is likely to have altered the hydrology regime and increased pollution and sedimentation (refer to Photograph 2) affecting natural processes and modifying the community composition. Good/moderate condition areas of this community (vegetation zone 1) have low-moderate levels of weed invasion. Poor condition areas of this community (vegetation zone 2) have been previously disturbed from clearing and underscrubbing many areas now support a dense sub-canopy of Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*), or are in a regenerating state with a mix of exotic species and regenerating trees and shrubs. Some areas of poor condition vegetation are currently being subject to weed control works which is contributing to an increase in site values within these areas.

Good/moderate condition patches have an average score of 51, with the main factors reducing the site value score from the benchmark being associated with lower species diversity, lack of hollow trees and no canopy regeneration.

	Vegetation Zone 1					Vegetation Zone 2				
Plot number:	3	4	10	12	Mean	5	6	7	9	Mean
Native plant species	13	9	14	14	13	6	28	19	8	15
Native overstorey cover (%)	22	23	24.5	27	24	36	20	6	16	20
Native midstorey cover (%)	19	17	18	34.5	22	0	27	47	22	24
Native ground cover - grass	0	0	0	0	0	0	4	2	0	2
Native ground cover – shrub (%)	2	0	4	8	4	2	0	0	0	1
Native ground cover – other (%)	36	76	32	28	43	0	26	6	0	8
Exotic plant cover (%)	31.5	13	0	43	22	44	28	68.5	73	53
Number of hollow trees	0	0	0	0	0	0	0	0	0	0
Canopy Regeneration (%)	0	0	0	0	0	0	1	0	0	0
Fallen logs (m)	45	10	8	12	19	12	6	9	26	13
Total score	53	42	56	53	51	31	75	47	38	48



**Description of the vegetation community: Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (1723)**


Photograph 2: Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937), vegetation zone 1. Note the substantial sediment deposition most likely a result of developments upstream of the study area.



Photograph 3: Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937), vegetation zone 2 (Plot 6). Disturbed regrowth where weed control and restoration works have been implemented resulting in increased site value scores.

Table 4-10 Typha rushland (1737)

**Description of the vegetation community: Typha rushland (1737)**

**Vegetation zones:** 3; 4 (Poor condition)

**PCT Code:** 1737

**BVT Code:** HU951

**Vegetation formation:** Freshwater Wetlands

**Vegetation class:** Coastal Freshwater Lagoons

**Conservation status:** Endangered, TSC Act

**Estimate of percent cleared:** 70%

**Condition:** Good/Moderate

**Extent in the study area:** 1.69 hectares (1.53 hectares good/moderate; 0.16 hectares poor condition)

**Plots completed in vegetation zone:** 2, 8, 11 (veg zone 3)



Photograph 4: Typha rushland (HU951), vegetation zone 3 (plot 8).

**Description:** This community occurs in low elevated depressions on alluvial soils surrounding the Pacific Highway, at the southern end of the site and also between the highway and the rail line on the western side of the road. This community is a forested wetland dominated by dense growth of Cumbungi (*Typha orientalis*) and an absent or sparse canopy and mid-storey cover. Other common species recorded in this community include Knotweeds (*Persicaria* species), River Buttercup (*Ranunculus inundatus*), Tall Sedge (*Carex appressa*), Tassel Sedge (*Carex fascicularis*), Harsh Ground Fern (*Hypolepis muelleri*) and *Triglochin microtuberosum*. This community is in relatively high condition with limited weed invasion, however urban runoff and modified hydrology regimes is likely to have resulted in some modification to the community. Areas of this community are likely to be permanently inundated outside of extended drought periods, with fringing areas being inundated intermittently.

**Landscape features:** This community occurs in low elevated depressions of alluvial soils surrounding the Pacific Highway. The substrate is generally alluvial sands and muds. Elevation is less than 50 metres.

**Distribution:** The community occurs as three main patches surrounding the Pacific Highway in the study area. This community

**Description of the vegetation community: Typha rushland (1737)**

typically occurs at the margins of standing fresh water along the coast from about Woy Woy to Hexham.

**Diagnostic features:** These areas are in low elevated depressions and have limited canopy cover with dense cover of Cumbungi (*Typha orientalis*) and other aquatic flora such as Knotweeds (*Persicaria* species) and *Carex* species.

**Threatened flora species:** *Melaleuca biconvexa* occurs mainly around the edges of this community in swamp forest habitats, however isolated individuals are also present within permanently inundated areas (refer to Photograph 5) that are mostly in poor condition and many have fallen over which may be an indication of the altered hydrology regimes resulting in higher water levels for a longer duration. No other threatened flora species were recorded.

**Threatened ecological community:** Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions

**Fauna habitat features:** the open wetlands vary across the study area to open water with submerged logs and dead trees to densely vegetated wetlands comprising of a cover of between 50-100% of emergent reeds and sedges, such as *Typha orientalis*, with surrounding fringes dominated by Saw sedges (*Gahnia* species). The degree of water depth varies considerably, and the deepest open wetland adjacent to The Ridgeway provides open water utilised by ducks, herons and ibis, while the shallow, densely vegetated wetlands are frequented by bird species seeking shelter, such as Purple Swamp Hen. These wetland areas provide habitat for breeding insects and are therefore frequented by microchiropteran bats, frogs and birds. The densely vegetated interior and fringes provides sheltering habitat for frogs, reptiles and birds and provides opportunities for frogs in terms of shelter, protection from predators, refuge during dry periods and as sites for the deposition of eggs.

**Condition:** There are two condition classes of this PCT in the study area. Lower elevated wetland areas in the study area have been indirectly impacted from surrounding developments which is likely to have altered the hydrology regime and increased pollution and sedimentation (refer to Photograph 2) affecting natural processes and modifying the community composition. It is likely that the distribution of this community has expanded into areas of the surrounding swamp forest following the alteration of hydrology regimes from surrounding developments which are likely to have increased the volume of and duration of inundation in low lying areas. Good/moderate condition areas of this community (vegetation zone 3) have low-moderate levels of weed invasion. Poor condition areas of this community (vegetation zone 4) are present adjacent to the rail corridor and support a dense sub-canopy of Pussy Willow (*Salix cinerea*) which is also present on the edges of good/moderate condition areas.

Good/moderate condition patches have an average benchmark score of 56, with the main factors reducing the site value score being the lack of overstorey species, overstorey regeneration and fauna habitats.

Site values	Vegetation Zone 3			
Plot number:	2	8	11	Mean
Native plant species	5	16	10	10
Native overstorey cover (%)	0	5	0	2
Native midstorey cover (%)	0.5	15	0	5
Native ground cover - grass	0	2	0	1
Native ground cover – shrub (%)	0	0	0	0
Native ground cover – other (%)	100	80	76	85
Exotic plant cover (%)	0	6	8	5
Number of hollow trees	0	0	0	0
Canopy Regeneration (%)	0	1	0	0
Fallen logs (m)	0	15	0	5
Total score	46	68	53	56



**Description of the vegetation community: Typha rushland (1737)**

Photograph 5: Typha rushland (HU951), vegetation zone 3. Lisarow wetland showing inundated trees in poor condition on the edges of the wetland.



Photograph 6: Typha rushland (HU951), zone 4 (poor condition) with dense growth of Pussy Willow (*Salix cinerea*) with Arum Lily (*Zantedeschia aethiopica*).

Table 4-11 Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (1568)

**Description of the vegetation community: Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (1568)**

Vegetation zones: 5; 6 (Poor condition)

PCT Code: 1568

BVT Code: HU782

Vegetation formation: Wet Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: North Coast Wet Sclerophyll Forests

Conservation status: Not listed

Estimate of percent cleared: 40%

Condition: Good/Moderate

Extent in the study area: 1.13 hectares (0.89 hectares good/moderate; 0.24 hectares poor condition)

Plots completed in vegetation zone: 1 (veg zone 5), 13 (veg zone 6)



Photograph 7: Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (HU782), vegetation zone 5 (plot 1).

**Description:** This majority of this community occurs in the elevated lands and slopes at the northern end of the study area northwest of the Main Northern Rail Line surrounding the cemetery. Dominant species include Sydney Blue Gum (*Eucalyptus saligna*), Turpentine (*Syncarpia glomulifera*) and Blackbutt (*Eucalyptus pilularis*). The understorey includes a high diversity of small trees, shrubs, grasses and forbs. Small trees include a Cheese Tree (*Glochidion ferdinandi*), White Euodia (*Melicope micrococca*), Willow Bottlebrush (*Callistemon salignus*), Brush Muttonwood (*Myrsine howittiana*) and Murrogon (*Cryptocarya microneura*). Dominant shrub species include Elderberry Panax (*Polyscias sambucifolia*), Yellow Pittosporum (*Pittosporum revolutum*), Coffee Bush (*Breynia oblongifolia*) and Narrow-leaf Geebung (*Persoonia linearis*). Groundcovers species include mix of grasses and forbs such as Bordered Panic (*Entolasia marginata*), Caterpillar Flower (*Gymnostachys anceps*), Soft Bracken (*Calochlaena dubia*) and Mat-rush (*Lomandra*



**Description of the vegetation community: Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (1568)**

*longifolia*). There is also a diversity of climbers including Lawyer Vine (*Smilax australis*), Snake Vine (*Stephania japonica*) and Wombat Berry (*Eustrephus latifolius*). The majority of this community is in a moderate to poor condition with a partially disturbed understorey dominated by invasive weeds.

**Landscape features:** This community occurs on slopes and ranges with soils derived from Narrabeen sandstone.

**Distribution:** In the study area this community occurs on elevated lands surrounding the Cemetery at the northern of the study area and it also occurs on elevated areas surrounding Wetland A which adjoins Lisarow High School. This community occurs on sandstones ranges of the Central Coast at elevations below 450 metres.

**Diagnostic features:** This community is distinctive from other vegetation types in the study area occurring on more elevated slopes and ridges with a mixed canopy of Sydney Blue Gum (*Eucalyptus saligna*), Turpentine (*Syncarpia glomulifera*) and Blackbutt (*Eucalyptus pilularis*).

**Threatened flora species:** *Melaleuca biconvexa* was recorded in a small portion of this community on the corner of Railway Crescent and Dora Street. *Melaleuca biconvexa* was also recorded in this vegetation community, within the locality, on elevated lands near the Newcastle University Central Coast campus.

**Threatened ecological community:** Not threatened

**Fauna habitat features:** the mesic tall open forest occurs on moderately steep slopes and comprises a complex structure of tall trees, dense midstorey and groundcover. There is a low abundance of tree hollows and logs and there are few resources for hollow-dependent fauna. The dense cover of midstorey and groundcover vegetation provides shelter for small mammals, reptiles and birds and there is a moderate diversity of shrubs and trees providing seasonal food resources for nectivorous fauna.

**Condition:** There are two condition classes of this PCT in the study area which will be impacted by the proposal. Better condition areas (vegetation zone 5) occur in lands surrounding the cemetery at the northern end of the study area, which support a diversity of native flora and moderate weed cover. Poor condition examples include road verges supporting highly modified examples, including the eastern side of the Pacific Highway opposite the cemetery supporting canopy and midstorey species and areas adjoining the rail corridor with a sparse canopy and dense weed abundance. Areas of disturbed understorey are dominated by invasive weeds in areas including Small-leaved Privet (*Ligustrum sinense*), Lantana (*Lantana camara*), Camphor Laurel (*Cinnamomum camphora*) and Ochna (*Ochna serrulata*).

Good/moderate condition patches have a benchmark score of 49, with the main factors reducing the site value score being the lack of overstorey regeneration, hollow trees and fallen logs. Poor condition areas of this community have a benchmark score of 19 with limited canopy cover, species diversity, fauna habitats and a high abundance of weeds.

	Vegetation Zone 5	Vegetation Zone 6
Plot number:	1	13
Native plant species	39	19
Native overstorey cover (%)	24	2
Native midstorey cover (%)	19.5	5
Native ground cover – grass	18	0
Native ground cover – shrub (%)	0	8
Native ground cover – other (%)	10	16
Exotic plant cover (%)	26	96
Number of hollow trees	0	0
Canopy Regeneration (%)	0	0
Fallen logs (m)	0	0
Total score	49	19

**Description of the vegetation community: Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (1568)**



Photograph 8: Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (HU782), vegetation zone 6 (plot 13).



Photograph 9: Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (HU782), vegetation zone 6 on the elevated edges of wetland areas adjacent to Lisarow High School.

#### 4.3.2 Flora subject species

A large population of *Melaleuca biconvexa* was confirmed in the study area and surrounding lands. No other threatened flora species were recorded despite further targeted surveys in particular for *Syzygium paniculatum*, *Prostanthera askania* and *Dendrobium melaleucaphilum*. Habitat in the study area for these potentially occurring threatened flora species is limited and generally unsuitable, based on the following conclusions:

- Targeted flora surveys covered all habitats and areas likely to be directly and indirectly impacted by the project and no individuals were found. These species are not cryptic, or seasonal is occurrence that may suggest individuals were missed.
- The characteristic habitat types for *Syzygium paniculatum* comprise littoral rainforest and riverside gallery rainforests which are absent from the study area and no planted individuals have been identified.
- Although the Coastal Narrabeen Moist Forest habitats in the study area provide potential habitat for *Prostanthera askania* it is known to occur next to drainage lines, which are absent from this area of habitat. Additional intensive searches of this area did not identify the species and the understorey is relatively disturbed with a dense cover of *Lantana camara*.
- Potential habitat for *Dendrobium melaleucaphilum* is limited to several *Melaleuca styphelioides* trees present in the study area, which are generally in more exposed locations unsuitable for growth of this species.

Considering the level of survey effort and generally unsuitable habitat conditions for threatened flora species other than *Melaleuca biconvexa*, additional threatened flora species are considered unlikely to be present and no further assessment is required.

#### ***Melaleuca biconvexa* – local and regional populations**

The results of the *Melaleuca biconvexa* surveys are summarised below including surveys of the local and regional populations (refer to Table 4-12) and map of the distribution in the study area (refer to Figure 4-3).

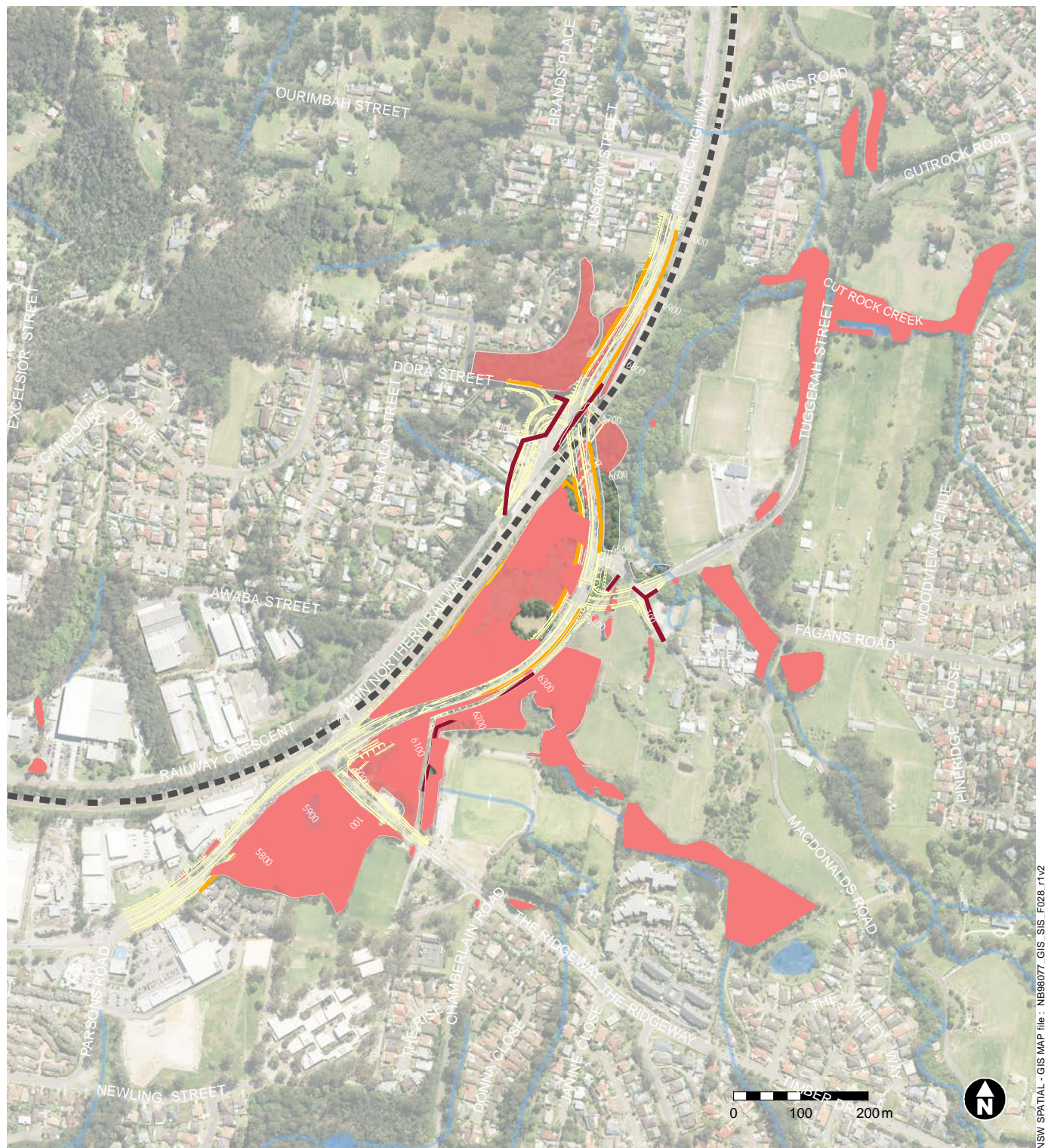
The local population within the study area has been identified using GIS and based on mapping the patches in the direct impact area as well as proximal areas connected by spaces less than 500 metres apart. This is about 13.35 hectares in size.

The regional population was developed using a range of data sources to map the distribution of *Melaleuca biconvexa* in the Gosford and Wyong LGAs (refer to Figure 4-4). From this spatial layer and field data the regional population of *Melaleuca biconvexa* has been estimated and mapped with varying levels of confidence.

Table 4-12 Summary of the local and regional *Melaleuca biconvexa* desktop and ground-truth survey results

Local and regional distribution of <i>Melaleuca biconvexa</i>	Population estimate	Area occupied (ha)
<b>DISTRIBUTION/ABUNDANCE</b>		
Confirmed extent within the study area (local population)		13.35
Area directly impacted	2,153	2.61
Area indirectly impacted	422	0.73
Estimated extant within the locality (confirmed and non-confirmed locations within 10 km radius)	130,535	254.15
Confirmed locations mapped with high degree of confidence in Gosford and Wyong LGA	41,571	48.82
Confirmed locations mapped with moderate degree of confidence in Gosford and Wyong LGA	67,429	101.46
Locations mapped with a low degree of confidence (not ground-truthed) in Gosford and Wyong LGA	51,036	204.11
<b>Total estimated regional population</b>	<b>160,036</b>	<b>354.38</b>
<b>HABITAT CONDITION</b>		
Area of occupied habitat in good/moderate condition	42,098	66.61
Area of occupied habitat in poor condition	62,968	79.37
Area of occupied habitat in low condition	1,658	3.03
Area of occupied habitat with unknown habitat condition	53,312	205.38
<b>LANDUSE</b>		
Environmental Conservation (E2-Gosford and Wyong LEPs)	67,829	164.43
Environmental Management (E3-Gosford and Wyong LEPs)	13,132	24.46
Environmental Living (E4-Gosford and Wyong LEPs)	15,973	36.11
State forest and recreation	19,829	27.22
Agriculture	19,260	66.1
Zoned for development (Industrial, residential, business)	24,260	29.79
Deferred matters	3,621	6.29
National parks and nature reserves	0	0











NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F028.r1v2

Figure 4-3 | Biconvex Paperbark (*Melaleuca biconvexa*) in the study area

#### Legend

- |   |                |   |  |
|---|----------------|---|--|
|  | Concept design |  | Potential habitat area investigated                          |
|  | Retaining wall |  | Biconvex Paperbark ( <i>Melaleuca biconvexa</i> ) population |
|  | Power line     |   |  |
|  | Watercourse    |   |  |

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014

A confidence rating was applied to the polygons based on the level of ground-truthing survey undertaken for this proposal. A high confidence rating was applied to around 49 hectares of habitat occupied by *Melaleuca biconvexa*, which included ground-truthed polygons from the Wyong LGA spatial data layer and additional polygons created in Gosford and Wyong LGAs.

A moderate confidence rating was applied to around 101 hectares of habitat. This includes polygons from the Wyong LGA spatial data layer, where only a small proportion of the population within polygon area was ground-truthed usually around the edges, and / or the presence of numerous records from existing datasets (OEH 2015). A low confidence rating was applied to around 204 hectares of habitat comprising polygons from the Wyong LGA spatial layer where no ground-truthing surveys were undertaken of which around 60 hectares of habitat polygons were modified based on aerial photograph interpretation.

The majority of the mapped population of *Melaleuca biconvexa* (53% of mapped population area) is located within areas zoned for environmental conservation (Zone E2) and environmental management (Zone E3) under the Gosford and Wyong LEPs (refer to Table 4-9). Some level of environmental protection is also provided to populations within recreational zonings (7.5%) and environmental living (Zone E4) (10%). The remaining population occurs within areas zoned for developments (8.5% of mapped population), agriculture (19%) or are deferred matters (2%).

A total of 62 stem-count plots were undertaken in the Gosford and Wyong LGAs including 15 within the study area and 47 in the locality/region outside of the study area. The results of these rapid plot assessments are summarised in Table 4-13.

Table 4-13: Results of *Melaleuca biconvexa* rapid plot assessments (62 plots)

Attribute ( <i>Melaleuca biconvexa</i> rapid plot assessments)	Local population (within study area) (N= 15 plots)	Regional population (N= 62 plots)
Average total number of stems per plot (400 metres squared)	38 stems	33 stems
Average number of mature stems per plot	33 stems	28 stems
Average number of immature stems per plot	5 stems	2 stems
Average cover/abundance recorded within all plots	26%	25%
Number of plots undertaken in good/moderate condition vegetation	7 (46.6 %)	27 (43.5 %)
Number of plots undertaken in poor condition vegetation	8 (53.3 %)	33 (53.2 %)
Number of plots undertaken in low condition vegetation	0	2 (3.2 %)

The average number of *Melaleuca biconvexa* stems within the study area and average cover / abundance score is slightly higher within the study area in comparison to the average across the entire population. The average density of *Melaleuca biconvexa* individuals within patches of occupied habitat in the study area is around 950 stems per hectare, in comparison to entire mapped population which is around 825 stems per hectare. The calculations for impacts to *Melaleuca biconvexa* stems has been based on the densities recorded in each polygon from plot assessments.

The number of individuals in the subject site has been estimated based on plot data and the confirmed extant of *Melaleuca biconvexa*. Individual polygons were assigned a density (stems/ha) and this density was extrapolated across each polygon, which resulted in a total of 2,153 stems being calculated for the 2.61 hectares of occupied habitat within the subject site. The total number of stems within the subject site is likely to be around 2,600 mature and immature stems (+/-400 stems).

The mapped area of occupied habitat within the locality (10 km radius of the site) comprises 254 hectares and the entire mapped area in the Gosford and Wyong LGAs (regional population) is around 354 hectares. The area of occurrence for the entire Central Coast regional population is likely to be greater than 400 hectares including the remaining area of the population within Lake Macquarie LGA (not mapped). There are at least 218 records of *Melaleuca biconvexa* in the southwest Lake Macquarie LGA (Mandalong area) consisting of at least 500



stems. Of the entire estimated population of *Melaleuca biconvexa* in the Wyong and Gosford LGAs, approximately two per cent is within the study area and approximately 0.7 per cent (2.61 ha) is within the proposed direct impact area. The proposed impact to *Melaleuca biconvexa* represents around one per cent of the mapped regional population.

#### 4.3.3 Fauna subject species

The Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded as common in the study area during the autumn and winter nocturnal surveys, and associated with the flowering Swamp Mahogany (*Eucalyptus robusta*). Swamp Mahogany is an important winter-flowering eucalypt in the diet of Grey-headed flying-fox in coastal areas and the number of flying-foxes observed indicates that habitat in the study area would be considered foraging habitat for a proportion of the local population.

Flying-foxes were observed feeding throughout all areas of the swamp forest habitat, including trees overhanging the existing highway, and up to 10 individuals were recorded on one evening. Sighted locations of Grey-headed Flying-fox are shown on Figure 4-5.

The results of the microbat call recording and analysis tentatively identified five threatened microbat species listed under the TSC Act. This included nine probable calls of the Little Bentwing-bat (*Miniopterus australis*), two probable calls of the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), one possible call of the Eastern Freetail-bat (*Mormopterus norfolcensis*) and 17 probable calls which could be attributed to either the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) or Greater brad-nosed Bat (*Scoteanax rueppellii*). Calls of the latter species are difficult to distinguish from each other and the common *Scotorepens orion*, and have been assigned to the threatened species as a precautionary measure.

The habitat in the study area provides foraging opportunities for microbats due to the abundance of standing water and insect prey species. There are numerous street lights in proximity to the Lisarow train station adjoining the wetland and these would likely attract insects. However, tree hollows are very scarce due to the dominance of *Melaleuca* spp and *Eucalyptus robusta* and there are limited opportunities for roosting or breeding for hollow-dependent species. Similarly there are no caves or suitable artificial roosting structures for the Little Bentwing-bat and the habitat would likely be used for foraging only.

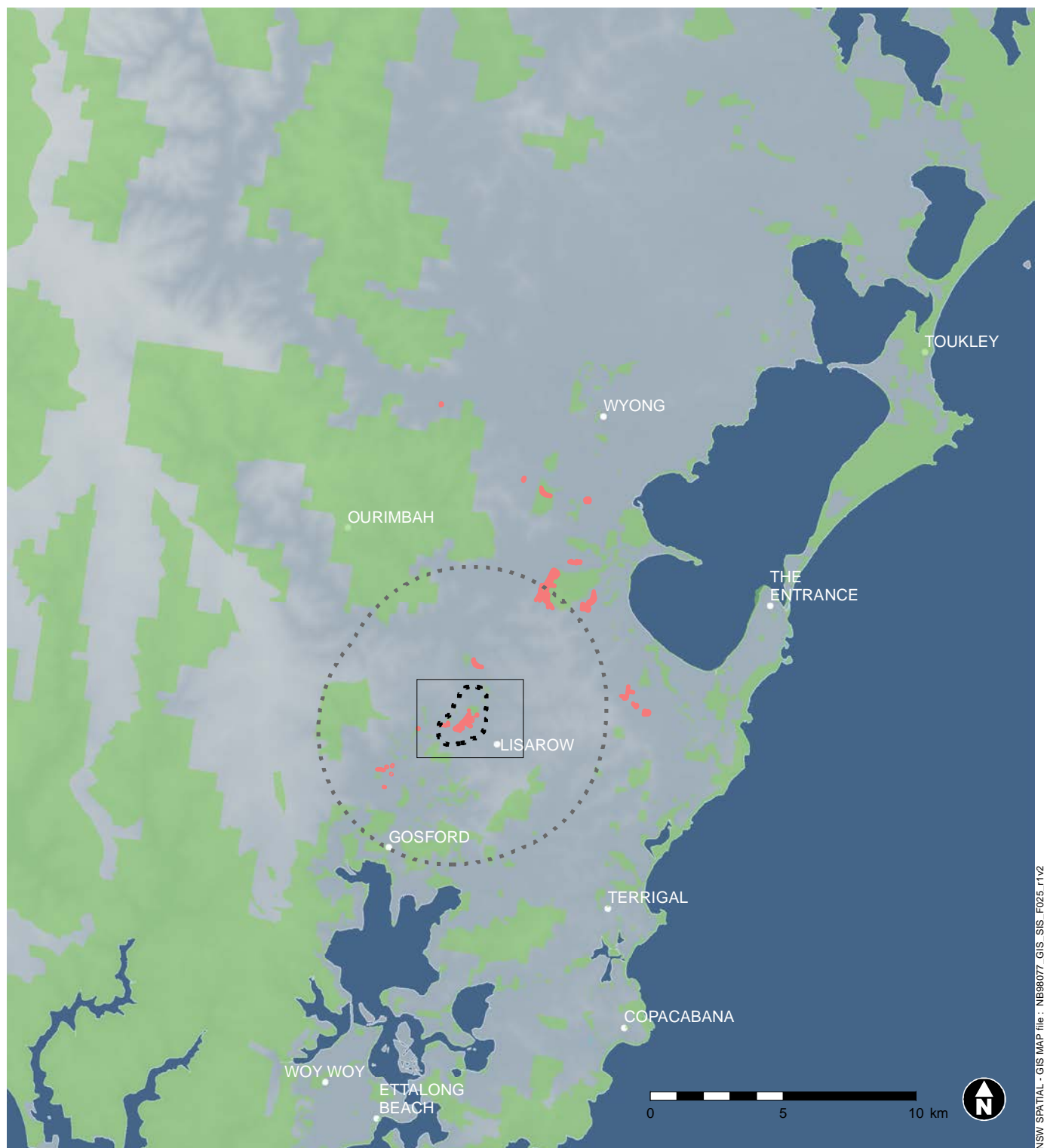
No other threatened fauna subject species were identified during surveys for the REF or SIS.

#### 4.3.4 Subject species habitat mapping

Two threatened species have been confirmed in the study area and described in the preceding sections of Chapter 4. A map of the distribution of *Melaleuca biconvexa* in the study area is provided as Figure 4-3 and a map of this species in the wider locality is shown as Figure 4-4. A map showing the locations of Grey-headed Flying-fox observations recorded in surveys for the SIS is shown as Figure 4-5.

A series of species habitat maps has been produced for additional potential subject species not identified from the surveys and potentially affected by the proposal. Known and potential habitats for threatened subject species and ecological communities have been mapped separately for each species based on known occurrence or preferred habitat types. A description of each of the threatened subject species and corresponding habitat map is provided in Section 5 of the report.










NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F025\_r1v2

Figure 4-4 | Regional distribution of Biconvex Paperbark (*Melaleuca biconvexa*)

#### Legend

- |   |                  |   |  |
|---|------------------|---|--|
|  | Project location |  | Biconvex Paperbark ( <i>Melaleuca biconvexa</i> ) population |
|  | 500 m radius     |  | Parkland   |
|  | 5 km radius      |   |  |

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Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



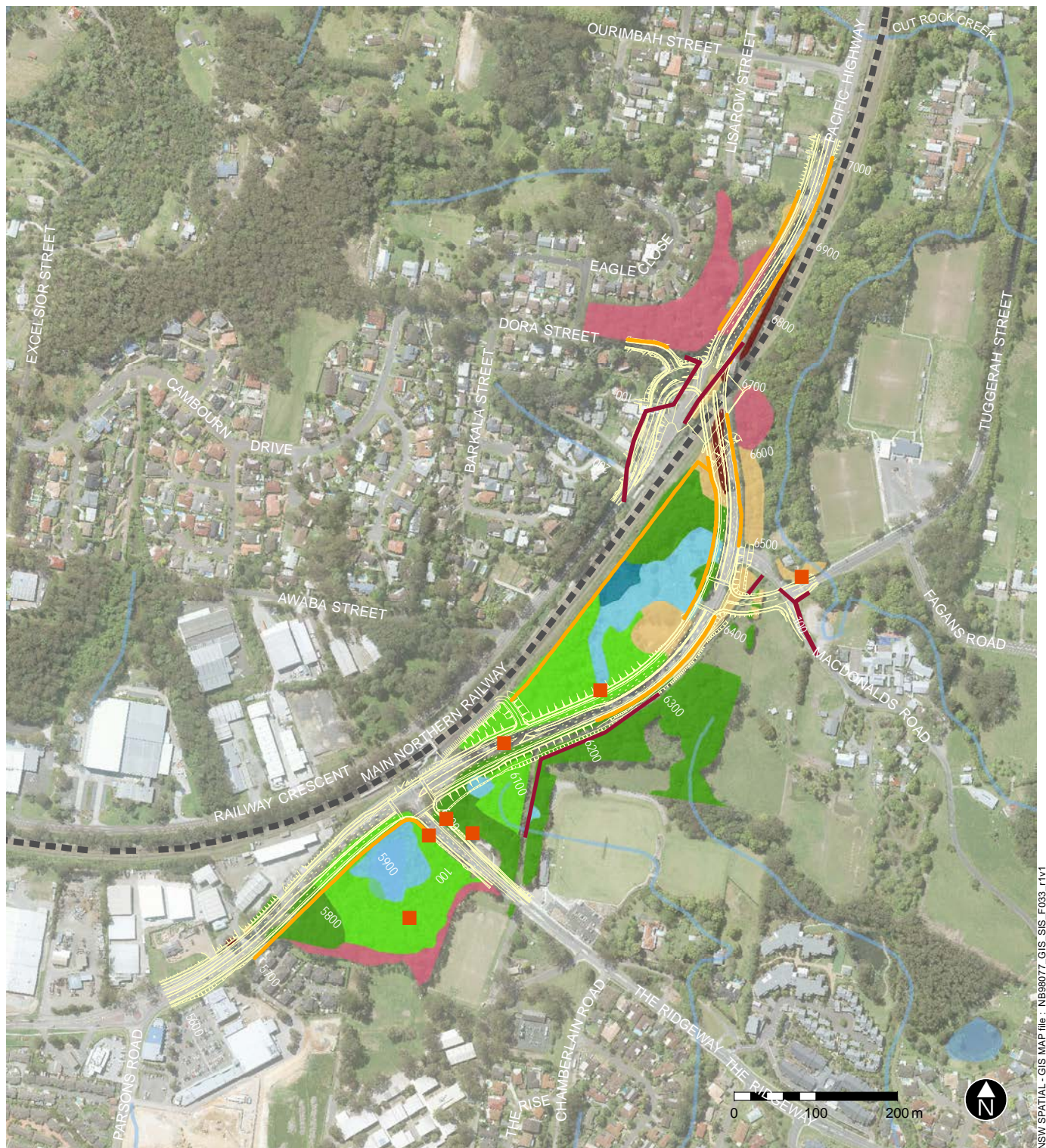








Figure 4-5 | Fauna habitats and threatened fauna records in the study area

### Legend

-  Concept design
-  Retaining wall
-  Power line
-  Watercourse
-  Grey-headed Flying-fox

### Vegetation zones and communities

-  1: Alluvial Paperbark Sedge Forest
-  2: Alluvial Paperbark Sedge Forest - Poor Condition
-  3: Freshwater Wetland
-  4: Freshwater Wetland
-  5: Coastal Narrabeen Moist Forest
-  6: Coastal Narrabeen Moist Forest - Poor Condition
-  Exotic Trees and Shrubs - Low Condition

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Jacobs 2014

### SPECIES IMPACT STATEMENT

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#### 4.3.5 Threatened ecological communities

The surveys identified and mapped two threatened ecological communities in the study area (Table 4-14). The two threatened ecological communities in the study area are described in detail in Section 2.3.1 comprising freshwater wetlands and swamp sclerophyll forest.

Table 4-14 Threatened ecological communities identified and mapped in the study area

Threatened ecological community	Condition class (refer to Table 4-3)	Subject site (ha)	Study area (ha)
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands)	High	0.32	1.53
	Moderate	0.03	0.16
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest)	High	1.48	3.46
	Moderate	1.3	3.84

These threatened ecological communities have been indirectly impacted from surrounding developments, which are likely to have altered the hydrology regime and increased pollution and sedimentation affecting natural processes and modifying the community composition. The original hydrology regime of the study area has been highly altered with water being contained at higher levels for longer periods. As a result of the previous alterations to the original hydrology regime it is likely that the distribution of freshwater wetlands has expanded into the surrounding swamp forest with numerous fallen trees observed surrounding the open wetland areas.

Good / moderate condition areas of threatened ecological communities have low-moderate levels of weed invasion. However, species diversity is relatively low and overstorey regeneration is limited. Good / moderate condition areas were identified based on the minimal weed abundance and moderate native flora diversity. Poor condition areas of these communities were identified based on the high to moderate levels of weed abundance and reduced levels of native flora diversity. Dominant weed species include Pussy Willow (*Salix cinerea*) and Arum Lily (*Zantedeschia aethiopica*) in freshwater wetlands and Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*) is present in the sub-canopy and canopy of poor condition areas of swamp sclerophyll forest. Some areas of poor condition vegetation in Wetland A and Wetland C are currently being subject to weed control works which is substantially contributing to the rehabilitation and increase in site values within these areas.

These areas of freshwater wetlands and swamp sclerophyll forest are consistent with the descriptions provided in the final determinations and identification guidelines for these ecological communities. Both communities in the study area occur on a coastal floodplain and are below the highest flood levels for the area, including areas of permanent and semi-permanent freshwater. Areas of freshwater wetland have been distinguished from the surrounding swamp sclerophyll forest based on the absence of woody plants and dominance of aquatic macrophytes and herbs including Cumbungi (*Typha orientalis*), Knotweeds (*Persicaria species*), River Buttercup (*Ranunculus inundatus*) and Tall Sedge (*Carex appressa*) which are all listed as characteristic species in the final determination and identification guidelines for freshwater wetlands. Areas of swamp sclerophyll forest occurs on sandy loam to humic clay soils subject to waterlogging and area dominated by flora species listed under the final determination including Swamp Mahogany (*Eucalyptus robusta*), Tall Saw-sedge (*Gahnia clarkei*), Tall Sedge (*Carex appressa*), Swamp Water-fern (*Blechnum indicum*) and Harsh Ground Fern (*Hypolepis muelleri*).











NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F031\_r1v1

Figure 4-6 | Threatened ecological communities




### Legend

-  Concept design
-  Retaining wall
-  Power line
-  Watercourse

### Threatened ecological communities

-  Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions
-  Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

### Condition of vegetation

-  High
-  Moderate
-  Low

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## SPECIES IMPACT STATEMENT

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## 4.4 Survey results – general species

### 4.4.1 Flora diversity

A moderate level of native floral species richness was recorded within the study area which is a reflection of the limited habitat types and the degree of habitat disturbance. A total of 206 flora species from 80 families were identified. This total comprised one conifer, 14 species of fern, 131 species of dicotyledons and 60 species of monocotyledons. Of the total species recorded, 70 species of introduced flora were identified, representing approximately 34 per cent of the total species diversity, and a further two non-indigenous native species were also recorded in the study area. A comprehensive list of the flora species present within the study area at the time of the survey has been included as Appendix A. The flora surveys have been conducted during autumn, winter and spring, and therefore it is likely that the large majority of flora species present have been detected.

### 4.4.2 Fauna diversity

A total of 78 species was recorded from the survey, comprising 9 mammals, 59 birds, five amphibians and five reptiles (refer to Appendix C for complete fauna list).

#### Mammals

The most common mammal species recorded was the Grey-headed Flying-fox (*Pteropus poliocephalus*) observed predominantly during the autumn-winter surveys associated with flowering Swamp Mahogany. Low numbers of the native Common Ringtail Possum (*Pseudocheirus peregrinus*), Common Brushtail Possum (*Trichosurus vulpecula*) and Brown Antechinus (*Antechinus stuartii*) were reported, particularly in the dominant swamp forest habitat. The introduced Black Rat (*Rattus rattus*) was also reported from the swamp forest habitat and is expected to be common in the study area. Individuals of the both the Brown Antechinus and Black Rat were captured in tree traps during the spring survey. A Water Rat (*Hydromys chrysogaster*) was observed in Wetland A.

One microchiropteran bat species was captured, a male Little Forest Bat (*Vespadelus vulturnus*), the species is likely to be common in the study area and roosts in tree hollows, and cracks in dead trees. No roosting bats were found in the inspection of the culverts during the April survey.

A total of 78 bat calls were recorded and able to be analysed, this resulted in possible and probable identification of 9 bat species (refer Appendix G). This included possible recording of five threatened species listed under the TSC Act as vulnerable, the Eastern Bentwing-bat (*Miniopterus schreibersii oceansis*), Little Bentwing-bat (*Miniopterus australis*), Eastern Freetail Bat (*Mormopterus norfolcensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and False Pipistrelle (*Pipistrellus tasmaniensis*).

#### Birds

A total of 59 bird species were recorded over four seasons, which includes a diversity of forest-dwelling and wetland bird species. No threatened bird species were recorded. The winter survey was dominated by nectivorous species associated with the abundance of flowering Swamp Mahogany, particularly Rainbow Lorikeet (*Trichoglossus haematodus*) and also Yellow-faced Honeyeater (*Lichenostomus chrysops*), Lewins Honeyeater (*Meliphaga lewinii*) with lower abundance of Scarlet Honeyeater (*Myzomela sanguinolenta*).

The wetland habitats support a low diversity of species, mainly Australian White Ibis (*Threskiornis moluccus*), Pacific Black Duck (*Anas superciliosa*), and Chestnut Teal (*A. castanea*).

Two migratory species listed under the *Environment Protection and Biodiversity Conservation Act, 1999*, the Cattle Egret (*Bulbulcus ibis*) and Black-faced Monarch (*Monarcha melanopsis*), were reported in the spring-summer survey. Cattle Egrets were commonly seen in the cleared grazing land to the east of the proposal area habitats.

Evidence of nesting by Brush Turkey (*Alectura lathamii*) was observed on the slopes associated with the moist forest habitat. Suitable habitat for this species is very limited, and it appears to be associated close to residences in the moist slope at the south western end of the study area.

Species which were only sighted once and considered uncommon included the Azure Kingfisher (*Alcedo azurea*), Shining Bronze Cuckoo (*Chrysoccyx lucidus*), Satin Bowerbird (*Ptilonorhynchus violaceus*), Eastern Spinebill (*Acanthorhynchus tenuirostris*), and White-headed Pigeon (*Columba leucomela*).

### **Amphibians and Reptiles**

Despite the abundance of expected potential habitat for frogs associated with the swamp forests and open wetland habitats, frog species diversity and richness was low. Five species were reported from four surveys. These surveys included two summer surveys following over 100 mm of rain and considered optimum for detection of frogs, suggesting that the species richness recorded is likely to represent the full extent of the frog assemblage. In all habitats, the water quality was observed to be very poor associated with siltation, but also run-off from urban areas with extensive evidence of algae and oils slicks on the surface of the water.

Several common amphibian species were recorded in the wetland habitats, including the Common Eastern Froglet (*Crinia signifera*), Striped Marsh-frog (*Limnodynastes peronii*), Tylers Tree Frog (*Litoria taylori*), and Eastern Dwarf Tree Frog (*Litoria fallax*). There is very limited potential for the study area to provide habitat for threatened frog species such as the Green-thighed Frog (*Litoria brevipalmata*) and Green and Golden Bell Frog (*Litoria aurea*) in the forested and open wetlands. Neither species was detected from four nocturnal surveys conducted during optimal season and weather conditions.

Five reptile species were observed, dominated by the Delicate Skink (*Lampropholis delicata*) which was found in all habitat types. Of interest was the presence of the Land Mullet (*Egernia major*) which was only observed in the swamp forest habitat at Site 2, and is likely to be uncommon in the study area. No threatened reptile species were recorded.



## 5. Assessment of likely impacts on threatened species

### 5.1 Overview of direct and indirect impacts

The following section discusses the requirements of the DGRs in relation to discussion and quantification of the likely direct and indirect impacts of the project on threatened species. The main impact of the proposal on subject species and communities would be the loss of habitat and/or individuals as a result of vegetation clearing. The proposal would result in a reduction in the extent of threatened ecological communities and *Melaleuca biconvexa*, and remove of a proportion of the available habitat and resources in the locality available for threatened fauna species.

The severity of the impact is minimised to a degree by the fact the proposal is an upgrade of the existing Pacific Highway which is an existing barrier and therefore there is unlikely to be an impact on the movements of fauna across the road corridor. A biodiversity offset strategy has been developed which includes offsetting the cumulative impacts associated with this proposal. It is anticipated that the biodiversity offset strategy would contribute to the long-term conservation of biodiversity in the bioregion.

A range of direct and indirect impacts are expected if the proposal is to go ahead, and these are discussed in further detail throughout this chapter. Assessment of the likely impacts on each plant and animal species is provided in Section 5.6 and on each vegetation community in Section 6.5. In general, the main impacts to biodiversity that are likely to occur during construction and operation of the proposal are summarised below:

- Direct loss of native vegetation (including threatened flora and threatened ecological communities and their habitats).
- Direct loss of terrestrial, riparian and aquatic habitat for protected and threatened fauna (including hollow-bearing trees, dead wood, food resources, shelter and refuge areas during non-breeding and breeding life-cycle events).
- Ongoing fragmentation of terrestrial and aquatic habitat and edge effects from changed conditions in noise, light and wind turbulence.
- Indirect impacts resulting from alteration of hydrology regimes such as by re-direction of culvert discharges or changes to stormwater detention.
- Indirect impacts resulting from changes to water quality as a result of works in or adjacent to aquatic habitats.
- Indirect impacts resulting from invasion and spread of weeds.
- Indirect impacts resulting from the potential spread of disease pathogens on construction machinery, equipment and personnel.
- Indirect impacts following clearing of vegetation resulting in erosion and sedimentation.

The range of measures to be adopted for the proposal to avoid and minimise impacts on biodiversity and to mitigate impacts during construction and operation of the proposal are discussed in Section 7. Assessments of significance are provided in Section 8.

### 5.2 Direct impacts

#### 5.2.1 Direct clearing of vegetation

Clearing of native vegetation is a key threatening process listed under the TSC Act. The proposal would involve the direct clearing of approximately 3.84 hectares of native vegetation and an additional 0.94 hectares of exotic trees and shrubs (Table 5-1). These clearing estimates are calculated based on the extent of native and exotic vegetation surveyed in the study area which overlaps with the proposed construction footprint comprising the road formation including water quality and sediment basins, a power easement plus an additional ten metre buffer for temporary construction access and construction activities.

### 5.2.2 Direct loss of habitat for fauna

#### ***Loss of hollow bearing trees and removal of dead wood and dead trees***

The loss of hollow-bearing trees is listed as a key threatening process under the TSC Act. Hollow bearing trees are a critical habitat feature for a number of threatened species (Gibbons & Lindenmayer 2002), providing breeding and / or sheltering habitat.

There were no hollow bearing trees recorded in the study area or subject site. The swamp forest habitats in the study area do not support large mature trees supporting hollows. Areas of wet sclerophyll forest on slopes are more conducive to the formation of hollows; however small areas of this habitat type in the study area which were surveyed, do not support large hollow bearing trees.

#### ***Loss of food resources***

The direct loss of foraging resources in the form of foliage, nectar and sap exudates equates coarsely to the clearing impacts described in Table 5-1. The indirect impacts of this clearing relate to loss of habitat for prey species, in particular insects. However, this may overestimate the impact by assuming that all habitats being lost have equal value as foraging habitat and equal accessibility and does not consider competition for resources and forage quality and quantity per habitat type.

Foliage and nectar foraging resources are present across the forested sections of the study area in multiple strata including the upper canopy, mid to lower and ground level strata. Threatened species potentially impacted at the patch scale are forest dependent species such as Squirrel Glider, Koala and small insectivorous bats. Species expected to be impacted at the landscape level include Swift Parrot, Regent Honeyeater, Little Lorikeet, and Grey-headed Flying-fox. The latter are responsible for cross-pollination and genetic diversity in many plant species.

More critically, a number of threatened species require winter flowering foraging resources to supply food year-round, or to coincide with migratory movements. As such, the presence of annually reliable winter-flowering species is considered a limiting factor in the distribution of a number of threatened species, including Squirrel Glider, Regent Honeyeater, Swift Parrot, Little Lorikeet and Grey-headed Flying-fox. Of the habitats impacted by the proposal, the swamp sclerophyll forest EEC contains the winter-flowering Swamp Mahogany (*Eucalyptus robusta*) and can be considered of value as a foraging resource. The loss of this habitat for the proposal equates to 2.74 hectares.

Table 5-1: Direct vegetation/habitat clearing

Vegetation zone	Biometric vegetation type	PCT ID	Legal status (TSC Act)	Direct impact (ha) (includes 10 m construction buffer)
1: Alluvial Paperbark Sedge Forest – Mod/Good	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	1723	Endangered Ecological Community (EEC)  Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest)	1.48
2: Alluvial Paperbark Sedge Forest – Mod/Good/Poor Condition				1.30
Sub-total				2.78 ha
3: Freshwater Wetland	Typha rushland (HU951)	1737	Endangered Ecological Community (EEC)  Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands)	0.32
4: Freshwater Wetland - Poor Condition				0.03
Sub-total				0.35 ha
5: Coastal Narrabeen Moist Forest - Moderate	Blackbutt - Turpentine - Sydney Blue Gum	1568	Not listed	0.49

Vegetation zone	Biometric vegetation type	PCT ID	Legal status (TSC Act)	Direct impact (ha) (includes 10 m construction buffer)
6: Coastal Narrabeen Moist Forest - Poor Condition	mesic tall open forest on ranges of the Central Coast (HU782)			0.22
<b>Sub-total</b>				<b>0.71 ha</b>
<b>Total remnant vegetation impacts</b>				<b>3.84 ha</b>
Exotic Trees and Shrubs – Low Condition	n/a	n/a	Not listed	0.94

### 5.3 Potential indirect impacts

The project has potential to indirectly impact on residual areas of vegetation and habitat adjoining the widened road footprint typically associated with edge effects. In the case of the Pacific Highway upgrade at Lisarow, the proposal will see widening of the existing pavement into adjacent vegetation where edge effects are already evident. This may result in shifting edge effects further into the small patches of retained remnants adjoining the road. Given the current disturbance to the vegetation at this location it is difficult to predict the extent of further indirect impacts. A potential disturbance zone beyond the construction footprint of up to 10 metres would result in around two hectares of edge affected vegetation. The area of potential indirect impact is illustrated on Figure 1-3. It is proposed to revegetate the fringe area cleared for construction and conduct ongoing weed maintenance until this area is established with the aim of reducing the degree of edge effects. Given the existing edge effects and proposed mitigation, offsets are not planned for this general indirect impact.

However potential indirect impacts to the *Melaleuca biconvexa* population are assessed and provided separately (Section 5.3.5) as the species is reported as 'unable to withstand a loss' in the Hunter Central Rivers CMA region. This indirect impact on the *Melaleuca biconvexa* population relate primarily to a small change in hydrology on the individual *Melaleuca biconvexa* on the fringes of the existing open wetland area and has been factored into the offset strategy (Section 7.4). Discussion on possible indirect impacts on residual areas of vegetation is described below.

#### 5.3.1 Indirect habitat fragmentation

All remnant bushland areas addressed in this SIS are already heavily fragmented by the existing Pacific Highway and Sydney-Newcastle rail line and surrounding network of local roads, residential and industrial development. The proposed upgrade of the highway in this location has a restricted footprint along the edges of the existing highway alignment which will effectively widen the road pavement leading to further division of existing fragmented habitat. However the proposal will not result in breaking apart of large areas of habitat into smaller patches and no significant wildlife corridors or riparian habitats exist in the study area that will be further fragmented.

#### 5.3.2 Indirect edge effects, noise, light and dust impacts

Edge effects are zones of changed environmental conditions (i.e. altered light levels, windspeed, temperature and noise) occurring along the edges of habitat fragments. These new environmental conditions can promote the growth of different plants and altered structure (including weeds), allow invasion by pest animals specialising in edge habitats or change the behaviour of resident animals (Moenting & Morris 2006). Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators having a long-term impact on sensitive species.

Species with excellent dispersal abilities, capable of invading and colonizing disturbed habitats, are attracted to edges, and move into the core of natural habitat if a road or utility corridor carries the edge into a previously undisturbed area (Andrews 1990). The edge experiences a different wind and radiation effect, resulting in a different microclimate. If habitats are fragmented considerably, and the ratio of edge to interior favours edges, the habitat would no longer be suitable for the interior species (Ranney *et al.* 1981).



In the case of the Pacific Highway upgrade at Lisarow, the proposal will see widening of the existing pavement into adjacent vegetation where edge effects are already occurring. This may result in shifting the edge effects further into the small cores of retained remnants adjoining the road.

In respect of potential impacts on edge areas from noise and light, there are two sources:

1. Temporary construction noise associated with vehicles and machinery such as pile drivers, generators, compressors, graders, rollers and gravel crushing.
2. Permanent traffic noise and road lighting spillover into adjacent vegetation, associated with operation of the upgraded road, although this impact is already occurring at the site on the existing highway.

Negative effects of traffic noise have been recorded mainly in species that frequently vocalise, including birds and amphibians (van der Zande et al 1980, Reijnen et al 1997) and species that rely on hearing for hunting such as forest owls. Whether noise could cause road avoidance and other barrier effects in isolation from other factors such as vehicle movements, presence of humans or edge effects remains to be ascertained (Kaseloo 2006). There is some evidence to support less vocal mammal species altering normal movement pattern to avoid traffic noise (Byrnes et al 2012). Therefore potential impacts from the existing highway will continue for a range of threatened bird and amphibian species in terms of altering vocalisations and interrupting breeding cycles and also a range of small mammal species in terms of negatively affecting movement patterns and habitat connectivity.

It is important to consider the impact of lighting spill and operational noise on the remaining small remnants in the study area has occurred already. This will not increase significantly after the upgrade is increased although the existing impacts from roads, rail and surrounding development will continue.

### 5.3.3 Indirect impacts from weed invasion

A total of 70 weed species were recorded from field surveys in the study area. Of these, there were seven declared noxious species under the *NSW Noxious Weeds Act 1993*, relevant to Gosford LGA and these are listed below in Table 5-2.

Table 5-2: Noxious weed species recorded in the study area

Species	Occurrence in the study area	Noxious class
Asparagus Fern <i>Asparagus aethiopicus</i>	Recorded at the northern end of the study area in the understorey of Coastal Narrabeen Moist Forest.	Class 4: The plant must not be sold, propagated or knowingly distributed.
Blackberry <i>Rubus fruticosus</i> aggregate species	Moderate to low abundance throughout study area mainly on edges of remnant vegetation and disturbed areas.	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distribute. This is an All of NSW declaration.
Crofton Weed <i>Ageratina adenophora</i>	Low abundance recorded in vicinity of cemetery at northern end of study area.	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Fireweed <i>Senecio madagascariensis</i>	Low to moderate abundance in paddock areas to east of Pacific Highway.	Class 4: The plant must not be sold, propagated or knowingly distributed. A weed of national environmental significance.
Giant Reed <i>Arundo donax</i>	Recorded in one location on northwest side of railway line.	Class 4: The plant must not be sold, propagated or knowingly distributed.
Mistflower <i>Ageratina riparia</i>	Low abundance recorded in vicinity of cemetery at northern end of study area and on road batters.	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.

Species	Occurrence in the study area	Noxious class
Pussy Willow ( <i>Salix cinerea</i> )	Recorded on the edges of freshwater wetlands. It dominates poor condition areas of freshwater wetland adjoining the rail corridor.	Class 4: The plant must not be sold, propagated or knowingly distributed. A weed of national environmental significance.

The dominant weed species in the study area, however, includes environmental weeds not listed as noxious in the Gosford LGA, and these are directly impacting the condition and viability of the restrained areas of vegetation. These species comprise:

- **Camphor Laurel (*Cinnamomum camphora*):** This species was recorded in low-moderate abundance throughout forested habitats and in some areas forms a co-dominant component of the canopy. Weed control works in Wetland A have substantially reduced the cover of this species within the patch.
- **Small-leaved Privet (*Ligustrum sinense*):** This species was recorded in low-high abundance throughout forested habitats and in some areas forms a dominant component of the mid-storey, and numerous seedlings dominant the groundlayer in some poor condition areas of swamp forest. Weed control works in Wetland A have substantially reduced the cover of this species within the patch.
- **Lantana (*Lantana camara*):** This was recorded in low-high abundance mainly within Coastal Narrabeen Moist Forest forming a dominant component of the mid-storey. It also occurs in areas of disturbed regrowth of swamp forest and exotic-dominated vegetation.

During construction there is potential to disperse weed seeds and plant material into adjoining areas of remnant vegetation where weed species do not currently occur or are in low abundance. The most likely causes of weed dispersal would be through the movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery involved with clearing of vegetation and stockpiling mulch and topsoil during earthworks.

#### 5.3.4 Indirect impacts from potential introduction of disease pathogens

Pathogens are agents that cause disease in flora and fauna and are usually living organisms such as bacterium, virus or fungus. Several pathogens known from NSW have potential to impact on biodiversity as a result their movement and infection during construction of the proposal (refer to Table 5-3).

Of these, three are listed as a key threatening process under the TSC Act including:

- Dieback caused by Phytophthora.
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis.
- Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae.

The potential for pathogens to occur should be considered a high likelihood on all proposals sections and treated as a potential risk during construction. This is particularly a risk for the proposal considering the dominance of wetland and floodplain habitats where the risk of transmission is higher. Pathogen management should therefore be implemented throughout all stages of construction.

Table 5-3: Pathogens that may impact on 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 ( <i>Uredo rangellii</i> )	An introduced fungus that attacks the young leaves, short tips and stems of Myrtaceous plants eventually killing the plant	Myrtle rust is an air-borne fungus that may be spread by moving infected plant material, contaminated clothing, equipment and vehicles.
Fusariumwilt / Panama disease ( <i>Fusarium exysporum</i> )	Widespread in banana plantations in north coast region including Woolgoolga and Coffs Harbour.	Spread when spores are moved in soil by water, workers, vehicles and movement of infected plant material.
Chytrid fungus ( <i>Batrachomyxium dendrobatidis</i> ).	An infectious disease that affects amphibian's worldwide causing death.	Chytrid is a water-borne fungus that may be spread as a result of handling frogs or through cross contamination of water bodies by vehicles and workers.

### 5.3.5 Indirect impacts from altered hydrology regimes and run-off

The original hydrology regime in the study area has been substantially altered over a number of years prior to this project. This is a result of the cumulative development of infrastructure in the lands surrounding the study area resulting from the retention of drainage run-off, longer duration of flood inundation in areas previously occupied by 'ephemeral' swamp forest communities and increased sediment and nutrient loads in the wetland habitats.

The proposal will likely result in additional alterations to the current hydrology regime, as a result of further clearing and fill for the road surface, increase road pavement and alterations to existing drainage infrastructure.

Flood modelling completed for the *Flooding and Hydrology Assessment* (refer to REF) has considered a number of annual exceedance probability (AEP) scenarios including the one per cent, five per cent, 20 per cent and the 50 per cent AEP events. The results of the *Flooding and Hydrology Assessment* indicate that the proposal will include the use of the D-shaped parcel of land located to the west of the Pacific Highway, east of the Main Northern Railway Line, south of the Lisarow Rail Overbridge and to the north of the Lisarow Railway Station for temporary flood detention. New and enlarged pipe culverts (0.825 metres diameter) will cross underneath the Pacific Highway to convey flows from the south-east of the proposal into the D-shaped parcel of land. In addition, a retaining wall will be constructed along the Main Northern Railway Line and will allow an increase in peak flood levels up to 0.45 metre in the one per cent AEP flood event in the D-shaped area and will likely have a short-term impact on the EECs and *Melaleuca biconvexa* population. The vegetated wetland area located upstream of The Ridgeway will also experience increases in peak flood levels exceeding 0.01 metre, with flood level increases of 0.06 metres in the five per cent AEP event and 0.03 metre in the one per cent AEP event.

A summary of the flood modelling impacts on the three wetlands is summarised in Table 5-4 with further detail included in the REF. This analysis has been used to predict the indirect impacts on the local population on *Melaleuca biconvexa* and the wetland EECs adjoining the proposal.

Table 5-4: Summary of flood level changes during the 1%, 5%, 20% and 50% AEP to Wetlands A, B and C

Wetland	50%	20%	5%	1%
A	<-0.06 m	0.02 – 0.05 m	0.06 to 0.10 m	0.02 to 0.05 m
B	0.21 – 0.40 m	>0.41 m	>0.41 m	>0.41 m
C	-0.01 to 0.01	-0.01 to 0.01 m	0.02 – 0.05 m	-0.01 – 0.01 m



The results of the flood modelling indicate there will be an increased depth of inundation under some of the flood scenarios presented above, which will potentially result in persistent pools of water throughout swamp forest habitats and waterlogging of soils. These hydrological modifications as a result of the proposal will potentially exacerbate the existing stresses to the system which is currently subject to indirect impacts from previous modifications to the original hydrology regime.

The change in depth of water from flood events during operation of the road within the three wetlands ranges from small to moderate and in all cases are above the existing hydrological regime, apart from the 50 per cent AEP in Wetland A and the 50 per cent, 20 per cent and one per cent in Wetland C. The model of actual extent of flooding across the wetlands indicates that these increased depths will not extend beyond the predicted existing extent of flooding and this is largely constrained by existing development. Wetland C is not constrained by physical infrastructure and the predicted changes in Wetland C will be a small and insubstantial increase (refer Table 5-4). No further consideration of indirect impacts on Wetland C is discussed here.

Wetland B is already a constrained environment surrounded by the road and rail embankments. The construction will see a retaining wall added along the rail corridor to further contain flood water in large events and new road batter through widening of the road will also retain water. The physical extent of flooding across Wetland B therefore cannot increase significantly beyond the existing area of the wetland. The flood modelling suggests that the flood duration will be similar to the existing duration of flooding, with post-construction flood levels returning to the pre-flood level in around 20 hours after the event and the peak depth subsiding within a couple of hours. However, with the inclusion of a larger culvert and proposed diversion of water into Wetland B, the depth of receiving water will increase during flood events to an average 0.21 metres to > 0.41 metres in the one per cent, five per cent, 20 per cent and 50 per cent AEP events. The total depth of inundation during operation would therefore increase to between 0.7 to greater than 2.41 metres depending on the event.

#### **Potential indirect impacts to *Melaleuca biconvexa* population**

The predicted depth of water in Wetland B during a flood event is considerable under both the existing and new scenarios, and the proposed increased depth may lead to further indirect impacts through increased soil saturation and waterlogging in the margins of the current ponded areas which are currently occupied by *Melaleuca biconvexa*.

There is potential for indirect impacts to occur from changed hydrology on the plant species composition which may affect the distribution and abundance of *Melaleuca biconvexa* from soil waterlogging around the perimeter of the ponded areas favouring other swamp sclerophyll species. To calculate the area of potential indirect operational impact it is hypothesised that the small changes in hydrology from the proposal may cause the areas of Freshwater Wetland to increase along its peripheries which will in turn cause a change in species composition favouring other waterlogging tolerant plant species over *Melaleuca biconvexa*. The life cycle of the remaining *Melaleuca biconvexa* individuals are likely to be indirectly impacted from the modified hydrology. Increased water levels are likely to place physiological stresses on the remaining individuals resulting in dieback and reduced vigour limiting flowering and seed set. Additionally germination niches such as ephemerally inundated areas with bare substrates are likely to be further reduced with increased waterlogging.

A survival threshold has been applied to the area of *Melaleuca biconvexa* in Wetland A and Wetland B within the indirect operation impact area and has considered that 30 per cent of the trees in the indirect impact area may continue to survive as healthy trees able to reproduce. Of the remaining 70 per cent, a proportion of these may slowly die and a proportion will survive in poor health and low ability to reproduce, making them vulnerable to other anthropogenic and stochastic disturbance events. A conservative indirect impact area on *in situ* *Melaleuca biconvexa* during operation of the proposal has been calculated based on the indirect operation impact area described earlier and the total area is around 0.73 hectares.

The proposal will not result in drawdown of groundwater. The increased road pavement has potential to alter the quality of run-off into wetland areas resulting in reduced water quality and increased nutrient loads and this is expected to have indirect impacts on residual areas. Temporary water quality treatment basins are to be used during construction to minimise the construction impacts.

#### **5.3.6 Erosion and siltation**

Large scale clearing of vegetation could result in erosion and sedimentation, resulting in more sediment, nutrients and other toxicants transported into rivers and streams deteriorating water quality. Increased

sediments in the water increase turbidity and reduce clarity (and light penetration) which restricts photosynthesis of aquatic plants. Sediments in water also absorb heat, therefore increasing water temperatures which can reduce dissolved oxygen as warmer water holds less oxygen than cold water. Increased nutrient loads of nitrogen and phosphorus which are bound to sediments entering the water can result in eutrophication and the occurrence of algal blooms. As part of construction management this will be mitigated by progressive development of erosion and sediment control plans during construction which may include the installation of temporary and permanent crossings over wetlands and drainage lines where required, along with temporary treatment basins, sediment traps and sediment fencing installed around and in disturbed areas of the proposal footprint. Revegetation and landscaping of disturbed ground outside the road formation will also occur for operation.

### 5.3.7 Cumulative impacts

It is acknowledged the project would result in a moderately large area of direct and indirect impact for *Melaleuca biconvexa*. This includes a likely significant impact on the local population of *Melaleuca biconvexa* located within 500 metres of the proposal. In relation to the cumulative impacts on *Melaleuca biconvexa* in this locality, it is likely the large regional population within five kilometres has been reduced over several decades from previous clearing for the existing highway and rail line as well as industrial and residential development. Changes to local hydrology or water quality may have minor impacts on residual areas of the regional population however the impacts are unlikely to be significant.

Other upgrades on the Pacific Highway in this locality have impacted on *Melaleuca biconvexa*. Information in the HW10 Pacific Highway to M1 (Lisarow to Ourimbah) Upgrade Stage 3a REF is as follows:

- Around six small independent patches of this species were located within the study area. These clusters comprised a total of around 20-30 regenerating suckers, two small trees and six medium / tall trees. One larger patch was also identified adjacent to the study area on the opposite side of the railway line.
- A total of about 240 metres squares of *Melaleuca biconvexa* canopy coverage in six independent patches would be heavily disturbed or cleared during construction.

In addition to upgrades of the Pacific Highway in this location, Transport for NSW is currently proposing construction of a new train maintenance facility approximately five kilometres north of the study area. This project will be affecting an area of *Melaleuca biconvexa* and thereby contribute to the regional loss of the species and its habitat. At the time of completing the SIS, the number or area of *Melaleuca biconvexa* affected by the Transport for New South Wales proposal was not known.

## 5.4 Assessment of species likely to be affected

The following section addresses requirements from Section 5.1, 5.2 5.3 and 5.4 of the DGRs. Threatened species considered likely to be affected by the proposal include those species confirmed at the site from the target surveys and additional species considered to have a moderate to high likelihood of occurring and that are considered to potentially be impacted by the project due to a loss of important habitat used for life-cycle events.

An assessment of the likelihood of occurrence for threatened species is provided in Appendix B. Based on this assessment and the surveys carried out within the study area and locality, the list of potential species identified for the study area in Section 3.0 has been refined to a list of species likely to be affected by the proposal. This includes one plant species and 11 fauna species. Further information and discussion is provided on each of these species including:

- a. Discussion of the conservation status the key threatening processes generally affecting it and any recovery plan or threat abatement plan applying to the species.
- b. General description of the species habitat requirements.
- c. Discussion of local and regional abundance including other known local populations, discussion of habitat utilisation.
- d. Assessment of habitat including description of habitat values, extent of habitat removal, consideration of corridors.

#### 5.4.1 Biconvex Paperbark (*Melaleuca biconvexa*)

##### a. Conservation Status, key threats and recovery plans

- NSW: Vulnerable.
- Commonwealth: Vulnerable.

##### Key Threats as they relate to the project (OEH, 2015)

- Direct loss through clearing for industrial and residential development, drainage and infrastructure.
- Alterations to the drainage hydrology of low-lying floodplains and swamps including swamp reclamation and stormwater detention.
- Increased pollution and nutrients through adjoining developments and rubbish dumping.
- Potentially affected by Myrtle Rust.
- Competition from noxious aquatic weeds.

##### Conservation advice, recovery plans and threat abatement plans

- This species has been described in the NSW OEH Threatened Species Profile Database (TSPD) as a species that is unable to sustain loss within the Hunter-Central Rivers Catchment Management Authority region.
- Commonwealth Conservation Advice on *Melaleuca biconvexa* (TSSC, 2008).
- No recovery plan or threat abatement plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Site-managed species management stream under the Saving Our Species program.

The Office of Environment and Heritage has established three management sites where conservation activities need to take place to ensure the conservation of this species (Porters Creek, Ourimbah and St Georges Basin).

##### b. Description of species and habitat requirements

Biconvex Paperbark is a shrub or small tree, usually up to ten metres tall, though occasionally as high as 20 metres. The bark is that of a typical paperbark. The leaves are small, to 18 mm long and 4 mm wide; each leaf has a centre-vein in a groove and the leaf blade curves upwards on either side of this centre-vein. Leaf placement is distinctive, with each pair of leaves emerging at right angles from the branch. Each pair is offset at right angles to the previous pair so the branch has a squarish appearance when looked at 'end-on'. This species' white flowers are usually clustered in dense heads and the fruit is urn-shaped and 3-5 mm in diameter (OEH, 2015).

The Biconvex Paperbark flowers in summer (Harden 1991) and are likely to be pollinated by nectivorous animals (insects, birds and bats) as well as wind pollination over shorter distances. Capsules support tiny seeds which are shed soon after maturity and are locally dispersed around the parent plant, and there is possibly a dormancy factor for germination of seeds (Benson & McDougall 1998).

It is known to resprout from rootstock in response to fire (Benson & McDougall 1998), and suckers grow from the base of plants and exposed roots in areas where subject to soil disturbance or areas that are frequently inundated for extended periods. Multiple stems may arise from single rootstocks so an estimate of population size is not possible from visual inspection of stands (NSW Scientific Committee, 2002). It is likely that disturbed areas of the proposal area allowed to regenerate will include suckers from the remaining rootstock of *Melaleuca biconvexa*.

The Biconvex Paperbark occurs in damp areas, often near watercourses, on alluvium soils over shale (Terrigal formation) (Benson & McDougall 1998). The species may form a dense stand in a narrow strip adjacent to a watercourse. The vegetation communities in which the Biconvex Paperbark generally occurs include 'Eucalypt open-forest' with Sydney Blue Gum (*Eucalyptus saligna*), Swamp Mahogany (*Eucalyptus robusta*) and Mountain Cedar Wattle (*Acacia elata*) and in 'Paperbark scrub' with Prickly-leaved Paperbark (*Melaleuca styphelioides*), Snow-in-summer (*Melaleuca linariifolia*), White Feather Honey-myrtle (*Melaleuca decora*), Sieber's Paperbark (*Melaleuca sieberi*) and *Melaleuca nodosa*.



### c. Local and regional distribution

The Biconvex Paperbark occurs in coastal districts and adjacent tablelands in NSW, from Jervis Bay to Port Macquarie (Harden 1991). The species occurs within the Hawkesbury-Nepean, Northern Rivers, Hunter-Central Rivers and Southern Rivers NSW Natural Resource Management (NRM) regions (Threatened Species Scientific Committee (TSSC) 2008). There are four main known populations of *Melaleuca biconvexa*, comprising:

- Jervis Bay.
- Central Coast (Wyang, Gosford and Lake Macquarie LGAs).
- Myall Lakes.
- Port Macquarie.

The study area is located within the Central Coast population, which is the largest remaining. In the locality, Lisarow Wetland, located in the south western end of the study area, is 54.2 hectares and a key management site identified by the OEH. Population size is likely similar to the proposal area, which was estimated at 925 mature stems per hectare for the REF (Jacobs, 2015).

The amount of this species distribution occurring on conservation reserves is unknown, however investigations undertaken for this proposal confirmed that approximately half of the mapped distribution of *Melaleuca biconvexa* within the Wyong and Gosford LGAs occurs within lands zoned for environmental protection (E2), and an additional 30 per cent of the mapped population occurs in areas zone for environmental management (E3), environmental living (E4) and recreation (state forests and council parks).

The Central Coast population of *Melaleuca biconvexa* extends from north of Brisbane Water to south-west Lake Macquarie. Surveys across a large majority of this distribution in the Wyong and Gosford LGAs confirmed the presence of a large population. The mapped area of occupied habitat within the locality comprises 254 hectares (around 131,000 stems) and the entire mapped area in the Gosford and Wyong LGAs is around 354 hectares (around 160,000 stems). The area of occurrence for the entire Central Coast population is estimated to be greater than 400 hectares including the remaining area of the population within Lake Macquarie LGA (not mapped). There are at least 218 records of *Melaleuca biconvexa* in the southwest Lake Macquarie LGA (Mandalong area) consisting of at least 500 stems. Refer to Section 4.3.2 for further details regarding the local and regional distribution and abundance of *Melaleuca biconvexa*.

### d. Assessment of habitat

#### Extent of habitat removal

The species is identified in to the Threatened Species Profile Database (TSPD) as a species that is 'unable to withstand further loss' in the Hunter Central Rivers CMA. The extent of habitat removal for this proposal will be up to **2.61 hectares** of occupied habitat supporting up to **2,153 mature stems** (based on an average density of 825 stems per hectare determined by the plot assessments). In comparison to the entire distribution of the species in the Gosford and Wyong LGA this represents around 0.7 per cent of the mapped population, and around one per cent of the mapped population within the locality (10 km radius). Considering it is unlikely the entire population has been captured in the mapping exercise within the Wyong and Gosford LGAs, and other parts of the regional population within Lake Macquarie LGA have not been included, the proportion of impact to the regional population is likely to be less.

Although it is likely only a minor proportion of the regional population will potentially be directly impacted (<0.5%), the direct impacts to the local population within 10 kilometres of the proposal area (around 1%) in addition to indirect impacts on the remaining population in the study area from altered hydrology and increased pollution, the proposal is considered to have a significant impact on *Melaleuca biconvexa*. Further to this, the proposal would directly impact on a small area of the *Melaleuca biconvexa* population identified in the OEH Saving our Species conservation program. This is one of the larger patches of *Melaleuca biconvexa* occurring in the locality and has been identified for conservation based on its size, location and importance for genetic diversity in this locality. However the current hydrology regime is a substantial existing threatening process which is directly affecting the distribution and abundance of the species with numerous drowned trees observed within and surrounding the freshwater wetland area.

## Potential indirect impacts

The potential for further indirect impacts to *Melaleuca biconvexa* as a result of modified hydrology regimes has been discussed previously in Section 5.3.5. To calculate the area of potential indirect operational impact it is hypothesised that the small changes in hydrology from the proposal may cause the areas of Freshwater Wetland to increase along its peripheries which will in turn cause a change in species composition favouring other flood tolerant Swamp Sclerophyll plant species over *Melaleuca biconvexa*. Areas of indirect impacts during operation include:

- A 10 metre buffer on the inner edge of mapped *Melaleuca biconvexa* located within Wetland A.
- A 20 metre buffer on the inner edge of mapped *Melaleuca biconvexa* located within Wetland B as there is a larger hydrological change during flood events (ie 0.2 to <0.40 metres).

A conservative indirect impact area during operation of the proposal has been calculated based on these indirect operational impact areas (i.e. a buffer of 10 to 20 metres) and the total area is around **0.73 hectares**.

A survival threshold has been applied to the area of *Melaleuca biconvexa* within the indirect operation impact area and has considered that 30 per cent of the trees in the indirect impact area may continue to survive as healthy trees able to reproduce. Of the remaining 70 per cent, a proportion of these may die and a proportion will survive in poor health and low ability to reproduce, making them vulnerable to other anthropogenic and stochastic disturbance events. Using the indirect impact area of 0.73 hectares multiplied by 825 mature stems per hectare and survival threshold of 0.7, the potential indirect loss of individual *Melaleuca biconvexa* equates to **422 mature stems**.

## Consideration of corridors

Vegetation in the study area is currently fragmented by the existing highway and adjacent rail corridor which can provide a barrier to effective pollination and seed dispersal for some plants. For *M.biconvexa* it is likely that substantial cross pollination will still occur despite these barriers through wind and flying animals (insects, birds, bats). Seed dispersal for *Melaleuca biconvexa* is also naturally limited to the area surrounding the parent plant, with seeds not being well adapted for dispersal by wind, water or animals. Therefore the proposal is unlikely to substantially impact pollination and seed dispersal for *Melaleuca biconvexa*.

## Species Mapping

Mapping of occupied habitat for *Melaleuca biconvexa* within the study area is shown in Figure 4-3 and the regional distribution is provided in Figure 4-4.

### 5.4.2 Black Bittern (*Ixobrychus flavicollis*)

#### a. Conservation Status, key threats and recovery plans

- NSW: Vulnerable.

Key Threats as they relate to the project (OEH, 2015)

- Clearing of riparian vegetation.
- Lack of knowledge about habitat use and the distribution of breeding activity.

Conservation advice, recovery plans and threat abatement plans

- This species has been described in the NSW OEH Threatened Species Profile Database (TSPD) as a species that is unable to sustain loss within the Hunter-Central Rivers Catchment Management Authority region.
- No conservation advice or recovery plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving our Species program.

- Threat Abatement Plan for Predation by Feral Cats (Department of the Environment, Water and Heritage, 2008).
- Threat Abatement Plan for Predation by the European Red Fox (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008).

#### Representation in conservation reserves

- Fifty five percent of this species' distribution occurs on reserve (within NSW NPWS estate).

#### **b. Description of species and habitat requirements**

The Black Bittern is a heron, dark grey to black in colour, with buff streaks on the throat and a characteristic yellow streak on the sides of the head and down the neck. The female is paler than the male, with a more yellow wash on the underparts (OEH, 2015).

The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, this species may occur in flooded grassland, forest, woodland, rainforest and mangroves (Marchant & Higgins 1993). The Black Bittern forages on reptiles, fish and invertebrates, including dragonflies, shrimps and crayfish (Barker & Vestjens 1989). It generally feeds at dusk and at night. During the day, the Black Bittern roosts in trees or on the ground amongst dense reeds (Marchant & Higgins 1993).

The species is generally solitary, but may occur in pairs during the breeding season, which is thought to be from December to March. Nests may be located on a branch overhanging water and consists of a bed of sticks and reeds on a base of larger sticks (Marchant & Higgins 1993). There is limited information regarding breeding. The clutch size is thought to be between three and five (Gilmore & Parnaby 1994) and both the male and female are involved in incubation and rearing of young (Marchant & Higgins 1993).

#### **c. Local and regional distribution**

The Black Bittern has a wide distribution, from the southern NSW north to Cape York and along the entire northern coast to the Kimberley region. The species also occurs in the south-western corner of Western Australia. It is most commonly recorded at low elevation, primarily below 200m above sea level. In NSW, records of the species are scattered along the east coast. Individuals are rarely recorded south of Sydney and inland

Local and regional abundance of the Black Bittern is unknown for the central coast. The species is known in the neighbouring Wyong Local Government area and records show sightings around Chittaway Bay on Tuggerah Lakes. Estimates of the population size of this species is thought to be low at 209 – 642 in south-east Australia and less than 1000 individuals in total across the country (Garnett et al., 2011).

#### **d. Assessment of habitat**

##### **Extent of habitat removal from the proposal**

The proposal will result in the removal and disturbance of around 2.6 hectares out of a predicted 6.8 hectares of potential habitat for this species, which was calculated based on clearing of the open wetland areas and adjoining densely vegetated swamp forest habitat that provide potential shelter, refuge, breeding and foraging habitat. This represents up to a quarter of the habitat available in the immediate study area, although this is much lower for the larger locality surrounding the project where up to 5,000 ha of habitat is predicted to exist. The potential habitat in the study area is considered marginal at best for the species given the existing impacts from surrounding development and highway including noise and lights and the existing low water quality which would reduce the quality of the habitat for prey species.

##### **Consideration of corridors and impacts on movements**

The Black Bittern is considered to be sedentary in permanent habitats, but possibly makes regular short-distance movements during winter and occasional migrations to expand into ephemeral habitats during wetter years. All habitats being impacted are currently fragmented into smaller patches and it is unlikely that the small patches would sustain a quality and viable habitat to support sedentary individuals. Therefore any use of the









study area by Black Bitterns at present would be intermittent and require movement across existing barriers formed by local and main roads, a busy rail corridor and urban development. The proposal will see widening within an existing road corridor and not introduce any new barriers and sources of habitat fragmentation. Therefore the proposal is unlikely to negatively impact the movements of the species beyond existing.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F010\_r1v3

Figure 5-1 | Mapped habitat for Black Bittern (*Ixobrychus flavicollis*)

### Legend

- |   |                |   |   |
|---|----------------|---|---|
|  | Concept design |  | Potential habitat area investigated                     |
|  | Retaining wall |  | Black Bittern ( <i>Ixobrychus flavicollis</i> ) habitat |
|  | Power line     |   |   |
|  | Watercourse    |   |   |

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014

### 5.4.3 Gang-gang Cockatoo (*Callocephalon fimbriatum*)

#### a. Conservation Status, key threats and recovery plans

##### Conservation Status

- NSW: Vulnerable.

##### Key Threats as they relate to the project (OEH, 2015)

- Loss and degradation of breeding and foraging habitat from rural and urban development.
- Lack of knowledge of locations of key breeding habitat and breeding ecology and success.
- Infestation of habitat by invasive weeds.

##### Conservation advice, recovery plans and threat abatement plans

- No conservation advice or recovery plan relates to this species. A conservation project is currently being developed for this species under the Saving Our Species program.
- Threat abatement plan for beak and feather disease affecting endangered psittacina species (DEH, 2005).

##### Representation in conservation reserves

- Fifty three percent of the species distribution occurs on reserve (within NSW NPWS estate).

#### b. Description of species and habitat requirements

Gang-gang Cockatoos are primarily slate-grey, with the males easily identified by their scarlet head and wispy crest, while females have a grey head and crest and feathers edged with salmon pink on the underbelly. They range in length from 32 to 37 cm, with a wingspan of 62 to 76 cm (OEH, 2015).

The Gang-gang Cockatoo inhabits eucalypt open forests and woodlands with an *Acacia* understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. This species requires tree hollows for nesting and sometimes for roosting. Eucalypt trees and *Acacia* shrubs are used for foraging.

The Gang-Gang Cockatoo nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. A clutch of usually two eggs is laid in spring to summer. Each pair has a single successful brood per year, though pairs may have a second attempt if the first attempt fails early in the season. The incubation period is about four weeks, the nestling period seven to eight weeks, and the post-fledging dependence period lasts at least four to six weeks.

#### c. Local and regional distribution

The Gang-gang Cockatoo is distributed from southern Victoria through south and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee.

The number of mature individuals of the Gang-gang Cockatoo is uncertain. There are no useful density or population estimates for this species. Densities of 'territories' (presumably nest sites) were 7-22/km<sup>2</sup> at one location in Victoria (Higgins 1999). If the Gang-gang Cockatoo occurs at similar densities to the similarly uncommon Glossy Black-Cockatoo, but over half the area, there may be about 5,000 mature individuals in Australia, although this value is highly speculative (NSW Scientific Committee, 2008).

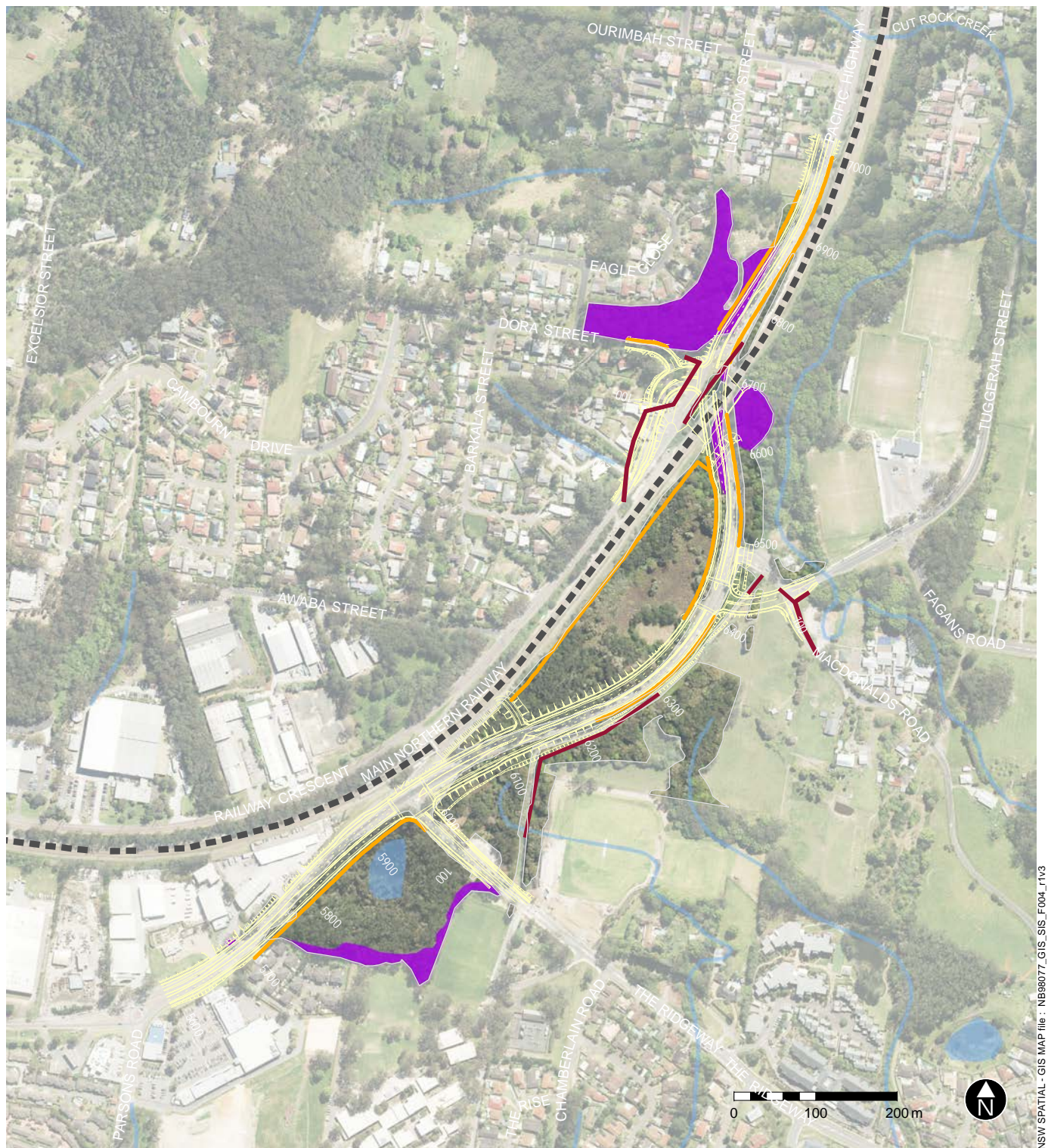


**d. Assessment of habitat****Extent of habitat removal from the proposal**

As stated the Gang-gang Cockatoo inhabits eucalypt open forests and woodlands with an Acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. This species requires tree hollows for nesting and sometimes for roosting. Eucalypt trees and Acacia shrubs are used for foraging. The species is unlikely to utilise the dominant dense swamp forest and wetland habitat in the study area and any use of the site would more likely be associated with the moist open forest at the northern end of the site. Impacts to this habitat equate to a small area of 0.72 ha along the existing edge of the highway. No hollow bearing trees with potential for breeding were recorded in this area during surveys and the clearing is expected to have minimal impact on the potential habitat of the species.

**Consideration of corridors and movements**







The species moves widely in response the seasonal conditions and availability of food and is capable of moving across landscapes with fragmented woodlands and open forest. If the species does indeed currently use the site individuals would be required to cross roads rail and urban areas to access habitat. The proposal will not introduce additional barriers and increase fragmentation beyond existing and is unlikely to affect the movements of the species.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F004\_r1v3

Figure 5-2 | Mapped habitat for Gang-gang Cockatoo (*Callocephalon fimbriatum*)

### Legend

- |   |                |   |  |
|---|----------------|---|--|
|  | Concept design |  | Potential habitat area investigated                            |
|  | Retaining wall |  | Gang-gang Cockatoo ( <i>Callocephalon fimbriatum</i> ) habitat |
|  | Power line     |   |  |
|  | Watercourse    |   |  |

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



#### 5.4.4 Little Lorikeet (*Glossopsitta pusilla*)

##### a. Conservation Status, key threats and recovery plans

- NSW: Vulnerable.

##### Key Threats as they relate to the project (OEH, 2015)

- Given that large old Eucalyptus trees on fertile soils produce more nectar, the extensive clearing of woodlands for agriculture has significantly decreased food for the lorikeet, thus reducing survival and reproduction. Small scale clearing, such as during roadworks and fence construction, continues to destroy habitat and it will 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.
- Infestation of habitat by invasive weeds.

##### Conservation advice, recovery plans and threat abatement plans

- No conservation advice or recovery plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving our Species program.
- Threat abatement plan for beak and feather disease affecting endangered psittacina species (DEH, 2005).

##### Representation in conservation reserves

- Thirty six percent of this species' distribution occurs on reserve (within NSW NPWS estate).

##### b. Description of species and habitat requirements

The Little Lorikeet is a small (16-19 cm; 40 g) bright green parrot, with a red face surrounding its black bill and extending to the eye. The undertail is olive-yellow with a partly concealed red base, and the underwing coverts are bright green. The mantle is imbued with light brown (OEH, 2015).

Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs (Courtney and Debus, 2006). This species forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca 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. The Little Lorikeet feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards. This species is gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries (OEH, 2015).

The Little Lorikeet nests in treetops in close proximity to feeding areas if possible (though often distant), most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees are often chosen, including species like Allocasuarina. The nesting season extends from May to September, with eggs observed in July, nestlings from August to November and fledging occurring in December. In years when flowering is prolific (particularly White Box), the Little Lorikeet pairs can breed twice producing three to four young per attempt. However, the survival rate of fledglings is unknown (Courtney and Debus, 2006).

##### c. Local and regional distribution

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury.



Local and regional abundance of the Little Lorikeet around Lisarow is unknown. Little Lorikeets were very common on the NSW Central Coast from February to May 2003-05, feeding on flowering Blackbutt (*Eucalyptus pilularis*) and Swamp Mahogany (*E. robusta*) (NSW Scientific Committee, 2011). Population trends in Little Lorikeets are uncertain. Nationally, Little Lorikeets were recorded significantly more often in the New Atlas of Australian Birds (Barrett et al. 2003) than in the Atlas of Australian Birds (Blakers et al. 1984) suggesting an increase in the national population between 1977-81 and 1998-2002. In NSW the species has either not changed or increased in reporting rate between the two Atlases (NSW Scientific Committee, 2011).

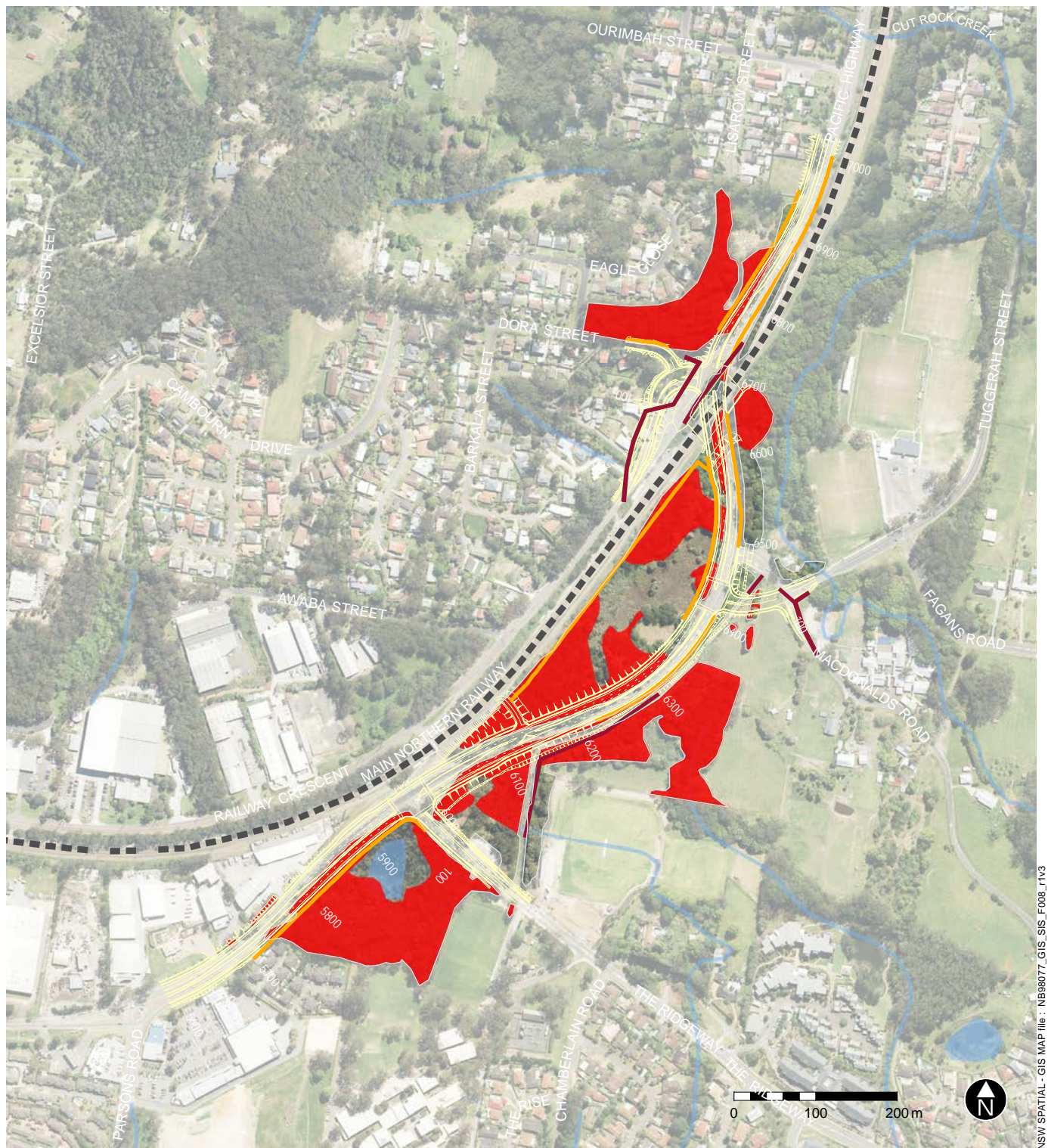
**d. Assessment of habitat**

**Extent of habitat removal from the proposal**

The proposal will remove potential food resources for this species which forages primarily in the canopy of open Eucalyptus forest and woodland. In particular, the proposal will involve impacts on up to 2.7 hectares of swamp forest dominated by *E.robusta* and Melaleuca species. During the winter surveys, the flowering of Swamp Mahogany was noted and numerous Rainbow Lorikeets were recorded on the site during the day and Grey-headed Flying-foxes at night, suggesting that wide-ranging nectivorous fauna commonly visit the site in winter. Impacts to this impact will occur along the edges of the existing highway, although some larger trees will be removed. Similar swamp forest habitat is widespread in the study area and locality and will remain following the upgrade, such that the potential to visit the site will likely remain.

**Consideration of corridors and movements**


The Little Lorikeet is a wide-ranging species. Nomadic movements are common, influenced by season and food availability. Any use of the existing habitats in the study area would require movements across roads, rail and urban areas and this scenario would be the same following completion of the proposal. There will be minor impacts associated with the widening of the road.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F008\_r1v3

Figure 5-3 | Mapped habitat for Little Lorikeet (*Glossopsitta pusilla*)

### Legend

- |   |                |   |   |
|---|----------------|---|---|
|  | Concept design |  | Potential habitat area investigated                     |
|  | Retaining wall |  | Little Lorikeet ( <i>Glossopsitta pusilla</i> ) habitat |
|  | Power line     |   |   |
|  | Watercourse    |   |   |

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
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#### 5.4.5 Powerful Owl (*Ninox strenua*)

##### a. Conservation Status, key threats and recovery plans

- NSW: Vulnerable.
- Forty one percent of this species' distribution occurs on reserve (within NSW NPWS estate).
- Potential habitat is mostly in conservation reserves and state forests (DEC, 2006).

##### Key Threats as they relate to the project (OEH, 2015)

- Historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. This loss also affects the populations of arboreal prey species, particularly the Greater Glider which reduces food availability for the Powerful Owl.
- Can be extremely sensitive to disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Disturbance during the breeding period may affect breeding success.
- Road kills.

##### Conservation advice, recovery plans and threat abatement plans

- NSW Recovery Plan for the Large Forest Owls: Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*) (DEC, 2006).
- Threat Abatement Plan for Predation by Feral Cats (Department of the Environment, Water and Heritage, 2008).
- Threat Abatement Plan for Predation by the European Red Fox (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008).
- A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving our Species program.

##### Representation in conservation reserves

- Forty one percent of this species' distribution occurs on reserve (within NSW NPWS estate).
- Potential habitat is mostly in conservation reserves and state forests (DEC, 2006).

##### b. Description of species and habitat requirements

The Powerful Owl is the largest owl in Australasia. It is a typical hawk-owl, with large yellow eyes and no facial-disc. Adults reach 60 centimetres in-length, have a wingspan of up to 140 centimetres and weigh up to 1.45 kilograms. Males are larger than females. The upper parts of the Powerful Owl are dark, greyish-brown with indistinct off-white bars. The underparts are whitish with dark greyish-brown V-shaped markings. Juvenile Powerful Owls have a white crown and underparts that contrasts with its small, dark streaks and dark eye patches (OEH, 2015).

The Powerful Owl lives in forests and woodlands occurring in the coastal, escarpment, tablelands and western slopes environments of NSW (Kavanagh 2002). This species requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species (DEC, 2006). The Powerful Owl is a specialist predator of arboreal marsupials, particularly the Common Ringtail Possum in coastal forests and the Greater Glider in escarpment and tableland forests (Kavanagh, 1992).

The Powerful Owl nests in old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines, with hollows greater than 45 cm diameter and greater than 100 cm deep; surrounded by canopy trees and subcanopy or understorey trees or tall shrubs. It lives as monogamous, sedentary life-long pairs in large permanent home ranges. Age at first breeding is two years in captivity,



unknown in the wild but probably three or four years. Most (84%) pairs nest each year and most of those nesting (93%) produce at least one young (Kavanagh 1997). Laying is strictly seasonal, occurring mainly in June (mid-May to mid-July). The clutch is one to two eggs; a single clutch is laid per year although, rarely, a replacement clutch may be laid if the first attempt fails early in the egg stage. The incubation period is five weeks. There are no data on egg success. Successful broods fledge one to two young. Young are altricial; the nestling period is two months; the breeding cycle occupies three months from laying to fledging. Juveniles are dependent for six to seven months post-fledging; thereafter they apparently survive either by remaining within the natal territory or by dispersing to other areas (DEC, 2006).

**c. Local and regional distribution**

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. It is more than twice as abundant in north-eastern NSW as in south-eastern NSW and on the western slopes (Kavanagh and Stanton 1998).

Studies of Powerful Owls around the NSW central coast suggest the area represents good habitat for this species and there are likely a number of breeding pairs around (Kavanagh and Bamkin, 1995, Kavanagh, 2002b). Kavanagh (2002b) identified 19 territories for the Powerful Owl on the NSW Central Coast. There are a total of 120 records of this species within the locality, ranging between 1977 and 2014.

**d. Assessment of habitat**

**Extent of habitat removal from the proposal**

As the Powerful Owl is known to occupy fragmented and urban bushland remnants, there is a moderate to high likelihood that the habitats within the study area are utilised or have potential to be utilised by resident pairs in the locality. In addition, the Common Ringtail Possum was confirmed in the study area and this is an important prey species. The proposal would remove up to 4.37 hectares of potential foraging habitat which includes the swamp forests, moist forest and dense weed infested gully. The swamp forest and riparian gully may be used for roosting. No large tree hollows are present and nesting habitat is not represented on site.

**Consideration of corridors and movements**

The species occupies large territories between 500-1000 hectares, and is capable of moving across modified landscapes. The widening of the cutting and clearing of habitat along the edge of the existing road will not impact the movements of this species.

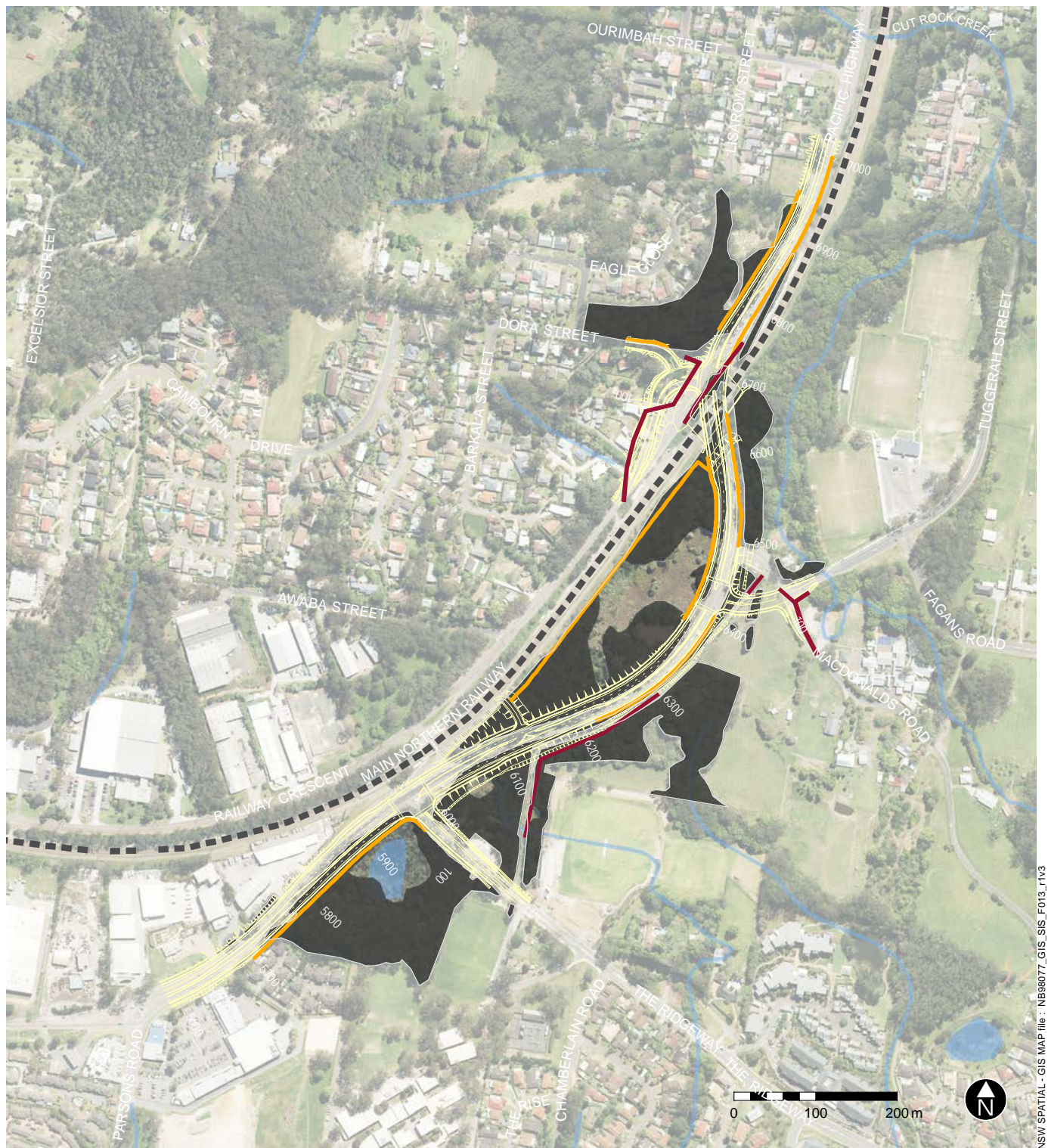


Figure 5-4 | Mapped habitat for Powerful Owl (*Ninox strenua*)

#### Legend

- |  |                |  |   |
|--|----------------|--|---|
|  | Concept design |  | Potential habitat area investigated           |
|  | Retaining wall |  | Powerful Owl ( <i>Ninox strenua</i> ) habitat |
|  | Power line     |  |   |
|  | Watercourse    |  |   |

Road Design 150424\_2D MX.dwg  
 Roads and Maritime Services 2014  
 AUSIMAGE 2014  
 LPI 2014  
 Jacobs 2014

#### SPECIES IMPACT STATEMENT

Upgrade of the Pacific Highway, Ourimbah Street to Parsons Road, Lisarow



#### 5.4.6 Regent Honeyeater (*Anthochaera phrygia*)

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Critically Endangered.
- Commonwealth: Critically Endangered.
- The amount of this species distribution occurring on conservation reserves is unknown.
- The OEH has established four management sites where conservation activities need to take place to ensure the conservation of this species (Bundarra – Barraba, Lower Hunter Valley, Capertee Valley and Taronga Zoo).

###### Key Threats as they relate to the project (OEH, 2015)

- Historical loss, fragmentation and degradation of habitat from clearing for agricultural and residential development, particularly fertile Yellow Box-White Box-Blakely's Red Gum woodlands.
- Competition from larger aggressive honeyeaters, particularly Noisy Miners, Noisy Friarbirds and Red Wattlebirds.

###### Conservation advice, recovery plans and threat abatement plans

- Approved conservation advice for *Anthochaera phrygia* (Regent Honeyeater) (TSSC, 2015).
- The Regent Honeyeater (*Xanthomyza phrygia*) Recovery Plan 1999-2003 (Menkhorst *et al.*, 1999) outlines recovery objectives and actions for the species.
- The 2011 Action Plan for Australian Birds outlines conservation objectives relevant to the recovery effort of the Regent Honeyeater (Garnett *et al.*, 2011).
- Threat abatement plan for competition and land degradation by rabbits (DEWHA, 2008).
- A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the site-managed species management stream under the Saving our Species program.

###### Representation in conservation reserves

- The amount of this species distribution occurring on conservation reserves is unknown
- The OEH has established four management sites where conservation activities need to take place to ensure the conservation of this species (Bundarra – Barraba, Lower Hunter Valley, Capertee Valley and Taronga Zoo).

##### b. Description of species and habitat requirements

The Regent Honeyeater is a striking and distinctive, medium-sized, black and yellow honeyeater with a sturdy, curved bill. Adults weigh 35-50 grams, are 20-24 cm long and have a wingspan of 30 cm. Its head, neck, throat, upper breast and bill are black and the back and lower breast are pale lemon in colour with a black scalloped pattern. Its flight and tail feathers are edged with bright yellow. There is a characteristic patch of dark pink or cream-coloured facial-skin around the eye (OEH, 2015).

Regent Honeyeaters mostly occur in dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, for example along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing River Sheoak (*Casuarina cunninghamiana*), and with Needle-leaf Mistletoe (*Amyema cabbagei*), are also important for feeding and breeding. Regent Honeyeaters usually nest in the canopy of forests or woodlands, and in the crowns of tall trees, mostly eucalypts (Oliver, 1998).

There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and



riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria (root system). An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DoE, 2015). Two or three eggs are laid and incubated by the female for 12-15 days (Oliver et al., 1998). Nestlings are brooded and fed by both parents at an average rate of 23 times per hour and fledge after 16 days. The fledgelings, which are fed by both adults, become independent approximately three to four weeks after leaving the nest (Oliver, 1998). Breeding can occur within the first year (DoE, 2015).

**c. Local and regional distribution**

The Regent Honeyeater is endemic to south-east Australia, where it is widespread but with an extremely patchy distribution (Garnett et al. 2011). Its range extends from south-east Queensland to central Victoria (Menkhorst et al. 1999).

Populations of Regent Honeyeaters at particular locations fluctuate greatly between years and sites, according to seasonal conditions (Garnett et al., 2011). Since 2000, only very small numbers (fewer than ten birds) of Regent Honeyeaters have been reported for each of the minor Regent Honeyeater sites in NSW, apart from the lower Hunter and Central Coast, where tens of birds are still sometimes reported. In spring-summer 2007 and in August 2008 there were five to ten birds on the Central Coast. It is estimated that the NSW population of Regent Honeyeaters may now be fewer than 250 mature individuals (NSW Scientific Committee, 2011).

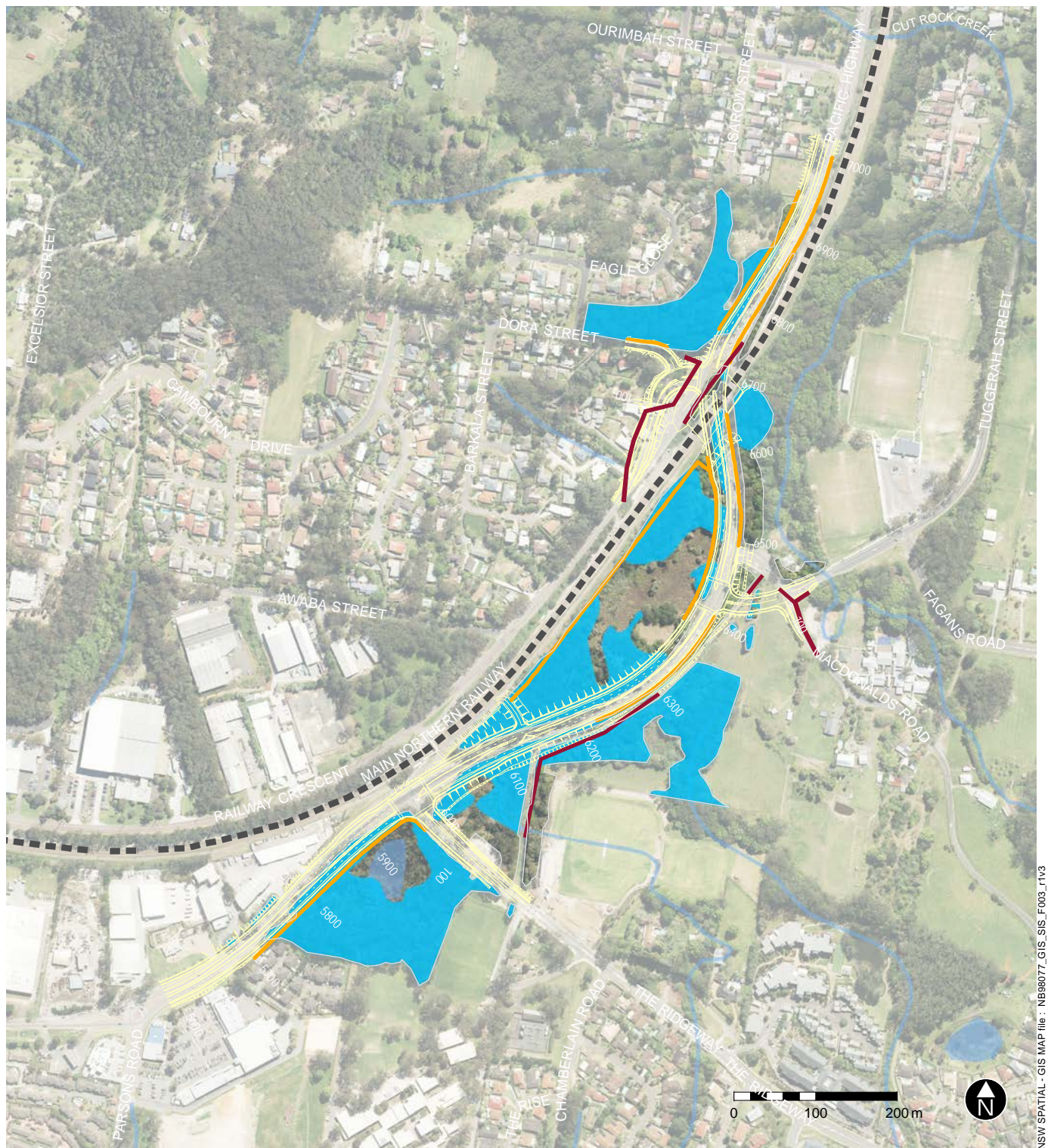
**d. Assessment of habitat**

**Extent of habitat removal**

The presence of Regent Honeyeaters in the NSW Central Coast has been reportedly associated with coastal lowlands and in particular the prolific flowering of Spotted Gum and Swamp Mahogany during winter months. There are no reported breeding population in the study area, and the habitats to be impacted represent no breeding habitat. The loss of swamp forest habitat in the study area will equate to around 2.7 hectares. In addition to this a further 0.7 hectares of moist forest will be cleared which contains mature eucalypts. The vegetation clearing will include mature swamp mahogany and thus contribute to the cumulative loss of foraging habitat for this species from the region.

**Consideration of corridors and movements**







There are no important movement corridors affected by the proposal. As this species moves nomadically in search of food resources it capable of moving across fragmented landscapes and its movements are unlikely to be impacted by the small scale vegetation clearing.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F003\_r1v3

Figure 5-5 | Mapped habitat for Regent Honeyeater (*Anthochaera phrygia*)

### Legend

- |   |                |   |  |
|---|----------------|---|--|
|  | Concept design |  | Potential habitat area investigated                      |
|  | Retaining wall |  | Regent Honeyeater ( <i>Anthochaera phrygia</i> ) habitat |
|  | Power line     |   |  |
|  | Watercourse    |   |  |

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Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



#### 5.4.7 Swift Parrot (*Lathamus discolor*)

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Endangered.
- Commonwealth: Endangered, Migratory (Marine).
- Thirty seven percent of this species' distribution occurs on reserve (within NSW NPWS estate). In NSW, only 5% of box-ironbark forests and woodland communities are reserved (Robinson & Traill 1996).

###### Key Threats as they relate to the project (OEH, 2015)

- Habitat loss and degradation.
- Competition for food resources.
- Collision mortality.
- Infestation by invasive weeds.
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.

###### Conservation advice, recovery plans and threat abatement plans

- National Recovery Plan for the Swift Parrot (Saunders and Tzaros, 2011).
- Commonwealth Listing Advice on *Lathamus discolor* (TSSC, 2012).
- Threat Abatement Plan for Predation by Feral Cats (Department of the Environment, Water and Heritage, 2008).
- Threat abatement plan for beak and feather disease affecting endangered psittacina species (DEH, 2005)
- A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving our Species program.

###### Representation in conservation reserves

- Thirty seven percent of this species' distribution occurs on reserve (within NSW NPWS estate).
- In NSW, only 5 per cent of box-ironbark forests and woodland communities are reserved (Robinson & Traill 1996).

##### b. Description of species and habitat requirements

The Swift Parrot is small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. The red on its throat is edged with yellow. Its crown is blue-purple. There are bright red patches under the wings. One of most distinctive features from a distance is its long (12 cm), thin tail, which is dark red (OEH, 2015).

The Swift Parrot feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Key habitats for the species on the coast and coastal plains of NSW include Spotted Gum (*Corymbia maculata*), Swamp Mahogany (*Eucalyptus robusta*), Red Bloodwood (*E. gummifera*) and Forest Red Gum (*E. tereticornis*) forests (Saunders 2002b; Saunders & Heinsohn 2008).

These tree species provide foraging and roosting habitat for the species. In northern NSW and south-eastern Queensland, Narrow-leaved Red Ironbark (*E. crebra*), Forest Red Gum forests and Yellow Box forest are commonly utilized (Swift Parrot Recovery Team 2001). While on the western slopes Mugga Ironbark (*E. sideroxylon*) and Grey Box (*E. microcarpa*) woodlands are used (Saunders & Heinsohn 2008).



## Life History

The Swift Parrot breeds only in Tasmania and breeding success is strongly correlated with the intensity and extent of flowering of Tasmanian Blue Gums. The breeding season is from mid-September to late January. Birds begin to return to Tasmania from their mainland wintering range in early August (Swift Parrot Recovery Team 2001). Nesting starts in late September, however birds unpaired on arrival in Tasmania may not begin until November after finding mates (Brown 1989). Laying occurs during October and November and clutch size is three to five eggs. Fledging occurs from early December to late January, at approximately six weeks (Swift Parrot Recovery Team 2001).

### c. Local and regional distribution

The Swift Parrot is endemic to south-eastern Australia. It breeds only in Tasmania, and migrates to mainland Australia in autumn (Swift Parrot Recovery Team 2001), undertaking the longest migration of any parrot species in the world (Tzaros 2002). This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales. Until recently it was considered that the New South Wales wintering range was mostly on the western slopes region along the inland slopes of the Great Dividing Range, and some areas along the northern and southern coasts including the Sydney region. However, increasing evidence suggests that coastal plains forests from southern to northern New South Wales are also extremely important (Swift Parrot Recovery Team 2001).

The Swift Parrot is a semi-nomadic winter visitor to mainland Australia, foraging in dry woodlands mainly in Victoria and New South Wales. Nearly all the records in the locality are from 2002, when an annual Swift Parrot survey was undertaken. This year, and also 2007, recorded the highest numbers of Swift Parrots in the Central Coast region (Swift Parrot Recovery Team, 2008). The Central Coast is likely an important habitat for this species due to the abundance of foraging resources. However population numbers likely depend on resource availability. Breeding season survey data suggest that the total population is at best stable, with an estimated 2000 breeding birds, or 1000 pairs (Garnett & Crowley 2000; Swift Parrot Recovery Team 2001).

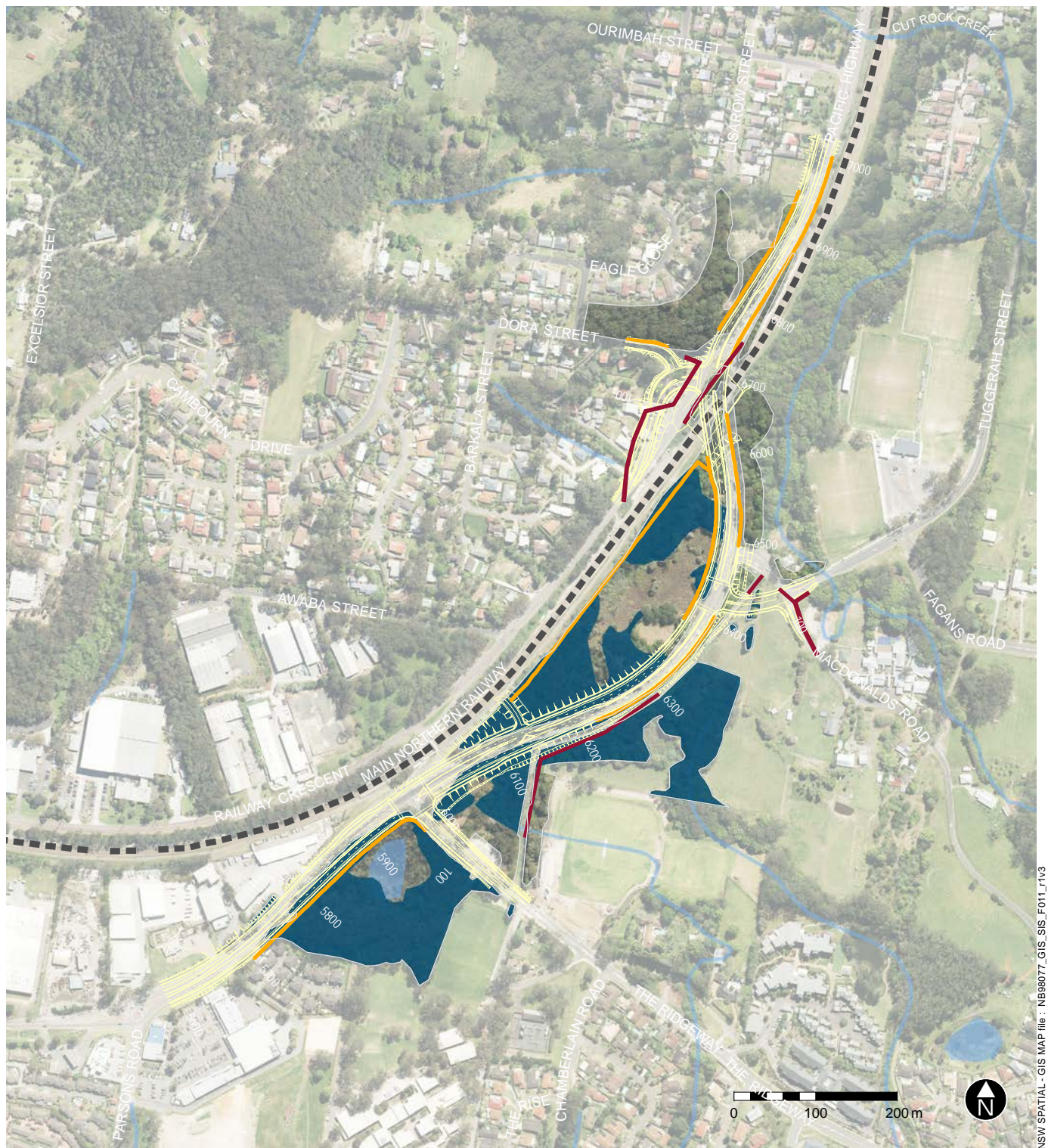
### d. Assessment of habitat

#### **Extent of habitat removal from the proposal**

The presence of Swift Parrot in the NSW Central Coast has been reportedly associated with coastal lowlands and in particular the prolific flowering of Spotted Gum and Swamp Mahogany during winter months. The loss of swamp forest habitat in the study area will equate to around 2.7 hectares. In addition to this a further 0.7 hectares of moist forest will be cleared which contains mature eucalypts. The vegetation clearing will include mature swamp mahogany and thus contribute to the cumulative loss of foraging habitat for this species from the region.

#### **Consideration of corridors and movements**







There are no important movement corridors affected by the proposal. As this species moves nomadically in search of food resources it is capable of moving across fragmented landscapes and its movements are unlikely to be impacted by the small scale vegetation clearing.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_SIS\_F011\_r1v3

Figure 5-6 | Mapped habitat for Swift Parrot (*Lathamus discolor*)

### Legend

- |   |                |   |   |
|---|----------------|---|---|
|  | Concept design |  | Potential habitat area investigated               |
|  | Retaining wall |  | Swift Parrot ( <i>Lathamus discolor</i> ) habitat |
|  | Power line     |   |   |
|  | Watercourse    |   |   |

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Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



#### 5.4.8 Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Vulnerable.
- Twenty two percent of this species' distribution occurs on reserve (within NSW NPWS estate).

###### Key Threats as they relate to the project (OEH, 2015)

- Disturbance to winter roosting and breeding sites.
- Loss of roosting habitat, primarily hollow-bearing eucalypts.
- Loss and fragmentation of foraging habitat, particularly extensive areas of continuous forest and areas of high productivity.

###### Conservation advice, recovery plans and threat abatement plans

- The Action Plan for Australian bats (Duncan *et al.*, 1999).
- No conservation advice, recovery plan or threat abatement plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving Our Species program.

###### Representation in conservation reserves

- Twenty two percent of this species' distribution occurs on reserve (within NSW NPWS estate).

##### b. Description of species and habitat requirements

The Eastern False Pipistrelle is relatively large with a head-body length of about 65 mm. It weighs up to 28 grams. It is dark to reddish-brown above and paler grey on its underside. It has long slender ears set well back on the head and some sparse hair on the nose (OEH, 2015).

The Eastern False Pipistrelle appears to prefer wet habitats, particularly riparian or high rainfall areas, with large trees greater than 20 metres tall (Menkhorst and Lumsden, 1995). It may be more common at high elevations (Phillips, 1995), though it has been recorded between sea level and 1500 metres in Victoria (Menkhorst and Lumsden, 1995). It usually roosts in hollows in Eucalyptus, though it has been recorded in caves and old buildings. It may hibernate over winter and has been known to travel at least twelve kilometres from its roost site while foraging. It hunts mostly in the upper canopy for moths, beetles, weevils, flies and ants (Churchill 1998).

Relatively little is known about the biology of this species (Strahan, 1995). Consistent with other vespertilionids, males produce sperm in late summer and store this in the epididymis over the colder period. Females are pregnant during late spring and early summer and lactating in mid-January (Strahan, 1995).

##### c. Local and regional distribution

The Eastern False Pipistrelle is found in south-eastern Australia from south-eastern Queensland to the southernmost extent of Victoria and all of Tasmania. Limited data exists regarding the local and regional abundance around Lisarow or population size of the Eastern False Pipistrelle. Twenty three records exist in the locality, all of which have been sighted in the last 20 years.

##### d. Assessment of habitat

###### **Extent of habitat removal from the proposal**

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and



cracks suitable for bat roosting. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality.

#### **Consideration of corridors**

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.

#### 5.4.9 Eastern Freetail-bat (*Mormopterus norfolkensis*)

##### a. Conservation Status, key threats and recovery plans

- NSW: Vulnerable.

Key Threats as they relate to the project (OEH, 2015)

- Loss of hollow-bearing trees.
- Loss of foraging habitat.

Conservation advice, recovery plans and threat abatement plans

- The Action Plan for Australian bats (Duncan *et al.*, 1999).
- No conservation advice, recovery plan or threat abatement plan relates to this species. The Office of Environment and Heritage has identified 18 priority actions to help recover the Eastern Freetail-bat in New South Wales. Priority actions are the specific, practical things that must be done to recover a threatened species, population or ecological community.

Representation in conservation reserves

- Twenty two percent of this species' distribution occurs on reserve (within NSW NPWS estate).

##### b. Description of species and habitat requirements

The Eastern Freetail-bat has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (three to four centimetres) bare tail protruding from the tail membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to ten grams. This species can be distinguished from other members of the group by its long forearm, upright ears and robust build (OEH, 2015).

Habitat preferences are not well understood, but the species appears to favour dry eucalypt forest and woodland, though it has also been captured in rainforest and wet sclerophyll forest (Churchill, 1998). It usually roosts in tree hollows (Gilmore and Parnaby, 1994), though it has been recorded in the roof of a hut and under the metal caps of telegraph poles (Churchill, 1998).

Little is known of the Eastern Freetail-bat reproductive cycle, however the capture of a number of females and no males at one site suggests that the sexes separate at certain times of the year, perhaps for birth and raising of young (Strahan, 1995).

##### c. Local and regional distribution

This is a poorly understood species, but it seems to be restricted to east of the Great Dividing Range between approximately Brisbane (Queensland) and Eden (New South Wales) (Duncan *et al.*, 1999; Parnaby 1992). Limited data exists regarding the local and regional abundance around Lisarow or population size of the Eastern Freetail-bat. Twenty one records exist in the locality, all of which have been sighted in the last 20 years. Suggestions of populations size include less than 10,000 mature individuals (Richards and Pennay, 2008)

##### d. Assessment of habitat

#### **Extent of habitat removal from the proposal**

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality.

### **Consideration of corridors and movements**

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.



#### 5.4.10 Greater Broad-nosed Bat (*Scoteanax rueppellii*)

##### a. Conservation Status, key threats and recovery plans

- NSW: Vulnerable.
- Forty one percent of this species' distribution occurs on reserve (within NSW NPWS estate).

##### Key Threats as they relate to the project (OEH, 2015)

- Disturbance to roosting and summer breeding sites.
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions
- Loss of hollow-bearing trees
- Changes to water regimes are likely to impact food resources, as is the use of pesticides and herbicides near waterways.

##### Conservation advice, recovery plans and threat abatement plans

- The Action Plan for Australian bats (Duncan *et al.*, 1999).
- No conservation advice, recovery plan or threat abatement plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving Our Species program.

##### Representation in conservation reserves

- Forty one percent of this species' distribution occurs on reserve (within NSW NPWS estate).

##### b. Description of species and habitat requirements

The Greater Broad-nosed Bat is a large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Eastern False Pipistrelle *Falsistrellus tasmaniensis*, it differs by having only two (not four) upper incisors (OEH, 2015).

The open nature of eucalypt woodlands and forests suit its direct flight pattern, and the more cluttered environments of the wetter forests are overcome by utilising natural and human-made opening in the forest. Creeks and small rivers are favoured corridors where it hawks backwards and forwards for beetles and other large, slow-flying insects; this species has been known to eat other bat species (Strahan, 1995).

Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young. Usually roosting in tree hollows, it has also been found in roof spaces of old buildings (Strahan, 1995).

##### c. Local and regional distribution

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m.

Limited data exists regarding the local and regional abundance around Lisarow or population size of the Greater Broad-nosed Bat. Twenty nine records exist in the locality, all of which have been sighted in approximately the last 20 years.

##### d. Assessment of habitat

##### **Extent of habitat removal from the proposal**

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow

cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality.

**Consideration of corridors and movements**

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.

#### 5.4.11 Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Vulnerable.
- Thirteen percent of this species' distribution occurs on reserve (within NSW NPWS estate).

###### Key Threats as they relate to the project (OEH, 2015)

- Disturbance to roosting and summer breeding sites.
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions.
- Loss of hollow-bearing trees; clearing and fragmentation of forest and woodland habitat.

###### Conservation advice, recovery plans and threat abatement plans

- No conservation advice, recovery plan or threat abatement plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving Our Species program.

##### b. Description of species and habitat requirements

The Yellow-bellied Sheathtail-bat is a very distinctive, large, insectivorous bat up to 87 mm long. It has long, narrow wings, a glossy, jet-black back, and a white to yellow belly extending to the shoulders and just behind the ear. Characteristically, it has a flattened head and a sharply-pointed muzzle. The tail is covered with an extremely elastic sheath that allows variation in the tail-membrane area. Males have a prominent throat pouch; females have a patch of bare skin in the same place (OEH, 2015).

Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory (Strahan, 1995).

Breeding receptivity in the yellow-bellied sheath-tailed bat begins in August when the right uterine horn increases in diameter, achieving maximum size in November. A single offspring is produced between December and March, with mammary glands regressing by the end of May (Chimimba and Kitchener, 1987; Strahan, 1995). Little more is documented about the reproductive ecology of this species.

##### c. Local and regional distribution

The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes.

##### d. Assessment of habitat

###### **Extent of habitat removal from the proposal**

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality.



### **Consideration of corridors and movements**

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal

#### 5.4.12 Eastern Bentwing-bat (*Miniopterus schreibersii* subsp *oceanensis*)

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Vulnerable.
- Nineteen percent of this species' distribution occurs on reserve (within NSW NPWS estate).

###### Key Threats as they relate to the project (OEH, 2015)

- Loss of high productivity foraging habitat.

###### Conservation advice, recovery plans and threat abatement plans

- The Action Plan for Australian bats (Duncan *et al.*, 1999).
- No conservation advice, recovery plan or threat abatement plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving Our Species program.

##### b. Description of species and habitat requirements

The Eastern Bentwing-bat has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. It has a short snout and a high 'domed' head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the 'bent wing' appearance. It weighs up to 20 grams, has a head and body length of about 6 centimetres and a wingspan of 30-35 centimetres (OEH, 2015).

This species has been recorded from most environments within the Greater Southern Sydney Region including: creeklines within semi-urban areas, above farm dams in cleared country, in sandstone woodland and in rainforest gullies. It utilises a wide variety of habitats where it usually roosts in caves, though it has been known to use mines, bridges and road culverts (Churchill 1998). It is a fast flying species and has been known to travel up to 65 kilometres in a night (Dwyer 1966). Though individuals often use numerous roosts, they congregate en masse in a small number of caves to breed and hibernate (Churchill 1998). Typically it is found in well-timbered valleys where it forages, above the tree canopy, on small insects (Strahan, 1995).

With the onset of spring, adult females move to specific nursery caves that provide high temperature and humidity throughout the year or, in the southern part of the range, have an internal conformation that retains air that has been warmed by the bats' activities. In north-eastern NSW, mating and fertilisation occur from May to June, prior to hibernation. A single young is born to each female, usually in December. In a nursery cave, up to 3,000 young bats per square metre are nursed and reared to independence. Nursery colonies disband between February and March, adults and juveniles going separate ways. Sexual maturity is reached in the second year of life and longevity may be in excess of 17 years (Strahan, 1995).

##### c. Local and regional distribution

The Common Bentwing-bat (*Miniopterus schreibersii*) is the most widely distributed bat in the world, occurring through Europe, Africa and Australasia (Churchill 1998), though research suggests that there may be three taxa in Australia (Duncan *et al.* 1999). The subspecies *oceanensis* (often referred to as the Eastern Bentwing-bat) is the relevant taxon for NSW and extends at least between central Victoria and Cape York Peninsula, Queensland (Duncan *et al.* 1999).

Limited data exists regarding the local and regional abundance around Lisarow or population size of the Eastern Bentwing-bat. Seventy three records exist in the locality, all of which have been sighted in the last 20 years.

##### d. Assessment of habitat

###### **Extent of habitat removal from the proposal**

There are no caves in the study area or project footprint that could potentially be used for roosting or breeding by this species. Two small pipe culverts occur under the existing highway that are heavily overgrown and silted and provide very poor or non-existent opportunities for roosting bats. These culverts will be removed for

construction although this is not expected to impact on roosting habitat for cave-roosting species. The habitat in the study area could potentially be used for hunting by this species, however any hunting activity would include utilising forest and cleared land in this location and likely to include movements across the highway, rail line and urban areas. Up to 4.7 hectares of forest and wetland habitat would be cleared and this activity may temporarily impact on the habitat of prey species in the locality.

### Consideration of corridors and movements

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.

#### 5.4.13 Little Bentwing-bat (*Miniopterus australis*)

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Vulnerable.
- Forty four percent of this species' distribution occurs on reserve (within NSW NPWS estate).

###### Key Threats as they relate to the project (OEH, 2015)

- Loss of high productivity foraging habitat.

###### Conservation advice, recovery plans and threat abatement plans

- The Action Plan for Australian bats (Duncan *et al.*, 1999).
- Threat Abatement Plan for Predation by Feral Cats (Department of the Environment, Water and Heritage, 2008).
- Threat Abatement Plan for Predation by the European Red Fox (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008)
- No conservation advice or recovery plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Landscape species management stream under the Saving Our Species program.

##### b. Description of species and habitat requirements

Little Bentwing-bats are small dark chocolate brown insectivorous bats with a body length of about 45 mm. The tip of the wing is formed by a particularly long joint of the third finger, folded back and bent under the wing while the bat is at rest. The fur is long and thick, especially over the crown and around the neck, and is slightly lighter in colour on the belly. They have distinctly short muzzles, and short, rounded roughly triangular shaped ears; distinguished from the Eastern Bentwing-bat by its smaller size (OEH, 2015).

This species inhabits moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters (Strahan, 1995).

In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (*Miniopterus schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young. Males are sexually active during winter, copulatory activity occurs through late July and August, and fertilisation takes place in the latter month. Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer. In Australia, only five nursery sites have been reported (Strahan, 1995).



**c. Local and regional distribution**

The Little Bentwing-bat occurs on the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Its Distribution becomes increasingly coastal towards the southern limit of its range in NSW.

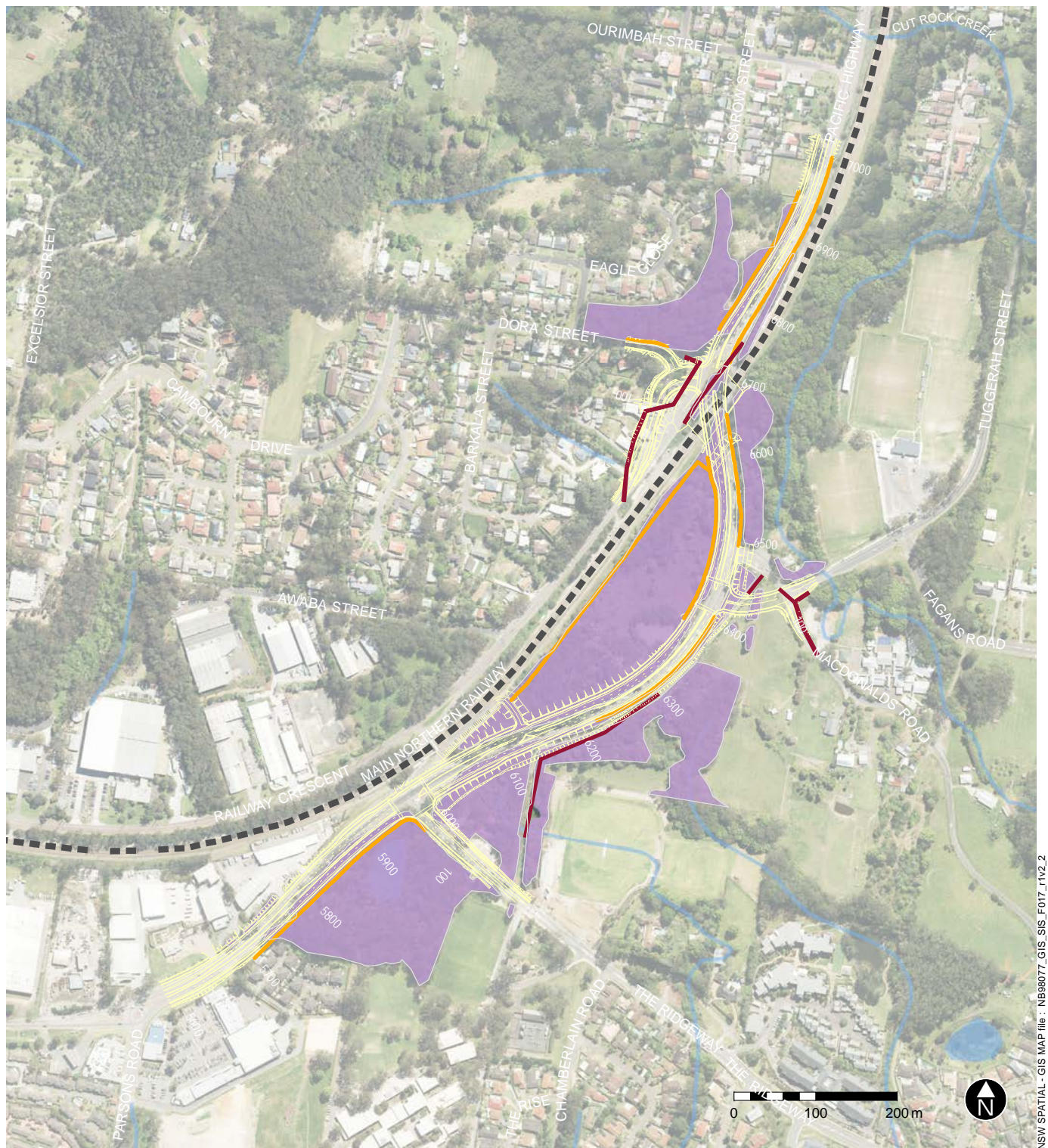
Limited data exists regarding the local and regional abundance around Lisarow or population size of the Little Bentwing-bat. Sixty eight records exist in the locality, all of which have been sighted in approximately the last 20 years.

**d. Assessment of habitat****Extent of habitat removal from the proposal**

There are no caves in the study area or project footprint that could potentially be used for roosting or breeding by this species. Two small culverts occur under the existing highway that are heavily overgrown and silted and provide very poor or non-existent roosting opportunities for cave-roosting bats. These culverts will be removed for construction although this is not expected to impact on roosting habitat for bats. The habitat in the study area could potentially be used for hunting by this species, however any hunting activity would include utilising forest and cleared land in this location and likely to include movements across the highway, rail line and urban areas. Up to 4.7 hectares of forest and wetland habitat would be cleared and this activity may temporarily impact on the habitat of prey species in the locality.

**Consideration of corridors and movements**







There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.



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Figure 5-7 | Mapped foraging habitat for Threatened Microbats (Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Little Bentwing-bat (*Miniopterus australis*))

## Legend

	Concept design		Potential habitat area investigated
	Retaining wall		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> ), Eastern Bentwing-bat ( <i>Miniopterus schreibersii oceanensis</i> ) and Little Bentwing-bat ( <i>Miniopterus australis</i> ) habitat
	Power line		
	Watercourse		

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



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

##### a. Conservation Status, key threats and recovery plans

###### Conservation Status

- NSW: Vulnerable.
- Commonwealth: Vulnerable.
- In NSW less than 15 per cent of potentially suitable forest occurs in conservation reserves; only 5 per cent of roost sites are similarly reserved (Hall and Richards, 2000).

###### Key Threats as they relate to the project (OEH, 2015)

- Loss of roosting and foraging sites.
- Electrocution on powerlines, entanglement in netting and on barbed-wire.
- Conflict with humans.

###### Conservation advice, recovery plans and threat abatement plans

- This species has been listed in the NSW OEH Threatened Species Profile Database (TSPD) as a species that is unable to withstand a loss of breeding habitat. Can withstand up to 10% loss of foraging habitat providing 'replanting' or 'supplementary planting' is undertaken in offset.
- Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (DECCW, 2010)
- The Action Plan for Australian bats (Duncan *et al.*, 1999).
- No conservation advice, or threat abatement plan relates to this species. A Saving Our Species conservation proposal is currently being developed for this species. This species has been assigned to the Landscape species management stream under the Saving Our Species program.

###### Representation in conservation reserves

- Forty one percent of this species' distribution occurs on reserve (within NSW NPWS estate).

##### b. Description of species and habitat requirements

The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23-29 centimetres. It has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck. The wing membranes are black and the wingspan can be up to one metre. It can be distinguished from other flying-foxes by the leg fur, which extends to the ankle (OEH, 2015).

The species is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW (associated with flowering Spotted Gum *Corymbia maculata*) and on the northwest slopes (generally associated with flowering White Box *Eucalyptus albens* or Mugga Ironbark *E. sideroxylon*) (NSW DECCW 2010). The Grey-headed Flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located within 20 km of a regular food source and near water, such as lakes, rivers or the coast (van der Ree *et al.* 2005).

Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young. Mating occurs in early autumn, after which time the larger camps begin to break up, reforming in late spring/early summer, as food resources become more abundant (Hall & Richards 2000). Males and females segregate in October when females usually give birth.

Following six months of gestation, females bear a single young each year. Lactation usually begins in October and continues for three to four months or sometimes longer (Nelson 1965). For a period of four to five weeks after giving birth, the mother carries her single young with her to feeding sites. Once the young are completely furred, they are left in maternal camps and continue to be nursed until they are independent after around 12 weeks (Hall & Richards 2000). During this nursery phase, males rejoin the females for courting with pair bonds



being formed (Hall & Richards 2000). Generally, females do not reach full sexual maturity until three years of age (Martin 2000).

**c. Local and regional distribution**

The Grey-headed Flying-fox is Australia's only endemic flying-fox and occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (Tidemann, 1998). However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. At a local scale, the species is generally present intermittently and irregularly (Eby and Lunney, 2002). At a regional scale, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration (Eby and Lunney, 2002). Whilst Brisbane, Newcastle, Sydney and Melbourne are occupied continuously (Pallin, 2000), elsewhere, during spring, Grey-headed Flying-foxes are uncommon south of Nowra and widespread in other areas of their range.

Two roost camps are located within the locality: Wingello Creek (approx. three kilometres) and Matcham (approx. eight kilometres). Camp sites are not always used by Grey-headed Flying Foxes. It is believed that Grey-headed Flying-foxes respond to changes in the amount of available food by migrating between camps in irregular patterns (Eby, 2000). The movements and numbers of Grey-headed Flying-foxes were recorded in and around the colony site at Matcham, between 1986 and 1990 (Parry-Jones & Augee 1992). During all four years of the study, population numbers were high during the period March to May, corresponding with the mating season reported by McGuckin and Blackshaw (1987). After mating, there was a rapid or gradual abandonment of the Matcham site, depending on the year, as the bats dispersed to scattered sites within the surrounding area (Parry-Jones & Augee 1992). No population information exists for Wingello Creek, however the same colony is likely to utilise this roost camp also. There a total of 183 known roost camp in NSW. Colonies can have over 10,000 individuals. A population size estimate in 2005 put the national population at 674,000 Grey-headed flying foxes (DoE, 2015).

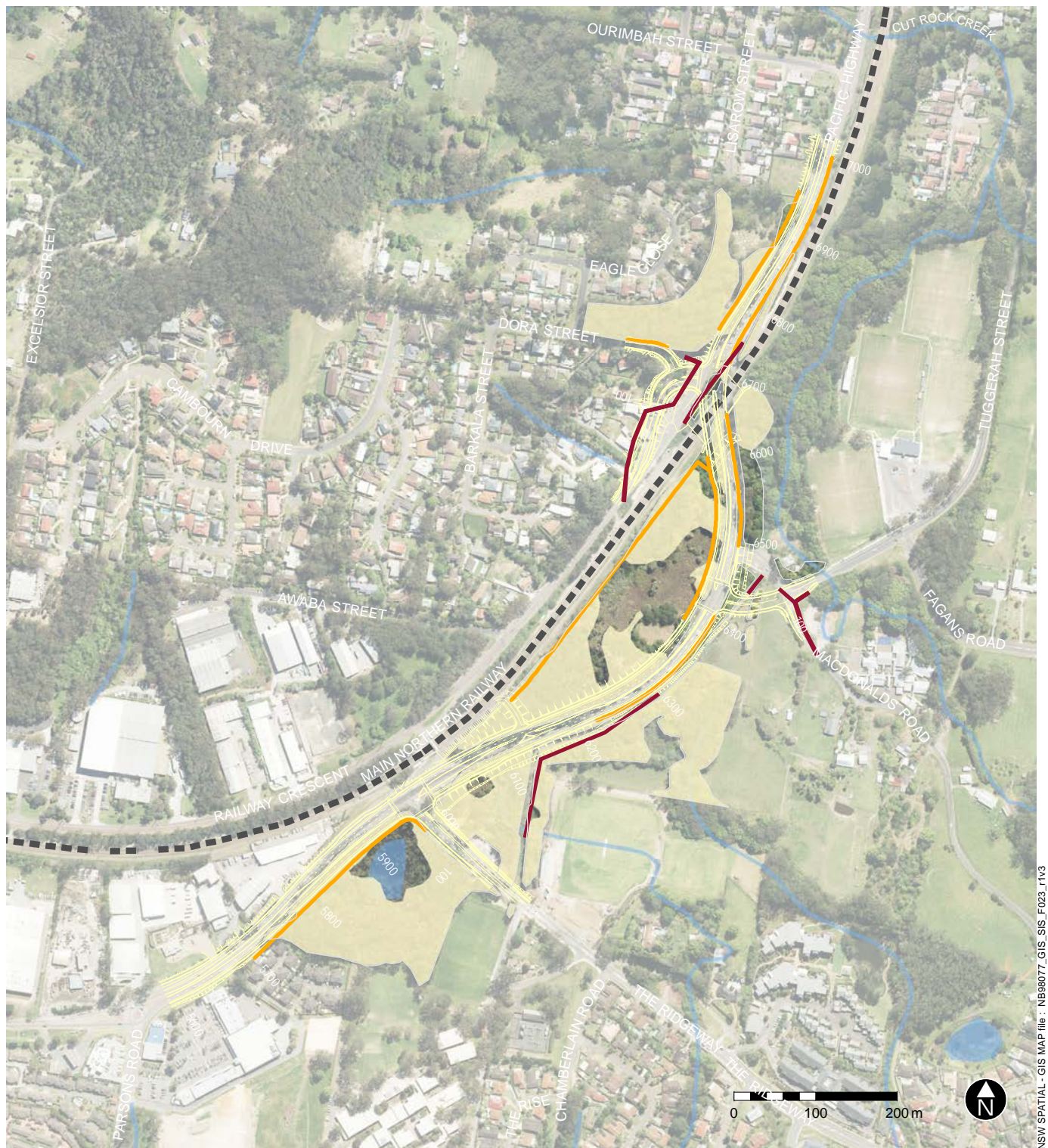
**d. Assessment of habitat**

**Extent of habitat removal from the proposal**

The Grey-headed Flying-fox was identified on five occasions in the proposal area with each observation associated with flowering Swamp Mahogany (*Eucalyptus robusta*). Swamp Mahogany has been identified as an important winter food source and critical foraging habitat for the species (DECCW 2009). Therefore the presence of Swamp Mahogany on the site represents critical foraging habitat for the species. While there are no roost camps on the site, the nearest known roost site is at 2.5 km south of the study area, the swamp sclerophyll habitat in the study area is expected to provide regionally important foraging habitat for the Grey-headed Flying-fox. The proposal will remove up to 3.45 hectares of important foraging habitat, there will be no impact to a known roosting camp.

**Consideration of corridors**







The species is capable of large movements and adapted to crossing fragmented landscapes. The proposal will not affect the movement of the species.



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Figure 5-8 | Mapped habitat for Grey-headed Flying-fox (*Pteropus poliocephalus*)

### Legend

- |   |                |   |  |
|---|----------------|---|--|
|  | Concept design |  | Potential habitat area investigated                              |
|  | Retaining wall |  | Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> ) habitat |
|  | Power line     |   |  |
|  | Watercourse    |   |  |

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014

## **5.5 Description of feasible alternatives**

A description of feasible alternatives is discussed in Section 2.4 of the project REF (Roads and Maritime, 2015).



## 6. Assessment of likely impacts on threatened ecological communities

### 6.1 Assessment of threatened ecological communities likely to be affected

The identification of threatened ecological communities within the study area was based on the results of targeted vegetation survey within the study area. Of the six threatened ecological communities identified from the background research as known from the locality, two of these were confirmed and mapped in the study area (refer Section 6.3). A detailed description of each EEC including an assessment of condition is provided in Section 2.3.1.

### 6.2 Description of potential impacts

An overview of direct and indirect impacts for the proposal is provided in Section 5.1 including impacts to threatened ecological communities.

### 6.3 Affected threatened ecological communities

The list of six subject threatened ecological communities (refer to Table 3-3) has been refined to two threatened ecological communities (refer to Table 6-1) that will be affected by the proposal. Known and potential habitats for threatened ecological communities have been mapped in Figure 4-6.

Table 6-1 Affected threatened ecological communities

Threatened ecological community	Further reference (Section No.)	Habitat mapping (Figure No.)	Direct construction and operation impact	Extent in study area
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands)	6.5.1	Figure 4-6	0.35 ha	1.69 ha
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest)	6.5.2	Figure 4-6	2.78 ha	7.30 ha

### 6.4 Non-affected threatened ecological communities

The non-affected threatened ecological communities (TSC Act) are listed below and have been excluded from the assessment based on the results of the survey.

- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion.
- River Flat Eucalypt Forest in Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner.
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin Bioregion and South East Corner Bioregions.
- Sydney Freshwater Wetlands in the Sydney Basin Bioregion.

### 6.5 Affected threatened ecological community information

#### 6.5.1 Freshwater Wetlands on Coastal Floodplains of the New South Wales Coast, Sydney Basin and South East Corner

##### a. Conservation Status, key threats and recovery plans

Freshwater wetlands on coastal floodplains is listed as an Endangered Ecological Community under the NSW TSC Act. In the lower Hunter – Central Coast region, about two-thirds was estimated to have remained during the 1990s (NPWS, 2000).

Key Threats as they relate to the project (OEH, 2015)

- Land clearing.
- Continuing fragmentation and degradation.
- Flood mitigation and drainage works.
- Filling associated with urban and industrial development.
- Pollution and eutrophication from urban and agricultural runoff.
- Weed invasion.
- Activation of acid sulfate soils.

Conservation advice, recovery plans and threat abatement plans

- No recovery plan relates to this ecological community. A targeted strategy for managing this ecological community has been developed under the Saving Our Species program.
- Commonwealth Conservation Advice on Lowland Rainforest of Subtropical Australia (TSSC, 2011).
- Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs.
- Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (DoE, 2014).

**b. Description**

This community is typically associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, back swamps, lagoons and lakes but may also occur in back barrier landforms where floodplains adjoin coastal sand plains. Generally occur below 20 metres elevation on level areas. They are dominated by herbaceous plants and have very few woody species.

In the study area this community occurs in low elevated depressions on alluvial soils surrounding the Pacific Highway, at the southern end of the study area and also between the highway and the rail line on the western side of the highway.

This community is a forested wetland dominated by dense growth of Cumbungi (*Typha orientalis*) and an absent or sparse canopy and mid-storey cover. Other common species recorded in this community include Knotweed (*Persicaria species*), River Buttercup (*Ranunculus inundatus*), Tall Sedge (*Carex appressa*), Tassel Sedge (*Carex fascicularis*), Harsh Ground Fern (*Hypolepis muelleri*) and *Triglochin microtuberosum*. This community is in relatively high condition with limited weed invasion, however urban runoff and modified hydrology regimes is likely to have resulted in some modification to the community. Areas of this community are likely to be permanently inundated outside of extended drought periods, with fringing areas being inundated intermittently.

The structure and composition of the community varies both spatially and temporally depending on the water regime: Those that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall. Where they are subject to regular inundation and drying the vegetation may include large emergent sedges over one metre tall. As standing water becomes deeper or more permanent, amphibious and emergent plants become less abundant, while floating and submerged aquatic herbs become more abundant.

*Melaleuca biconvexa* occurs mainly around the edges of this community in swamp forest habitats. However, isolated individuals are also present within permanently inundated areas.

**c. Local and regional distribution**

This community is known to occur along the majority of the NSW coast. However, it is distinct from Sydney Freshwater Wetlands which are associated with sand plains in the Sydney Basin bioregion. Extensively cleared

and modified. In the 1990s the extent remaining were: 3% in the NSW North Coast bioregion, 66 per cent in the lower Hunter – Central Coast region, 40 per cent on the Cumberland Plain, 70 per cent in the Sydney – South Coast region, and 30 per cent in the Eden region.

Broad-scale mapping (NPWS 2003) in the locality (ten kilometre radius) identifies a total 5,382 hectares of floodplain vegetation which form a mosaic of communities including freshwater wetlands. Around 3,500 hectares of this community occurs in the lower Hunter – Central Hunter region based on estimates from the 1990s (OEH 2016). When compared with the identified extant of this community the proposed impact represents a small proportion (i.e. 0.01 per cent) of the potential extant in the locality.

This community is distributed on coastal floodplains along the majority of the NSW coast. This community has been extensively cleared and modified. The major extents on major coastal floodplains (OEH 2016) in NSW comprise:

- Less than 150 hectares remaining on the Tweed lowlands based on estimates from 1985.
- Around 10,600 hectares on the lower Clarence floodplain based on estimates from 1982.
- About 11,200 hectares on the lower Macleay floodplain based on estimates from 1983.
- About 3,500 hectares in the lower Hunter – Central Hunter region based on estimates from the 1990s.
- Less than 2,700 hectares on the NSW south coast from Sydney to Moruya based on estimates from the mid 1990s including around 660 hectares on the Cumberland Plain in 1998.
- Around 100 hectares on the Illawarra Plain in 2001.
- Less than 1000 hectares in the Eden region in 1990.

Small areas of Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Ukerebagh, Tuckean, Tabbimoble Swamp, Hexham Swamp, Pambalong and Pitt Town Nature Reserves and Bungawalbin, Scheyville and Seven Mile Beach National Parks. These are unevenly distributed throughout the range and unlikely to represent the full diversity of the community.

The proposal will not impact on any OEH estates.

#### **d. Assessment of habitat**

A total of 1.69 hectares of freshwater wetland has been mapped in the study area. Of this around 0.35 hectares of good / moderate condition to poor condition habitats will be impacted by the proposal. There are two condition classes of freshwater wetlands in the study area. Good/moderate condition areas of this community (vegetation zone 3) have low-moderate levels of weed invasion. Poor condition areas of this community (vegetation zone 4) are present adjacent to the rail corridor and support a dense sub-canopy of Pussy Willow (*Salix cinerea*) which is also present on the edges of good/moderate condition areas.

#### **Corridor Values**

Freshwater Wetlands in the study area are currently highly fragmented from existing development and habitat disturbance with limited connectivity as the main patch of the community is positioned between the highway and the railway corridor. There is some connectivity between wetlands through culverts and pipes beneath the existing roads where seeds and other propagules can be dispersed in addition to broad range of aquatic fauna. Further fragmentation of habitats as a result of the proposal is not expected to be significant considering the current high level of habitat fragmentation. Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat.

#### **Description of disturbance history**

Lower elevated wetland areas in the study area have been indirectly impacted from surrounding developments which is likely to have altered the hydrology regime and increased pollution and sedimentation (refer to Photograph 2) affecting natural processes and modifying the community composition. It is likely that the distribution of this community has expanded into areas of the surrounding swamp forest following the alteration



of hydrology regimes from surrounding developments which are likely to have increased the volume of and duration of inundation in low lying areas resulting in substantial changes to species composition including flora, invertebrates and microorganisms. Ephemeral inundated habitats appear to be largely absent, and are likely to be part of the former habitat mosaic which provided habitat for a broader suite of species. Numerous drowned trees observed on the edges of the ecological community adjoining swamp sclerophyll forest suggest freshwater wetlands are expanding into these forested wetlands.

### **Extent of habitat removal from the proposal**

Impacts to this community are minor and affect mainly the disturbed edge habitats of wetland areas supporting a mix of macrophytes and weed species. Direct impacts would be limited to approximately 0.35 hectares of good/moderate to poor condition examples of this community. A wetland management plan has been prepared to ensure that areas of this community will be avoided where possible and impacts to the community will be managed during construction and allowed to regenerate in areas of suitable habitat after construction in line with weed management actions.

The proposal will result in further modifications to the hydrology regime, with an overall increase in water depth levels within wetland habitats during weather events. This increased water level is likely to result in a change in the soil wetting and drying regime, leading to possible waterlogging and soil saturation and therefore further expansion of freshwater wetland species such as *Typha orientalis* into areas currently occupied by swamp forest habitat. The floristics and macroinvertebrate assemblages are likely to be further modified as a result of increased water and nutrients possibly resulting in increased dominance of Cumbungi (*Typha orientalis*) potentially leading to reduced habitat values and diversity.

When compared with the identified regional and local extant of this community the proposed impact represents a small proportion (ie 0.01 per cent) of the potential extant in the locality.

### **6.5.2 Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions**

#### **a. Conservation Status, key threats and recovery plans**

Swamp sclerophyll forest on coastal floodplains is listed as an Endangered Ecological Community under the NSW TSC Act. In the lower Hunter - central coast region, about two-thirds was estimated to have remained during the 1990s (NPWS, 2000). One estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Swamp Sclerophyll Forest on Floodplains, currently cover 800-1400 kilometres squared, representing less than 30 per cent of the original extent of this broadly defined vegetation class (Keith 2004).

#### Key Threats as they relate to the project (OEH, 2015)

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation.
- Flood mitigation and drainage works.
- Landfilling and earthworks associated with urban and industrial development.
- Changes in water quality, particularly increased nutrients and sedimentation.
- Weed invasion.
- Activation of acid sulfate soils.
- Removal of dead wood.

#### Conservation advice, recovery plans and threat abatement plans

- No conservation advice or recovery plan relates to this ecological community. A targeted strategy for managing this ecological community has been developed under the Saving Our Species program.
- Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (DoE, 2015).

### Conservation reserves

- Small areas of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Bungawalbin, Tuckean and Moonee Beach Nature Reserves, and Hat Head, Crowdy Bay, Wallingat, Myall Lakes and Garigal National Parks. These occurrences are unevenly distributed throughout the range and unlikely to represent the full diversity of the community.
- The proposal will not impact on any OEH estates.

### **b. Description**

This community occurs on low elevated flats of alluvial soils surrounding the Pacific Highway. This community is a forested wetland dominated by a canopy of Swamp Mahogany (*Eucalyptus robusta*) to 20 metres high and with a sub-canopy dominated by Biconvex Paperbark (*Melaleuca biconvexa*) up to ten metres high. Other small tree species in this community include Cheese Tree (*Glochidion ferdinandi*), Cabbage Tree Palm (*Livistona australis*) and Snow-in-summer (*Melaleuca linariifolia*). The ground layer is dominated by sedges and ferns including Tall Saw-sedge (*Gahnia clarkei*), Tall Sedge (*Carex appressa*), Tassel Sedge (*Carex fascicularis*), Harsh Ground Fern (*Hypolepis muelleri*) and Swamp Water Fern (*Blechnum indicum*).

Many areas of this community is in a disturbed condition resulting from weed invasion, urban runoff and altered hydrology from surrounding development, with a moderate to high abundance of Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*).

The composition of the community is primarily determined by the frequency and duration of waterlogging and the texture, salinity nutrient and moisture content of the soil, and latitude. The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers.

Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law et al. 2000). The blossoms of *Eucalyptus robusta* and *Melaleuca quinquenervia* are also an important food source for the Grey-headed Flying Fox (*Pteropus poliocephalus*) and Common Blossom Bat (*Sycoynceteris australis*) (Law 1994), as well as the Yellow-bellied Glider (*Petaurus australis*), Sugar Glider (*Petaurus breviceps*), Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot (*Lathamus discolor*). Other animals found in this community include the Osprey (*Pandion haliaetus*), Australasian Bittern (*Botaurus poiciloptilus*), Large-footed Myotis (*Myotis adversus*), Litoria olongburensis and Wallum Froglet (*Crinia tinnula*).

Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Sclerophyll Forest on Coastal Floodplains generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains in the NSW North Coast, Sydney Basin and South East Corner bioregions.

### **c. Local and regional distribution**

Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven but may occur elsewhere in these bioregions.

### Significance within a local context

Broad-scale mapping (NPWS 2003) in the locality (10 kilometre radius) identifies a total 5,382 hectares of floodplain vegetation of which 1,458 hectares has been identified as Swamp Sclerophyll Forest. Up to 7,000 hectares in the lower Hunter – central coast district (OEH 2016). The potential direct impacts to this threatened ecological community represent less than 0.19 per cent of the local occurrence and a very small proportion of the regional occurrence in the lower Hunter and central coast (0.025 per cent).

### Regional significance

This community is distributed on coastal floodplains along the majority of the NSW coast. This community has been extensively cleared and modified, with estimates of less than 30 per cent of the original extant remaining. The major extents on major coastal floodplains (OEH 2016) in NSW comprise:

- Less than 350 hectares of native vegetation attributable to this community on the Tweed lowlands.
- Less than 2,500 hectares on the Clarence floodplain.
- Less than 700 hectares on the Macleay floodplain.
- Up to 7,000 hectares in the lower Hunter – Central Coast district.
- Less than 1,000 hectares in the Sydney – South Coast region.

When considering the impacts from the proposal to swamp sclerophyll forest (2.74 hectares) in relation to regional distribution of the ecological community as summarised above the proposal would impact a very small proportion of the regional distribution. The freshwater wetlands in the study area are not considered to be regionally significant.

#### d. Assessment of habitat

A total of 7.3 hectares of swamp sclerophyll forest has been mapped in the study area. Of this around 2.74 hectares of good/moderate condition to poor condition habitats will be impacted by the proposal. Good / moderate condition areas of this community (vegetation zone 1) have low-moderate levels of weed invasion. Poor condition areas of this community (vegetation zone 2) have been previously disturbed from clearing and underscrubbing many areas now support a dense sub-canopy of Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*), or are in a regenerating state with a mix of exotic species and regenerating trees and shrubs. Some areas of poor condition vegetation are currently being subject to weed control works which is contributing to an increase in site values within these areas.

### Description of disturbance history

Lower elevated wetland areas in the study area have been indirectly impacted from surrounding developments such as sporting fields, roads and associated drainage which is likely to have altered the hydrology regime and increased pollution and sedimentation affecting natural processes and modifying the community composition. As a result of this the area of occupation is likely to have retracted and replaced with freshwater wetlands. The current hydrology regime is a substantial existing threatening process which is directly affecting the distribution and abundance of the ecological community with numerous drowned trees observed within and surrounding the freshwater wetland area.

### Extent of habitat removal

Impacts to this community include around 2.74 hectares of mostly good/moderate condition vegetation of direct impact. A wetland management plan has been prepared to ensure that areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat disturbed during construction in line with weed management actions.

The proposal will result in further alterations to existing hydrology regime with further land reclamation and alterations to the existing drainage patterns from replacing and removing existing culverts. Indirect impacts resulting from these proposed hydrological changes and specifically increased water levels include further



expansion of freshwater wetlands into areas of swamp sclerophyll forest and further attrition of canopy species as a result of increased waterlogging and inundation.

The potential direct impacts to this threatened ecological community represent less than 0.19 per cent of the local occurrence and a very small proportion of the regional occurrence in the lower Hunter and central coast (0.025 per cent). When considering indirect impacts the overall impact to swamp sclerophyll forest from the project is up to four hectares which still represents a small proportion of the community in the locality (0.27 per cent).

### **Corridor values**

Patches of Swamp Sclerophyll Forest in the study area are currently highly fragmented from existing development and habitat disturbances with limited existing connectivity. There is some connectivity between wetlands through culverts and pipes beneath the existing roads where seeds and other propagules can be dispersed in addition to broad range of aquatic fauna. Further fragmentation of habitats as a result of the proposal is not expected to be significant considering the current high level of habitat fragmentation. Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat.

## **6.6 Description of feasible alternatives**

A description of feasible alternatives is discussed in Section 2.4 of the project REF (Roads and Maritime, 2015).

## 7. Avoidance and management measures

### 7.1 Avoidance of impacts

The key principle of the Roads and Maritime Biodiversity Guidelines (RTA 2011) with regard to managing biodiversity for road development and associated impacts on biodiversity is that the planning and construction of roads should, in order of consideration, endeavour to:

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

Considering the location of the upgrade within an urbanised landscape with a range of infrastructure, the potential to avoid impacts to biodiversity is constrained. While disturbance and clearing of vegetation as a result of the proposal would be unavoidable, there are further opportunities to avoid and minimise the loss of native vegetation and fauna habitat during the detailed design. The following principles would be prioritised during all aspects of the detailed design:

- Avoiding and minimising vegetation removal wherever possible, particularly in locations where *Melaleuca biconvexa* occurs in the identified buffer areas indirectly or temporarily disturbed for construction.
- Construction compounds and stockpile sites are to be sited in existing cleared areas to avoid unnecessary impacts to vegetation / habitat.
- Water quality basins and drainage structures will be designed to minimise vegetation removal, particularly where *Melaleuca biconvexa* occurs.

### 7.2 Construction management measures

A Flora and Fauna Management Plan will be prepared as part of the Construction Environmental Management Plan (CEMP). It will be prepared in accordance with the Roads and Maritime Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) (Biodiversity Guidelines) and Section 4.8 of Roads and Maritime QA Specification G36 Environment Protection. A summary of the expected content of the FFMP is described in the following sections.

#### 7.2.1 Pre-clearing process

The pre-clearing process will include the following:

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

#### 7.2.2 Management of unexpected species finds (particularly microbats and frogs)

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

Because no structures are proposed to be demolished, it is unlikely that works will have a significant impact on any microbats roosting in adjacent structures. However, if bats are found, an appropriately qualified ecologist will be engaged and provide advice on work methods and timing to minimise impacts on the bats. If exclusions

are required, these will be done in accordance with a Bat Management Plan prepared by an appropriately qualified ecologist.

While the study area has been assessed as containing sub-optimal habitat for threatened frogs there is moderate potential for some species to occur. Because of this, the unexpected threatened species finds procedure would be followed as outlined in the Roads and Maritime Biodiversity Guidelines (RTA 2011). The procedure is to be adopted through the construction phase of the proposal.

As a first step photos and descriptions of roosting bats and threatened frogs are to be included in the CEMP and/or the flora and fauna management sub-plan. All personnel are to be inducted on the potential for these threatened species occurring on site and the unexpected threatened species finds procedure.

### **7.2.3 Exclusion zones**

The location of exclusion zones would be established to avoid damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Delineation of areas with temporary fencing, barrier tape or flagging tape is to be used to indicate the limits of clearing and vegetation to be protected. Maps of exclusion zones will be provided and developed in accordance with Guide 2 of the Biodiversity Guidelines. The function and importance of the exclusion zones would be communicated to construction personnel.

### **7.2.4 Weed management**

A weed management plan would be developed as part of the CEMP given the potential for weed invasion into habitats occupied by threatened ecological communities and a population of the threatened *Melaleuca biconvexa*.

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

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

- Weed management priorities and objectives.
- Sensitive environmental areas within or adjacent to the site.
- Location of weed infested areas.
- Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance.
- Measures to prevent the spread of weeds.
- A monitoring program to measure the success of weed management.
- 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.

### **7.2.5 Pathogen management**

No plant or animal diseases are currently known from the project study area but could potentially be present particularly given the extent of surface water in the study area and high degree of human activity. Measures to prevent the introduction and / or spread of pathogens such as *Phytophthora* or *Chytrid* would be incorporated into the CEMP in accordance with Guide 7 of the Roads and Maritime Biodiversity Guidelines (RTA 2011).

In the first instance measures to confirm the presence of pathogen in the study area may be undertaken before construction and would inform the process for targeted management actions. 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 would be required to confirm the presence of pathogens in the soil and/or water.

If pathogens / disease causing agents are found to be present, measures to prevent the introduction and/or spread of these are to be incorporated into the CEMP in accordance with the best practice hygiene guidelines outlined in RTA (2011) which include for example:

- Identifying exclusion zones with fencing and signage to restrict access into contaminated areas.
- Providing vehicle and boot wash down facilities and ensuring vehicles and footwear are free of soil before entering or exiting the site.
- Regular communication to staff and contractors during inductions and toolbox talks, of the risk of spreading pathogens and the mitigation measures required on site.
- Programming construction works to move from uninfected areas to any known infected areas.
- Restricting vehicles to designated tracks, trails and parking areas.
- Using a certified supply of plants or soil that is disease free.
- Avoiding transferring water between the wetlands.

#### **7.2.6 Re-establishment of habitat**

The clearing footprint includes a ten metre buffer from the base of batters. Following construction this area would comprise suitable habitat for threatened ecological communities (freshwater wetlands and swamp sclerophyll forest) and will be allowed to regenerate naturally and may be landscaped with local species and be included in weed management activities. Other areas such as surrounding sedimentation basins, cut faces and batters will be subject to landscaping.

#### **7.2.7 Water quality and hydrology**

The preservation of water quality is an important issue to be managed effectively during construction. This particularly relates to construction activities within proximity to the identified wetlands and swamp forest habitats and the need to avoid and minimise sediments and pollutants from entering these environments during construction.

A Soil and Water Management Plan (SWMP) will be developed in accordance with the Managing Urban Stormwater – Soils and Construction, Volumes 1 and 2D (Landcom, 2004 and DECCW, 2008) and RTA Road Design Guideline: Section 8 Erosion and Sedimentation (RTA 2003) and QA Specification G38 Soil and Water Management (SWMP) (Roads and Maritime, 2011).

The SWMP will include, but not be limited to procedures for controlling the following standard activities:

- Mud and litter transfer.
- Maintenance and cleaning of sediment controls.
- Soil and stockpile management (in accordance with Roads and Maritime *Stockpile Site Management Guideline*).
- Work within wetlands and in Cut Rock Creek.
- Tannin leachate management control (if stockpiling of vegetation will occur during construction).
- Chemical water quality controls.
- Maintenance regimes for all controls.
- Water quality monitoring method and checklists.

The SWMP will include a preliminary erosion and sediment control plan (ESCP) which will identify the erosion and sediment control measures that will be implemented on site. Progressive ESCPs will be developed

throughout construction to reflect the changes in activities and risk throughout the construction process. The plan will include diagrams of erosion and sediment control techniques and details of when and where these measures will be applied.

### 7.3 Wetland Management Plan

Given the extent of potential impact from the upgrade on the Swamp Sclerophyll Forest and Freshwater Wetlands as well as the associated *Melaleuca biconvexa* population, a Wetland Management Plan has been prepared to document specific pre-construction and construction mitigation measures to protect these values. The Wetland Management Plan is provided as Appendix D.

Ongoing monitoring is also required during construction and immediate operation of the upgrade to monitor and assess the effectiveness of the mitigation measures outlined in the Wetland Management Plan. Monitoring will also provide a means of detecting when performance criteria have or have not been reached during construction, and to identify if corrective measures need to be implemented. The monitoring program consists of the following components:

- **Monitoring Water Quality during Construction.** This monitoring program applies to the preconstruction and construction phases of the proposal. The program will evaluate the success of the water quality and sediment mitigation measures and provide input into management and corrective actions as required. It is aimed at identifying any new changes to water quality within the adjoining wetland from the existing baseline which may impact on *Melaleuca biconvexa* or wetland vegetation at the site scale.
- **Monitoring Compliance with the Construction Environmental Management Plan (CEMP).** It applies to the construction phase and construction footprint area only. It will be developed by the Contractor during construction only to monitor that construction activities are undertaken in accordance with the requirements of this plan, and G36 and G38. It is a program to monitor compliance of the construction contractor with environmental mitigation measures for construction of the project.
- **Monitoring Success of Revegetation / Landscape.** This program applies to monitoring the success of landscape plantings and revegetation in areas cleared for construction along the road fringe. Monitoring would occur in the initial stages of operation until the success of the revegetation is determined against performance criteria.

### 7.4 Biodiversity Offsets

The proposal exceeds the documented impact thresholds in the Roads and Maritime Guideline for Biodiversity Offsets (2011). Thresholds are exceeded for clearing an area of greater than one hectare of a Threatened Ecological Community (TEC) in moderate to good condition and that contains a threatened species that cannot withstand any loss (i.e. *Melaleuca biconvexa*) in the relevant Catchment Management Authority Region as defined in the OEH Threatened Species Profile database.

The Roads and Maritime guideline would apply in the absence of any other requirements, however in this instance, a Species Impact Statement has been prepared and the requirements for offsetting as stated in the Director Generals Requirements (DGRs) are therefore applicable.

Section 7.1.2 DGRs states that OEH is of the opinion that where a proposal which involves clearing of threatened species habitat (i.e. native vegetation) that cannot be avoided or mitigated against, then appropriate offsets which compensate for the clearing of the habitat must be provided. Justification for any area(s) proposed as compensatory habitat / offsets is to include an assessment of the threatened species / biodiversity values impacted on by the proposed works (i.e. those of the subject site) and a comparison of whether the proposed offset area(s) provides equivalent or greater values – ‘improve or maintain important biodiversity values’.

In accordance with these requirements, RMS proposes to provide offsets for the direct impacts on the two endangered ecological communities and the direct and indirect impacts on the population of *Melaleuca biconvexa*. Given the existing edge effects and modification of the habitat at this location offsets are not planned for general indirect impacts however indirect impacts have been quantified separately for the *Melaleuca biconvexa* population. The proposed offsets requirements equate to:

- 2,575 mature *Melaleuca biconvexa* individuals (direct and indirect impact).
- 2.78 hectares Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest). The swamp sclerophyll forest also provides critical foraging habitat for Grey-headed Flying-fox according to the species recovery plan (DECC 2009) and this offset is considered to adequately compensate for the loss of foraging habitat for this species. The offset will target Swamp Sclerophyll Forest containing Swamp Mahogany (*E.robusta*) and therefore compensate for the loss of this important winter flowering resource for species such as Swift Parrot and Regent Honeyeater.
- 0.35 hectares Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands).

For assessments under the EPBC Act, offsets are only required if residual impacts are significant. In this case, offsets are only required to compensate for impacts on the vulnerable species *Melaleuca biconvexa*. Offset requirements have been calculated for this species using the BBAM in accordance with the strategic assessment.

The following section describes the biodiversity offsets required in terms of the ecosystem and species credits generated by the proposed activity. The availability of suitable offsets in the locality to compensate for the loss of habitat associated with the proposal is discussed in the biodiversity offset strategy (Appendix E). The quantum of offset credits required was determined using the Biobanking Credit Calculator (BBCC) with inputs from the detailed vegetation condition assessment as per the following discussion and consideration of the proposed commitments to offsets described above.

#### 7.4.1 Landscape values

##### Bioregion and catchment

The study area is located within the Sydney Basin Bioregion in the Wyong subregion, predominantly within the Ourimbah sub catchment of the Greater Sydney Local Land Services area (formerly the Hunter Central Rivers Catchment Management Area). A very small section of the study area lies within the Narara Creek catchment. Remnant vegetation in this locality is patchy and fragmented by the existing road and rail network, including the Pacific Highway and as well as developed cleared industrial and residential land.

##### Mitchell landscapes

The Mitchell landscapes (Mitchell 2003) occurring in the study area are described in Table 7-1. The south-western end of the proposal area is located within a portion of the Gosford Cooranbong Coastal Slopes and extends for approximately 200 metres from Parson Road north-east before the landscape transitions to Sydney-Newcastle Coastal Alluvial Plains which covers the majority of the proposal area.

Table 7-1 Mitchell landscapes occurring in the study area (Mitchell 2003).

Mitchell landscape	Description
Gosford Cooranbong Coastal Slopes	Characterised by rolling hills and sandstone plateau outliers of Triassic Narrabeen sandstones, extensive rock outcrops and low cliffs along ridge margins. These areas have textured contrast soils on lithic sandstones and shales; loamy sand alluvium along creeks; and organic sand and mud in lagoons and swamps. Elevations for these areas typically range from 0-75 metres (Mitchell 2003).
Sydney-Newcastle Coastal Alluvial Plains	Characterised by undulating plains and low rises on Quaternary sand or Permian/Triassic sandstone or shale with swampy valley floors. The soil profiles are typically composed of siliceous uniform sand, deep podsol and yellow or brown texture-contrast soils on bedrock. Elevations for these areas typically range from 0-80 metres with a 20 metre local relief (Mitchell 2003).



## Landscape connectivity

Information on key habitats and movement corridors in the study area was obtained from the Key Habitats and Corridors project (DEC 2003) and Climate Change Corridors project (DECC 2007). These projects adopted a strategic approach to landscape conservation in north-east NSW by identifying regional key fauna habitats and linking habitat corridors, including current corridor locations and corridors likely to become important in the face of future climate change. Key habitats are typically large areas of remnant vegetation such as reserves, and state forests and regional corridors have been identified to link these key habitats.

Two such corridors have been identified in the locality of the proposal described as:

- Berrys-Head regional corridor which includes the southern half of the proposal area.
- Lake Macquarie-Gosford valley floor linkage coastal climate change corridor which encompasses areas to the east of the existing Pacific Highway.

### 7.4.2 Condition plots

Habitat condition assessments were undertaken using the BBAM to assess the vegetation condition in the impact area in relation to recognised benchmarks for the plant community types. Field data was recorded using the BioBanking plot layout, which consists of a 20 x 20 metre plot (0.04 hectare), a 20 x 50 metre plot (0.1 ha) and a 50 metre line transect.

The condition assessment involved the collection of quantitative plot data on the number of native species; over-storey and mid-storey cover abundance, groundcover attributes including native and exotic species cover; the number of hollow bearing trees; over-storey regeneration and length of fallen logs.

Native canopy and mid-storey cover were visually estimated at 10 points along the 50 metre line transect to provide an estimated projected foliage cover for the plot. The projected foliage cover (%) of ground covers (native grasses, shrubs, other and exotic species), was calculated by recording their presence/absence at 50 points along the 50 metre line transect.

### 7.4.3 Assessment circles

One assessment circle is required to cover the entire study area. The area of native vegetation cover within the 100 hectare and 1000 hectare assessment circles has been calculated using ArcGIS software. The vegetation calculations are based on a GIS-layer adapted from existing broad-scale mapping (LHCCREMS 2003). The 100 hectare circle is centred over the area of greatest change comprising the area of impact. The 1000 hectare circle has been positioned to cover the entire study area. A total of 3.84 hectares of moderate / good condition vegetation will be impacted including a 10 metre buffer on the proposal footprint to account for any indirect impacts. The area of vegetation the assessment circles and the associated cover class to be entered into the BBCC are provided in Table 7-2.

Table 7-2 Area of remnant vegetation cover in each assessment circle before and after development

Assessment circle (area)	Before development		After development	
	Remnant vegetation cover	Cover class	Remnant vegetation cover	Cover class
1. (100 ha)	32.4 ha	31-35%	28.85 ha	26-30%
1. (1000 ha)	454.7 ha	41-45%	451.15 ha	41-45%

### 7.4.4 Connectivity assessment

The BBAM assesses connectivity through consideration of the width of the existing link in terms of the current level of habitat connectivity and the width of future connecting link in the context of revegetation activities. The condition of these current and future habitat connectivity widths is also considered. The results of the connectivity assessment are summarised below in Table 7-3.

Table 7-3 Connectivity values before and after BioBanking

Connectivity value	Before BioBanking	After BioBanking
Width class	>5-30 metres	>5-30 metres
Over-storey condition	Within benchmark	Within benchmark
Mid-storey/ground cover condition	>50% of lower benchmark	>50% of lower benchmark

Habitats in the study area are heavily fragmented by the existing highway, the rail corridor and cleared industrial and residential development. There are several narrow links connecting habitats within the study area. These include a number of narrow drainage reserves extending to the east from the study area between cleared agricultural land and residential and industrial estates. These corridors are generally around 15-20 metres in the narrowest sections.

#### 7.4.5 Vegetation zones

Vegetation zones are identified in the BBAM as 'relatively homogenous areas of the same vegetation type and similar condition'. Vegetation that is in a low condition always forms a different vegetation zone to areas that are in a good or moderate condition. A total of six vegetation zones have been identified in the proposal area refer to Table 7-4. This table includes the area of direct impact from the proposal including a ten metre construction buffer.

Table 7-4 Vegetation zones and threatened species sub-zones

Zone No.	Vegetation zone code	Biometric Vegetation Type (BVT code)	Threatened ecological community	Area (ha)
1	HU591 - Moderate/Good	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	Yes	1.48
2	HU591 - Moderate/Good - Poor	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	Yes	1.30
3	HU673 - Moderate/Good	Typha rushland (HU951)	Yes	0.32
4	HU673 - Moderate/Good - Poor	Typha rushland (HU951)	Yes	0.03
<b>TOTAL CLEARING</b>				<b>3.13 ha</b>

#### 7.4.6 Management zones

Where the extent of development impact or improvement through management varies over a vegetation zone, a management zone is used for the purpose of calculating the change in Site Value for that vegetation zone. It has been assumed that the final management outcome for all areas will be road pavement and cleared and maintained road edges. Therefore based on this assumption, the future site value has not been increased to account for rehabilitation/landscaping or indirect impacts.

#### 7.4.7 Geographic and habitat features

Potential geographic and habitat features of the study area are identified in the BBCC as a series of questions associated with threatened species potentially occurring in the locality. These questions are listed below in Table 7-5 with the corresponding answer as relevant for the site conditions.

Table 7-5 Geographic and habitat features of the site

Threatened Species	Feature	Presence in study area	Impacted?
Biconvex Paperbark ( <i>Melaleuca biconvexa</i> )	Swamps, swamp margins or creek edges	Yes Swamp forest habitats support a high abundance of <i>Melaleuca biconvexa</i> .	Yes

Threatened Species	Feature	Presence in study area	Impacted?
Giant Barred Frog ( <i>Mixophyes iteratus</i> )	Land below 1000 m in altitude and within 40 m of rainforest or eucalypt forest with deep leaf litter	Yes Geographic features present, however stream habitats are too degraded for this species, surrounding catchment is urban and narrow riparian corridor with high density of weeds, and very poor water, there is shallow leaf litter. The study area is considered unsuitable for this species.	No
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	No Landscape features are not present for this species and no suitable roosting or foraging habitat available.	No
Wallum Froglet ( <i>Crinia tinnula</i> )	Land within 40 m of swamps, wet or dry heaths or sedge grasslands	Yes Geographic features present, however potential habitat for this species is not present in the study area. Swamp forest and freshwater wetlands do not contain acid paperbark habitat preferred by this species despite the presence of paperbark swamps.	No
Pale-headed Snake ( <i>Hoplocephalus bitorquatus</i> )	Land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber	No Hollow-bearing trees absent, and habitat isolated, surrounded by urban landscape, not suited to this species	No
Comb-crested Jacana ( <i>Irediparra gallinacea</i> )	Land within 40 m of permanent wetlands with a good surface cover of floating vegetation	No. Freshwater wetlands support limited cover of floating vegetation.	No
Black Bittern ( <i>Ixobrychus flavicollis</i> )	Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation	Yes Potential habitat for this species is present in the study area comprising areas of freshwater wetlands.	No
Eastern Osprey ( <i>Pandion haliaetus</i> )	Land within 40 m of fresh/brackish/saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters	No There are no substantial rivers or creeks in the study area suitable for this species.	No
Common Planigale ( <i>Planigale maculata</i> )	Rainforest, eucalypt forest, heathland, marshland, grassland or rocky areas	Yes Geographic features present. Eucalypt forest present as swamp forest community and not suitable for this species. Not expected as the habitat not suited to this species and there are no records from the locality.	No
<i>Eucalyptus parramattensis</i> <i>subsp. decadens</i>	Land within northern section of sub-region, associated with poorly drained sand deposits within 10km radius of Kurri Kurri in Wyong CMA subregion	No Outside of natural distribution and habitat unsuitable for this species.	No



Threatened Species	Feature	Presence in study area	Impacted?
Green and Golden Bell Frog ( <i>Litoria aurea</i> )	Land within 100 m of emergent aquatic or riparian vegetation	Yes Freshwater wetlands in the study area support emergent aquatic vegetation. Marginal habitat has been identified for this species in the study area. This species was not recorded during targeted surveys.	No
Green-thighed Frog ( <i>Litoria brevipalmata</i> )	Land within 100 m of semi-permanent or ephemeral ponds or depressions containing leaf litter	Yes Semi-permanent and ephemeral ponds and depressions are present in the study area. Marginal habitat has been identified for this species in the study area.	No
<i>Maundia triglochinos</i>	Swamps or shallow fresh water on clay	Yes Potential habitat present, however not identified during targeted searches.	No
<i>Zannichellia palustris</i>	Land containing freshwater bodies	Yes Freshwater wetlands in the study area are potential habitat for this species, however the habitat is considered to be unsuitable and there are no records in the locality.	No
Black-necked Stork ( <i>Ephippiorhynchus asiaticus</i> )	Land within 40 m of freshwater or saline wetlands (eg saltmarsh, mangroves, mudflats, swamps, billabongs, floodplains, watercourse pools, wet heathland and/or farm dams)	Yes Freshwater wetlands are present in the study area, records in the central coast are related to considerably larger open wetlands in high condition	No
Broad-billed Sandpiper ( <i>Limicola falcinellus</i> )	Intertidal mudflats or sandflats within inlets, bays, harbours, estuaries, lagoons, ocean beaches and/or sandy spits	No Only freshwater wetlands are present with no tidal influence	No
Australasian Bittern ( <i>Botaurus poeciloptilus</i> )	Land east of Cessnock in Hunter CMA subregion	No Study area is outside of the Hunter CMA subregion; however suitable habitat for this species is present.	No
Stuttering Frog ( <i>Mixophyes balbus</i> )	Rainforest or tall open wet forest with understorey and/or leaf litter and within 100 m of streams	No Rainforest and tall open wet forest absent from the study area. Habitat is considered unsuitable for this species in the study area.	No
Brush-tailed Rock-wallaby ( <i>Petrogale penicillata</i> )	land within 1 km of rock outcrops or clifflines	No No rock outcrops or clifflines present	No
Littlejohn's Tree Frog ( <i>Litoria littlejohni</i> )	Land within 100 m of permanent rocky streams with thick fringing vegetation	No No permanent rocky creeks are present in the study area or adjacent to the site.	No
Red Helmet Orchid ( <i>Corybas dowlingii</i> )	Sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m	Yes Sheltered slopes are present at the northern end of the study area, south of the cemetery. However habitat is considered unsuitable for this species and it has not been previously recorded in the locality	No

Threatened Species	Feature	Presence in study area	Impacted?
Terek Sandpiper ( <i>Xenus cinereus</i> )	Mangroves and intertidal mudflats or sandflats within inlets, bays, harbours, estuaries, lagoons, ocean beaches and/or sandy spits	No Only freshwater wetlands are present with no tidal influence	No

#### 7.4.8 Threatened species

The threatened species survey results as entered into the BBCC are provided in Table 7-6 including species that were identified by habitat surrogates in the calculator. Note that the habitat loss for threatened fauna is shown as zero because ecosystem credits to be offset are considered to adequately compensate for the loss of habitat for threatened fauna species, in particular critical foraging habitat for the Grey-headed Flying-fox and important winter flowering food resources for other nectarivorous fauna impacted by the project.

Species credits will be assigned for *Melaleuca biconvexa* as this species is unable to withstand a loss in the CMA and is considered significantly impacted by the project. The number of individual *Melaleuca biconvexa* impacted was calculated using the direct and indirect impact areas multiplied by the density of mature stems (as determined by plot assessments) and taking into consideration a likely survival threshold (refer Section 5.4.1 for details on calculations). The number of individuals requiring offset equates to 2,575 (direct loss 2,153 + indirect loss 422).

Table 7-6 Threatened species survey results

Common Name	Scientific Name	Impacted by proposal	Identification method	Impact	Unit
Biconvex Paperbark	<i>Melaleuca biconvexa</i>	Yes	Survey	2,575	Individuals
Black Bittern	<i>Ixobrychus flavicollis</i>	No	Assumed	0.00	ha
Black-eyed Susan	<i>Tetratheca juncea</i>	No	Survey	0.00	individual
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	No	Assumed	0.00	ha
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	No	Survey	0.00	ha
Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>	No	Assumed	0.00	ha
Eastern Bentwing-bat	<i>Miniopterus schreibersii</i> subsp. <i>oceanensis</i>	No	Survey	0.00	ha
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	No	Survey	0.00	ha
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	No	Survey	0.00	ha
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	No	Survey	0.00	ha
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	No	Survey	0.00	ha
Eucalyptus parramattensis subsp. parramattensis population, Wyong and Lake Macquarie local government areas	<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> - endangered population	No	Survey	0.00	individual
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	No	Survey	0.00	ha
Golden-tipped Bat	<i>Kerivoula papuensis</i>	No	Survey	0.00	ha
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	No	Survey	0.00	ha
Green and Golden Bell Frog	<i>Litoria aurea</i>	No	Survey	0.00	ha
Green-thighed Frog	<i>Litoria brevipalmata</i>	No	Survey	0.00	ha
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	No	Survey	0.00	ha
Grove's Paperbark	<i>Melaleuca groveana</i>	No	Survey	0.00	individual
Koala	<i>Phascolarctos cinereus</i>	No	Survey	0.00	ha

Common Name	Scientific Name	Impacted by proposal	Identification method	Impact	Unit
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	No	Assumed	0.00	individual
Parma Wallaby	<i>Macropus parma</i>	No	Assumed	0.00	ha
Red-Helmet Orchid	<i>Corybas dowlingii</i>	No	Assumed	0.00	Individual
Red-backed Button-quail	<i>Turnix maculosus</i>	No	Assumed	0.00	ha
Regent Honeyeater	<i>Anthochaera phrygia</i>	No	Survey	0.00	ha
Rough Doubletail	<i>Diuris praecox</i>	No	Assumed	0.00	individual
Southern Myotis	<i>Myotis macropus</i>	No	Survey	0.00	ha
Stephens' Banded Snake	<i>Hoplocephalus stephensii</i>	No	Survey	0.00	ha
Tall Knotweed	<i>Persicaria elatior</i>	No	Survey	0.00	individual
Wallum Froglet	<i>Crinia tinnula</i>	No	Survey	0.00	ha
White-flowered Wax Plant	<i>Cynanchum elegans</i>	No	Survey	0.00	individual

#### 7.4.9 Credits required to offset impacts

BioBanking calculations in accordance with the RMS Offset Guideline and the SIS DGRs are required for impacts on threatened species and EECs impacted by the project. Offsets are not required for the other vegetation impacted by the project (i.e. vegetation zones 5 and 6 - HU782). This means that offsets are only required for Swamp Sclerophyll Forest, Freshwater Wetland (i.e. vegetation zones 1-4) and Melaleuca biconvexa. The ecosystem credits to be offset are considered to adequately compensate for the loss of habitat for threatened fauna species, in particular critical foraging habitat for the Grey-headed Flying-fox and important winter-flowering food resources for other nectarivorous fauna.

#### Ecosystem credits

A total of 79 ecosystem credits are required to adequately offset the impacts from the proposed upgrade as specified by the BBCC and input variables detailed above. The final credit report specifies four credit groups and these are summarised below in Table 7-7.

Table 7-7 Ecosystem credits required for the proposal

Veg Zone No.	Biometric Vegetation Type	Red Flag	Area (ha)	Ecosystem credits required
1	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	Yes	1.48	42
2	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	Yes	1.30	25
3	Typha rushland (HU951)	Yes	0.32	11
4	Typha rushland (HU951)	Yes	0.03	1
<b>TOTAL</b>				<b>79</b>

#### Species Credits

One species credit species has been identified as requiring offsetting comprising Melaleuca biconvexa, the number of species credits required is specified in Table 7-8.



Table 7-8 Species credits required for the proposal

Species	Red flag	Threatened species offset multiplier	Loss of habitat (ha) or individuals	Species credits required
Biconvex Paperbark ( <i>Melaleuca biconvexa</i> )	Yes	1.3	2,575 individuals	33,475

The offset strategy focuses on identifying offsets that contain a population of *Melaleuca biconvexa* and the endangered ecological communities (swamp sclerophyll forest and/or freshwater wetlands) and which would include potential habitat for threatened fauna species affected by the proposal as described above. Further details on the offset strategy are provided as Appendix E.

## 8. Assessment of significance of likely effect of proposed action

### 8.1 Flora

#### 8.1.1 Biconvex Paperbark (*Melaleuca biconvexa*)

*(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.*

*Melaleuca biconvexa* generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. The species flowers in summer (Harden 1991) and is likely to be pollinated by nectivorous animals (insects, birds and bats) as well as wind pollination over shorter distances. Capsules support tiny seeds which are shed soon after maturity and are locally dispersed around the parent plant resulting in limited dispersal, and there is possibly a dormancy factor for germination of seeds (Benson & McDougall 1998).

The species is known to re-sprout from rootstock in response to fire (Benson & McDougall 1998), and suckers grow from the base of plants and exposed roots in areas subject to soil disturbance or that are frequently inundated for extended periods forcing the plant to shoot from rootstock.

Threats to *Melaleuca biconvexa* have been identified as the direct clearing of plants for urban development as well as potential habitat, alterations to hydrology associated with changed surface and groundwater regimes and the introduction of polluted run-off.

The main impacts to the life cycle of *Melaleuca biconvexa* as a result of the proposal will be from direct removal of individuals. This would equate to around 2.61 hectares currently occupied by the species. Around 13.35 hectares has been identified as the local population taking into consideration all patches within 500 metres distance from each other that are surrounding the project footprint. The project would remove around 35 per cent of the local population and impact on the largest remaining patches, increasing fragmentation of the residual population. Seed dispersal for *Melaleuca biconvexa* is generally limited to the area surrounding the parent plant, with seeds not being well adapted for dispersal by wind, water or animals.

The reduction in the population and increased fragmentation as well as ongoing indirect impacts has potential to disrupt the life-cycle of remaining areas of the population. This would occur through decreased health and vigour and flowering and seed setting. The result would be a reduction in reproductive ability and recruitment as well as dispersal ability.

*(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.*

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

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

Not applicable

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

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

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

Not applicable

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

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

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

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

The main impacts *Melaleuca biconvexa* will be from direct removal of individuals. This species has been described in the NSW OEH Threatened Species Profile Database (TSPD) as a species that is unable to sustain loss within the Hunter-Central Rivers Catchment Management Authority region.

The likely loss of habitat for this species would equate to around 2.61 hectares. Around 13.35 hectares has been identified as the extent of the surrounding local population taking into consideration all patches within 500 metres distance from each other and surrounding the project footprint. The project would remove around 35 per cent of the local population and impact on the largest remaining patches, increasing fragmentation of the residual population.

Habitat for *Melaleuca biconvexa* in the study area is currently fragmented from existing infrastructure, residential and industrial development, and has fragmented the population east and west of the existing highway and adjoining roads. The road widening and upgrade will further fragment the population in this location. Although these barriers potentially affect seed dispersal and pollinator movements, it is likely that substantial cross pollination occurs across these barriers through wind pollination and animal pollinators (insects, birds, bats). Seed dispersal for *Melaleuca biconvexa* is generally limited to the area surrounding the parent plant, with seeds not being well adapted for dispersal by wind, water or animals.

There is also potential for indirect impacts to the remaining population particularly in areas adjoining the highway footprint, this may result in further loss of plants. Indirect impacts may occur as a result of increased weed invasion as well as from further modification of the hydrology regime (increased water levels) associated with increased run-off. This may lead to increased waterlogging within 10-20 metres of the edges of the freshwater wetlands. Soil waterlogging has potential to change the plant community structure and species composition, however there is likely to be some degree of tolerance to waterlogging by *Melaleuca biconvexa*. For example the density of suckers surrounding mature plants was very high in some locations of the study area at over 21,000 stems per hectare indicating high regenerative capacity within the population despite the obvious impacts from disturbance. Indeed impacts from altered hydrology, poor water quality and weed invasion are already evident throughout the *Melaleuca biconvexa* population which shows very high regenerative capacity and resilience.

These factors were considered in quantifying the indirect loss of plants. For plants that do not dieback there may be a reduction in health and consequently a reduced ability to reproduce. A conservative survival estimate has been determined based on 30 per cent of the trees in the indirect impact area expected to continue to survive as healthy trees able to reproduce. Of the remaining 70 per cent, a proportion of these may die and a proportion will survive in poor health and low ability to reproduce, making them vulnerable to other anthropogenic and stochastic disturbance events. In consideration of this impact threshold, a further 0.73 hectares is identified as a potential loss due to indirect impacts.

The species occurs through the Gosford and Wyong LGAs. It is an important population due to its size and status within public lands and environmental protection zones, which means there is less pressure from further development. The proposal would directly impact on a small area of the population mapped as part of the OEH Saving our Species conservation program to the south-east of the intersection of the Pacific Highway and The Ridgeway. This is one of the larger patches occurring in the locality and given the existing management actions being implemented and the relatively large size of the population within and surrounding this patch, it is considered viable and likely to survive over the long-term and important for genetic diversity in this locality.

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



Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for Biconvex Paperbark (*Melaleuca biconvexa*).

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

The proposal would directly impact on a small area of the population mapped as part of the OEH Saving our Species conservation program to the south-east of the intersection of the Pacific Highway and The Ridgeway. The proposal to remove individuals and place further indirect impacts on the population is not consistent with the recovery actions of the SOS priorities.

(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.

It is considered likely that the proposal may increase the following Key Threatening Processes associated with *Melaleuca biconvexa*:

- Invasion, establishment and spread of Lantana (*Lantana camara*).
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.
- Clearing of native vegetation.
- Infection of native plants by *Phytophthora cinnamomi*.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.
- Invasion and establishment of exotic vines and scramblers.
- Invasion of native plant communities by exotic perennial grasses.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Due to the invasion, establishment and spread of Lantana (*Lantana camara*) throughout the study area it is likely that any cleared habitats as a result of the proposal would be occupied in time by Lantana in addition to other environmental weeds such as vines and scramblers, escaped garden plants and exotic perennial grasses. Therefore it is recommended that a series of priority actions are implemented to mitigate the threat from environmental weeds.

The existing hydrology regime has been altered from previous surrounding developments and is a substantial existing threatening process which is directly affecting the distribution and abundance of the species in the study area with numerous drowned trees observed within and surrounding areas of freshwater wetland. The proposal will result in further modifications to the hydrology and is likely to result in further attrition of individuals surrounding areas of freshwater wetland. The proposal will result in modifications to the hydrology regime and will potentially cause further attrition of individuals surrounding areas of freshwater wetland.

Hygiene protocols will be implemented during construction to ensure no pathogens potentially harmful to native biodiversity are not introduced to the study area.

## Conclusion

The conclusion of the assessment is the proposal is likely to have a significant impact on this species. This is based on the magnitude of the direct impact (around thirty-five per cent of the population in the locality) and potential for long-term indirect impacts from altered hydrology, run-off of untreated pollutants into the remaining habitat. As well as the high likelihood of weed invasion into adjacent habitats influenced by the disturbance and edge effects.

The species has been identified under the Threatened Species Profile Database (TSPD) as a species that is unable to withstand further loss in the Hunter / Central Rivers CMA sub-region and the population at the site is considered viable in its current state given its size and extent, however the population is currently threatened by the existing hydrology regime which is likely to be resulting in attrition of individuals due to higher water levels

for longer durations in comparison to the original (pre-development) hydrology regime. The proposal will result in modifications to the hydrology regime and will potentially cause further attrition of individuals surrounding areas of freshwater wetland.

## 8.2 Fauna

### 8.2.1 Black Bittern (*Ixobrychus flavicollis*)

*(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 Black Bittern (*Ixobrychus flavicollis*) inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, this species may occur in flooded grassland, forest, woodland, rainforest and mangroves (Marchant & Higgins 1993). The Black Bittern forages on reptiles, fish and invertebrates, including dragonflies, shrimps and crayfish (Barker & Vestjens 1989). It generally feeds at dusk and at night. During the day, the Black Bittern roosts in trees or on the ground amongst dense reeds (Marchant & Higgins 1993).

The Black Bittern (*Ixobrychus flavicollis*) is generally solitary, but may occur in pairs during the breeding season, which is thought to be from December to March. Nests may be located on a branch overhanging water and consists of a bed of sticks and reeds on a base of larger sticks (Marchant & Higgins 1993). There is limited information regarding breeding. The clutch size is thought to be between three and five (Gilmore & Parnaby 1994) and both the male and female are involved in incubation and rearing of young (Marchant & Higgins 1993).

This species was not identified during surveys. Most records of the Black Bittern are more than 20 years old, however there are some recent records located to the north east on the edge of Chittaway Bay. The presence of a viable population using the site habitat has not been confirmed.

The proposal will result in the removal and disturbance of around 3.13 hectares of potential habitat for this species, which was calculated based on clearing of the open wetland areas and adjoining densely vegetated swamp forest habitat that provide potential shelter, refuge, breeding and foraging habitat. Potential habitat for the species in the study area is relatively small and up to 6.8 hectares is considered to occur on the site and in the properties surrounding the proposal. The proposal will remove approximately 25 per cent of the habitat available in this location, although around 5000 ha of similar habitat was calculated in a ten km radius of the site. The habitat in the study area is considered marginal for the species given the existing impacts from noise and lights and the low water quality, which would reduce the quality of the habitat for prey species.

All habitats being impacted are currently fragmented into smaller patches and it is unlikely that the small patches would sustain sedentary individuals. Therefore any use of the study area by Black Bitterns at present would require movement across roads, rail and urban development. The proposal will see widening of the existing road and not significantly alter the current degree of fragmentation. The proposal is unlikely to negatively impact the movements of the species.

On the basis of these conclusions, it is unlikely that the impacts would have an adverse impact on the life-cycle of the species in the locality.

*(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:*

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

N/A

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

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

The proposal will result in the removal and disturbance of around 3.13 hectares of potential habitat for this species, which was calculated based on clearing of the open wetland areas and adjoining densely vegetated swamp forest habitat that provide potential shelter, refuge, breeding and foraging habitat. Potential habitat for the species in the study area is relatively small and up to 6.8 hectares is considered to occur on the site and in the properties surrounding the proposal. The proposal will remove approximately 25 per cent of the habitat available in this location, although around 5000 ha of similar habitat was calculated in a ten km radius of the site. The habitat in the study area is not considered important, and in fact is likely marginal for the species given the existing impacts from noise and lights and the low water quality which would reduce the quality of the habitat for prey species.

All habitats being impacted are currently fragmented into smaller patches and it is unlikely that the small patches would sustain sedentary individuals. Therefore any use of the study area by Black Bitterns at present would require movement across roads, rail and urban development. The proposal will see widening of the existing road and not significantly alter the current degree of fragmentation. The proposal is unlikely to negatively impact the movements of the species.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Black Bittern.

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

A recovery plan does not exist for the Black Bittern. However, the following actions have been identified by the OEH for recovery of this species:

- Control of feral animals, in particular foxes and cats.
- Protect and manage habitat, including fencing of riparian vegetation to prevent trampling and grazing by cattle.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Black Bittern has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Black Bittern are largely not applicable to the proposal as they are



actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Black Bittern.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Black Bittern that will be increased by the proposal is clearing of native vegetation / habitat.

### **Conclusion**

Despite the apparent suitability of the wetland habitats in the study area, these habitats are possibly too small, isolated and disturbed for the Black Bittern due to the surrounding urban developments. This is combined with the constant noise, activity and light from traffic that would limit the value of the habitat for this species. The small patch size and level of inundation also makes these habitats potentially vulnerable to predators and largely unsuitable to the majority of wetland bird species.

It is unlikely that existing viable populations of the Black Bittern in the locality would be dependent on the habitats in the study area although may utilise the habitats on an infrequent basis. It is therefore considered unlikely that a local population of the Black Bittern are dependent on the habitat of the study area for their survival in the locality.

### 8.2.2 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.*

The Little Lorikeet (*Glossopsitta pusilla*) forages primarily in the canopy of open Eucalypt forest and woodland, yet also finds food in Angophora, Melaleuca 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. The Little Lorikeet feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards. This species is gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries (OEH, 2015).

The Little Lorikeet nests in treetops in close proximity to feeding areas if possible (though often distant), most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2-15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees are often chosen, including species like Allocasuarina. The nesting season extends from May to September, with eggs observed in July, nestlings from August to November and fledging occurring in December. In years when flowering is prolific (particularly White Box), the Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown (Courtney and Debus, 2006).

The proposal will remove potential food resources for this species which forages primarily in the canopy of open Eucalyptus forest and woodland. In particular, the proposal will involve impacts on up to 2.78 hectares of swamp forest dominated by *E.robusta* and Melaleuca species. During the winter surveys, the flowering of Swamp Mahogany was noted and numerous Rainbow Lorikeets were recorded on the site during the day and Grey-headed Flying-foxes at night, suggesting that wide-ranging nectarivorous fauna commonly visit the site in winter when this resource bottlenecks. The habitat to be removed represents a small area of potential foraging habitat. It is not likely to be critically important or unique to this species, based on the fact that it does not constitute important nesting habitat and that it is widespread surrounding the study area in similar low-lying areas. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Little Lorikeet.

Impacts to this impact will occur along the edges of the existing highway, although some larger trees will be removed. Similar swamp forest habitat is widespread in the study area and locality and will remain following the upgrade, such that the potential to visit the site will likely remain.

The Little Lorikeet is a wide-ranging species. Nomadic movements are common, influenced by season and food availability. Any use of the existing habitats in the study area would require movements across roads, rail and urban areas. This scenario would be the same following completion of the proposal. There will be minor impacts associated with the widening of the road through the removal of potential food resources, particularly winter flowering species.

The loss of winter-flowering food resources will contribute to the cumulative loss of food resources for this species throughout its range. The loss is relatively small and will occur in an area that is subject to high degree of fragmentation and disturbance. Food resources will remain in the study area outside of the upgrade footprint and the species could be reasonably expected to continue to visit the site, suggesting that the loss would not lead to local extinction.

Hollow trees suitable for nesting in the study area are very limited and habitat value in the study area for this species is likely limited to foraging resources. The proposal would have a short to medium term impact on a very small proportion of the available habitat for this species in the locality.

*(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:*

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

N/A

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

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

The proposal will remove potential food resources for this species which forages primarily in the canopy of open Eucalyptus forest and woodland. In particular, the proposal will involve impacts on up to 2.78 hectares of swamp forest dominated by *E.robusta* and *Melaleuca* species. During the winter surveys, the flowering of Swamp Mahogany was noted and numerous Rainbow Lorikeets were recorded on the site during the day and Grey-headed Flying-foxes at night, suggesting that wide-ranging nectivorous fauna commonly visit the site in winter. Impacts to this impact will occur along the edges of the existing highway, although some larger trees will be removed. Similar swamp forest habitat is widespread in the study area and locality and will remain following the upgrade, such that the potential to visit the site will likely remain.

The habitat to be removed represents a small area of potential habitat. It is not likely to be critically important or unique to this species, based on the fact that it does not constitute important nesting habitat and that it is widespread surrounding the study area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Little Lorikeet.

The Little Lorikeet is a wide-ranging species. Nomadic movements are common, influenced by season and food availability. Any use of the existing habitats in the study area would require movements across roads, rail and urban areas. This scenario would be the same following completion of the proposal. There will be minor impacts associated with the widening of the road through removal of food resources, particularly winter flowering plants.

Hollow trees suitable for nesting in the study area appear to be very limited and habitat in the study area is limited to foraging resources. The activity would not further isolate or fragment habitat due to the existing levels of fragmentation caused by the original construction of the highway and the ability of this species to fly large distances to access scattered resources.

The habitat to be removed is not likely to be important or unique to the assessed species, based on the fact that it does not constitute nesting habitat and that it is widespread surrounding the disturbance area. Swamp Mahogany (*E. robusta*), an important winter flowering resource for this species, however this eucalypt species is widespread throughout the locality. It would be highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Little Lorikeet.

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

A recovery plan does not exist for the Little Lorikeet. However, the following actions have been identified by the OEH for recovery of this species:

- Retain large old trees, especially those that are hollow-bearing.
- Ensure recruitment of trees into the mature age class so that there is not a lag period of decades between the death of old trees and hollow formation in younger trees.
- Protect large flowering Eucalyptus trees throughout the habitats frequented by this species.
- Manage remnant woodlands and forest for recovery of old-growth characteristics.
- Where natural tree recruitment is inadequate, replant local species to maintain foraging habitat and breeding sites.
- Reduce the abundance of feral Honeybees and limit the exploitation of nectar by domestic bees where resources are spatially or temporally sparse (e.g. in years of drought).
- Document nest sites and ensure their protection.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Little Lorikeet has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Little Lorikeet are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery 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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Little Lorikeet that will be increased by the proposal is clearing of native vegetation.

The major threats to the Little Lorikeet 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. The proposal will not result in the loss of roadside nest trees and the foraging habitat that will be removed is marginal.

## Conclusion

The habitat to be removed represents a small area of potential habitat in the form of winter-flowering blossom. It is not likely to be critically important or unique to this species and is widespread surrounding the study area. It is



highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Little Lorikeet.

### 8.2.3 Swift Parrot (*Lathamus discolor*)

(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 Swift Parrot (*Lathamus discolor*) is endemic to south-eastern Australia. It breeds only in Tasmania, and migrates to mainland Australia in autumn (Swift Parrot Recovery Team 2001), undertaking the longest migration of any parrot species in the world (Tzaros 2002). This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales. Until recently it was considered that the New South Wales wintering range was mostly on the western slopes region along the inland slopes of the Great Dividing Range, and some areas along the northern and southern coasts including the Sydney region. However, increasing evidence suggests that coastal plains forests from southern to northern New South Wales are also extremely important (Swift Parrot Recovery Team 2001).

The Swift Parrot (*Lathamus discolor*) feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Key habitats for the species on the coast and coastal plains of NSW include Spotted Gum (*Corymbia maculata*), Swamp Mahogany (*Eucalyptus robusta*), Red Bloodwood (*E. gummifera*) and Forest Red Gum (*E. tereticornis*) forests (Saunders 2002b; Saunders & Heinsohn 2008). These tree species provide foraging and roosting habitat for the species. In northern NSW and south-eastern Queensland, Narrow-leaved Red Ironbark (*E. crebra*), Forest Red Gum forests and Yellow Box forest are commonly utilized (Swift Parrot Recovery Team 2001). While on the western slopes Mugga Ironbark (*E. sideroxylon*) and Grey Box (*E. microcarpa*) woodlands are used (Saunders & Heinsohn 2008).

Breeding success of the Swift Parrot (*Lathamus discolor*) is strongly correlated with the intensity and extent of flowering of Tasmanian Blue Gums. The breeding season is from mid-September to late January. Birds begin to return to Tasmania from their mainland wintering range in early August (Swift Parrot Recovery Team 2001). Nesting starts in late September, however birds unpaired on arrival in Tasmania may not begin until November after finding mates (Brown 1989). Laying occurs during October and November and clutch size is three to five eggs. Fledging occurs from early December to late January, at approximately six weeks (Swift Parrot Recovery Team 2001).

The largest impact of the proposal on the Swift Parrot will be the removal of an important winter-flowering food resource, Swamp Mahogany (*E. robusta*). While the proposal will not impact any breeding habitat, the loss of potential feed trees would directly affect this species opportunity to feed in the area. The project will remove up to 2.78 hectares of swam sclerophyll forest containing Swamp Mahogany (*Eucalyptus robusta*).

The current potential for the species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal such that foraging, and movement life-cycle activities would not be significantly impacted. The proposal is unlikely to reduce the population size of the Swift Parrot or decrease the reproductive success of this 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:*

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

N/A

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

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

Potential habitat for the Swift Parrot within the study area is limited to foraging habitat. The presence of Swift Parrot in the NSW Central Coast has been reportedly associated with coastal lowlands and in particular the prolific flowering of Spotted Gum and Swamp Mahogany during winter months. The loss of swamp forest habitat in the study area will equate to around 2.78 hectares. In addition to this a further 0.71 hectares of moist forest will be cleared which contains mature eucalypts. The vegetation clearing will include mature swamp mahogany and thus contribute to the cumulative loss of foraging habitat for this species from the region.

There are no important movement corridors affected by the proposal. As this species moves nomadically in search of food resources it capable of moving across fragmented landscapes and its movements are unlikely to be impacted by the small scale vegetation clearing.

This amount of habitat removal is small when the amount of available foraging habitat in the locality is considered. Importantly, the proposal will not result in further fragmentation of habitat for the Swift Parrot. The patches of vegetation that will be impacted by the proposed works are already highly fragmented. This species is highly mobile and will freely fly long distances over open areas to move between habitats. The proposal will not affect the movement of the Swift Parrot between habitat patches.

The loss of feed trees would directly affect the species opportunity to feed in the area; however, the study area is not considered a critical area for this species. The *National Recovery Plan for the Swift Parrot* (Saunders & Tzaros 2011) identifies priority habitats as those which are used:

- For nesting.
- By large proportions of the Swift Parrot population.
- Repeatedly between seasons (site fidelity).
- For prolonged periods of time (site persistence).

The study area does not represent any of these, however the Swift Parrot is likely to utilise trees in the study area opportunistically for foraging. Extensive areas of suitable habitat occur elsewhere in the locality. The current potential for the species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be impacted.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Swift Parrot.

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

The *National Recovery Plan for the Swift Parrot* (Saunders & Tzaros 2011) identifies the following actions for recovery of this species:

- Identify the extent and quality of habitat.
- Manage and protect Swift Parrot habitat at the landscape scale.

- Monitor and manage the impact of collisions, competition and disease.
- Monitor population and habitat.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Swift Parrot has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Swift Parrot are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Swift Parrot.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Swift Parrot that will be increased by the proposal is clearing of native vegetation.

## **Conclusion**

The Swift Parrot will suffer a small reduction in extent of foraging habitat from the proposal. No important nesting trees will be impacted. The proposal is unlikely to reduce the population size of the Swift Parrot or decrease the reproductive success of this species. The proposal will not interfere with the recovery of the Swift Parrot. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to the Swift Parrot.



#### 8.2.4 Gang-gang Cockatoo (*Callocephalon fimbriatum*)

*(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 Gang-gang Cockatoo (*Callocephalon fimbriatum*) inhabits eucalypt open forests and woodlands with an *Acacia* understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. This species requires tree hollows for nesting and sometimes for roosting. Eucalypt trees and *Acacia* shrubs are used for foraging. Plantations of exotic pines are usually avoided.

The Gang-Gang Cockatoo (*Callocephalon fimbriatum*) nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. A clutch of usually two eggs is laid in spring to summer. Each pair has a single successful brood per year, though pairs may have a second attempt if the first attempt fails early in the season. The incubation period is about four weeks, the nestling period seven to eight weeks, and the post-fledging dependence period lasts at least four to six weeks.

As stated the Gang-gang Cockatoo inhabits eucalypt open forests and woodlands with an *Acacia* understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. This species requires tree hollows for nesting and sometimes for roosting. Eucalypt trees and *Acacia* shrubs are used for foraging. The species is unlikely to utilise the dominant dense swamp forest and wetland habitat in the study area and any use of the site would more likely be associated with the moist open forest at the northern end of the site. Impacts to this habitat equate to a small area of 0.72 ha along the existing edge of the highway. No hollow bearing trees were recorded in this area and the clearing is expected to have minimal impact on the potential habitat of the species.

The species moves widely in response the seasonal conditions and availability of food and is capable of moving across landscapes with fragmented woodlands and open forest. If the species does indeed currently use the site individuals would be required to cross roads rail and urban areas to access habitat. The proposal will not significantly increase the degree of fragmentation and is unlikely to affect the movements of the species.

There is a low potential that the proposal would adversely affect the life-cycle of the species to be impacted given the widespread occurrence of suitable foraging habitat.

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

N/A

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

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

N/A

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

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

As stated the Gang-gang Cockatoo inhabits eucalypt open forests and woodlands with an *Acacia* understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. This species requires tree hollows for nesting and sometimes for roosting. Eucalypt trees and *Acacia* shrubs are used for foraging. The species is unlikely to utilise the dominant dense swamp forest and wetland habitat in the study area and any use of the site would more likely be associated with the moist open forest at the northern end of the site. Impacts to this habitat equate to a small area of 0.72 ha along the existing edge of the highway. No hollow bearing trees were recorded in this area and the clearing is expected to have minimal impact on the potential habitat of the species.

The species moves widely in response the seasonal conditions and availability of food and is capable of moving across landscapes with fragmented woodlands and open forest. If the species does indeed currently use the site individuals would be required to cross roads rail and urban areas to access habitat. The proposal will not significantly increase the degree of fragmentation and is unlikely to affect the movements of the species.

No important large hollow-bearing trees will be impacted by the proposal and the habitats do not form part of an important movement corridor for this species. It is unlikely that the habitat would be considered important for populations in the locality.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Gang-gang Cockatoo.

*(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 the Gang-gang Cockatoo. The OEH has developed the following activities to assist in the conservation of this species:

- Ensure known breeding habitat is protected from wildfire and hazard reduction burns.
- Ensure that impacts to known or likely breeding and foraging habitat are avoided, mitigated or offset as part of development applications and approvals.
- Ensure that forestry management and planning practices avoid and minimises impacts to breeding and foraging habitat.
- Landholders undertaking private native forestry activities should adequately protect and buffer known or likely Gang-gang Cockatoo habitat.
- Conduct surveys and research on the locations of key breeding sites, and measure the breeding ecology and success of the Gang-gang Cockatoo.
- Identify key breeding and foraging habitat on private lands and work with landholders to secure and manage these areas, including the use of stewardship and incentive agreements.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. These species have been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Gang-gang Cockatoo are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will avoid removing roadside vegetation where possible. The proposal will not interfere with the recovery of the Gang-gang Cockatoo.

(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Gang-gang Cockatoo (*Callocephalon fimbriatum*) that will be increased by the proposal are clearing of native vegetation and removal of dead wood and dead trees.

### **Conclusion**

The Gang-gang Cockatoo (*Callocephalon fimbriatum*) will suffer a small reduction in extent of foraging habitat from the proposal. No important large hollow-bearing trees will be impacted by the proposal. The proposal is unlikely to reduce the population size of this species or decrease its reproductive success. The proposal will not interfere with the recovery of this species. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to the Gang-gang Cockatoo (*Callocephalon fimbriatum*).

### 8.2.5 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.*

The Powerful Owl (*Ninox strenua*) lives in forests and woodlands occurring in the coastal, escarpment, tablelands and western slopes environments of NSW (Kavanagh 2002). This species requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species (DEC, 2006). The Powerful Owl is a specialist predator of arboreal marsupials, particularly the Common Ringtail Possum in coastal forests and the Greater Glider in escarpment and tableland forests (Kavanagh, 1992). Common Ringtail Possum was confirmed in the study area and the Powerful Owl is considered to have potential to use the habitats for hunting.

The Powerful Owl nests in old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines, with hollows greater than 45 cm diameter and greater than 100 cm deep; surrounded by canopy trees and subcanopy or understorey trees or tall shrubs; lives as monogamous, sedentary life-long pairs in large permanent home ranges. Age at first breeding is two years in captivity, unknown in the wild but probably three or four years. Most (84%) pairs nest each year and most of those nesting (93 per cent) produce at least one young (Kavanagh 1997). Laying is strictly seasonal, occurring mainly in June (mid-May to mid-July). The clutch is one to two eggs; a single clutch is laid per year although, rarely, a replacement clutch may be laid if the first attempt fails early in the egg stage. The incubation period is five weeks. There are no data on egg success. Successful broods fledge one to two young. Young are altricial; the nestling period is two months; the breeding cycle occupies three months from laying to fledging. Juveniles are dependent for six to seven months post-fledging; thereafter they apparently survive either by remaining within the natal territory or by dispersing to other areas (DEC, 2006).

As the Powerful Owl is known to occupy fragmented and urban bushland remnants, there is a moderate to high likelihood that the habitats within the study area are utilised or have potential to be utilised by resident pairs in the locality. In addition, the Common Ringtail Possum was confirmed in the study area and this is an important prey species. The proposal would remove up to 4.37 hectares of potential habitat which includes the swamp forests, moist forest and dense weed infested gully. The swamp forest and riparian gully may be used for roosting. No large tree hollows are present and nesting habitat is not represented on site.

The species occupies large territories between 500-1000 hectares, and is capable of moving across modified landscapes. The widening of the cutting and clearing of habitat along the edge of the existing road will not impact the movements of this species.

The current potential for the species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be impacted. The proposal is unlikely to reduce the population size of the Powerful Owl or decrease the reproductive success of this 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:*

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

N/A

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

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

The proposal would remove up to 4.37 hectares of potential habitat which includes the swamp forests, moist forest and dense weed infested gully. The swamp forest and riparian gully may be used for roosting. No large tree hollows are present and nesting habitat is not represented on site. The habitats are not considered important for breeding although may constitute an important area of habitat for hunting / food resources.

The proposal would not increase fragmentation or isolate habitat for this species.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Powerful Owl (*Ninox strenua*).

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

The NSW Recovery Plan for the Large Forest Owls (Department of Environment and Conservation 2006) identifies the following objectives for recovery of the Powerful Owl:

- Model and map owl habitat and validate with surveys.
- Monitor owl population parameters.
- Audit forestry prescriptions.
- Manage and protect habitat off reserves and state forests.
- Undertake research.
- Increase community awareness and involvement in owl conservation.
- Provide organisational support and integration.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Powerful Owl has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Powerful Owl are largely not applicable to the proposal as they are

actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Powerful Owl.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Powerful Owl that will be increased by the proposal is clearing of native vegetation. However, clearing in this case is of marginal foraging habitat only.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management would be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

### **Conclusion**

The Powerful Owl will suffer a small reduction in extent of marginal foraging habitat from the proposal. No important large hollow-bearing trees will be impacted by the proposal. The proposal is unlikely to reduce the population size of this species or decrease its reproductive success. The proposal will not interfere with the recovery of this species. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to the Powerful Owl.

### 8.2.6 Regent Honeyeater (*Anthochaera phrygia*)

(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 Regent Honeyeater (*Anthochaera phrygia*) mostly occurs in dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, for example along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing River Sheoak (*Casuarina cunninghamiana*), and with Needle-leaf Mistletoe (*Amyema cambagei*), are also important for feeding and breeding. Regent Honeyeaters usually nest in the canopy of forests or woodlands, and in the crowns of tall trees, mostly eucalypts (Oliver, 1998).

There are three known key breeding areas, two of them in NSW – Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria (root system). An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DoE, 2015). Two or three eggs are laid and incubated by the female for 12-15 days (Oliver *et al.*, 1998). Nestlings are brooded and fed by both parents at an average rate of 23 times per hour and fledge after 16 days. The fledgelings, which are fed by both adults, become independent approximately three to four weeks after leaving the nest (Oliver, 1998). Breeding can occur within the first year (DoE, 2015).

The study area contains marginal foraging habitat for the Regent Honeyeater (*Lathamus discolor*) in the form of nectar producing shrubs and trees, and other areas that may provide an insectivorous diet. The study area is unlikely to provide suitable nesting habitat as nesting locations are re-used and have been well-documented (Menkhorst *et al.*, 1999). The Regent Honeyeater Recovery Plan highlights the importance of Swamp Mahogany forests in coastal NSW as refuge areas when conditions on the inland slopes are unfavourable. The loss of swamp forest habitat in the study area will equate to around 2.78 hectares. In addition to this a further 0.71 hectares of moist forest will be cleared which contains mature eucalypts. The vegetation clearing will include mature swamp mahogany and thus contribute to the cumulative loss of foraging habitat for this species from the region.

There are no important movement corridors affected by the proposal. As this species moves nomadically in search of food resources it is capable of moving across fragmented landscapes and its movements are unlikely to be impacted by the small scale vegetation clearing.

The current potential for the species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal such that foraging, movement and other life-cycle attributes would not be impacted. The proposal is unlikely to reduce the population size of the Regent Honeyeater or decrease the reproductive success of this 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:*

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

N/A

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

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

The presence of Regent Honeyeaters in the NSW Central Coast has been reportedly associated with coastal lowlands and in particular the prolific flowering of Spotted Gum and Swamp Mahogany during winter months. The loss of swamp forest habitat in the study area will equate to around 2.78 hectares. In addition to this a further 0.71 hectares of moist forest will be cleared which contains mature eucalypts. The vegetation clearing will include mature swamp mahogany and thus contribute to the cumulative loss of foraging habitat for this species from the region.

There are no important movement corridors affected by the proposal. As this species moves nomadically in search of food resources it is capable of moving across fragmented landscapes and its movements are unlikely to be impacted by the small scale vegetation clearing. Importantly, the proposal will not result in fragmentation of habitat for the Regent Honeyeater. This species is highly mobile and will freely fly long distances over open areas to move between habitats. The proposal will not affect the movement of the Regent Honeyeater between habitat patches and will not isolate or fragment habitat for the species.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for Regent Honeyeater.

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

The *Regent Honeyeater (Xanthomyza phrygia) Recovery Plan 1999-2003* (Menkhorst *et al.*, 1999) outlines recovery objectives and actions for the species including:

1. Effectively organise and administer the recovery effort to ensure that recovery plan objectives are met.
2. Maintain and enhance the value of Regent Honeyeater habitat at the key sites and throughout the former range, by active participation in land-use planning processes and by active vegetation rehabilitation at strategic sites.
3. Monitor trends in the Regent Honeyeater population size and dispersion across its range to allow assessment of the efficacy of management actions.
4. Facilitate research on strategic questions which will enhance the capacity to achieve the long-term objectives. In particular, determine the whereabouts of Regent Honeyeaters during the nonbreeding season and during breeding season absences from known sites. Identify important sites and habitat requirements at these times.
5. Maintain and increase community awareness, understanding and involvement in the recovery effort.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Regent Honeyeater has been assigned to the Site-managed species management stream under the OEH Saving our Species program. The Office of Environment and Heritage has established four management sites where conservation activities need to take place to ensure the conservation of this species, including Bundarra – Barraba, Cessnock, Lithgow and Mosman.



The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Regent Honeyeater are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Regent Honeyeater.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTPs relevant to the Regent Honeyeater that will be increased by the proposal are clearing of native vegetation and removal of dead wood and dead trees.

### **Conclusion**

The Regent Honeyeater will suffer a small reduction in extent of potential foraging habitat from the proposal. No breeding habitat will be impacted. The importance of the habitat patch is not known, however the species is known to regularly use coastal forest of Swamp Mahogany. The proposal is unlikely to reduce the population size of this species or decrease its reproductive success. The proposal will not interfere with the recovery of the Regent Honeyeater. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to the Regent Honeyeater.

### 8.2.7 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.*

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW (associated with flowering Spotted Gum *Corymbia maculata*) and on the northwest slopes (generally associated with flowering White Box *Eucalyptus albens* or Mugga Ironbark *E. sideroxylon*) (NSW DECCW 2010). The Grey-headed Flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located within 20 km of a regular food source and near water, such as lakes, rivers or the coast (van der Ree *et al.* 2005).

Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young. Mating occurs in early autumn, after which time the larger camps begin to break up, reforming in late spring/early summer, as food resources become more abundant (Hall & Richards 2000). Males and females segregate in October when females usually give birth. Following six months of gestation, females bear a single young each year. Lactation usually begins in October and continues for three to four months or sometimes longer (Nelson 1965). For a period of four to five weeks after giving birth, the mother carries her single young with her to feeding sites. Once the young are completely furred, they are left in maternal camps and continue to be nursed until they are independent after around 12 weeks (Hall & Richards 2000). During this nursery phase, males rejoin the females for courting with pair bonds being formed (Hall & Richards 2000). Generally, females do not reach full sexual maturity until three years of age (Martin 2000).

There are no roost camps located in the study area and at the time of this assessment the proposal would not directly impact on any known breeding / maternity site. Known roost camps within 50 kilometres of the study area include Wingello Creek (three kilometres south), Matchham (eight kilometres south east), Jilliby (17 kilometres north), Toukley (25 kilometres north east), Morrisset (35 kilometres north) and Martinsville (47 kilometres north). As such, the impacts of the proposal to the Grey-headed Flying-fox will be limited to loss of feeding habitat caused by direct clearing or damage to native vegetation during the construction phase.

The Grey-headed Flying-fox was identified on five occasions in the proposal area with each observation associated with flowering Swamp Mahogany (*Eucalyptus robusta*). Swamp Mahogany has been identified as an important winter food source and critical foraging habitat for the species (DECCW 2009). Therefore the presence of Swamp Mahogany on the site represents critical foraging habitat for the species. While there are no roost camps on the site as discussed the swamp sclerophyll habitat in the study area is expected to provide regionally important foraging habitat for the Grey-headed Flying-fox. The proposal will remove up to 3.45 hectares of important foraging habitat.

The species is capable of large movements and adapted to crossing fragmented landscapes. The proposal will not affect the movement of the species.

The draft recovery plan for the Grey-headed Flying-fox (DECCW 2009) identifies critical foraging habitat for this species. One of the criteria is if the area is known to support populations of greater than 30,000 individuals within a 50 kilometre radius of the site. Considering the presence of numerous camps within a 50 kilometre radius, habitats in the study area are likely to be classed as critical foraging habitat. Additionally Swamp Mahogany (*E. robusta*) is relatively common and is a known food source during winter and spring. The large majority of foraging habitat for this species will be retained within the study area.

Considering the above factors the proposal is unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this 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:*

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

N/A

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

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

The Grey-headed Flying-fox was identified on five occasions in the proposal area with each observation associated with flowering Swamp Mahogany (*Eucalyptus robusta*). Swamp Mahogany has been identified as an important winter food source and critical foraging habitat for the species (DECCW 2009). Therefore the presence of Swamp Mahogany on the site represents critical foraging habitat for the species. While there are no roost camps on the site, the nearest known roost site is at 3.0 km south of the study area, the swamp sclerophyll habitat in the study area is expected to provide regionally important foraging habitat for the Grey-headed Flying-fox. The proposal will remove up to 2.78 hectares of important winter-flowering foraging habitat plus 0.71 hectares of moist Eucalypt forest which may also be used for foraging. There will be no impact to a known roosting camp.

The proposal will not fragment habitat for this species. The species is capable of large movements and adapted to crossing fragmented landscapes. The proposal will not affect the movement of the species.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Grey-headed Flying-fox (*Pteropus poliocephalus*).

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

The *Draft National Recovery Plan for the Grey-headed Flying-fox* (Department of Environment, Climate Change and Water NSW. 2009) outlines the following actions:

- Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes across their range.
- Enhance winter and spring foraging habitat for Grey-headed Flying-foxes.
- Identify, protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes.
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture.
- Provide information and advice to managers, community groups and members of the public that are involved with controversial flying-fox camps.
- Produce and circulate educational resources to improve public attitudes toward Grey-headed Flying-foxes, promote the recovery program to the wider community and encourage participation in recovery actions.
- Monitor population trends for the Grey-headed Flying-fox.

- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts.
- Oversee a program of research to improve knowledge of the demographics and population structure of the Grey-headed Flying-fox.
- Maintain a National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Grey-headed Flying-fox has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Grey-headed Flying-fox are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Grey-headed Flying-fox.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Grey-headed Flying-fox that will be increased by the proposal is clearing of native vegetation. The main threats to the Grey-headed Flying-fox include:

- Loss and disturbance of roosting sites.
- Unregulated shooting.
- Electrocution on powerlines, entanglement in netting and on barbed-wire.
- Competition with Black Flying-foxes.
- Negative public attitudes and conflict with humans.
- Impacts from climate change.
- Disease.

The proposal will not increase any of the above threats.

## **Conclusion**

The Grey-headed Flying-fox will suffer a small reduction in extent of suitable foraging habitat from the proposal. No camps or other important habitat will be impacted. The proposal is unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this species. The proposal will not interfere with the recovery of the Grey-headed Flying-fox and will not contribute to the key threats to this species. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to the Grey-headed Flying-fox.



### 8.2.8 Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

(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 Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) appears to prefer wet habitats, particularly riparian or high rainfall areas, with large trees greater than 20 metres tall (Menkhorst and Lumsden, 1995). It may be more common at high elevations (Phillips, 1995), though it has been recorded between sea level and 1500 metres in Victoria (Menkhorst and Lumsden, 1995). It usually roosts in hollows in Eucalyptus, though it has been recorded in caves and old buildings. It may hibernate over winter and has been known to travel at least twelve kilometres from its roost site while foraging. It hunts mostly in the upper canopy for moths, beetles, weevils, flies and ants (Churchill 1998).

Relatively little is known about the biology of this species (Strahan, 1995). Consistent with other vespertilionids, males produce sperm in late summer and store this in the epididymis over the colder period. Females are pregnant during late spring and early summer and lactating in mid-January (Strahan, 1995).

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal and the proposal is not expected to significantly impact on the roosting activities of the species.

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality. The impact is a minimal reduction in habitat for prey, particularly given that edge areas will be cleared, and large expanses of open water and swamp forest will remain in this location.

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal. The proposal is unlikely to impact on the movements of the species.

The impact is on the potential habitat of insect prey and some potential roosting habitat for the Eastern False Pipistrelle. The proposal would have a short to medium term impact on a very small proportion of the available habitat for Eastern False Pipistrelle in the locality. Similar foraging attributes for the Eastern False Pipistrelle would remain following completion of the proposal with only slight modification. The small number of small hollows is unlikely to represent an important roosting resource for this species. Considering the small potential impact and extensive areas of foraging habitat surrounding the proposal area there would be negligible impact to this 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:*

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

N/A

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

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

The impact is on the potential habitat of insect prey and some potential roosting habitat for the Eastern False Pipistrelle. Up to 4.7 hectares of forest and wetland will be removed which represents potential foraging habitat for this species. The habitat to be impacted is unlikely to be critically important for the species and similar habitat types and condition are widespread in this location and wider locality.

The proposed activity is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal and habitat will not be isolated for this highly mobile species.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*).

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

Whilst no recovery plan has been prepared for the Eastern False Pipistrelle, there is an *Action Plan for Australian Bats* (Environment Australia 1999) and a list of Priority Action Statements for threatened microbats provided by the OEH under the TSC Act. The aims and objectives of these plans include the protection and conservation of land and habitat considered important for life-cycle activities including roosting, foraging and breeding.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Eastern False Pipistrelle has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Eastern False Pipistrelle are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Eastern False Pipistrelle.

(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Eastern False Pipistrelle that will be increased by the proposal is clearing of native vegetation and loss of hollow-bearing trees.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management would be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

## **Conclusion**

The habitat to be removed is not likely to be important or unique to the Eastern False Pipistrelle, based on the fact that it is unlikely to constitute an important roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Eastern False Pipistrelle.

### 8.2.9 Eastern Freetail-bat (*Mormopterus norfolkensis*)

*(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 Eastern Freetail-bat (*Mormopterus norfolkensis*) is a poorly understood species, but it seems to be restricted to east of the Great Dividing Range between approximately Brisbane (Queensland) and Eden (New South Wales) (Duncan *et al.*, 1999; Parnaby 1992). Habitat preferences are not well understood, but the species appears to favour dry eucalypt forest and woodland, though it has also been captured in rainforest and wet sclerophyll forest (Churchill, 1998). It usually roosts in tree hollows (Gilmore and Parnaby, 1994), though it has been recorded in the roof of a hut and under the metal caps of telegraph poles (Churchill, 1998).

Little is known of the Eastern Freetail-bat reproductive cycle, however the capture of a number of females and no males at one site suggests that the sexes separate at certain times of the year, perhaps for birth and raising of young (Strahan, 1995).

Up to 4.7 hectares of forest and wetland habitat will be removed which comprises potential foraging habitat for this species, tree hollows are very scarce within the road footprint. Similar habitat types and condition are widespread in this location and wider locality. The proposal is not expected to have an adverse impact on the breeding, roosting or foraging life-cycle activities 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:*

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

N/A

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

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

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality.

The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting, although these occur outside the road footprint. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.



The habitat to be removed is not likely to be important or unique to the Eastern Freetail-bat, based on the fact that it will not impact a large area roosting habitat and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Eastern Freetail-bat (*Mormopterus norfolkensis*).

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

Whilst no recovery plan has been prepared for the Eastern Freetail-bat, there is an *Action Plan for Australian Bats* (Environment Australia 1999) and a list of Priority Action Statements for threatened microbats provided by the OEH under the TSC Act. The aims and objectives of these plans include the protection and conservation of land and habitat considered important for life-cycle activities including roosting, foraging and breeding.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Eastern Freetail-bat has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Eastern Freetail-bat are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Eastern Freetail-bat.

(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Eastern Freetail-bat that will be increased by the proposal is clearing of native vegetation and loss of hollow-bearing trees.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management would be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

## Conclusion

The habitat to be removed is not likely to be important or unique to the Eastern Freetail-bat, based on the fact that it is unlikely to constitute an important roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Eastern Freetail-bat.

**8.2.10 Greater Broad-nosed Bat (*Scoteanax rueppellii*)**

*(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 open nature of eucalypt woodlands and forests suit the Greater Broad-nosed Bats (*Scoteanax rueppellii*) direct flight pattern and the more cluttered environments of the wetter forests are overcome by utilising natural and human-made opening in the forest. Creeks and small rivers are favoured corridors where it hawks backwards and forwards for beetles and other large, slow-flying insects; this species has been known to eat other bat species (Strahan, 1995).

Little is known of the reproductive cycle of the Greater Broad-nosed Bat (*Scoteanax rueppellii*), however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young. Usually roosting in tree hollows, it has also been found in roof spaces of old buildings (Strahan, 1995).

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting, although these occur outside of the proposal footprint. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.

The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal. The proposed activity is not expected to impact the movement activities of the species due to the already existing fragmented nature and high degree of human activity.

The impact is on the potential habitat of insect prey and some minor potential roosting habitat for the Greater Broad-nosed Bat. The proposal would have a short to medium term impact on a very small proportion of the available habitat for Greater Broad-nosed Bat in the locality. Similar foraging attributes for the Greater Broad-nosed Bat would remain following completion of the proposal with only slight modification. The small number of hollows is unlikely to represent an important roosting resource for this species. Considering the small potential impact and extensive areas of foraging habitat surrounding the proposal area there would be negligible impact to the life-cycle activities 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:*

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

N/A

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

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

Up to 4.7 hectares of forest and wetland will be removed which comprises potential foraging habitat for this species. Similar habitat types and condition are widespread in this location and wider locality.

The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal. Area of habitat are already isolated in the study area, however they would be accessible by this highly mobile species.

The Greater Broad-nosed Bat is unlikely to be reliant on the habitat from the proposal area for roosting or breeding life-cycle events. The habitat to be removed is not likely to be important or unique to the Greater Broad-nosed Bat, based on the fact that it will not impact a large area roosting habitat and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Greater Broad-nosed Bats (*Scoteanax rueppellii*).

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

Whilst no recovery plan has been prepared for the Greater Broad-nosed Bat, there is an *Action Plan for Australian Bats* (Environment Australia 1999) and a list of Priority Action Statements for threatened microbats provided by the OEH under the TSC Act. The aims and objectives of these plans include the protection and conservation of land and habitat considered important for life-cycle activities including roosting, foraging and breeding.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Greater Broad-nosed Bath has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Greater Broad-nosed Bat are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Greater Broad-nosed Bat.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Greater Broad-nosed Bat that will be increased by the proposal is clearing of native vegetation and loss of hollow-bearing trees.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management would be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

### **Conclusion**

The habitat to be removed is not likely to be important or unique to the Greater Broad-nosed Bat, based on the fact that it is unlikely to constitute an important roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Greater Broad-nosed Bat.



**8.2.11 Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)**

*(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 Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory (Strahan, 1995).

Breeding receptivity in the yellow-bellied sheath-tailed bat begins in August when the right uterine horn increases in diameter, achieving maximum size in November. A single offspring is produced between December and March, with mammary glands regressing by the end of May (Chimimba and Kitchener, 1987; Strahan, 1995). Little more is documented about the reproductive ecology of this species.

The species requires tree hollows for roosting and breeding, tree hollows are in very low abundance in this location due to the dominance of Swamp Mahogany and large paperbarks which do not appear to form hollow cavities readily. This is evidenced by the number of mature trees present without hollows. Some dead trees are present in the large open wetland on the south side of The Ridgeway and these may comprise hollows and cracks suitable for bat roosting, these trees occur outside the proposal footprint. It is possible that roosting opportunities are present in areas to be cleared, although they are likely to be minimal.

The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal and will not impact on the movements of the species.

The impact is on the potential habitat of insect prey and some potential roosting habitat for the Yellow-bellied Sheathtail-bat. The proposal would have a short to medium term impact on a very small proportion of the available habitat for Yellow-bellied Sheathtail-bat in the locality. Similar foraging attributes for the Yellow-bellied Sheathtail-bat would remain following completion of the proposal with only slight modification. The small number of small hollows is unlikely to represent an important roosting resource for this species. Considering the small potential impact and extensive areas of foraging habitat surrounding the proposal area there would be negligible impact to this 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:*

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

N/A

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

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

The proposal will result in the removal of approximately 4.7 hectares of potential foraging habitat for the Yellow-bellied Sheathtail-bat. The Yellow-bellied Sheathtail-bat is unlikely to be reliant on the habitat from the proposal area for roosting or breeding life-cycle events. Site usage for foraging purposes is expected to occur, but would be very minor. A small area of the proposal area may offer roosting opportunities. Foraging opportunities for the Yellow-bellied Sheathtail-bat would remain following completion of the proposed activities and the activity would not isolate or fragment habitat due to the existing state of habitat in the study area and the fact that bats can fly large distances to access scattered resources.

The habitat to be removed is not likely to be important or unique to the Yellow-bellied Sheathtail-bat, based on the fact that it will not impact a large area of potential roosting habitat and that similar habitats are widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

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

Whilst no recovery plan has been prepared for the Yellow-bellied Sheathtail-bat, there is an *Action Plan for Australian Bats* (Environment Australia 1999) and a list of Priority Action Statements for threatened microbats provided by the OEH under the TSC Act. The aims and objectives of these plans include the protection and conservation of land and habitat considered important for life-cycle activities including roosting, foraging and breeding.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Greater Broad-nosed Bat has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Yellow-bellied Sheathtail-bat are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Yellow-bellied Sheathtail-bat.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Yellow-bellied Sheathtail-bat that will be increased by the proposal is clearing of native vegetation and loss of hollow-bearing trees.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management would be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

### **Conclusion**

The habitat to be removed is not likely to be important or unique to the Yellow-bellied Sheath-tail-bat, based on the fact that it is unlikely to constitute an important roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Yellow-bellied Sheath-tail-bat.

### 8.2.12 Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)

(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 Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) species has been recorded from most environments within the Greater Southern Sydney Region including: creeklines within semi-urban areas, above farm dams in cleared country, in sandstone woodland and in rainforest gullies. It utilises a wide variety of habitats where it usually roosts in caves, though it has been known to use mines, bridges and road culverts (Churchill 1998). It is a fast flying species and has been known to travel up to 65 kilometres in a night (Dwyer 1966). Though individuals often use numerous roosts, they congregate *en masse* in a small number of caves to breed and hibernate (Churchill 1998). Typically it is found in well-timbered valleys where it forages, above the tree canopy, on small insects (Strahan, 1995).

With the onset of spring, adult females move to specific nursery caves that provide high temperature and humidity throughout the year or, in the southern part of the range, have an internal conformation that retains air that has been warmed by the bats' activities. In north-eastern NSW, mating and fertilisation occur from May to June, prior to hibernation. A single young is born to each female, usually in December. In a nursery cave, up to 3000 young bats per square metre are nursed and reared to independence. Nursery colonies disband between February and March, adults and juveniles going separate ways. Sexual maturity is reached in the second year of life and longevity may be in excess of 17 years (Strahan, 1995).

There are no caves within the study area or project footprint that may be used by this species for roosting or breeding life-cycle activities. Two small culverts occur under the existing highway that are heavily overgrown and silted and generally flooded. They present very poor opportunities for roosting bats and are not expected to be important for this species. There was no evidence of bats using these culverts from an inspection with spotlights. The habitat in the study area could potentially be used for hunting life-cycle activities by this species, however any hunting activity would include utilising forest and cleared land in this location and likely to include movements across the highway, rail line and urban areas. Up to 4.7 hectares of forest and wetland habitat would be cleared and this activity may temporarily impact on the habitat of prey species in the locality.

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the life-cycle movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.

The impact is on the potential habitat of insect prey for the Eastern Bentwing-bat. The proposal would have a short to medium term impact on a very small proportion of the available habitat for Eastern Bentwing-bats in the locality. Similar foraging attributes for the Eastern Bentwing-bat would remain following completion of the proposal with only slight modification. Considering the small potential impact and extensive areas of foraging habitat surrounding the proposal area there would be negligible impact to this 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:*

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

N/A



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

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

There are no potential cave-roosts for this species in the study area. Two small culverts occur under the existing highway that are heavily overgrown and silted and provide very poor opportunities for roosting bats. These culverts will not be removed for construction. The habitat in the study area could potentially be used for hunting by this species, however any hunting activity would include utilising forest and cleared land in this location and likely to include movements across the highway, rail line and urban areas. Up to 4.7 hectares of forest and wetland habitat would be cleared and this activity may temporarily impact on the habitat of prey species in the locality and foraging activity.

The proposal will increase fragmentation of habitat in the locality however is not likely to impact on the movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal

The habitat to be removed is not likely to be important or unique to the Eastern Bentwing-bat, based on the fact that it does not constitute a roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*).

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

Whilst no recovery plan has been prepared for the Eastern Bentwing-bat, there is an *Action Plan for Australian Bats* (Environment Australia 1999) and a list of Priority Action Statements for threatened microbats provided by the OEH under the TSC Act. The aims and objectives of these plans include the protection and conservation of land and habitat considered important for life-cycle activities including roosting, foraging and breeding.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Eastern Bentwing-bat has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Eastern Bentwing-bat are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Eastern Bentwing-bat.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed

KTPs under the TSC Act, the only KTP relevant to the Eastern Bentwing-bat that will be increased by the proposal is clearing of native vegetation.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management should be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

### **Conclusion**

The habitat to be removed is not likely to be important or unique to Eastern Bentwing-bat, based on the fact that it does not constitute a roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Eastern Bentwing-bat.

### 8.2.13 Little Bent-wing Bat (*Miniopterus australis*)

(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 Little Bentwing-bat (*Miniopterus australis*) inhabits moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters (Strahan, 1995).

In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (*Miniopterus schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young. Males are sexually active during winter, copulatory activity occurs through late July and August, and fertilisation takes place in the latter month. Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer. In Australia, only five nursery sites have been reported (Strahan, 1995).

There are no caves in the study area or project footprint that may be used by this species for roosting or breeding life-cycle events. Two small culverts occur under the existing highway that are heavily overgrown and silted and generally flooded. They present very poor opportunities for roosting bats and are not expected to be used or important for this species. These pipes were filled with water at the time of the survey and considered unsuitable for the Little Bentwing-bat. There was no evidence of bats using these culverts from an inspection with spotlights. The habitat in the study area could potentially be used for hunting life-cycle events by this species, however any hunting activity would include utilising forest and cleared land in this location and likely to include movements across the highway, rail line and urban areas. Up to 4.7 hectares of forest and wetland habitat would be cleared and this activity may temporarily impact on the habitat of prey species in the locality.

There are no major corridors in the proposal area and the proposed activity is not likely to impact on the life-cycle movements of the species which is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal.

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

N/A

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

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

N/A

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

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

There are no caves in the study area or project footprint that may be used by this species for roosting or breeding life-cycle events. Up to 4.7 hectares of potential foraging habitat will be removed. Similar habitat types and condition are widespread in this location and wider locality.

The species is not dependent on continuous forest for movements. The habitats in the study area are already heavily fragmented and the proposal will involve widening of the existing highway and so further fragmentation will be minimal and habitat will not be isolated for this highly mobile species.

The Little Bentwing-bat would not be reliant on the habitat from the proposal area for roosting or breeding life-cycle events. Site usage for foraging purposes is expected to occur, but would be very minor. The habitat to be removed is not likely to be important or unique to the Little Bentwing-bat, based on the fact that it does not constitute a roosting site and that it is widespread surrounding the disturbance area. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Little Bentwing-bat (*Miniopterus australis*).

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

Whilst no recovery plan has been prepared for the Little Bentwing-bat, there is an *Action Plan for Australian Bats* (Environment Australia 1999) and a list of Priority Action Statements for threatened microbats provided by the OEH under the TSC Act. The aims and objectives of these plans include the protection and conservation of land and habitat considered important for life-cycle activities including roosting, foraging and breeding.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. OEH is currently developing a targeted approach for managing threatened species. The Little Bentwing-bat has been assigned to the Landscape species management stream under the OEH Saving our Species program.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Little Bentwing-bat are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal will not interfere with the recovery of the Little Bentwing-bat.

*(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.*

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Little Bentwing-bat that will be increased by the proposal is clearing of native vegetation.



There are limited areas of dead wood on the ground and no significant dead trees which provide habitat were recorded.

The proposal could potentially involve the listed key threatening processes for the invasion of native vegetation by *Lantana camara*, exotic vines and scramblers, escaped garden plants and exotic perennial grasses. Weed species are currently in high abundance within the study area including in threatened ecological communities. Weed management should be implemented during construction to limit the spread of exotic weed species, including appropriate disposal of exotic vegetative material and propagules.

### **Conclusion**

The habitat to be removed is not likely to be important or unique to the Little Bentwing-bat, based on the fact that it does not constitute a roosting or breeding site and that it is widespread surrounding the disturbance area suggesting that foraging movements are also widespread. It is highly likely that foraging activity would continue at the site and surrounding areas following construction over the medium to long-term and the potential impacts of the proposal are not considered significant for the Little Bentwing-bat.

### 8.3 Threatened ecological communities

#### 8.3.1 Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

*(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.*

No consideration under this part of the assessment is required.

*(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.*

No consideration under this part of the assessment is required.

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

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

The community has generally been modified and artificially created as a result of surrounding urban development and the associated altered hydrology. It is likely that the community has expanded following the development of the existing infrastructure (road, rail, fill) due to altered hydrology regimes increasing the area of inundation and creating a more permanent flooding regime in parts of the former swamp forest community. This is evidenced by tree dieback and altered floristic structure in edge areas. This current scenario of more permanent inundation of water in low-lying areas is expected to continue post-construction and there will be no draining of the freshwater wetlands as a result of the proposal, such as the wetlands are expected to survive in the long-terms with no risk of local extinction.

The predicted impacts to this community are minor and affect mainly the disturbed edge habitats of wetland areas supporting a mix of macrophytes and weed species. Direct impacts would be limited to approximately 0.35 hectares of good/moderate to poor condition examples of this community. Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas directly disturbed.

Broad-scale mapping (NPWS 2003) in the locality (10 kilometre radius) identifies a total 5,382 hectares of floodplain vegetation which form a mosaic of communities including freshwater wetlands. Around 3,500 hectares of this community occurs in the lower Hunter – Central Hunter region based on estimates from the 1990s (OEHS 2016). When compared with the identified extant of this community the proposed impact represents a small proportion (ie 0.01 per cent) of the potential extant in the locality.

Considering the moderate level of disturbance in freshwater wetlands in the study area, the modification which would result from the proposal would be unlikely to significantly increase the current levels of weed invasion, edges effects and other disturbance and is unlikely to place the community at risk of extinction

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

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

Impacts to this community are minor and affect mainly the disturbed edge habitats of wetland areas supporting a mix of macrophytes and weed species. Impacts would be limited to approximately 0.35 hectares of

good/moderate to poor condition examples of this community. Broad-scale mapping (NPWS 2003) in the locality (10 kilometre radius) identifies a total 5,382 hectares of floodplain vegetation which form a mosaic of communities including freshwater wetlands. Around 3,500 hectares of this community occurs in the lower Hunter – Central Hunter region based on estimates from the 1990s (OEH 2016). When compared with the identified extant of this community the proposed impact represents a small proportion (ie 0.01 per cent) of the potential extant in the locality.

Freshwater Wetlands in the study area are currently highly fragmented from existing development and habitat disturbance with limited connectivity as the main patch of the community is positioned between the highway and the railway corridor. There is some connectivity between wetlands through culverts and pipes beneath the existing roads where seeds and other propagules can be dispersed in addition to broad range of aquatic fauna. Further fragmentation of habitats as a result of the proposal is not expected to be significant considering the current high level of habitat fragmentation. Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat.

Given that the wetland areas likely have an artificial element being created from increased water depth and duration and the surrounding areas are heavily urbanised they are not expected to be regionally or locally important wetlands.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for this ecological community.

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

No recovery or threat abatement plan has been prepared for this ecological community however consideration is given to priority action statements that set out measures to promote recovery in accordance with DECCW requirements. Proposed actions for this proposal are generally consistent with the recovery strategies and associated priority actions for Freshwater Wetlands. The following recovery strategies will be incorporated as part of the management and mitigation measures for the proposal during construction and where applicable during operation:

- Undertake research into environmental flows with a view to the restoration of natural flow regimes.
- Investigate acquisition of property that contains this EEC to complement and expand on existing areas reserved.
- Use mechanisms such as Voluntary Conservation Agreements to promote the protection, particularly from threats such as grazing, of this EEC on private land.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.

The proposed mitigation and management measures for the proposal will substantially contribute to the recovery of the ecological community in terms of reinstating the natural hydrology regime where possible which is likely to increase species diversity and habitat values.

*(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.*

It is considered likely that the proposal may increase the following Key Threatening Processes listed associated with freshwater wetlands under the TSC Act:

- Invasion, establishment and spread of Lantana (*Lantana camara*).
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.
- Clearing of native vegetation.
- Infection of native plants by *Phytophthora cinnamomi*.

- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.
- Invasion and establishment of exotic vines and scramblers.
- Invasion of native plant communities by exotic perennial grasses.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Some aquatic weeds such as escaped garden plants may become established within areas of freshwater wetland facilitated by disturbances associated with the proposal. Some aquatic weeds are currently present including Parrots Feather (*Myriophyllum aquaticum*) and Arum Lily (*Zantedeschia aethiopica*). Therefore it is recommended that a series of priority actions are implemented to mitigate the threat from environmental weeds.

The existing hydrology regime has been altered from previous surrounding developments and is a substantial existing threatening process which is directly affecting the distribution and abundance of the species in the study area with numerous drowned trees observed within and surrounding areas of freshwater wetland. The proposed modifications to the hydrology regimes with adaptive management protocols will potentially improve the habitat conditions, encouraging recruitment and regeneration of species adapted for more ephemerally inundated habitats.

Hygiene protocols will be implemented during construction to ensure no pathogens potentially harmful to native biodiversity are not introduced to the study area.

The proposal would involve clearing of native vegetation and therefore involve the operation of a key threatening process. The proposed impact represents around 0.01 per cent of the potential extant in the locality.

## **Conclusion**

Considering the small size, altered hydrology and levels of weed invasion present in this community in the study area and the small area of potential impact relatively to the distribution in the locality, it is unlikely there would be a significant impact to local occurrence of this community and would not be placed at a risk of extinction.



### 8.3.2 Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

*(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.*

No consideration under this part of the assessment is required.

*(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.*

No consideration under this part of the assessment is required.

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

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

Impacts to this community include around 2.74 hectares of mostly good/moderate condition vegetation of direct impact.

Broad-scale mapping (NPWS 2003) in the locality (10 kilometre radius) identifies a total 5,382 hectares of floodplain vegetation of which 1,458 hectares has been identified as Swamp Sclerophyll Forest, this represents the local occurrence of this community. The potential direct impacts to this threatened ecological community represent less than 0.19 per cent of the local occurrence and is not considered an adverse effect on the extent of the community in the local occurrence. Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat disturbed during construction. Considering the relatively small impact in comparison to the local extant it is unlikely that the proposal would place the community at risk of extinction within the study area.

This community is likely to have been indirectly impacted from altered hydrology regimes and the area of occupation is likely to have retracted and replaced with freshwater wetlands. The current hydrology regime is a substantial existing threatening process which is directly affecting the distribution and abundance of the ecological community with numerous drowned trees observed within and surrounding the freshwater wetland area. On the basis of the degree of modification and the location of the community relative to existing urban infrastructure and threats, is it not considered an important area of habitat for this EEC.

The magnitude of the vegetation clearing is moderately large and the disturbances will likely lead to increased and persistent weed invasion in adjoining habitats. The increased road pavement will likely increase the quantity of polluted run-off into the remaining area of this ecological community and this is expected to have indirect impacts on residual areas. The existing hydrology regime is currently a major threatening process to the viability of the ecological community with numerous drowned trees observed on the edges of the ecological community adjoining freshwater wetlands. Although the introduction of known threats (ie habitat removal, weed invasion, pollution) to the ecological community has potential to substantially impact the remaining areas, proposed mitigation measures including weed control measures and modifications to the hydrology regimes with adaptive management protocols will substantially improve the habitat conditions for the ecological community, and encourage recruitment and regeneration of swamp forest canopy and midstorey species as well as macrophytes.

The extent of this community impacted by the proposal is unlikely to be important for the long-term survival of this community considering the small size, altered hydrology, levels of weed invasion and poor water quality. Around 60% of the swamp sclerophyll forest will be retained surrounding the proposal. Considering the larger better quality examples of these threatened ecological communities in the locality the extant of these in the study area, the extant of the community in the proposal area is unlikely to be important for the long-term survival of this community.

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

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

Impacts to this community include around 2.74 hectares of mostly good/moderate condition vegetation of direct impact. Broad-scale mapping (NPWS 2003) in the locality (10 kilometre radius) identifies a total 5,382 hectares of floodplain vegetation of which 1,458 hectares has been identified as Swamp Sclerophyll Forest. Up to 7,000 hectares in the lower Hunter – central coast district (OEH 2016). The potential direct impacts to this threatened ecological community represent less than 0.19 per cent of the local occurrence and a very small proportion of the regional occurrence in the lower Hunter and central coast (0.025 per cent). Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat disturbed during construction.

Patches of Swamp Sclerophyll Forest in the study area are currently highly fragmented from existing development and habitat disturbances with limited existing connectivity. There is some connectivity between wetlands through culverts and pipes beneath the existing roads where seeds and other propagules can be dispersed in addition to broad range of aquatic fauna. Further fragmentation of habitats as a result of the proposal is not expected to be significant considering the current high level of habitat fragmentation. Areas of this community will be avoided where possible and the community will be allowed to regenerate in areas of suitable habitat.

The extent of this community impacted by the proposal is unlikely to be very important for the long-term survival of this community considering the small patch size, levels of weed invasion and lack of connectivity. Considering the larger better quality examples of these threatened ecological communities in the locality the extant of the impacted area of habitat in the study area is unlikely to be important for the long-term survival of this ecological community.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for this ecological community.

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

No recovery or threat abatement plan has been prepared for this ecological community however consideration is given to priority action statements that set out measures to promote recovery in accordance with DECCW requirements. Proposed actions for this proposal are generally consistent with the recovery strategies and associated priority actions for Swamp Sclerophyll Forest. The following recovery strategies will be incorporated as part of the management and mitigation measures for the proposal during construction and where applicable during operation:

- Undertake research into environmental flows with a view to the restoration of natural flow regimes.
- Investigate acquisition of property that contains this EEC to complement and expand on existing areas reserved.
- Use mechanisms such as Voluntary Conservation Agreements to promote the protection, particularly from threats such as grazing, of this EEC on private land.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.

The proposed mitigation and management measures for the proposal will substantially contribute to the recovery of the ecological community in terms of reinstating the natural hydrology regime where possible which is likely to increase species diversity and habitat values.

(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.*

It is considered likely that the proposal may increase the following Key Threatening Processes listed associated with Swamp Sclerophyll Forest under the TSC Act:

- Invasion, establishment and spread of Lantana (*Lantana camara*).
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.
- Clearing of native vegetation.
- Infection of native plants by *Phytophthora cinnamomi*.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.
- Invasion and establishment of exotic vines and scramblers.
- Invasion of native plant communities by exotic perennial grasses.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Due to the invasion, establishment and spread of Lantana (*Lantana camara*) throughout the study area it is likely that any cleared habitats as a result of the proposal would be occupied in time by Lantana in addition to other environmental weeds such as vines and scramblers, escaped garden plants and exotic perennial grasses. Some aquatic weeds are currently present including Parrots Feather (*Myriophyllum aquaticum*) and Arum Lily (*Zantedeschia aethiopica*) in addition to a high abundance in areas of more terrestrial species such as Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*). Therefore it is recommended that a series of priority actions are implemented to mitigate the threat from environmental weeds.

The existing hydrology regime has been altered from previous surrounding developments and is a substantial existing threatening process which is directly affecting the distribution and abundance of the species in the study area with numerous drowned trees observed. The proposed modifications to the hydrology regimes with adaptive management protocols will potentially improve the habitat conditions, encouraging recruitment and regeneration of species adapted for more ephemerally inundated swamp forest habitats.

Hygiene protocols will be implemented during construction to ensure no pathogens potentially harmful to native biodiversity are not introduced to the study area.

The proposal would involve clearing of native vegetation and therefore involve the operation of a key threatening process. The proposed impact represents around 0.19 per cent of the potential extant in the locality.

## Conclusion

Considering the small size, altered hydrology and levels of weed invasion present in this community in the study area and the small area of potential impact relatively to the distribution in the locality, it is unlikely there would be a significant impact to local occurrence of this community and would not be placed at a risk of extinction.

## 9. Additional information

### 9.1 Qualifications and experience

Curriculum vitae for all Jacobs ecologists involved in the study area provided in Appendix G

### 9.2 Other approvals required for the development or activity

#### 9.2.1 Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) aims to protect and preserve items of non-Aboriginal heritage significance. The Heritage Act provides for the protection of items of local, regional and State heritage significance. It establishes a list of State Heritage Items and outlines processes for approval of development which may impact items of heritage significance.

Two historic items (The Lisarow Store (Pryor Brothers Store) and Lisarow Anglican Cemetery, listed on the Gosford LEP 2014 as being of local significance have been identified in proximity to the proposal. The Pryor Brothers Store would be removed as part of the proposal and approval for demolition by Gosford City Council was given on 13 August 2013.

The boundary of the Lisarow Anglican Cemetery was considered a hard boundary throughout the design process and all work with machinery would be undertaken outside the boundary of the Lisarow Cemetery during construction. However the design of the proposal includes the construction of a retaining wall along the eastern curtilage of the cemetery which will result in direct impacts to the cemetery gate located in this location and clearance of existing vegetation. Consequently the proposal will require relocation of cemetery gates to a new suitable location, and reduced distance between the graves and the Pacific Highway will also occur. As the proposal is close to the cemetery there would also be the potential for physical damage from vibration during construction to the headstones and above ground components of the graves. These impacts would be managed through the implementation of mitigation measures to be included in the Construction Environment Management Plan (CEMP).

An assessment of the impacts on non-Aboriginal heritage was undertaken, and is provided in the Statement of heritage Impact (SOHI). The SOHI found that the Lisarow Cemetery has rare local historic and social significance as a mid-19th century cemetery associated with the early settlement of the district. Set above the Pacific Highway, the cemetery is an important feature of the landscape. The SOHI concluded that the proposal was unlikely to have a significant impact to this local heritage item.

Roads and Maritime have consulted with Gosford City Council about the Lisarow Cemetery and a copy of the SOHI was provided on the 25 July 2014 as part of the ISEPP consultation.

#### 9.2.2 Water Management Act 2000

The *Water Management Act 2000* (WM Act) controls the extraction of water, the use of water, the construction of work such as dams and weirs and the carrying out of activities in or near water sources in NSW. The proposal is located within the *Central Coast Unregulated Water Sources Sharing Plan* (started on 1 August 2009) and therefore subject to the WM Act.

In September 2012, the NSW Government released the policy for the licensing and approval of aquifer interference activities (NSW Office of Water, 2012). The WM Act defines an aquifer interference activity as one which involves any of the following:

- The penetration of an aquifer.
- The interference with water in an aquifer.
- The obstruction of the flow of water in an aquifer.



- The taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.
- The disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.

Any activity that results in a reduction in the groundwater resource pool of three megalitres per year or more, or at an instantaneous rate of greater than five litres per second will require a groundwater extraction and aquifer interference license. The primary potential interference posed by this proposal involves the obstruction of flow of water in an aquifer. The proposal also has the potential to contaminate groundwater or result in unacceptable loss of storage or structural damage to an aquifer.

As the construction of the proposal is not expected to reduce the groundwater resource pool by either of these volumes, potential impacts to groundwater are likely to be only minimal and temporary. Accordingly, the proposal is a 'defined minimal impact aquifer interference activity' and a license would not be required.

### 9.2.3 Environment Protection and Biodiversity Conservation Act 1999

The project REF recommended that as *Melaleuca biconvexa* is a threatened species under the EPBC Act and is considered a matter of national environmental significance (MNES) a referral would be required. However the Federal Government granted approval for strategic assessments under the EPBC Act in September 2015, with respect to the impacts of Roads and Maritime activities on nationally listed threatened species, ecological communities and migratory species. Consequently, Federal approval is not required for the proposal, provided Roads and Maritime apply the measures approved under the endorsed strategic assessment.

## 9.3 Licensing matters relating to the survey

Relevant licences and approvals for flora and fauna survey held by Jacobs Group Australia are

- NSW *National Parks and Wildlife Act 1974* – Licence Number SL100044 to harm/trap/pick/hold/study protected fauna and native flora.
- NSW *Animal Research Act 1985* – Certificate of Approval by the Animal Care and Ethics Committee of the Secretary of NSW Trade and Investment to conduct fauna surveys carried out as part of EIS, SIS and Biodiversity Assessment Reports.

## 9.4 Section 110(5) reports

The information provided by the OEHS in fulfilment of this requirement is available at <http://www.environment.nsw.gov.au/threatenedspecies/index.htm>. This website provides basic profiles for the majority of species listed as threatened, as well as links to the Scientific Committee determinations, more detailed profiles, environmental impact assessment guidelines and recovery plans, where these documents are available. OEHS is unable to provide any further information for section 110(5) reports.

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## **Appendix A. Director Generals Requirements**





Office of  
Environment  
& Heritage

Your reference: SF2014/154248  
Our reference: DOC15/80261-01  
Contact: Robert Gibson, 4908 6851

Mr Colin Nunn  
Principle Manager Project Development  
Roads & Maritime Services  
PO Box 766  
WOY WOY NSW 2256

Attention: Ms Teresa Ting

Dear Mr Nunn

**RE: DIRECTOR GENERAL'S REQUIREMENTS FOR PROPOSED UPGRADE OF THE PACIFIC HIGHWAY AT LISAROW, NSW**

I refer to your letter dated 2 March 2015 seeking Director General's Requirements (DGRs) for the proposed upgrade of the Pacific Highway at Lisarow, between and including Ourimbah Street and Parsons Road in accordance with Section 111 of the *Threatened Species Conservation Act 1995* (TSC Act). The Office of Environment and Heritage (OEH) understands that Roads and Maritime Services (RMS) is planning to upgrade the Pacific Highway under the Part 5 provisions of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

In response to your request, please find attached DGRs for a Species Impact Statement (SIS) (**Attachment A**) to address all known and potential threatened species, populations and ecological communities (including their habitat). As discussed during a meeting for this project held between OEH and RMS on 15 December 2015, this project will likely have a significant impact on *Melaleuca biconvexa*, a species listed under the TSC Act. Apart from this species, OEH is of the opinion that the SIS must address all likely species, populations, ecological communities and their habitats that may be directly or indirectly impacted by the proposal. A list of potential species, populations and ecological communities has been provided in Attachment A.

Following completion of the SIS, if RMS determines that the proposal is likely to have a significant effect on threatened species, populations or ecological communities (including their habitat), then the concurrence of the Chief Executive of OEH is required before consent may be granted. A concurrence application is not required should RMS decide to reject the application or if RMS determines that the proposal is unlikely to have a significant effect on threatened species, populations or ecological communities.

The SIS must be submitted to OEH as part of a request for concurrence within 12 months of this letter. As the consent authority, RMS must ensure the SIS is compliant with the DGRs. If concurrence is requested outside the 12 month timeframe, OEH must be consulted to determine whether the DGRs need to be modified to reflect, among other things, changes to the listings of threatened species, populations and ecological communities, new information on threatened species, populations and ecological communities or changes to relevant legislation.

Please note that the issuing of DGRs is a statutory requirement for OEH and should not be considered as support or endorsement of the proposed development.

If seeking concurrence, OEH requests that RMS provide: one (1) printed copy and a searchable electronic copy (i.e. \*.pdf format) of the SIS (including copies of survey data sheets etc.), the original development application, any social and economic appraisal of the development and any supporting or background reports (including previous surveys etc.) (**Attachment B**).

If you require any further information regarding this matter please contact Robert Gibson, Regional Biodiversity Conservation Officer, on 4908 6851.

Yours sincerely



26 MAR 2015

**RICHARD BATH**  
**Senior Team Leader Planning, Hunter Central Coast Region**  
**Regional Operations**

Enclosures:

Attachment A – Director-General's Requirements for a Species Impact State for proposed Pacific Highway upgrade at Lisarow, NSW

Attachment B – Checklist for determining if an SIS has met the requirements of the Director General of the Office of Environment and Heritage

## ATTACHMENT A:

### DIRECTOR GENERAL'S REQUIREMENTS FOR A SPECIES IMPACT STATEMENT FOR A PROPOSED UPGRADE OF THE PACIFIC HIGHWAY AT LISAROW BETWEEN OURIMBAH STREET AND PARSONS ROAD, GOSFORD LGA, NSW

The purpose of a Species Impact Statement (SIS) is to:

- allow the applicant or proponent to identify threatened species issues and provide appropriate amelioration for adverse impacts resulting from the proposal
- assist consent and determining authorities in the assessment of a development application under Part 4 or request for Part 5 approval under the *Environmental Planning and Assessment Act 1979* (EP&A Act)
- assist the Chief Executive of the Office of Environment and Heritage in deciding whether or not concurrence should be granted for the purposes of Parts 4 or 5 of the EP&A Act
- assist the Chief Executive of the Office of Environment and Heritage or the Minister for the Environment when consulted for the purposes of Parts 4 or 5 of the EP&A Act
- assist the Chief Executive of the Office of Environment and Heritage in the assessment of Section 91 Licence applications lodged under the *Threatened Species Conservation Act 1995* (TSC Act).

## DEFINITIONS

The definitions given below are relevant to these requirements:

- **abundance** means a quantification of the population of the species or community.
- **activity** has the same meaning as in the EP&A Act.
- **affected species** means subject species likely to be affected by the proposal.
- **conservation status** is regarded as the degree of representation of a species or community in formal conservation reserves.
- **DA** number means Development Application number.
- **development** has the same meaning as in the EP&A Act.
- **Director General** means the Director General of the Department of Premier and Cabinet, Office of Environment and Heritage (OEH).
- **DP** means *Deposited Plan* which is the **plan** number given to a subdivision that is registered by the Land Property Information.
- **EPA** means the Environment Protection Authority (formerly part of OEH).
- **LGA** means Local Government Area.
- **locality** means the area within a 5 km radius of the study area.
- **region** has the same meaning as that contained in the TSC Act.
- **significant species** means species not listed in the TSC Act but considered to be of regional or local significance.
- **study area** is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly.
- **subject site** means the area which is proposed for development/activity.
- **subject species** means those threatened and significant species, populations and ecological communities which are known or considered likely to occur in the study area.
- **threatening process** has the same meaning as that contained in the TSC Act; the definition is not limited to key threatening processes.

All other definitions are the same as those contained in the TSC Act.

## MATTERS WHICH HAVE BEEN LIMITED OR MODIFIED

The following Section 110 matters in the TSC Act need only be addressed where relevant:

- all reference to threat abatement plans; and
- all reference to critical habitat. At the time of printing, the areas of declared critical habitat are not relevant to this proposal.

The proponent should be aware that recovery plans may be approved, critical habitat may be declared and key threatening processes may be listed between the issue of these requirements and the granting of consent. If this occurs, these additional matters will need to be addressed in the SIS and considered by the consent, determining or concurrence authority.

## **MATTERS TO BE ADDRESSED**

The TSC Act provides that the SIS must meet all the matters specified in Sections 109 and 110 of the TSC Act with the exception of those matters limited above. The requirements outlined in Sections 109 and 110 (excluding the matters limited above) have been repeated below (*italics*) along with the specific Director General Requirements (DGRs) for your proposal. Previous surveys and assessments that are relevant to the locality may be used to assist in addressing these requirements.

Section 111 (1) of the TSC Act states that an applicant must comply with the DGRs concerning the form and content of the SIS. Failure to fully comply with the DGRs is therefore a potential breach of the legislation, and may result in OEH being unable to grant concurrence to a request by the consent authority to carry out the activity. Accordingly, the SIS must be formatted to follow the sections and subsections provided in the DGRs.

## **1 FORM OF THE SPECIES IMPACT STATEMENT**

- 1.1 *A species impact statement must be in writing (Section 109 (1));*
- 1.2 *A species impact statement must be signed by the principal author of the statement and by:*
  - (a) *the applicant for the licence, or*
  - (b) *if the species impact statement is prepared for the purposes of the Environmental Planning and Assessment Act 1979, the applicant for development consent or the proponent of the activity proposed to be carried out (as the case requires) Section 109(2)).*

The applicant or proponent must sign the following declaration:

"I...[insert name], of ...[address], being the applicant for the development consent...[insert DA number, Lot & DP numbers, street, suburb and LGA names] have read and understood this species impact statement. I understand the implications of the recommendations made in the statement and accept that they may be placed as conditions of consent or concurrence for the proposal".

## **2. CONTEXTUAL INFORMATION**

### **2.1 Description of proposal, subject site and study area**

*A species impact statement must include a full description of the action proposed, including its nature, extent, location, timing and layout (Section 110 (1))*

#### **2.1.1 Description of the proposal**

A full description of the action includes a description of all associated actions, including, but not restricted to: - location of all lots / building envelopes, installation and maintenance of any proposed buildings / dwellings and associated structures, the proposed number and size of such lots, buildings / dwellings and associated structures, location of any associated facilities (including roads, amenities and other services), fire protection zones, access and egress routes, changes in surface water flows, impacts of noise disturbance and pollution, and any increases in people and road traffic. Actions that occur both on and off the subject land as a result of the proposal must be assessed; including actions conducted during any



construction phase and any proposed action post-construction (e.g. proposed actions within a management plan).

### 2.1.2 Definition of SIS study area

The SIS study area must be defined. The study area will generally be larger than the development site as it includes any adjacent areas that will be directly or indirectly affected by the proposal. In defining the study area consideration shall be given to possible indirect effects of the proposed action on the area surrounding the subject site, for example habitat fragmentation, vegetation corridors, altered hydrology regimes, soil erosion, pollution, and increased human presence or associated impacts. These may include adjacent parcels of land containing suitable habitat for threatened species. It is therefore important to recognise that these parcels may need to be investigated along with the development site. The location, size and dimensions of the study area shall be provided.

The study area should be established before the list of likely impacted threatened species, populations, ecological communities (including their habitat) is determined so species etc. that are less obviously affected are also included. The study area must be clearly defined, marked on a geo-referenced map / aerial photograph (or equivalent), clearly showing the development site boundary and any additional areas facing indirect impact, and included in the final report.

Direct impacts are those that directly affect individuals or their habitat. Examples of direct impacts include:

- poisoning or removal of the organism itself
- removal of habitat
- clearing of native vegetation / habitat.

If the proposal involves the clearing of vegetation and/or removal / damage to habitat the environmental assessment must clearly articulate the size of this impact, and where applicable delineate this on the basis of vegetation / habitat type.

Indirect impacts occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Examples of indirect impacts include (but not limited to):

- sediment, pollutant or nutrient runoff into adjacent vegetation
- habitat fragmentation or isolation
- implementation of asset protection zones (\*though these may also represent direct impact)
- loss of genetic diversity of threatened species, populations or communities
- altered pollination syndromes that may adversely affect seed set
- soil erosion
- altered hydrology regimes (including downstream impacts)
- changes to the saline / freshwater balance in marine environments
- exposure to heat or predators, or loss of shade
- inhibition of nitrogen fixation
- weed invasion and feral animal incursion
- introduction and spread of pathogens, such as Dieback fungus (*Phytophthora*) and Myrtle Rust (*Uredo rangeli*)
- noise
- dust
- light pollution (i.e. increasing skyglow from uncontrolled urban uplight)
- fire (such as changes to intensity and frequency)
- fertilizer drift
- increased human activity (including litter) within or directly adjacent to sensitive habitat areas.

Indirect impacts should not be just limited to the terrestrial habitats. In stances where a development site adjoins marine, estuarine and/or riparian / riverine environs / habitat, impacts on these must be considered.

Note: Indirect impacts may lead to direct loss, and as such must be adequately quantified and assessed. Both impacts within the proposed development footprint and on adjacent / surrounding lands must be taken into account, and where appropriate adequately considered and addressed.

### 2.1.3 Description of SIS study area

The description of the study area must include (but not limited to):

- The vegetation communities and habitat types, including identification of the classification system used in the SIS. Details of the methodology adopted to delineate vegetation communities on site (e.g. random stratified sampling). Full floristic description of all vegetation communities present (including disturbed and undisturbed). A listing of the amount (in hectares) of each vegetation community in the study area. A geo-referenced map / aerial photograph (or equivalent) showing the location of the vegetation communities. A full floristic list in tabular format of all taxa (both native and exotic) recorded on the subject site, indicating which communities they occur in, their cover / abundance and frequency, conservation (including taxa of conservation significance) and comparisons to previous vegetation studies / mapping (if applicable);
- An examination of previous land uses and events, and the effect of these land uses and events on the study area. Examples of such land uses and events are clearing, timber felling, draining, recreational use and agricultural activities (including grazing);
- An examination of the fire history, or at least the time since the last fire, for the subject site is to be provided. Ideally, information on the frequency, season and intensity of fire events on the subject site will be provided. To adequately address this requirement, it may be necessary to consider fire events in the surrounding landscape;
- The local government land zoning and any proposed rezoning, and an examination of the degree of protection that current zoning and any proposed rezoning provides or will provide to native vegetation and threatened species, populations and ecological communities on the subject site and in the study area and the locality;
- The land tenure and any proposed changes (e.g. acquisition by OEH as a Nature Reserve, National Park, Regional Park etc.), and an examination of the degree of protection that current land tenures and any proposed land tenures provides or will provide to native vegetation and threatened species in the study area;
- State Environmental Planning Policies (e.g. SEPP 14 Coastal Wetlands, SEPP 44 Koala Habitat Protection, SEPP 71 Coastal Protection) and an examination of the degree of protection these policies provide to native vegetation and threatened species on the subject site and in the study area; and
- Relevant Local Government planning instruments, including Local Environmental Plans and Development Control Plans, such as the 'Cessnock Development Control Plan Part E: Specific Areas E.6:HEZ'.

## **2.2 Provision of relevant plans and maps**

A plan of the subject area, including the scale of the plan should be provided. An aerial photograph (preferably colour) of the locality (or reproduction of such a photograph) shall be provided, if possible. This aerial photograph should clearly show the subject site and the scale of the photograph. It should be geo-referenced and show the date of the photograph.

A geo-referenced topographic map or equivalent of the subject site and immediate surrounds at an appropriate scale should be provided. This map should detail the location of the proposal and location of works on site (including areas of indirect impact). Additionally, to provide an overview of the natural landscape in the general locality, the map should show or be overlain with details of vegetated (i.e. woody [e.g. forests, woodland, shrubland and heath] and non-woody native vegetation [e.g. grassland, sedgeland and saltmarsh]) vs. cleared areas, as well as indicating the current activities/usage of this land, such as rural, agricultural, industrial and residential. OEH expects a separate map will be provided to indicate what specific vegetation communities are on subject site (as detailed above in Section 2.1.3).

A map of the locality, showing any locally significant areas for threatened species such as parks and reserves, and areas of high human activity such as townships, regional centres and major roads will also be provided. The location, size and dimensions of study area shall be provided.

Where any biodiversity offsets are proposed, the proponent must provide OEH with a proper survey plan, prepared by a registered surveyor that clearly shows the location and boundaries of any offset land. A printed copy of each survey plan must be provided to OEH at A1 or A0 scale. The survey plan must be of a form that is acceptable to OEH. Electronic copies should also be provided.

### 2.3 Land tenure information

Information about the land tenure across the study area. Any limitations to sampling across the study area (e.g. denied access to private land) shall be noted.

## 3 INITIAL ASSESSMENT

*A general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110 (2)(a)).*

### 3.1 Identifying subject species

#### 3.1.1 Assessment of available information

In determining these species ('the subject species'), consideration shall be given to the habitat types present within the study area, recent and historic records of threatened species or populations in the locality and the known distribution of threatened species.

Databases such as OEH's *Atlas of NSW Wildlife* ([www.bionet.nsw.gov.au/](http://www.bionet.nsw.gov.au/)), *BioBanking Credit Calculator* ([www.environment.nsw.gov.au/biobanking/calculator.htm](http://www.environment.nsw.gov.au/biobanking/calculator.htm)), *Atlas of Living Australia* ([www.ala.org.au/](http://www.ala.org.au/)), *Australian Museum* (<http://ozcam.org.au/>), *Birdlife Australia* (<http://birdsaustralia.ala.org.au/BDRS/home.htm>), and the *Royal Botanic Gardens* (<http://plantnet.rbgsyd.nsw.gov.au/>) should be consulted to assist in compiling the list. It should be noted that if the OEH Wildlife Atlas is the only database that is referred to, due to data exchange agreements, the data provided by OEH will only include that for which OEH is a custodian. In many cases, this may only be a small subset of the data available. Other databases must also be consulted to create a comprehensive list of subject species.

The following species shall be considered for inclusion in the list of subject species, as they have either been recorded in the general area, are within the species' known geographic limits or their broad habitat preferences may be present on site:

#### Threatened Species

\* indicates species that are listed on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

#### Flora (4 taxa):

For targeted surveys please note the following known flowering / fruiting times for each species to time surveys appropriately. Surveying at these times is required for species that are not readily detectable (and/or are cryptic), where flowers and/or fruits are necessary for their positive identification. If targeted flora surveys for these species are conducted outside a species known phenology then justification must be provided as to why; if this is not provided or considered inappropriate, then all such species will be considered to be present on all available habitat and in viable numbers, and as such will require suitable biodiversity offsets or their habitat avoided. For species which do not require flowers / fruits for positive identification (e.g. large trees / shrubs), then survey as appropriate (though appropriate justification on methods used is still required).

Targeted flora surveys must also adequately sample / cover all suitable habitat on the study area, and utilise suitable detection techniques such as belt transects (at appropriate widths to spot cryptic species) or random meanders (that sufficiently cover all known / potential habitat areas [i.e. not just the tracks or readily accessible areas]). If targeted flora surveys are poorly conducted and/or surveyed then appropriate justification must be provided as to why; if this is not provided or considered inappropriate, then all such affected species will be considered to be present on all available habitat and in viable numbers, and as such will require suitable biodiversity offsets or their habitat avoided.

**Spider Orchid (*Dendrobium melaleucaphilum*)** – is an epiphytic orchid that has been recorded flowering across its range between July and October (Harden, 2002). Its square stems are distinctive, however, floral details are required to tell it from the very similar *D. tetragonum*;

**Biconvex Paperbark (*Melaleuca biconvexa*)** - flowering occurs over just 3 to 4 weeks in September and October (OEH – Threatened species profile database, accessed March 2015), though Harden (2002) notes generally summer;

**Tranquility Mintbush (*Prostanthera askania*)** – is a strongly-aromatic shrub to 1 m high with opposite leaves with deeply toothed margins and purple flowers produced in terminal clusters in Spring (Harden, 2002); and

**Magenta Lilly Pilly (*Syzygium paniculatum*)\*** - flowers December to January / March (Harden 2002, Benson & McDougall 1998), though mature fruits are required to positively identify this species, which mature in May (Payne 1997).

## **Fauna**

For Fauna species please be aware of: (i) habitat preferences and known distribution for each of the species as an indication as to whether they may occur in the study area, and (ii) the best times of year these species may be detected if subject to surveys. If animals are captured with an uncertain taxonomy, species should be forwarded to the Australian Museum by a suitably qualified scientific licence holder.

### **Amphibians (5 species):**

Giant Burrowing Frog *Heleioporus australiacus*  
Green and Golden Bell Frog *Litoria aurea*  
Green-thighed Frog *Litoria brevipalmata*  
Stuttering Frog *Mixophyes balbus*  
Giant Barred Frog *Mixophyes iteratus*

### **Reptiles (2 species):**

Stephens banded Snake *Hoplocephalus stephensii*  
Pale-headed Snake *Hoplocephalus bitirquatus*  
Rosenberg's Goanna *Varanus rosenbergi*

### **Birds (24 taxa):**

Regent Honeyeater *Anthochaera phrygia*\*  
Gang-gang Cockatoo *Callocephalon fimbriatum*  
Glossy Black Cockatoo *Calyptorhynchus lathami*  
Varied Sittella *Daphoenositta chrysoptera*  
Black-necked Stork *Ephippiorhynchus asiaticus*  
Little Lorikeet *Glossopsitta pusilla*  
Painted Honeyeater *Grantiella picta*  
Little Eagle *Hieraaetus morphnoides*  
Black Bittern *Ixobrychus flavicollis*  
Swift Parrot *Lathamus discolor*\*  
Square-tailed Kite *Lophoictinia isura*  
Barking Owl *Ninox connivens*  
Powerful Owl *Ninox strenua*



Eastern Osprey *Pandion cristatus*  
 Grey-crowned Babbler *Pomatostomus temporalis temporalis*  
 Wampoo Fruit-Dove *Ptilinopus magnificus*  
 Superb Fruit-Dove *Ptilinopus superb*  
 Masked Owl *Tyto novaehollandiae*  
 Sooty Owl *Tyto tenebricosa*

#### **Mammals (14 species):**

Eastern Pygmy-possum *Cercartetus nanus*  
 Spotted-tailed Quoll *Dasyurus maculatus*\*  
 Eastern False Pipistrelle *Falsistrellus tasmaniensis*  
 Little Bentwing-bat *Miniopterus australis*  
 Eastern Bent-wing Bat *Miniopterus schreibersii* subsp. *oceanensis*  
 Eastern Freetail bat *Mormopterus norfolkensis*  
 Large-footed Myotis *Myotis adversus*  
 Yellow-bellied Glider *Petaurus australis*  
 Squirrel Glider *Petaurus norfolcensis*  
 Koala *Phascolarctos cinereus*  
 Eastern Chestnut Mouse *Pseudomys gracilicaudatus*  
 Grey-headed Flying-fox *Pteropus poliocephalus*\*  
 Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*  
 Greater Broad-nosed Bat *Scoteanax rueppellii*

#### **Endangered ecological communities (6)**

- *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*
- *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions*
- *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*
- *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*
- *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*
- *Sydney Freshwater Wetlands in the Sydney Basin Bioregion.*

The above lists are not necessarily exhaustive. The applicant must carry out their own process of determining the subject species. This process should incorporate consideration of:

- the vegetation communities present within the study area
- the presence, quantity, quality and degree of fragmentation of likely habitat for individual threatened species
- recent (within the last ten years) records of threatened species, populations and ecological communities in the locality
- the known distribution of threatened species, populations and ecological communities
- the known and predicted use of habitat for all potential species.

OEH's *Atlas of NSW Wildlife*, *Australian Museum* and *Royal Botanic Gardens* databases, the *Birds Australia* and *NSW Bird Atlas* databases (for birds) and other relevant databases should be used to assist in compiling or assessing the list. The Data Licensing Officer at OEH's Head Office should be contacted on (02) 9585 6684 to obtain information on the Atlas database.

Threatened species, populations and ecological communities on the above list may be excluded from further consideration as subject species only if a fully documented justification, robust to external examination, is provided. This documentation must address, as a minimum, the criteria for determining subject species that are listed above. In particular, threatened species that are cryptic, mobile or little surveyed (or possess combinations of these parameters (e.g. bats)), and for which the study area provides

suitable habitat and falls within the species' range, must not be excluded solely on the basis of a lack of records in the locality. Furthermore, threatened species that occur in a range of habitats must not be excluded on the basis that their core habitat is not present in the study area or locality.

The proponent should be aware that additional species, populations, and ecological communities could be added to the schedules of the TSC Act between the issue of these requirements and the granting of consent. If this occurs, these additional matters will need to be addressed in the SIS and considered by the consent, determining, or concurrence authority.

### Preliminary Listed Species

OEH draws your attention to species that may have preliminary listing under the TSC Act. They may be found on the website of the NSW Scientific Committee at [www.environment.nsw.gov.au/committee/ListOfScientificCommitteeDeterminations.htm](http://www.environment.nsw.gov.au/committee/ListOfScientificCommitteeDeterminations.htm). Any preliminary-listed may receive final determination under the Act during your SIS process and hence you would need to consider them.

Any 'final determination' to list a species, population or ecological community as 'critically endangered' or 'endangered' made after lodgement of a development application or activity proposal needs to be included in the consideration of impacts and the application of the assessment of significance. Vulnerable species listed after lodgement are not subject to impact assessment as long as the application is determined within 12 months of lodgement.

## **4 SURVEY**

### **4.1 Requirement to survey**

A fauna and flora survey must be conducted in the study area. Targeted surveys should be conducted for all subject species determined in accordance with Section 3.1. Recent (less than 5 years old) surveys and assessments may be used to assist in addressing this requirement. However, previous surveys will not be considered to have addressed this requirement if they have:

- been undertaken in seasons, weather conditions or following extensive disturbance events when the target subject species are unlikely to be detected or present (e.g. outside known flowering / fruiting periods, adverse drought conditions, flooding, bushfire [though some species are 'fire obligates' requiring fire to germinate], slashing and overgrazing etc.); or
- utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate ones for detecting the target subject species unless these differences can be clearly demonstrated to be likely to have had an insignificant impact upon the outcomes of the surveys.

Surveys must be undertaken by appropriately experienced and qualified persons. A recognised expert, from institutions such as the Australian Museum (Sydney), the National Herbarium of NSW at the Royal Botanic Gardens (Sydney) or the Queensland Herbarium (Brisbane), or who is otherwise considered acceptable by OEHS, must be used to determine or confirm the identification of species that are unknown or which have been only provisionally identified.

Survey methods adopted must be those considered by experienced wildlife surveyors to be those most likely to detect the targeted subject species (more than one survey method must be utilized for those subject species for which complementary methods have the potential to result in a significant increase in detection). Survey effort (including intensity, repetition and coverage) must be at a level that can be reasonably expected to detect the subject species if present in the study area. Surveys must be undertaken at the time of year when the subject species are most likely to be detected (e.g. targeted threatened flora should be carried out when a species is flowering and/or fruiting, as these features are typically required to positively identify species) and, where possible, in appropriate weather conditions. OEHS expects the weather conditions (e.g. minimum ambient air temperature, maximum ambient air temperature, amount of precipitation that occurs each 24 hour period, details about wind speed and direction and the amount of



cloud cover) and the phase of the moon to be recorded for each day of survey (including dates) to be documented and included in the report.

Survey procedures and assessment of results should be consistent with those procedures and assessment approaches contained within the following OEH publications:

- '*Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities*' (DEC – November 2004). (\*Note: Section 6.1 *Assessment of Significance* has now been amended by DECC 2007b)
- '*Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians*' (DECC – April 2009)
- '*Threatened Species Assessment Guidelines: The Assessment of Significance*' (DECC – August 2007b).

\*Note that OEH has recently produced new survey guidelines to cover Amphibians (frogs), which replaces the amphibian section in the DEC (2004) guidelines. However, the survey requirements for all other species (flora and fauna) are still found in the DEC (2004) guidelines.

The above documents can be located on OEH's website under the 'Threatened species survey and assessment guidelines' at:

- [www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm](http://www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm)

If a proposed survey methodology is likely to vary significantly from widely accepted methods, the proponent should discuss the proposed methodology with OEH prior to undertaking the SIS, to determine whether OEH considers that it is appropriate.

In addition to the above guidelines, OEH has recently posted new information on OEH website to ensure appropriate surveys are completed, with particular reference to fauna surveying. Below is a summary of this information as well as other clarifying points, often relating to vegetation survey. This updated information can be accessed from:

- [www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm](http://www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm)

#### *False absences and imperfect detection*

While the presence of a target species can often be confirmed at a site relatively easily, it is generally impossible to confirm a species is absent. Unless a species has a 100% chance of being detected on a single visit (i.e. it has a probability detection of 1) non-detection does not necessarily mean the species is absent (MacKenzie *et al.* 2002). Very few species are so conspicuous that they are always detected in each survey (MacKenzie *et al.* 2002).

A species' detectability is influenced by several factors (Tyre *et al.* 2003). Such factors include:

- the species in question – fauna species with large home ranges are especially likely to go undetected in an area, as at any given time they may be in another part of their range
- climatic conditions (e.g. temperature, rainfall)
- experience of the surveyor/s
- the survey methodology used.

An observed absence may be due to an observer failing to detect a species that is actually resident at the site, for example, a bird that was elsewhere in its home range at the time of the survey or failed to call during a point count (MacKenzie 2005). False absences have serious consequences for habitat modelling and monitoring studies as well as impact assessments. When fauna surveys are conducted for the purpose of impact assessment, false absences may result in inadequate conservation measures and an increased risk of local extinction (Wintle *et al.* 2005).



Hence, the SIS should be conservative when determining whether a species, population and/or community (including their habitat) are potentially present (i.e. precautionary approach).

### *Stratifying the site*

When designing a field survey, firstly stratify the study area (i.e. divide the area into relatively homogenous units – often referred to as ‘environmental sampling units’ or ‘stratification units’). Stratified sampling provides a logical, objective and efficient method of undertaking surveys and ensures that the full range of potential habitats and vegetation types will be systematically sampled and mapped. For the mapping of vegetation and delineation of habitat types, the study area / subject site should be initially stratified on biophysical attributes (e.g. landform, geology, elevation, slope, soil type, aspect, climate, rainfall etc.) that best delineate likely vegetation changes across the landscape. Vegetation structure or type (as per the OEH Biometric vegetation type or other acknowledged vegetation mapping / classification), condition and disturbance history may be used to better define the boundaries of stratification units.

Once the stratification units have been identified, they should be recorded on a survey map. Remote sensing such as aerial or satellite photograph interpretation coupled with ground truthing will help better refine and determine the spatial vegetation patterns and habitat types across a study area.

For further information on stratification and the use of Biometric tool (BioBanking Credit Calculator) in this process (particularly for fauna) refer to the new information posted on OEH website, as detailed above.

### *Visiting the site*

Conduct a preliminary site visit to refine the initial stratification units, determine the broad vegetation types (e.g. if using OEH Biometric determine the CMA vegetation types) present at the site, assess the vegetation condition and conduct a broad habitat assessment to help delineate specific features suitable for sampling.

Taking a copy of OEH's Biometric Vegetation Types Database ([www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm](http://www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm)) for the relevant former Catchment Management Authority (CMA) or equivalent (e.g. existing vegetation mapping) into the field during the preliminary site visit, may be useful in determining the likely vegetation types present. However, for some CMAs this should only be used as a guide as some vegetation types / communities have not been captured or delineated in the NSW Vegetation Types Database.

### *Survey Design*

Once the site has been stratified, an adequate survey design (e.g. stratified random sampling for vegetation / flora) should be developed which adequately samples all stratification units and habitat types. Vegetation survey sites should be selected randomly and be based on the variation inherent in the stratification, while fauna sites are likely to be selected on the basis of vegetation change and specific habitat types present (e.g. hollow bearing trees, feed trees, rock outcrop, presence of water etc.). Additional targeted surveying will be required for threatened species that are dependent on specific vegetation types and/or habitats or require specific sampling because of seasonality (e.g. flowering season for some plants, warmer months for fauna etc.).

To sample vegetation, for example, a standard plot should be adopted to ensure the structural and floristic character of all vegetation types on site is adequately captured (e.g. 0.04 ha [20m × 20m] quadrat).

### *Targeted Surveys - Flora*

For targeted flora surveys please note the known flowering / fruiting times for each species to time surveys appropriately (as listed above for potential ‘subject species’). Surveying at known flowering times is required for all potential species that are not readily detectable (and/or are cryptic), where flowers and/or fruits are necessary for their positive identification. If targeted flora surveys for potential species are



conducted outside a species known phenology then justification must be provided as to why; if this is not provided or considered inappropriate, then all such species will be considered to be present on all available habitat and in viable numbers, and as such will require suitable biodiversity offsets or their habitat avoided. For species which do not require flowers / fruits for positive identification (e.g. large trees / shrubs), then survey as appropriate (though appropriate justification on methods used is still required).

Targeted flora surveys must also adequately sample / cover all suitable habitat on the study area, and utilise suitable detection techniques such as belt transects (at appropriate widths to spot cryptic species) or random meanders (that sufficiently cover all known / potential habitat areas [i.e. not just the tracks or readily accessible areas]). If targeted flora surveys are poorly conducted and/or surveyed then appropriate justification must be provided as to why; if this is not provided or considered inappropriate, then all such affected species will be considered to be present on all available habitat and in viable numbers, and as such will require suitable biodiversity offsets or their habitat avoided.

### *Targeted Surveys – Fauna*

When undertaking targeted fauna surveys you must be aware of: (i) habitat preferences and known distribution for each of the species as an indication as to whether they may occur in the study area, (ii) the best times of year these species may be detected if subject to surveys, and (iii) suitable survey techniques to adequately detect a potential species. If targeted fauna surveys are poorly conducted, inappropriately surveyed and/or undertaken outside known detection periods, then appropriate justification must be provided as to why; if this is not provided or considered inappropriate, then all such affected species will be considered to be present on all available habitat and in viable numbers, and as such will require suitable biodiversity offsets or their habitat avoided.

If animals are captured with an uncertain taxonomy, species should be forwarded to the Australian Museum by a suitably qualified scientific licence holder.

### *Habitat assessment*

Habitat assessment is recommended for all sites and should be used to supplement surveying and survey design. In instances where intensive or species specific surveys have not been carried out due to either timing or seasonality constraints, habitat assessment may be used as a surrogate for intensive surveys. However, in this instance threatened species should be assumed present if their habitat requirements are met. Ensure all impact assessments include a thorough habitat assessment.

Undertaking a habitat assessment of the study area will assist with predicting the occurrence of threatened species in the study area and will guide the location of targeted surveys. A comprehensive habitat assessment should be conducted across the whole site, identifying key habitat features for both flora and fauna.

You should be familiar with the habitat requirements of each threatened species identified as possibly occurring in the study area. This information can be obtained from OEH's recovery plans website ([www.environment.nsw.gov.au/threatenedspecies/recoveryplans.htm](http://www.environment.nsw.gov.au/threatenedspecies/recoveryplans.htm)), threatened species profiles and scientific literature. Threatened species profiles are available on OEH website:

- [www.environment.nsw.gov.au/threatenedspecies/](http://www.environment.nsw.gov.au/threatenedspecies/)

The habitat assessment should include information on:

- landscape features in the study area (e.g. river banks, rocky outcrops, dry slopes, wetlands, undulating terrain)
- any other features that could provide habitat such as hollow-bearing trees or culverts
- the vegetation types present (such as OEH's Biometric vegetation types ([www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm](http://www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm)) and/or appropriate vegetation mapping).



It is important to record all areas of native and introduced vegetation, as even weeds can potentially provide habitat for threatened fauna. As part of the habitat assessment, you should look for:

- hollow-bearing trees, including dead stags;
- bush rock and rocky outcrops;
- natural burrows, such as those of the Hastings River Mouse;
- large trees with basal cavities;
- logs;
- wetlands, streams, rivers, dams and other water bodies;
- nests and roosts;
- wombat burrows;
- dens used by yellow-bellied gliders, squirrel gliders and brush-tailed phascogales;
- yellow-bellied glider and squirrel glider sap feed trees;
- distinctive scats (e.g. those of the spotted-tailed quoll or koala);
- latrine and den sites of the spotted-tailed quoll;
- *Allocasuarina* spp.;
- flying-fox camps;
- Microchiropteran bat tree roosts;
- Microchiropteran bat subterranean roosts (caves, culverts, tunnels and disused mineshafts);
- swift parrot and regent honeyeater feed or nest trees;
- winter-flowering eucalypts;
- mistletoes;
- permanent soaks and seepages; and
- areas that can act as corridors for plant or animal species.

Another important factor to consider is the connectivity value of the site. If the proposal site forms an important corridor in the area, the development is likely to have an effect on threatened species in the region.

A geo-referenced map / aerial photograph (or equivalent), of the study area detailing key habitat features, including the vegetation types, must be included in the report.

### *Flora / Vegetation Survey and Mapping*

Typically a floristic quadrat / transect will be used for vegetation based surveying. This should record the vegetation structure and cover of all structural layers, all species present, including their cover and abundance, and general location (e.g. Global Positioning System (GPS) co-ordinates etc.) and physiographic details (e.g. condition, position in landscape, soils etc.). These techniques are described in the OEH guidelines and are generally the accepted national (NVIS – National Vegetation Inventory System) standard ([www.environment.gov.au/topics/science-and-research/databases-and-maps/national-vegetation-information-system](http://www.environment.gov.au/topics/science-and-research/databases-and-maps/national-vegetation-information-system)). Each stratification unit must be adequately sampled.

All quadrats / transects should be adequately assessed to determine a suitable vegetation classification which accurately reflects the site. This may be done manually, or through the aid of appropriate statistical software / numerical analysis, such as cluster analysis and ordination analysis computer packages (e.g. PATN (Belbin 1989)). The latter will be dependent on how detailed the survey was, the size of the area sampled, the inherent diversity / complexity of vegetation on site and the amount of plot data collected. Details of the classification and how it was determined must be supplied in the report.

To complement and better refine the vegetation classification, ground truthing and aerial photograph or satellite imagery interpretation should be used. This will be used to generate the vegetation map and enable greater definition / delineation of vegetation communities present, and ensure a more accurate map. Ground-truthing and/or Aerial Photograph Interpretation (API) should be conducted at a level which captures all the obvious vegetation changes / communities on the subject site (particularly those that are



noticeable at the ground-level) and ensure that all vegetation communities are adequately delineated on a geo-referenced map (the 'vegetation map'). Floristic quadrats / transects and any associated analysis will help define and describe the communities shown on the vegetation map. Recognition and delineation of native vegetation patterns on aerial photography may be based on combinations of:

- texture (crown size and shape)
- vegetation height and density
- vegetation and background tone and colour
- landuse pattern (non-woody areas).

#### *Determining Biometric vegetation types*

The classification of native vegetation in NSW follows the system described by Dr David Keith in '*Ocean Shores to Desert Dunes: The Native Vegetation of New South Wales and the ACT*' (Keith 2004). This classification scheme divides native vegetation into 17 broad vegetation formations. Each formation consists of a number of vegetation classes. There are 99 vegetation classes.

OEH has developed a 'NSW Vegetation Types Database' for use with the BioMetric tool, which is designed to assist in assessing biodiversity values when preparing property vegetation plans under the *Native Vegetation Act 2003* and BioBanking agreements under the *Threatened Species Conservation Act 1995*. OEH has provided a spreadsheet containing a definition of these vegetation types on a catchment management authority basis, which is located at:

- [www.environment.nsw.gov.au/biobanking/tools.htm](http://www.environment.nsw.gov.au/biobanking/tools.htm)

If you are proposing to conduct a biodiversity assessment using BioBanking Assessment Methodology under Biodiversity Banking and Offsets Scheme, as outlined in the 'BioBanking Assessment Methodology 2014' (OEH 2014), to determine the offset requirements of the proposal, then it is advisable and advantageous that during the survey component of the SIS that you collect the relevant data in the appropriate format for the Biometric tool (i.e. BioBanking Credit Calculator) (\*Note: this may reduce duplication or further surveying at a later date). This process can provide details of the required ecosystem and species (threatened) credits that need to be retired to offset the impacts of the development. Under this scenario all vegetation types in the study area should be identified and matched to a OEH BioMetric vegetation type.

For details on the use of Biometric, the 'BioBanking Assessment Methodology 2014' (OEH 2014) and BioBanking in general refer to the following OEH website (Note: - the new information posted on the OEH website, as detailed above, includes details on site selection, survey intensity and methodology, and vegetation condition measurements):

- [www.environment.nsw.gov.au/biobanking/](http://www.environment.nsw.gov.au/biobanking/)

If a BioBanking assessment is conducted using the Credit Calculator then OEH requests that the proponent provide an explanation of how the local vegetation communities were assigned to Biometric vegetation types, copies of BioBanking Credit Reports, copies of all field data sheets, an explanation of the underlying assumptions used at every step of the BioBanking Credit Calculator (see Section 4.5 below), and the submission of the credit calculator files via the OEH portal (as described in **Appendix 2**).

## **4.2 Documentation of survey effort and technique**

### 4.2.1 Description of survey techniques and survey sites

Survey technique(s) must be described and a reference given, where available, outlining the survey technique employed. Specific subject species targeted by each survey technique should be listed.

Survey site(s) and stratification units must be identified on a geo-referenced map / aerial photograph (or equivalent), with a clear legend, at the same scale as previous maps where possible. The size, orientation and dimensions of a quadrat or a length of transect should be clearly noted for each type of survey technique undertaken. Full Australian Map Grid (AMG) grid (Geocentric Datum of Australia (GDA) compliant) references for the survey site(s) should be noted.

#### 4.2.2 Documenting survey effort

The time invested in each survey technique applied shall be summarised in the SIS e.g. - number of person hours per transect, duration of call playback, number of nights traps set. It is not sufficient to aggregate all time spent on all survey techniques. Effort must be expressed for each separate survey technique and each separate vegetation community. Environmental conditions during the survey should be noted at the commencement of each survey technique.

Personnel details including name of all surveyor(s) and contact phone number should be provided. The person who identified records (e.g. Anabat, hair tubes, motion-sensor camera, and scat analysis) should also be identified.

### **4.3 Survey results**

#### 4.3.1 Subject species survey results

The report should provide a full list of all flora and fauna recorded in the study area / subject site.

Subject species recorded in the study area shall be identified, and the vegetation community in which they were recorded noted. Information concerning all records of threatened species made during the survey is to be provided in an appendix to the SIS. This information is to be in a form consistent with *Atlas of NSW Wildlife* data recording cards and include information for all fields listed on these cards.

The limitations of survey techniques employed (including survey intensity, detectability of species, seasonality, weather conditions and adverse disturbance conditions) must be considered and discussed with respect to the results of the survey, and additional subject species considered to potentially occur in the study area identified. This assessment must be robust to external evaluation.

#### 4.3.2 General species survey results

The SIS must provide details of all the vegetation communities (including disturbed and undisturbed / modified), habitat types, and all fauna and flora recorded on the subject site and study area in general.

A full list of the protected fauna and native plant species (as defined by the *National Parks and Wildlife Act 1974*) found during the course of surveys must be included. Such information is indicative of the habitat quality of the site. This list must indicate the significance of each species, whether the species is introduced, and the habitat in which each species was recorded.

### **4.4 Subject species habitat mapping**

Areas identified as known or potential habitat in the study area are to be mapped on a geo-referenced map / aerial photograph (or equivalent) separately for each of the subject species. These maps should be at the same scale as previous maps where feasible, and are to include any point locality records of the relevant subject species recorded from the SIS survey in the study area. Note: Records obtained from the 'Atlas of NSW Wildlife' database can be used in determining likely habitat, but they are not to be schematically mapped in the SIS, as this is considered a breach of licence conditions for such records.

While in some circumstances the task of identifying potential habitat can be problematic, the SIS should provide the best expert estimate of the habitat of each threatened species, populations and ecological communities known or considered likely to occur in the study area. This is necessary in order to clearly



support conclusions concerning the quantitative significance of habitat loss associated with the proposal. Information which can be used in preparing these maps includes records of threatened species in the local area, maps of vegetation communities and broad habitat types in the study area, information on the habitat requirements of threatened species and site-specific knowledge gained through field survey and inspection during preparation of the SIS.

#### 4.5 General report structure

In summary, the report must include details on the following (but not be limited to):

- a description of the subject site, study area and its regional context; including a geo-referenced map / aerial photograph (or equivalent) indicating their location;
- details of the survey methodology and design adopted, including:
  - the number and location of traps (e.g. cage, Elliott, hair sampling tubes etc.), call playback sites, diurnal searches, random meanders, quadrats and transects,
  - the number of repetitions (Note: – you will need to provide a justification if this differs from the recommendations in these guidelines),
  - details of all floristic plots and/or transects,
  - details of the stratification,
  - identification of the classification system used (e.g. Specht *et. al.* (1974), Walker & Hopkins (1998) [Note: the classification must have regard to both structural and floristic composition elements]),
  - timing of surveying, climatic (weather) conditions and phases of the moon during survey,
  - details of how the vegetation classification for the site was developed, including details and associated products (e.g. dendrograms / two-way tables) of any analyses used, if applicable,
  - copies of any analyses used (e.g. PATN or other statistical files) and all field data sheets, and
  - geo-referenced maps / aerial photographs (or equivalent) showing the location of all survey points, quadrats and transects, and stratification units.
- detailed description of all vegetation communities / types (both undisturbed and disturbed) on the site and study area (it is preferable to link them to, OEH's Plant Community Types / Biometric vegetation types – in which case a step by step summary of how the site vegetation was matched with available Biometric vegetation types should also be included), including a geo-referenced map / aerial photograph (or equivalent) showing their location. The descriptions should include: - a general description, characteristic features (e.g. lacks a mid-storey, restricted to a particular geomorphic / edaphic feature etc.), their distribution and size (e.g. hectares), their vegetation structure (including cover), their condition, key diagnostic species, relationship to other communities, species richness and any significant species present (e.g. threatened species, Rare or Threatened Australian Plants (ROTAP: Briggs & Leigh 1996), regionally significant taxa);
- details of all habitat features / types should be included and mapped (where appropriate), such as frequency and location of stags, hollow bearing trees (including size), mature / old growth trees, culverts, rock shelters, rock outcrops, presence of feed tree / shrub / groundcover species (e.g. winter-flowering eucalypts, *Acacia* and *Banksia* trees, *Casuarina* / *Allocasuarina* and areas of native grasses], crevices, caves, drainage lines, soaks etc.;
- if a BioBanking assessment is conducted for the development site and any offset sites then the proponent must provide:
  - copies of any BioBanking Credit Reports and BioBanking Agreement Credit Reports generated,
  - copies of all field data sheets,
  - copies of a checklist that includes the data and underlying assumptions used at every step of the BioBanking Credit Calculator, and
  - submission of the credit calculator files via the OEH portal (as outlined in **Appendix 2**).
- a list of all flora and fauna detected on the study area / subject site during the surveys, including threatened species. All threatened species, populations and ecological communities must be clearly marked on geo-referenced map / aerial photograph (or equivalent);

- details of how the proposal will impact (both direct and indirect) and affect known and potential threatened species, populations and ecological communities (including their habitat). This is likely to include a revised 5A assessment of significance;
- details of the habitat assessment;
- details of how the proposal may impact on corridors, connective links and fragmentation;
- details of how the proposal will impact (both directly and indirectly) on adjacent and/or nearby OEH conservation estate and/or if applicable, other internationally / nationally important areas, (e.g. Ramsar wetlands, wetlands listed in the Directory of Important Wetlands, SEPP14 mapped wetlands and Forestry flora reserves);
- details of any impacts on or relevance of other environmental policies and/or guidelines (as outlined in Section 2.1.3);
- details of mitigation and offset / compensatory habitat measures;
- details of any other approvals required under any other State and/or Federal legislation;
- names, qualifications and experience of all personnel involved in the field surveys, analysis of results and report writing;
- paper copies of any maps of proposed biodiversity offset areas at A0 or A1 scale that clearly show the location and boundaries of any proposed offset area. These maps must be prepared by a registered surveyor and be proper survey plans that are acceptable to local Councils;
- an assessment of how the project meets the principles of Ecologically Sustainable Development, as defined in section 6(2) of the *Protection of the Environment Administration Act 1991*;
- a discussion of the likely social and economic consequences of granting or of not granting concurrence; and
- any other information outlined elsewhere in these guidelines, such as background and comparisons to previous studies (e.g. vegetation mapping reports), mitigation and offset measures etc. that should be included in the report.

## **5 ASSESSMENT OF LIKELY IMPACTS ON THREATENED SPECIES AND POPULATIONS**

Section 5 need only be addressed if threatened species or endangered populations are likely to be affected.

Assessment of impacts must include the assessment of indirect impacts and those of associated activities, including, but not restricted to: installation and maintenance of utilities, access and egress routes; and changes in surface water flows. These actions or impacts may occur on or off the subject land.

Assessment of impacts must also include an assessment of impacts from the provision of fire protection zones. If, as part of the development, there will be a requirement to provide fuel free and/or fuel reduced zones in retained bushland, the impacts of this on any threatened species and/or populations must be addressed as part of the impacts of the overall proposal. Proponents should also consider recommendations in *'Planning for Bushfire Protection'* (NSW Rural Fire Service 2006) and consider the use of perimeter roads as an option in providing fuel free zones and reducing impacts on retained bushland.

### **5.1 Assessment of species likely to be affected**

*An assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action (Section 110(2)(b)).*

This requirement is asking you to refine your list of subject species and populations (given the outcome of survey and analysis of likely impacts) in order to identify which threatened species or endangered populations may be affected and the nature of the impact.

The remaining requirements in this section need only be addressed for those species that are likely to be affected by the proposal.

## 5.2 Discussion of conservation status

*For each species or population likely to be affected, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it (Section 110 (2)(c)).*

*An assessment of whether those species or populations are adequately represented in conservation reserves (or other similar protected areas) in the region (Section 110 (2)(e)).*

*An assessment of whether any of those species or populations is at the limit of its known distribution (Section 110 (2)(e1)).*

Assessment should include reference to the threatening processes that are generally accepted by the scientific community as affecting the species or population and are likely to be caused or exacerbated by the proposal. Assessment should also include reference to any approved or draft recovery plans which may be relevant to the proposal; including those prepared by other state Governments of the Commonwealth Government.

## 5.3 Discussion of local and regional abundance

*An estimate of the local and regional abundance of those species or populations (Section 110 (2)(d)).*

### 5.3.1 Discussion of other known local populations

A discussion of other known populations in the locality shall be provided, along with an assessment of their regional significance. The long-term security of other habitats shall be examined as part of this discussion. The relative significance of the subject site for threatened species or endangered population in the locality shall be discussed.

### 5.3.2 Discussion of habitat utilisation

An estimate of the numbers of individuals utilising the area and how these individuals use the area (e.g. residents, transients, adults, juveniles, nesting, foraging). This should include discussion of the significance of these individuals to the viability of the threatened species or endangered population in the locality.

### 5.3.3 Description of vegetation

The vegetation present within the study area and the area covered by each vegetation community should be mapped and described, as previously stated in Section 4.3.2.

## 5.4 Assessment of habitat

*A full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region (Section 110 (2)(f)).*

### 5.4.1 Description of habitat values

Specific habitat features shall be described, such as frequency and location of stags, hollow bearing trees (including size), mature / old growth trees, culverts, rock shelters, rock outcrops, presence of feed tree / shrub / groundcover species (e.g. winter-flowering eucalypts, Acacia and Banksia trees, *Casuarina* / *Allocasuarina*, Mistletoes and areas of native grasses), crevices, caves, drainage lines, soaks etc.), and density of understorey vegetation / groundcover.

The condition of the habitat within the study area shall be discussed, including the prevalence of introduced species, species of weeds present and an estimate of the total weed cover as a percentage of each

vegetation community, whether trampling or grazing is apparent, effects of erosion, prevalence of rubbish dumping, history of resource extraction or logging and proximity to roads, and assessment of the potential for native seed bank resilience in disturbed areas.

Details of the fire history of the subject site (e.g. frequency, time since last fire, intensity) and the source of fire history (e.g. observation, local records) shall be provided.

#### 5.4.2 Extent of habitat removal

The location, nature and extent of habitat removal or modification (e.g. including impacts of Asset Protection Zones (APZs)) which may result from the proposed action including the cumulative loss and fragmentation (isolation) of habitat from the study area (including all Development Applications and those areas in the subject area already with development consent or identified for development) and the impacts of this on the viability of the threatened species or endangered population in the locality.

This shall include an assessment of the proportion of the habitat of the affected species to be affected by the proposal, in relation to the total extent of the habitat in the study area and subject site, and the impact of this on the viability of the affected species in the locality.

#### 5.4.3 Consideration of corridors

Areas within the subject site which may act as local or regional corridors (or part thereof) for affected species must be identified and described. A geo-referenced map showing identified corridors must be provided, and the impact of the proposal on these areas shall be discussed. If relevant, this section should include consideration of *Key Habitats and Corridors for Forest Fauna* (NPWS Occasional Paper 32: Scotts 2003) and regional linkages, as identified within *Regional Conservation Assessment, Lower Hunter and Central Coast Region* (2004), or other appropriate studies (e.g. Council specific LES, LEP documents and structure plans).

#### 5.4.4 Impacts on Threatened Species and/or Populations in OEH Estate

This section only needs to be addressed when threatened species and/or populations in OEH estate (e.g. National Parks, Nature Reserves) are likely to be either directly or indirectly impacted upon.

The SIS must assess the potential impacts on any threatened species and/or populations which may likely be directly or indirectly impacted upon that reside with OEH estate, including but not limited to fragmentation or loss of connective linkages, edge effects (e.g. increased boundary to area ratio), increased predation potential, weed invasion, loss or impacts on pollination vectors, changes to hydrology, nutrient increases, pollution, anthropogenic impacts (e.g. increased visitation, refuse) etc.

OEH notes the following conservation estate which contain threatened species in the vicinity (5 km radius) of the proposed development that may be affected or impacted upon either directly or indirectly (e.g. fragmentation or reduction of corridor links): - Brisbane Water National Park, Jiliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrabalong National Park.

### **5.5 Description of feasible alternatives**

*A description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development (Section 110(2)(h)).*

Where a Statement of Environmental Effects (SEE), Environmental Impact Statement (EIS) or Review of Environmental Factors (REF) deals with these matters, the SIS may refer to the relevant section of the SEE, EIS or REF.



This section must include details of the condition and use of other parts of the subject area and why these can or cannot be considered as feasible alternatives.

## **6 ASSESSMENT OF LIKELY IMPACTS ON ECOLOGICAL COMMUNITIES (ENDANGERED AND CRITICALLY ENDANGERED)**

Section 6 need only be addressed when ecological communities are likely to be affected.

Assessment of impacts must include the assessment of indirect impacts and those of associated activities, including, but not restricted to: installation and maintenance of utilities, access and egress routes; and changes in surface water flows. These actions or impacts may occur on or off the subject land.

Assessment of impacts must also include an assessment of impacts from the provision of fire protection zones. If, as part of the development, there will be a requirement to provide fuel free and/or fuel reduced zones in retained bushland, the impacts of this on any endangered and/or critically endangered ecological communities must be addressed as part of the impacts of the overall proposal. Proponents should also consider recommendations in 'Planning for Bushfire Protection' (NSW Rural Fire Service 2006) and consider the use of perimeter roads as an option in providing fuel free zones and reducing impacts on retained bushland.

### **6.1 Assessment of ecological communities (both endangered and critically endangered) likely to be affected**

*A general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110(3)(a)).*

This must include reference to the ecological community as described by the NSW Scientific Committee, including maps of the extent and condition of the community with particular reference to those parts of the community that may only be represented by soil stored seed with no above ground components of the community present.

### **6.2 Discussion of conservation status**

*For each ecological community present, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or any threat abatement plan applying to it (Section 110(3)(b)).*

*An assessment of whether those ecological communities are adequately represented in conservation reserves (or other similarly protected areas) in the region (Section 110(3)(b1)).*

*An assessment of whether any of those ecological communities is at the limits of its known distribution (Section 110(3)(b2)).*

Assessment should include reference to the threatening processes that are generally accepted by the scientific community as affecting the endangered and/or critically endangered ecological community and are likely to be caused or exacerbated by the proposal. The assessment should also include reference to any approved or draft recovery plans which may be relevant to the proposal.

#### **6.2.1 Significance within a local context**

An assessment of the community on the subject site in relation to other sites in the study area and in the locality. The tenure and long term security of other localities shall be examined as part of this discussion.

The relative significance of the subject site for the endangered and/or critically endangered ecological community shall be discussed. The assessment of the community should be considered in terms of the

following features including, the size of the remnant, the quality of the habitat and the level of disturbance on this site in comparison to other sites in the locality.

#### 6.2.2 Discussion of corridor values

The potential of the proposal to increase fragmentation of the community and increase edge effects.

If corridors that allow connectivity between localities of endangered and/or critically endangered ecological communities are present within the subject site, the impact of the proposal on these areas shall also be discussed.

#### 6.2.3 Discussion of regional significance

The significance of the locality for the community from a regional perspective shall be noted and discussed.

#### 6.2.4 Impacts on Ecological Communities in OEH Estate

This section only needs to be addressed when endangered and/or critically endangered ecological communities in OEH estate are likely to be either directly or indirectly impacted upon.

The SIS must assess the potential impacts on any endangered and/or critically endangered ecological communities which may likely be directly or indirectly impacted upon that reside with OEH estate.

OEH notes a number of conservation estates which may contain ecological communities in the vicinity (5 km radius) as outlined in Section 5.4.4.

### **6.3 Assessment of habitat**

*A full description of the type, location, size and condition of the habitat of the ecological community and details of the distribution and condition of similar habitats in the region (Section 110 (3)(c)).*

#### 6.3.1 Description of disturbance history

If the site shows signs of disturbance, details should be provided of the site's disturbance history and an assessment should be made of the ability of the ecological community to recover to a pre-disturbance condition.

#### 6.3.2 Extent of habitat removal

The location, nature and extent of habitat removal or modification which may result from the proposed action including the cumulative loss of habitat from the study area (including all proposed DAs and those areas in the subject area already with development consent or identified for development) and the impacts of this on the viability of the endangered and/or critically endangered ecological community in the locality.

This shall include an assessment of the proportion of the ecological community to be affected by the proposal, in relation to the total extent of the ecological community, and the impact of this on the viability of the ecological community in the locality.

### **6.4 Description of feasible alternatives**

*A description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development (Section 110(3)(e)).*

Where a Statement of Environmental Effects (SEE), Environmental Impact Statement (EIS) or Review of Environmental Factors (REF) deals with these matters, the SIS may refer to the relevant section of the SEE, EIS or REF.

In the discussion of feasible alternatives to the proposed development with regards to biophysical, economic and social considerations, and the principles of ecologically sustainable development, the SIS must also include details on the condition and use of other parts of the subject area and why these can or cannot be considered as feasible alternatives.

## **7 AMELIORATIVE MEASURES**

### **7.1 Description of ameliorative measures**

*A full description and justification of the measures proposed to avoid or mitigate any adverse effect of the action on the species and populations and ecological community including a compilation (in a single section of the statement) of those measures (Section 110 (2)(i) and Section 110 (3)(f)).*

#### 7.1.1 Long-term management strategies

Consideration shall be given to developing long-term management strategies to protect areas within the study area which are of particular importance for the threatened species, endangered populations or endangered / critically endangered ecological communities likely to be affected. This may include proposals to restore, improve or provide long term protection for habitat on site where possible. Any such proposal is to be accompanied by a plan of management identifying the specific areas to be restored, improved or protected, the threatened species / ecological community values of those areas, and detailing the management actions to be implemented to maintain and protect those values, including corrective actions to be taken in the event that monitoring indicates that management does not achieve specified objectives.

#### 7.1.2 Compensatory strategies

OEH notes that its 'offset provision' principles (**Appendix 1**) state that impacts must be avoided first by using prevention and mitigation measures (DECC 2007a). Where significant modification of the proposal to minimise impacts on threatened species, populations or endangered / critically endangered ecological communities is not possible then compensatory strategies should be considered. These should include offsite or local area proposals that contribute to long term conservation of affected threatened species, population or ecological communities. If on or off-site compensatory habitat is not considered appropriate, justification must be provided. OEH is of the opinion that where a proposal which involves the clearing of threatened species habitat (i.e. native vegetation) that cannot be avoided or mitigated against, and then appropriate offsets which compensate for the clearing of the habitat must be provided. The proponent must provide proper survey plans of any biodiversity offsets with the SIS, as described in sections 2.2 and 4.5 above.

Compensatory benefits likely to result from such measures proposed for alternative sites are to be discussed and evaluated along with a discussion of mechanisms of how they might best occur.

The tenure of lands, land use and the future use of lands proposed to support compensatory habitat must be considered.

Justification for any area(s) proposed as compensatory habitat / offsets is to include an assessment of the threatened species / biodiversity values impacted on by the proposed works (i.e. those of the subject site) and a comparison of whether the proposed offset area(s) provides equivalent or greater values – 'improve or maintain important biodiversity values'.

To determine the adequate biodiversity offset required to compensate the loss of threatened species, populations, ecological communities and/or their habitat (e.g. vegetation communities) either one of the following methodologies are to be used:

- OEH's 'offsetting principles', as outlined on OEH's website: *Principles for the use of biodiversity offsets in NSW* (OEH's website - [www.environment.nsw.gov.au/biodivoffsets/index.htm](http://www.environment.nsw.gov.au/biodivoffsets/index.htm)) can be used as general guide for offsetting and compensatory habitat requirements
- a biodiversity assessment using BioBanking Assessment Methodology under Biodiversity Banking and Offsets Scheme, as outlined in the '*BioBanking Assessment Methodology 2014*' (OEH 2014). This would provide details of the required ecosystem and species (threatened) credits that need to be retired to offset the impacts of the development.

Although the '*BioBanking Assessment Methodology (BBAM) 2014*' (OEH 2014) under the Biodiversity Banking and Offsets Scheme represents an alternative pathway to that of the SIS for Part 4 matter, OEH is of the opinion that a biodiversity assessment using process provides a transparent framework and a quantitative alternative to the principles-based approach (i.e. 'offset provision' principles as outlined in the biodiversity accreditation guideline - DECC 2011 – Appendix 1). OEH acknowledges that in this instance BBAM is a voluntary process and not a requirement under the SIS DGRs, but believes it provides a valuable insight and quantitative appraisal into what would be an acceptable offset package to compensate the likely impacts of the development. OEH notes that under the *Principles for the use of biodiversity offsets in NSW* – Principle 9 states that '*offsets must be quantifiable – the impacts and benefits must be reliably estimated*', in that offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. OEH is of the opinion that the BBAM represents the only currently recognised quantitative methodology that ensures offsets are quantifiable.

**Note:** On 1 October 2014, a new version of the BioBanking Credit Calculator (BioBanking Assessment Methodology 2014 [OEH 2014]) has become the compulsory version of the tool to use for BioBanking assessments (see [www.environment.nsw.gov.au/biobanking/calculator.htm](http://www.environment.nsw.gov.au/biobanking/calculator.htm) for more details). The credit calculator is now web-based and no longer produces 'xml' files. Instead a copy of the assessment can be sent electronically to OEH by following the steps outlined in **Appendix 2**. The requirement of submitting background files for OEH to use in checking the BioBanking assessment still stands and is also explained in **Appendix 2**.

The following principles are relevant to areas without an existing biodiversity offsets program. Offsets will require the proponent to consider adequate conservation in perpetuity, appropriate management regimes (including other habitat enhancement or mitigation measures) and financial security with respect to ongoing management. OEH would typically consider suitable measures to ensure conservation in perpetuity, such as:

- the establishment of BioBanking sites with BioBanking agreements under the TSC Act
- the retirement of BioBanking credits (where appropriate credits are available)
- the dedication of land as a public reserve under the NPW Act
- a Conservation Agreement in-perpetuity registered on title under s69A-KA of the NPW Act
- a Trust Agreement in-perpetuity registered on title under the Nature Conservation Trust Act 2001
- a Planning Agreement under s 93F (soon to be s116T) of the EP&A Act.

**Note:**

- OEH preferred method of securing an offset is under the BioBanking provisions of the *Threatened Species Conservation Act 1995* (i.e. a registered BioBanking Agreement site).
- OEH no longer supports public positive covenant under s88E of the *Conveyancing Act 1919* as an appropriate conservation mechanism to secure and/or manage biodiversity offsets.
- Although OEH supports the use of conservation agreements under the NPW Act as one of the acceptable offsetting mechanisms, we are reviewing this approach and it is advisable that if you are considering this mechanism you contact OEH's Conservation Partners Program (ph: 9995 6761) about its applicability.

The principles do not apply where there is legislation defining requirements for biodiversity offsets (e.g. under the *Native Vegetation Act 2003*).

To appropriately manage any proposed compensatory offsets, any retained habitat enhancement features within the development footprint and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs), OEH would require that an appropriate Management Plan (such as



vegetation or habitat) be developed as a key amelioration measure. These plans should be prepared prior to any potential approval of the development. Management Plans should clearly document how any retained vegetated areas or habitat features will be managed with respect to long-term conservation and viability, including clear details on how they will be funded. They should cover (where applicable), but not be limited to, the following issues:

- weed management (both control and suppression) and monitoring
- management of retained native vegetation and habitat (including buffer zones)
- feral animal control
- fire management (including asset protection zones [APZs])
- public access (including restriction of, increased traffic, and associated impacts, such as increased refuse and pets)
- size and management of buffer zones
- minimisation of edge effects and fragmentation
- stormwater control and changes to hydrology (including stormwater / runoff control and sediment / erosion control measures)
- management of specific habitat enhancement measures (e.g. hollow / habitat trees, animal fencing to facilitate movement, artificial hollows and nest boxes etc.)
- fauna displacement and if appropriate translocation (including any licence requirements)
- proposed surveys, such as pre-extraction baseline, pre-clearance and rehabilitation surveys
- details of long-term monitoring (including proposed timing)
- details of any rehabilitation program, including details of timing (including proposed staging details), rehabilitation measures (including details of proposed revegetation and species mix), and post-rehabilitation monitoring
- measures to ensure conservation in perpetuity (e.g. transfer to OEH [NPWS] estate, conservation agreements or covenants)
- funding details of long-term financial commitment to any proposed conservation measures, including any mechanisms to be implemented to achieve this.

### 7.1.3 Ongoing monitoring

Any proposed pre-construction flora, fauna or vegetation monitoring plans or on-going monitoring of the effectiveness of the mitigation measures shall be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency. Generally, ameliorative strategies which have not previously been proved effective should be undertaken under experimental design conditions, appropriately monitored and appropriately analyzed. Data analysis could include an 'Analysis of similarities' (ANOSIM) assessment of changes in foliage cover of plant species recorded in fixed quadrats or transects between sampling periods (Clarke 1993). Objectives of any monitoring plans are to include identifying any modifications needed to improve the effectiveness of ameliorative measures. These aspects should also be covered in any relevant management plans. Additionally a review of management plans should be undertaken at regular intervals (e.g. 5 years) to ensure adaptive management, where required, is undertaken.

## **8 ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION**

An 'Assessment of Significance' (s. 5A EP&A Act) is to be provided for each of the affected species (threatened species, populations or ecological communities) identified in the SIS, incorporating relevant information from sections 5.1 to 7 of the SIS. On the basis of these assessments a conclusion is to be provided concerning whether, based on more detailed assessment through the SIS process and consideration of alternatives and/or ameliorative measures proposed in the SIS, the proposal is still considered likely to have a significant effect on threatened species, populations or ecological communities or their habitats.

The threatened species 'Assessment of significance' should be consistent with those procedures and assessment approaches contained within OEH publication:

- 'Threatened Species Assessment Guidelines: The Assessment of Significance' (DECC – August 2007b). This document is available from OEH's website: [www.environment.nsw.gov.au/threatenedspecies/tsaguide.htm](http://www.environment.nsw.gov.au/threatenedspecies/tsaguide.htm)

## 9 ADDITIONAL INFORMATION

### 9.1 Qualifications and experience

*A species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement (Section 110(4)).*

You should have extensive experience in conducting field surveys and should be able to identify threatened species and their habitats relevant to the study area, as well as any similar species that may be confused with them. You should familiarise yourself with herbarium or museum specimens of any threatened species you are not already familiar with, before you conduct field surveys.

### 9.2 Other approvals required for the development or activity

*A list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population or ecological community (Sections 110(2)(j) and 110(3)(g)).*

In providing a list of other approvals the following shall be included:

- Where a consent is required under Part 4 of the *Environmental Planning and Assessment Act 1979*, the name of the consent authority and the timing of the development application should be included; or
- Where an approval(s) is required under Part 5 of the *Environmental Planning and Assessment Act 1979*, the name of the determining authority or authorities, the basis for the approval and when these approvals are proposed to be obtained should be included; or
- Where an approval(s) is required under *Native Vegetation Act 2003*, the name of the determining authority or authorities, the basis for the approval and when these approvals are proposed to be obtained should be included.

#### Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

An action will require the approval of the Federal Minister for the Environment (in addition to any State or Local Government approval or determination) if that action will have, or is likely to have, a significant impact on a matter of national environmental significance. Threatened species and communities listed in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are considered to be a matter of national environmental significance.

Many of the species and ecological communities listed in the *Threatened Species Conservation Act 1995* (NSW) are also listed in the Commonwealth EPBC Act. Further information regarding the operation of the EPBC Act (including Federally-listed threatened species and communities) may be obtained from the Commonwealth Department of Environment (DOE) website [www.environment.gov.au/](http://www.environment.gov.au/) or by contacting the DOE on (02) 6274 1111.



### 9.3 Licensing matters relating to the survey

Persons conducting flora and fauna surveys must have appropriate licences or approvals under relevant legislation. The relevant legislation and associated licences and approvals that may be required are listed below:

#### *National Parks and Wildlife Act 1974:*

- General Licence (Section 120) to harm or obtain protected fauna (this may include threatened fauna).
- Licence to pick protected native plants (Section 131).
- Scientific Licence (Section 132C) to authorise the carrying out of actions for scientific, educational or conservation purposes.

#### *Threatened Species Conservation Act 1995:*

- Licence to harm threatened animal species, and/or pick threatened plants and/or damage the habitat of a threatened species (Section 91).

#### *Animal Research Act 1985:*

- Animal Research Authority to undertake fauna surveys.

Typically you will require a licence under section 132C of the NPW Act to undertake an activity (e.g. survey) for scientific, educational or conservation purposes that is likely to result in one or more of the following:

- harm to any protected fauna, or to an animal that is a threatened species or is part of an endangered population or an endangered ecological community
- harm to any protected native plant, or any plant that is a threatened species or is part of an endangered population or an endangered ecological community. You will need a licence if you plan to collect voucher specimens for identification purposes, pick cuttings or whole plants, or collect seed
- damage to critical habitat
- damage to a habitat of a threatened species, an endangered population or an endangered ecological community.

Information pertaining to section 132C licences can be obtained from the following website:

- [www.environment.nsw.gov.au/wildlifelicences/ScientificResearchLicences.htm](http://www.environment.nsw.gov.au/wildlifelicences/ScientificResearchLicences.htm)

Section 132C licences came into effect in January 2003 and replaced the previous need for separate licences under other provisions of the NPW Act and the TSC Act.

It is a condition of all licences that you submit a report of the work carried out under the licence, including any results and specific details / locations of all flora and fauna, to OEH within two months of the expiry of the licence.

Also, be aware of the requirements relating to animal care and ethics when conducting wildlife surveys. The handling and capture of animals is regulated by the *NSW Animal Research Act 1985* and the *NSW Animal Research Regulation 1995*, which are administered by Department of Trade and Investment, Regional Infrastructure and Services. The Act requires that every person undertaking animal research must hold an Animal Research Authority. Under the Act, animal research includes the 'use' (e.g. handling, trapping etc.) of animals in field surveys. Details on animal ethics can be obtained from the following website:

- [www.animaletics.org.au/home](http://www.animaletics.org.au/home)

All surveys must be carried out in accordance with the NSW Department of Trade and Investment, Regional Infrastructure and Service's Guidelines for wildlife surveys located at:



- [www.animaethics.org.au/policies-and-guidelines/wildlife-research/wildlife-surveys](http://www.animaethics.org.au/policies-and-guidelines/wildlife-research/wildlife-surveys)

## 9.4 Section 110 (5) reports

Section 110(5) of the *Threatened Species Conservation Act 1995* has the effect of requiring OEH to provide that information regarding the State-wide conservation status of the subject species that it has available, in order to satisfy ss.110(2)&(3) of the Act. These documents are available on the internet at:

- [www.environment.nsw.gov.au/threatenedspecies/index.htm](http://www.environment.nsw.gov.au/threatenedspecies/index.htm)

This website provides basic profiles for the majority of species listed as threatened, as well as links to the Scientific Committee determinations, more detailed profiles, environmental impact assessment guidelines and recovery plans, where these documents are available. OEH is unable to provide any further information for section 110(5) reports.

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**OEH March 2015**

## **APPENDIX 1:**

### **Principles for the use of biodiversity offsets in NSW (OEH 2014)**

Located at: [www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm](http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm)

These principles have been developed by the Office of Environment and Heritage (OEH) to provide a useful framework when considering biodiversity impacts and appropriate offset requirements.

They are intended to be used for proposals other than those for state significant development (SSD) or state significant infrastructure (SSI). A [Biodiversity Offsets Policy for Major Projects](#) has been developed to deal with proposals for SSD and SSI.

#### **1. Impacts must be avoided first by using prevention and mitigation measures.**

Offsets are then used to address the remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.

#### **2. All regulatory requirements must be met.**

Offsets cannot be used to satisfy approvals or assessments under other legislation, such as assessment requirements for Aboriginal heritage sites and for pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).

#### **3. Offsets must never reward ongoing poor performance.**

Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.

#### **4. Offsets will complement other government programs.**

A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks, and incentives for private landholders.

#### **5. Offsets must be underpinned by sound ecological principles.**

They must:

- include the conservation of structure, function and compositional elements of biodiversity, including threatened species
- enhance biodiversity at a range of scales
- consider the conservation status of ecological communities
- ensure the long-term viability and functionality of biodiversity.

Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.

#### **6. Offsets should aim to result in a net improvement in biodiversity over time.**

Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.

Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.

Offsets may include:

- enhancing habitat
- reconstructing habitat in strategic areas to link areas of conservation value
- increasing buffer zones around areas of conservation value
- removing threats by conservation agreements or reservation.

**7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.**

As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.

**8. Offsets should be agreed prior to the impact occurring.**

Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.

**9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.**

Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include:

- the area of impact
- the types of ecological communities and habitat or species affected
- connectivity with other areas of habitat or corridors
- the condition of habitat
- the conservation status and/or scarcity or rarity of ecological communities
- management actions
- level of security afforded to the offset site.

The best available information or data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:

- they protect land with high conservation significance
- management actions have greater benefits for biodiversity
- the offset areas are not isolated or fragmented
- the management for biodiversity is in perpetuity, such as secured through a conservation agreement.

Management actions must be deliverable and enforceable.

**10. Offsets must be targeted.**

They must offset impacts on the basis of like-for-like or better conservation outcomes. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats.

Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.

**11. Offsets must be located appropriately.**

Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.

**12. Offsets must be supplementary.**

They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space, cannot be used as offsets.

**13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or contracts.**

Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.



## APPENDIX 2

### Checklist of information required when utilising the Biobanking Assessment Methodology and Submitting BioBanking assessments to OEH using the BioBanking Credit Calculator v.4.0

The 'Assessors' Guide to Using the BioBanking Credit Calculator v.4.0' has been finalised and it is now available for download from the Office of Environment and Heritage (OEH) website [www.environment.nsw.gov.au/resources/biobanking/120182AssessGdeBBCC.pdf](http://www.environment.nsw.gov.au/resources/biobanking/120182AssessGdeBBCC.pdf). The guide provides information on the operation and use of the web-based BioBanking Credit Calculator version.4.0.

To submit your assessment to OEH, open your assessment in *Edit* mode. Navigate to the *Assessment details* page and select the *Submit* button in the top right hand corner. A *Submit the assessment for approval* box will appear (Figure 1), where you can confirm submission (*OK* button) or cancel submission (*Cancel* button). Once a case has been submitted to OEH, the status of the case will change in your *My work* tab from *Work in progress (WIP)* to *submitted*. Please note that you cannot make any edits to an assessment that has been submitted, although you will be able to view the assessment.

#### Submit the assessment for approval



**Figure 1: Submitting an assessment**

The following documentation must be submitted with your Environmental Impact Statement or Species Impact Statement report (in hard copy and soft copy):

- BioBanking Assessment Report including a list of dominant indigenous species for overstorey, mid-storey and ground cover for each vegetation type and, where required:
  - local benchmark data,
  - request for increase in gain of site value,
  - a description of the proposed development,
  - measures to avoid and mitigate the impacts of development,
  - an assessment of indirect impacts,
  - a statement of onsite measures,
  - a description of the application of the BioBanking Assessment Methodology, including details of and assumptions made in utilising the methodology, such as (but not limited to) placement of assessment circles, remnant value, connectivity and reasoning behind selection of vegetation types in the Biometric Vegetation Type database,
  - plot and transect values including a list of the indigenous plant species identified in each of the plots,
  - a description of targeted threatened flora and fauna surveys, and any general baseline surveys (incl. vegetation specific surveys). These should be also be provided schematically, and

Where required, the BioBanking Assessment Report should also include:

- expert reports,
  - an application for a determination on red flag areas,
  - more appropriate use of local data for vegetation types, benchmarks or threatened species,
  - environmental contributions accompanied by a BioBanking Agreement Credit Report (if applicable), and
  - application for deferred retirement arrangements (if applicable).
- Copies of completed field data sheets, and updated with correct plant taxonomy in instances where field names have been used.
- Maps (soft copy as A4 jpgs) of:

- offset site / BioBanking Agreement boundary or development footprint
- vegetation zones
- management zones
- and where required:
  - existing waste
  - existing erosion
  - existing structures (in waterways)
- Separate shape files should be supplied for all the maps mentioned above plus:
  - plots and transects
  - assessment circles
  - species polygons
  - polygons for adjacent remnant area
  - the location or habitat area of sensitive species, and the management area related to that sensitive species (as this information cannot be displayed publicly).

All maps must include:

- a title (as per the names above)
- the site's name, location and lot/DP numbers
- the scale
- the date it was prepared
- a clear and unambiguous legend.

Boundaries and zones must be confirmed on the site using a GPS. This information should be digitised onto an ortho-rectified aerial photo or SPOT-5 image. Maps must be easily readable and submitted to OEH as a Geographic Information System (GIS) file that is ESRI compatible. Shape files must use GDA94 datum. Name each shape file as: 'biobank site name\_descriptor'. For example, 'Hill Farm\_photo points' or 'Hill Farm\_management zones'.

Photo points should be named A, B, C, D, E, F, G, etc. Photo points should be located in areas where change is expected (i.e. where replanting, natural regeneration, intensive weeding or other active management actions are to be carried out). As a rough guide, include at least one photo point in each management zone where active management actions will be undertaken. Boundaries and zones must be confirmed on the site using a GPS. This information should be digitised onto an ortho-rectified aerial photo or SPOT-5 image. Maps must be easily readable and submitted to OEH as a Geographic Information System (GIS) file that is ESRI compatible.

Shape files must use GDA94 datum. Name each shape file as: 'biobank/development site name\_descriptor'. For example, 'Hill Farm\_photo points' or 'Hill Farm\_management zones'.

Additional requirements for offset sites that may be required (based on liaison with OEH):

- completed biobanking agreement management action template (provided in MS-Word format), and
- Biodiversity Credits Pricing Spreadsheet

Once the case has been received OEH will review the data entered, and any supporting documentation. For State Significant Development (SSD), State Significant Infrastructure and residual Part 3A (under the *Environmental Planning and Assessment Act 1979*) this review will take place during the assessment of the Environmental Impact Statement or Environmental Assessment report (for Part 3A matters).

**ATTACHMENT B:****CHECKLIST FOR DETERMINING IF AN SIS HAS MET THE REQUIREMENTS OF THE MINISTER ADMINISTERING THE THREATENED SPECIES CONSERVATION ACT 1995**

Under the *Environmental Planning and Assessment Act 1979*, where a significant effect on threatened species, populations or ecological communities is likely, a development application must be accompanied by concurrence from the Minister administering the *Threatened Species Conservation Act 1995* (TSC Act). As such a species impact statement prepared in accordance with Division 2 of Part 6 of the TSC Act must accompany the application.

The development is taken not to significantly affect threatened species, populations or ecological communities, or their habitats if:

- a) the development is to be carried out on biodiversity certified land (within the meaning of Part 7AA of the TSC Act, or
- b) a BioBanking statement has been issued in respect of the development under Part 7A of the TSC Act.

Therefore, before deciding to issue consent or approval and consequently requesting the concurrence of the Minister administering the TSC Act, it is required of the consent or determining authority to determine whether the SIS meets the Director General's requirements (DGRs).

This checklist has been drawn up to assist consent and determining authorities in this matter. A comments column has been included to allow authorities to provide, among other things, reasons for their decisions or comments on whether an omission is significant.

Note that this is a generic checklist and some items may not be relevant to the application being reviewed or the Director General's requirements issued. If the requirements do not specify one of the matters below, then it is recommended that this be noted in the comments column. Consultants preparing an SIS may also use this checklist as a brief guide to preparing the SIS.

<b>Matter</b>	<b>Yes/No</b>	<b>Comments</b>
Has the SIS been signed by both its author and the applicant for consent/approval?		
Has the description of the proposal included all associated activities and works, such as hazard reduction zones, access roads and road upgrades, utilities, etc?		
Have all requested plans, maps and aerial photographs been provided? This includes any A1 or A0 sized proper survey plans prepared by a registered surveyor that clearly show the location and boundaries of any proposed offsets.		
Has the SIS determined the subject species by reviewing the suggested list in the DGRs, other available information and survey results and assessing which species, populations and ecological communities are to be impacted by the development?		
Has the survey undertaken provided sufficient information to determine the likely impacts of		

Matter	Yes/No	Comments
the proposal on threatened species, populations and ecological communities?		
Have surveys been undertaken during the appropriate season(s) for the detection of the species that may possibly occur on site?		
Have surveys been undertaken during appropriate weather conditions?		
Have climatic conditions preceding the surveys (e.g. drought c.f. wet) affected the possibility of subject species being detected?		
Have all specific survey methods, techniques and intensities requested in the DGRs been followed completely?		
Has the documentation of survey effort, locations and techniques provided sufficient information to determine the above?		
Has the assessment of impacts included the impacts of ALL activities associated with the development, including fire hazard reduction requirements, access road upgrades, downstream and downslope impacts, detention basins, severing of fauna movement corridors, etc.		
Has the SIS discussed the extent, conservation significance and security of other occurrences of the subject species' in the locality (locality is defined in the DGRs)?		
Has the SIS discussed the significance of the population/remnant to be affected, relative to others within the locality?		
Has the SIS discussed the extent, conservation significance and security of other occurrences of the subject species in the region (region is defined in the TSC Act).		
Has the SIS discussed the significance of the population/remnant to be affected, relative to others within the region?		
Have alternatives to the proposal been discussed? Alternatives may include relocation of infrastructure or, for example, reducing minimum lot size so that a similar number of lots may be realised whilst retaining a larger conservation lot within a subdivision, or changing mining techniques.		
Has the discussion of alternatives included assessment of the social and economic (not merely financial) aspects of these alternatives (particularly, of not proceeding)?		
Has the discussion included an assessment of how the project meets the principles of Ecologically Sustainable Development, as defined in section 6(2) of the <i>Protection of the Environment Administration Act 1991</i> ?		
Have all proposals for compensatory actions		



Matter	Yes/No	Comments
(e.g. purchase of similar vegetation / habitat or revegetation of habitat, where appropriate) been discussed with the relevant landowners/manager?		
Is there documented agreement for sale or revegetation activities?		
Is there agreement to change zoning or enter into a covenant on title in order to secure the conservation of the properties being purchased or revegetated?		
If translocation is proposed, has the impact of the translocation on the recipient site(s) been assessed?		
Is there a 'Plan of Management' or similar titled document?		
Has the SIS utilised relevant information from published draft and final recovery plans? If no plan has been published, but it is known that one is being prepared, has the SIS utilised advice from the NPWS as to the likely contents of that recovery plan (liaison to obtain this advice may have been specified in the DGRs)? For example, would the proposal result in the loss of a local population or remnant that a recovery plan describes as being of particular importance to the conservation of the species, population or ecological community?		
If a BioBanking assessment has been done for the proposal have the following been provided: copies of BioBanking Credit reports, copies of field datasheets, and copies of a checklist that includes all data used in the credit calculator and the underlying assumptions, such as how local vegetation communities were assigned to BioMetric vegetation types?		
Has the SIS discussed the relationship of the proposal to any listed Key Threatening Processes (e.g. does the proposal result in the need for High Frequency Fire as a fire hazard reduction measure, or does it result in the Clearing of Native Vegetation)?		
Has the SIS discussed the relationship of the proposal to any published Threat Abatement Plan (e.g. does the proposal result in an increased threat in a manner that is specifically at odds with a published plan)?		
Has a revised Part 5A assessment of significance been included?		
Has the 'Additional Information' specified in section 9 of the DGRs been provided?		
Have the qualifications and experience of those involved in the surveys been included?		
Have other approvals which are required for		

Matter	Yes/No	Comments
the development or activity been documented?		
Any licensing requirements (e.g. s.91 under TSC Act).		

## Appendix B. Flora species

### KEY TO APPENDIX B

#### ABBREVIATIONS:

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

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

t = listed as a threatened species under State and/or Commonwealth legislation

spp. = unidentified species<sup>2</sup>

sp. aff. = unidentified species with characteristics similar to the indicated species or genus<sup>2</sup>

? = unconfirmed species<sup>2</sup>

r = RoTAP species (Briggs and Leigh 1996)

var. = variety

subsp. = subspecies

agg. = an aggregate of several yet to be defined species

#### COVER/ABUNDANCE SCORES

Modified Braun Blanquet scale

1 = cover less than 5% of site and uncommon

2 = cover less than 5% of site and common

3 = cover of 6-20% of site

4 = cover of 21-50% of site

5 = cover of 51-75% of site

6 = cover of 76-100% of site

#### NOTES:

1. 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.

2. Not all species can be accurately identified in a 'snapshot' survey due to absence of flowering or fruiting material, etc.

#### SCIENTIFIC NAMES & AUTHORITIES:

Scientific names & families are those used in the *Flora of New South Wales* as maintained by the Royal Botanic Gardens (<http://plantnet.rbgsyd.gov.au>).

Orders and higher taxa are based on Angiosperm Phylogeny Group (2003).

For sake of simplicity, scientific names in this list do not include authorities. These can be found in the *Flora of New South Wales*.

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
Conifers															
PINACEAE	<i>Pinus radiata</i>	Monterey Pine i													
Ferns															
ADIANTACEAE	<i>Adiantum hispidulum</i>	Rough Maidenhair												1	
BLECHNACEAE	<i>Blechnum camfieldii</i>	Canfield's Water-fern									2				
BLECHNACEAE	<i>Blechnum cartilagineum</i>	Gristle Fern													
BLECHNACEAE	<i>Blechnum indicum</i>	Swamp Water-fern		1					2						
BLECHNACEAE	<i>Doodia aspera</i>	Prickly Rasp-fern													
CYATHEACEAE	<i>Cyathea cooperi</i>	Scaly Tree-fern				1									
DAVALLIACEAE	<i>Nephrolepis cordifolia</i>	Fishbone Fern i													
DENNSTAEDTIACEAE	<i>Calochlaena dubia</i>	False Bracken		1											
DENNSTAEDTIACEAE	<i>Hypolepis muelleri</i>	Harsh Ground-fern		1	1	3	1	1	2		2		2	2	
DENNSTAEDTIACEAE	<i>Pteridium esculentum</i>	Bracken													
LINDSAEACEAE	<i>Lindsaea microphylla</i>	Lacy Wedge-fern													
MARSILEACEAE	<i>Marsilea hirsuta</i>	Hairy Nardoo													
THELYPTERIDACEAE	<i>Christella dentata</i>	Christella													
THELYPTERIDACEAE	<i>Cyclosorus interruptus</i>	Cyclosorus												2	
Dicotyledons															
ACANTHACEAE	<i>Pseuderanthemum variable</i>	Pseuderanthemum	2												
AMARANTHACEAE	<i>Alternanthera denticulata</i>	Lesser Joyweed							1			1			
APIACEAE	<i>Centella asiatica</i>	Swamp Pennywort					1							2	
APIACEAE	<i>Hydrocotyle bonariensis</i>	Pennywort i													
APIACEAE	<i>Hydrocotyle laxiflora</i>	Stinking Pennywort						1						2	
APIACEAE	<i>Hydrocotyle peduncularis</i>	Hairy Pennywort					1								



FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
APIACEAE	<i>Hydrocotyle tripartita</i>	Tre-foil Pennywort							2						2
APOCYNACEAE	<i>Araujia hortorum</i>	Moth Vine i													
APOCYNACEAE	<i>Marsdenia rostrata</i>	Common Milk Vine	2												
APOCYNACEAE	<i>Parsonsia straminea</i>	Common Silkpod	2	2		2	1	2			2			3	1
ARALIACEAE	<i>Astrotricha latifolia</i>	Broad-leaf Star-hair													
ARALIACEAE	<i>Polyscias sambucifolia</i>	Elderberry Panax	2												
ASTERACEAE	<i>Ageratina adenophora</i>	Crofton Weed i													2
ASTERACEAE	<i>Ageratina riparia</i>	Mistflower i													2
ASTERACEAE	<i>Aster subulatus</i>	Wild Aster i						1							
ASTERACEAE	<i>Bidens pilosa</i>	Cobblers Peg i						1							1
ASTERACEAE	<i>Cirsium vulgare</i>	Spear Thistle i													
ASTERACEAE	<i>Conyza sp.</i>	Fleabane i						1							1
ASTERACEAE	<i>Coreopsis lanceolata</i>	Coreopsis i			1										
ASTERACEAE	<i>Cotula australis</i>	Lawn Cotula													
ASTERACEAE	<i>Hypochaeris radicata</i>	Catsear i	1					2							
ASTERACEAE	<i>Ozothamnus diosmifolius</i>	Tall Paperdaisy						1							1
ASTERACEAE	<i>Senecio madagascariensis</i>	Fireweed i			1			2							
ASTERACEAE	<i>Sigesbeckia orientalis</i>	Indian Weed													2
ASTERACEAE	<i>Sonchus oleraceus</i>	Common Sow-thistle i						1							1
ASTERACEAE	<i>Tagetes minuta</i>	Stinking Roger i			1										
ASTERACEAE	<i>Vernonia cinerea</i> var. <i>cinerea</i>	Vernonia													
BASELLACEAE	<i>Anredera cordifolia</i>	Madeira Vine i													
BIGNONIACEAE	<i>Campsis x tagliabuana</i>	Trumpet Creeper i													
BIGNONIACEAE	<i>Pandorea pandorana</i>	Wonga Vine	2												

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
BRASSICACEAE	<i>Rorippa laciniata</i>	Watercress													1
CAPRIFOLIACEAE	<i>Lonicera japonica</i>	Honeysuckle i			1			2						1	
CARYOPHYLLACEAE	<i>Cerastium vulgare</i>	Mouse Ear Chickweed i													
CARYOPHYLLACEAE	<i>Stellaria media</i>	Common Chickweed i													
CELASTRACEAE	<i>Maytenus silvestris</i>	Forest Maytenus	2												
CONVOLVULACEAE	<i>Dichondra repens</i>	Kidney Weed						2							1
CONVOLVULACEAE	<i>Ipomoea indica</i>	Blue Morning Glory i						2							
ELATINACEAE	<i>Elatine gratioloides</i>	Waterwort										1			
ERICACEAE	<i>Leucopogon juniperinus</i>	Juniper Beard-heath	2												
ERICACEAE	<i>Leucopogon lanceolatus</i> var. <i>lanceolatus</i>	Lance-leaf Beard-heath													
FABACEAE-CAESALPINIOIDEAE	<i>Senna pendula</i> var. <i>glabrata</i>	i				1		2			2			1	2
FABACEAE-FABOIDEAE	<i>Glycine clandestina</i> agg.	Twining Glycine							1						
FABACEAE-FABOIDEAE	<i>Indigofera australis</i>	Native Indigo	2												
FABACEAE-FABOIDEAE	<i>Kennedia rubicunda</i>	Dusky Coral Pea						1							
FABACEAE-FABOIDEAE	<i>Trifolium repens</i>	White Clover i													
FABACEAE-FABOIDEAE	<i>Vicia sativa</i> subsp. <i>sativa</i>	Common Vetch i			1										
FABACEAE-MIMOSOIDEAE	<i>Acacia elata</i>	Cedar Wattle													
FABACEAE-MIMOSOIDEAE	<i>Acacia irrorata</i> subsp. <i>irrorata</i>	Rough Green Wattle						2							
FABACEAE-MIMOSOIDEAE	<i>Acacia longifolia</i> subsp. <i>longifolia</i>	Sydney Golden Wattle													
FABACEAE-MIMOSOIDEAE	<i>Acacia longifolia</i> subsp. <i>sophorae</i>	Coastal Wattle n													
FABACEAE-MIMOSOIDEAE	<i>Acacia maidenii</i>							3	1						
FABACEAE-MIMOSOIDEAE	<i>Acacia prominens</i>	Gosford Wattle						2							
GERANIACEAE	<i>Geranium solanderi</i> var. <i>solanderi</i>	Native Cranesbill						1							
HALORAGACEAE	<i>Gonocarpus teucroides</i>	Raspwort													

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
HALORAGACEAE	<i>Myriophyllum aquaticum</i>	Water-milfoil i								3				2	
IRIDACEAE	<i>Aristea ecklonii</i>	i													
IRIDACEAE	<i>Crocasmia x crocosmiiflora</i>	Montbretia						1							
LAMIACEAE	<i>Prunella vulgaris</i>	Self-heal													
LAURACEAE	<i>Cassytha glabella</i>	Devils Twine	2												
LAURACEAE	<i>Cinnamomum camphora</i>	Camphor Laurel i	2	2		3	1	2	3		3			3	4
LAURACEAE	<i>Cryptocarya glaucescens</i>	Native Laurel													
LAURACEAE	<i>Cryptocarya microneura</i>	Murrogun	3				1								
LOBELIACEAE	<i>Pratia purpurascens</i>	White Root													
LYTHRACEAE	<i>Lagerstroemia indica</i>	Crepe Myrtle i													
LYTHRACEAE	<i>Lythrum hyssopifolia</i>	Hyssop Loosestrife						1							
MALACEAE	<i>Abutilon</i> sp.	Chinese Lantern Hybrid i													
MALACEAE	<i>Cotoneaster glaucophyllus</i>	Cotoneaster i	1												
MALACEAE	<i>Malus pumila</i>	Apple i													3
MALVACEAE	<i>Sida rhombifolia</i>	Paddy's Lucerne i	1												1
MENISPERMACEAE	<i>Stephania japonica</i>	Snake Vine	2												1
MYRSINACEAE	<i>Myrsine howittiana</i>	Brush Muttonwood	2	1					1		1	1			
MYRTACEAE	<i>Acmena smithii</i>	Lilly Pilly										3			
MYRTACEAE	<i>Backhousia myrtifolia</i>	Grey Myrtle													
MYRTACEAE	<i>Callistemon salignus</i>	Willow Bottlebrush	3					1							
MYRTACEAE	<i>Eucalyptus microcorys</i>	Tallowwood n													
MYRTACEAE	<i>Eucalyptus pilularis</i>	Blackbutt	3												
MYRTACEAE	<i>Eucalyptus robusta</i>	Swamp Mahogany		3		3		4	3	2	4	4		4	
MYRTACEAE	<i>Eucalyptus saligna</i>	Sydney Blue Gum	3					3							

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
MYRTACEAE	<i>Melaleuca biconvexa</i>	Biconvex Paperbark t		3		3	1	3	5	2	4	3		4	3
MYRTACEAE	<i>Melaleuca linariifolia</i>	Snow-in-Summer						2		3				1	
MYRTACEAE	<i>Melaleuca styphelioides</i>	Prickly Paperbark													
MYRTACEAE	<i>Rhodamnia rubescens</i>	Brush Turpentine	2												
MYRTACEAE	<i>Syncarpia glomulifera</i>	Turpentine	3												
MYRTACEAE	<i>Syzygium oleosum</i>	Blue Lilly Pilly	1												
OCHNACEAE	<i>Ochna serrulata</i>	Ochna i	2								2				1
OLEACEAE	<i>Ligustrum lucidum</i>	Large-leaf Privet i						2							
OLEACEAE	<i>Ligustrum sinense</i>	Small-leaf Privet i	2	1	1	2	1	2	4		3	1		2	6
ONAGRACEAE	<i>Ludwigia longifolia</i>	Long-leaf Willow Primrose i													
OXALIDACEAE	<i>Oxalis perennans</i>														
OXALIDACEAE	<i>Oxalis purpurea</i>	i													1
PASSIFLORACEAE	<i>Passiflora edulis</i>	Passion-fruit i													
PHORMIACEAE	<i>Dianella caerulea</i>	Blue Flax Lily												1	
PHYLLANTHACEAE	<i>Breynia oblongifolia</i>	Breynia	2												
PHYLLANTHACEAE	<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	Cheese Tree	3	1		1		1	1		1	1		1	1
PHYTOLACCACEAE	<i>Phytolacca octandra</i>	Inkweed i													1
PITTOSPORACEAE	<i>Billardiera scandens</i>	Apple-berry	2												
PITTOSPORACEAE	<i>Pittosporum revolutum</i>	Yellow Pittosporum	1												
PITTOSPORACEAE	<i>Pittosporum undulatum</i>	Native Daphne		1		1									
PLANTAGINACEAE	<i>Plantago lanceolata</i>	Plantain i													
POLYGONACEAE	<i>Acetosa sagittata</i>	Rambling Dock i						2							
POLYGONACEAE	<i>Persicaria decipiens</i>	Slender Knotweed								2			2		1
POLYGONACEAE	<i>Persicaria hydropiper</i>	Water Pepper												2	



FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
POLYGONACEAE	<i>Persicaria praetermissa</i>				1					3			2	2	
POLYGONACEAE	<i>Rumex crispus</i>	Curled Dock													
PROTEACEAE	<i>Hakea salicifolia</i>	Willow Hakea													
PROTEACEAE	<i>Persoonia linearis</i>	Narrow-leaf Geebung	2												
RANUNCULACEAE	<i>Clematis glycinoides</i>	Entire-leaf Clematis	2												
RANUNCULACEAE	<i>Ranunculus inundatus</i>	River Buttercup							1	2			2		
RANUNCULACEAE	<i>Ranunculus repens</i>	Creeping Buttercup i						2	3						
RHAMNACEAE	<i>Alphitonia excelsa</i>	Red Ash	2												
RHAMNACEAE	<i>Pomaderris</i> spp.	Pomaderris	2												
ROSACEAE	<i>Rubus fruticosus</i> agg.	Blackberry i		1	1	1		2						1	1
ROSACEAE	<i>Rubus moluccanus</i> var. <i>trilobus</i>	Broad-leaf Bramble													
ROSACEAE	<i>Rubus rosifolius</i>	Rose-leaf Bramble													
RUBIACEAE	<i>Morinda jasminoides</i>	Morinda					1		1						
RUBIACEAE	<i>Opercularia hispida</i>	Hairy Stinkweed													
RUTACEAE	<i>Acronychia oblongifolia</i>	Common Acronychia													
RUTACEAE	<i>Melicope micrococca</i>	White Euodia	2												
RUTACEAE	<i>Nematolepis squamea</i> subsp. <i>squamea</i>	Satinwood													
SALICACEAE	<i>Salix babylonica</i>	Weeping Willow i													
SALICACEAE	<i>Salix cinerea</i>	Pussy Willow i													
SCROPHULARIACEAE	<i>Veronica plebeia</i>	Trailing Speedwell						1							
SOLANACEAE	<i>Duboisia myoporoides</i>	Poison Corkwood	2												
SOLANACEAE	<i>Solanum mauritianum</i>	Wild Tobacco i													2
SOLANACEAE	<i>Solanum nigrum</i>	Black Nightshade i													1
VERBENACEAE	<i>Lantana camara</i>	Lantana i	4					2							3

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
VERBENACEAE	<i>Verbena bonariensis</i>	Purple Top i			1			2							1
VERBENACEAE	<i>Verbena rigidus</i>	Creeping Verbena i													
VIOLACEAE	<i>Viola hederacea</i>	Ivy-leaf Violet							1						
VITACEAE	<i>Cayratia clematidea</i>	Slender Grape													
VITACEAE	<i>Cissus hypoglauca</i>	Five-leaf Water Vine													
<b>Monocotyledons</b>															
ANTHERICACEAE	<i>Chlorophytum comosum</i>	Chlorophytum i													
ARACEAE	<i>Gymnostachys anceps</i>	Caterpillar Flower	2												
ARACEAE	<i>Zantedeschia aethiopica</i>	Arum Lily		3	1	3	1	2	1	3	3		3	3	
ARECACEAE	<i>Archontophoenix cunninghamiana</i>	Bangalow Palm													
ARECACEAE	<i>Livistona australis</i>	Cabbage Tree Palm				1					3	4		1	
ASPARAGACEAE	<i>Asparagus aethiopicus</i>	Asparagus Fern i	2												
COMMELINACEAE	<i>Commelina cyanea</i>	Scurvy Weed													
COMMELINACEAE	<i>Tradescantia fluminensis</i>	Wandering Jew i						2							2
CYPERACEAE	<i>Baumea articulata</i>	Jointed Twig-rush				2							3		
CYPERACEAE	<i>Carex appressa</i>	Tussock Tassel-sedge			1				2	3				2	2
CYPERACEAE	<i>Carex fascicularis</i>	Drooping Tassel-sedge											2		
CYPERACEAE	<i>Cyperus brevifolius</i>	Mullumbimby Couch													
CYPERACEAE	<i>Cyperus eragrostis</i>	Umbrella Sedge i						2							
CYPERACEAE	<i>Cyperus polystachyos</i>	Bunchy Flat-sedge													
CYPERACEAE	<i>Eleocharis sp.</i>						1			2					
CYPERACEAE	<i>Gahnia clarkei</i>	Tall Saw-sedge		1		4		2			3			4	
CYPERACEAE	<i>Isolepis inundata</i>	Club-rush													2
CYPERACEAE	<i>Isolepis prolifera</i>	Club-rush i							1						

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
CYPERACEAE	<i>Lepidosperma concavum</i>														
CYPERACEAE	<i>Lepidosperma laterale</i>	Variable Sword-sedge													
DIOSCOREACEAE	<i>Dioscorea transversa</i>	Native Yam	2	1											
IRIDACEAE	<i>Watsonia borbonica</i> subsp. <i>ardernei</i>	Watsonia i						1							
JUNCACEAE	<i>Juncus planifolius</i>	Broadleaf Rush											1		2
JUNCACEAE	<i>Juncus polyanthemus</i>	A Rush								1			1		
JUNCACEAE	<i>Juncus prismatocarpus</i>	Branching Rush													
JUNCACEAE	<i>Juncus usitatus</i>	Common Rush						2	1						3
JUNCAGINACEAE	<i>Triglochin microtuberosum</i>									3				2	
LEMNACEAE	<i>Lemna disperma</i>	Duckweed													
LILIACEAE	<i>Lilium formosanum</i>	Formosan Lily			1										
LOMANDRACEAE	<i>Lomandra longifolia</i> subsp. <i>longifolia</i>	Spiny Mat-rush	2					1							
LUZURIAGACEAE	<i>Eustrephus latifolius</i>	Wombat Berry	2						1						
LUZURIAGACEAE	<i>Geitonoplesium cymosum</i>	Scrambling Lily	2					1	1						
ORCHIDACEAE	<i>Epidendrum radicans</i> x <i>secundum</i> hybrid complex	Crucifix Orchid i													
PHORMIACEAE	<i>Dianella caerulea</i> var. <i>producta</i>	Stemmed Blue Flax Lily	2	1											
POACEAE	<i>Andropogon virginicus</i>	Whisky Grass i						2							
POACEAE	<i>Arundo donax</i>	Giant Reed i													
POACEAE	<i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass i													
POACEAE	<i>Chloris gayana</i>	Rhodes Grass i													
POACEAE	<i>Cynodon dactylon</i>	Common Couch													
POACEAE	<i>Digitaria diffusa</i>	Open Summer-grass	2												
POACEAE	<i>Ehrharta erecta</i>	Panic Veldtgrass i													
POACEAE	<i>Eleusine tristachya</i>	Crab Grass i													

FAMILY	SPECIES	COMMON NAME	PLOT NUMBER												
			1	3	2	4	5	6	7	8	9	10	11	12	13
POACEAE	<i>Entolasia marginata</i>	Margined Panic	2					2	2						
POACEAE	<i>Eragrostis tenuifolia</i>	Elastic Grass i													
POACEAE	<i>Imperata cylindrica</i>	Blady Grass	2												
POACEAE	<i>Isachne globosa</i>	Swamp Millet								2					
POACEAE	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass							2						
POACEAE	<i>Oplismenus aemulus</i>	Broad-leaf Beard-grass						1							
POACEAE	<i>Oplismenus imbecillis</i>	Narrow-leaf Beard-grass						2	2						3
POACEAE	<i>Panicum maximum</i> var. <i>maximum</i>	Guinea Grass i													
POACEAE	<i>Paspalum dilatatum</i>	Paspalum i						2							
POACEAE	<i>Paspalum urvillei</i>	Vasey Grass i													
POACEAE	<i>Phragmites australis</i>	Common Reed													
POACEAE	<i>Poa</i> sp.		3												
POACEAE	<i>Setaria gracilis</i>	Slender Pigeon Grass i													
POACEAE	<i>Sporobolus africanus</i>	Parramatta Grass i													
POACEAE	<i>Themeda australis</i>	Kangaroo Grass													
SMILACACEAE	<i>Smilax australis</i>	Lawyer Vine	2												
TYPHACEAE	<i>Typha orientalis</i>	Broad-leaf Cumbungi			1					3			5	1	
ZINGIBERACEAE	<i>Hedychium gardnerianum</i>	Ginger Lily i		1							1				



## Appendix C. Fauna species

Family / Scientific Name	Common Name	status*		Habitat in study area								
		TSC Act	EPBC Act	Open Wetland			Swamp Forest				Moist Forest	Modified / disturbed
				Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9
BIRDS												
MEGAPODIIDAE												
<i>Alectura lathami</i>	Australian Brush-turkey	P									x	
ANATIDAE												
<i>Chenonetta jubata</i>	Australian Wood Duck	P		x								
<i>Anas castanea</i>	Chestnut Teal	P		x								
<i>Anas superciliosa</i>	Pacific Black Duck	P		x								
PHALACROCORACIDAE												
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	P		x								
ARDEIDAE												
<i>Bubulcus ibis</i>	Cattle Egret	P	M					x				
<i>Egretta novaehollandiae</i>	White-faced Heron	P		x					x			
THRESKIORNITHIDAE												
<i>Threskiornis moluccus</i>	Australian White Ibis	P		x								
FALCONIDAE												
<i>Falco cenchroides</i>	Nankeen Kestrel	P									x	
RALLIDAE												
<i>Porphyrio porphyrio</i>	Purple Swamphen	P		x				x				
CHARADRIIDAE												
<i>Vanellus miles</i>	Masked Lapwing	P		x				x				
COLUMBIDAE												

Family / Scientific Name	Common Name	status*		Habitat in study area								
		TSC Act	EPBC Act	Open Wetland			Swamp Forest				Moist Forest	Modified / disturbed
				Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9
<i>Columba leucomela</i>	White-headed Pigeon	P									x	
<i>Streptopelia chinensis</i>	Spotted Dove	E	E								x	
<b>CACATUIDAE</b>												
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	P					x		x		x	
<i>Cacatua roseicapilla</i>	Galah	P						x				
<i>Cacatua sanguinea</i>	Little Corella	P		x			x					
<b>PSITTACIDAE</b>												
<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	P							x			
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	P		x	x	x	x	x	x		x	
<i>Alisterus scapularis</i>	King Parrot	P		x	x							
<i>Platycercus eximius</i>	Eastern Rosella	P		x			x					
<b>CUCULIDAE</b>												
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	P						x	x			
<i>Chrysococcyx lucidus</i>	Shining bronze-cuckoo	P			x							
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	P									x	
<b>PODARGIDAE</b>												
<i>Podargus strigoides</i>	Tawny Frogmouth	P					x				x	
<b>ALCEDINIDAE</b>												
<i>Alcedo azurea</i>	Azure Kingfisher	P		x								
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	P		x			x	x				
<b>MALURIDAE</b>												
<i>Malurus cyaneus</i>	Superb Fairy Wren	P		x	x		x	x	x		x	

Family / Scientific Name	Common Name	status*		Habitat in study area								
		TSC Act	EPBC Act	Open Wetland			Swamp Forest				Moist Forest	Modified / disturbed
				Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9
PARDALOTIDAE												
<i>Pardalotus punctatus</i>	Spotted Pardalote	P									x	
<i>Pardalotus striatus</i>	Striated Pardalote	P		x	x							x
ACANTHIZIDAE												
<i>Acanthiza lineata</i>	Striated Thornbill	P		x		x		x	x			
<i>Acanthiza nana</i>	Yellow Thornbill	P						x				
<i>Acanthiza pusilla</i>	Brown Thornbill	P		x					x			
<i>Sericornis citreogularis</i>	Yellow-throated scrubwren	P				x	x		X			
<i>Sericornis frontalis</i>	White-browed Scrubwren	P		x	x	x	x	x	x			
MELIPHAGIDAE												
<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	P		x	x	x		x				
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	P						x	x			
<i>Meliphaga lewinii</i>	Lewins Honeyeater	P		x	x	x	x	x	x		x	
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	P		x				x				
<i>Manorina melanocephala</i>	Noisy Miner	P		x			x				X	
<i>Manorina melanophrys</i>	Bell Miner	P									x	
<i>Anthochaera carunculata</i>	Red Wattlebird	P		x			x	x				
<i>Anthochaera chrysoptera</i>	Little Wattlebird	P		x		x	x		x			
<i>Philemon corniculatus</i>	Noisy Friarbird	P							x			
PETROICIDAE												
<i>Eopsaltria australis</i>	Eastern Yellow Robin	P		x	x	x	x	x	x		x	
EUPETIDAE												

Family / Scientific Name	Common Name	status*		Habitat in study area								
		TSC Act	EPBC Act	Open Wetland			Swamp Forest				Moist Forest	Modified / disturbed
				Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9
<i>Psophodes olivaceus</i>	Eastern Whipbird	P		x		x	x	x				
<b>PACHYCEPHALIDAE</b>												
<i>Pachycephala pectoralis</i>	Golden Whistler	P		x	x			x	x		x	
<i>Pachycephala rufiventris</i>	Rufous Whistler	P			x							
<b>DICRURIDAE</b>												
<i>Rhipidura albiscapa</i>	Grey Fantail	P		x	x	x	x		x		x	
<i>Rhipidura leucophrys</i>	Willie Wagtail	P										x
<i>Monarcha melanopsis</i>	Black-faced Monarch	P	M		x				x			
<i>Grallina cyanoleuca</i>	Magpie Lark	P		x			x					
<b>CAMPEPHAGIDAE</b>												
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-Shrike	P					x	x				
<b>ARTAMIDAE</b>												
<i>Strepera graculina</i>	Pied Currawong	P						x				
<i>Cracticus nigrogularis</i>	Pied Butcherbird	P					x					
<i>Cracticus torquatus</i>	Grey Butcherbird	P										x
<i>Gymnorhina tibicen</i>	Australian Magpie	P										x
<b>CORVIDAE</b>												
<i>Corvus coronoides</i>	Australian Raven	P									x	
<b>PTILONORHYNCHIDAE</b>												
<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird	P					x					
<b>ESTRILDIDAE</b>												
<i>Neochmia temporalis</i>	Red-browed Firetail	P		x	x		x	x			x	



Family / Scientific Name	Common Name	status*		Habitat in study area								
		TSC Act	EPBC Act	Open Wetland			Swamp Forest				Moist Forest	Modified / disturbed
				Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9
HIRUNDINIDAE												
<i>Hirundo neoxena</i>	Welcome Swallow	P										x
ZOSTEROPIDAE												
<i>Zosterops lateralis</i>	Silvereye	P				x		x	x			
PYCNONOTIDAE												
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	E	E		x	x		x	x			
PASSERIDAE												
<i>Passer domesticus</i>	House Sparrow	E	E									x
STURNIDAE												
<i>Sturnus vulgaris</i>	Common Starling	E	E									x
MAMMALS												
Dasyuridae												
<i>Antechinus stuartii</i>	Brown Antechinus	P							x			
Pseudocheiridae												
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	P					x				x	
Acrobatidae												
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	P									x	
Pteropodidae												
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V				x	x	x	x		
Vespertilionidae												
<i>Vespadelus vulturnus</i>	Little Forest Bat	P						x				
Muridae												

Family / Scientific Name	Common Name	status*		Habitat in study area								
		TSC Act	EPBC Act	Open Wetland			Swamp Forest				Moist Forest	Modified / disturbed
				Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9
<i>Hydromys chrysogaster</i>	Water-rat	P		x								
<i>Rattus rattus</i>	Black Rat	E	E	x								
<b>Leporidae</b>												
<i>Oryctolagus cuniculus</i>	Rabbit	E	E									x
<i>Lepus capensis</i>	Brown Hare	E	E									x
<b>AMPHIBIANS</b>												
<b>Myobatrachidae</b>												
<i>Crinia signifera</i>	Common Eastern Froglet	P		x	x	x	x	x	x			
<i>Limnodynastes peronii</i>	Brown-striped Frog	P		x	x	x			x	x		
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	P					x	x				
<b>Hylidae</b>												
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	P		x	x	x			x	x		
<i>Litoria tyleri</i>	Tyler's Tree Frog	P		x	x							
<b>REPTILES</b>												
<b>Scincidae</b>												
<i>Egernia major</i>	Land Mullet	P		x								
<i>Eulamprus quoyii</i>	Eastern Water-skink	P		x	x	x						
<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink	P					x	x	x		x	
<i>Lampropholis guichenoti</i>	Pale-flecked Garden Sunskink	P									x	
<i>Tiliqua scincoides</i>	Eastern Blue-tongue	P									x	

\* P = Protected, V = Vulnerable, M = Migratory, E = Exotic

## **Appendix D. Wetland Management Plan**

# Upgrade of the Pacific Highway – HW10 Ourimbah Street to Parsons Road, Lisarow

NSW ROADS AND MARITIME SERVICES

Wetland Management Plan

Final

16 June 2016



**JACOBS**



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**Important note about your report**

The sole purpose of this report and the associated services performed by Jacobs is to provide a Wetlands Management Plan in accordance with the scope of services set out in the contract between Jacobs and Roads and Maritime. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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## Glossary

Acronym or term	Definition
AEP	Annual Exceedance Probability. The likelihood of a flood of given size or larger occurring in any one year.
AIAS	Australian Institute of Agricultural Science
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand.
BAM	BioBanking Assessment Methodology
CAWS	Council of Australasian Weed Societies
CEMP	Construction Environment Management Plan
CMA	Catchment Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBH	Diameter and Breast Height (refers to measure of tree girth)
DEC	Department of Conservation – now OEH
DECC	Department of Environment Climate Change – now OEH
DECCW	Department of Environment Climate Change and Water – now OEH
DEH	Department of Environment and Heritage (Commonwealth) – now DoE
DoE	Department of Environment (Commonwealth)
DPI	NSW Department of Primary Industries (Fisheries)
DSEWPac	Department of Sustainability Environment, Water, Population and Communities (Commonwealth) – now DoE
EEC	Endangered Ecological Community
EPA	Environmental Protection Agency
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESCP	Erosion and Sediment Control Plan
EWMS	Environmental Work Method Statements
FFMP	Flora and Fauna Management Plan
FM Act	<i>Fisheries Management Act 1994</i>
G36	Roads and Maritime Services G36 Environmental Protection specification
G38	Roads and Maritime Services G38 Soil and Water Management (Soil and Water Management Plan) specification.
GPS	Global Positioning System
Local Area	The area with a 10 kilometres radius of the study area
LGA	Local Government Area
MNES	Matters of National Environmental Significance (Commonwealth)
NPWS	National Parks and Wildlife Service (now included under OEH)
NRM	Natural Resource Management
NSW	New South Wales
OEH	Office of Environment and Heritage
PMF	Probable Maximum Flood
Project Footprint	The area of direct impact required for the proposal and the associated infrastructure and construction compounds
Proposal	The proposed Pacific Highway road upgrade between Ourimbah Street and Parsons Road
RAMSAR	List of Wetlands of International Importance



Acronym or term	Definition
REF	Review of Environmental Factors
Roads and Maritime	Roads and Maritime Services
RTA	Roads and Traffic Authority – now Roads and Maritime
SARDI	South Australian Research and Development Institute
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
SMART Principles	A broad framework for defining management goals being an acronym of Smart, Measurable, Achievable, Results-based and Time-based.
SWMP	Soil and Water Management Plan
Study Area	Between Ourimbah Street and Parsons Road within the Gosford Local Government Area
Sucker	Botanical term for a basal shoot that grows from the base of a tree or shrub
TEC	Threatened Ecological Community
TSC Act	<i>Threatened Species Conservation Act 1995</i>
TSPD	OEH Threatened Species Profile Database
TSS	Total Suspended Solids
TSSC	Threatened Species Scientific Committee
USA	United States of America
WMP	Wetland Management Plan

# 1. Introduction

## 1.1 Project overview

The NSW State Infrastructure Strategy outlines the progressive upgrading of the Pacific Highway to a four-lane road between North Gosford and the M1 Pacific Motorway. This was divided into five progressive stages by NSW Roads and Maritime Services (Roads and Maritime), two of which are now complete. As a part of Stage 3, Roads and Maritime proposes to upgrade 1.6 kilometres of the Pacific Highway between Ourimbah Street and Parsons Road at Lisarow (the proposal). The study area is illustrated on **Figure 1-1**. For further information on upgrade projects along the Pacific Highway on the Central Coast visit [www.rms.nsw.gov.au/projects/central-coast/pacific-highway](http://www.rms.nsw.gov.au/projects/central-coast/pacific-highway)

The Review of Environmental Factors (REF) identified a significant impact on a population of *Melaleuca biconvexa* (Biconvex Paperbark) listed as vulnerable under the *Environmental Planning and Biodiversity Conservation Act, 1999* (EPBC Act) and the *NSW Threatened Species Conservation Act 1995* (TSC Act). The loss of habitat for threatened fauna species and two endangered ecological communities (EECs) listed under the (TSC Act) was also identified. Because of this, a Species Impact Statement (SIS) was prepared and this Wetland Management Plan (WMP) is a component of the SIS and associated mitigation strategy. The footprint of the proposal is shown in **Figure 1-2**.

## 1.2 Background to the management plan

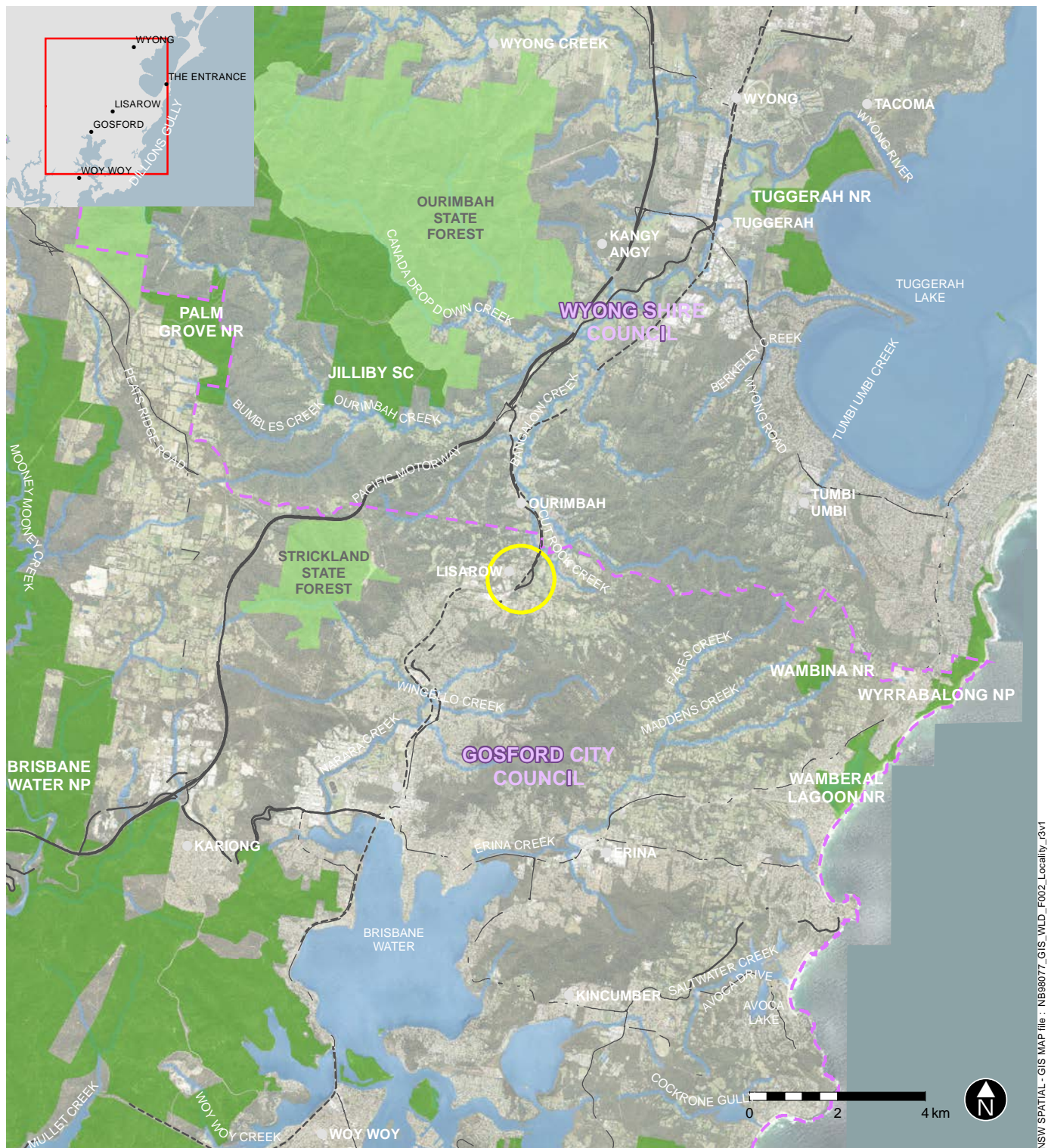
A REF has been prepared under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). A Biodiversity Assessment Report and SIS reported the extensive coverage of surface water at this site associated with forested and open freshwater wetlands located east and west of the highway. A large population of the threatened Biconvex Paperbark (*Melaleuca biconvexa*) was identified as a component of the dominant swamp sclerophyll vegetation community in the study area; refer to **Figure 1-3**. *Melaleuca biconvexa* is listed as vulnerable under the *Threatened Species Conservation Act, 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

Freshwater wetlands in the project area are consistent with the EEC listing under the TSC Act; referred to as *Freshwater wetlands on coastal floodplains of the NSW North coast, Sydney Basin and South East Corner bioregions* (Freshwater Wetlands). Adjacent to the freshwater wetlands are areas of swamp forest consistent with the EEC listing under the TSC Act; identified as *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (Swamp Sclerophyll Forest). Surrounding low hills comprise moist open forest types, refer to **Figure 1-4**.

For the purposes of this report, the project area has been split into three interconnected wetlands comprised mainly of Freshwater Wetland and Swamp Sclerophyll Forest EEC habitat. The nominal boundaries and extents of these three wetland areas (A, B & C) are shown in **Figure 1-5**.

An Assessment of Significance in the project REF found that the proposal is likely to have a significant impact on *Melaleuca biconvexa*. Therefore, a SIS was prepared under Section 110 of the TSC Act (Jacobs 2016). A separate referral to the Commonwealth Department of the Environment (DoE) is not required due to a strategic agreement between Roads and Maritime and DoE in May 2015 for Part 5 projects.

The REF and SIS reported measures to mitigate the impact of the project on the two EECs – Freshwater Wetlands and Swamp Sclerophyll Forest (referred herein as wetlands for this purposes of this plan), as well as the *Melaleuca biconvexa* population. This included the preparation of a wetland management plan.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_WLD\_F002\_Locality\_13v1

Figure 1-1 | Regional locality

### Legend

<span style="border: 2px solid yellow; display: inline-block; width: 20px; height: 10px;"></span>	The project location	<span style="border-bottom: 2px solid blue; width: 20px;"></span>	Watercourse	<span style="background-color: #92d050; display: inline-block; width: 20px; height: 10px;"></span>	National Parks and Reserves
<span style="border-bottom: 2px solid black; width: 20px;"></span>	Road	<span style="background-color: #add8e6; display: inline-block; width: 20px; height: 10px;"></span>	Water body	<span style="border-bottom: 2px dashed magenta; width: 20px;"></span>	Local Government Area
<span style="border-bottom: 2px dashed black; width: 20px;"></span>	Railway	<span style="background-color: #90ee90; display: inline-block; width: 20px; height: 10px;"></span>	State forest		

Roads and Maritime Services 2016  
AUSIMAGE 2015  
LPI 2015  
Jacobs 2016



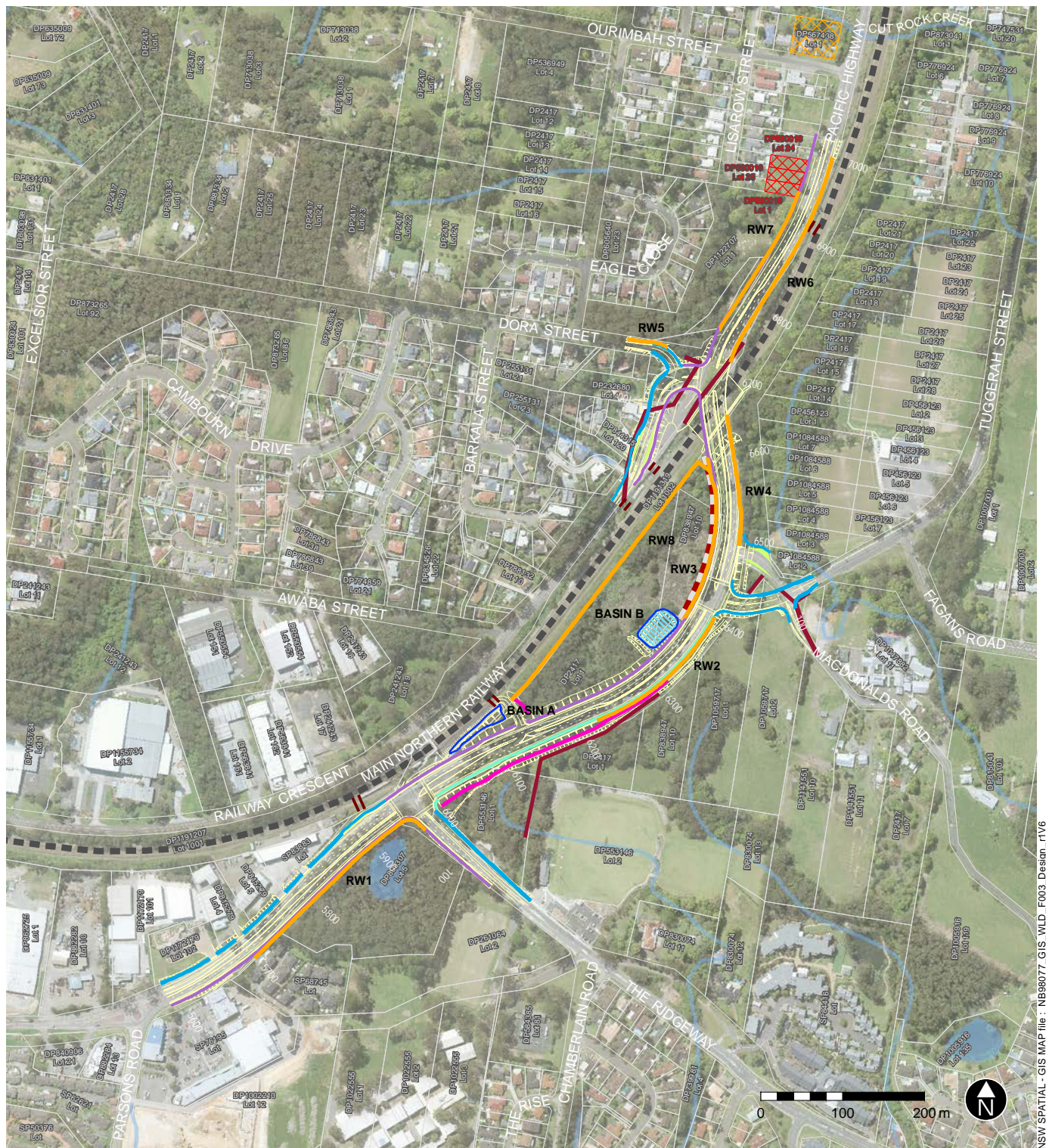


Figure 1-2 | The proposal

### Legend






	Concept design		Construction sediment basin		New footpath
	Retaining wall		Construction sediment basin and operational water quality basin		Shared pedestrian and cycle path
	Power line		Vegetated swale		Existing footpath
	Stockpile site		Construction access road		Cadastre
	Compound site stage 3a		Bus-bay, stop or lane		Railway
	Existing rail gate				

Roads and Maritime Services 2016  
AUSIMAGE 2015  
LPI 2015  
Jacobs 2016





### Legend

- |  |  |
|--|--|
|  Concept design |  Biconvex Paperbark ( <i>Melaleuca biconvexa</i> ) population |
|  Retaining wall |  Watercourse  |
|  Power line     |  |

Ref\_Design7D.dwg  
 Roads and Maritime Services 2014  
 AUSIMAGE 2014  
 LPI 2014  
 Jacobs 2014





Figure 1-4 | Threatened ecological communities

### Legend

- Concept design
- Retaining wall
- Power line
- Watercourse

### Threatened ecological communities

- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

### Condition of vegetation

- High
- Moderate
- Low

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014












NSW SPATIAL - GIS MAP file : NB98077\_GIS\_WLD\_F001\_Wetlands\_R114

Figure 1-5 | Wetlands A, B, C and Cut Rock Creek

### Legend

	Concept design		Cut Rock Creek
	Retaining wall		Unnamed watercourse
	Power line		Wetland (comprised of Alluvial Paperbark Sedge Forest and Freshwater Wetlands)
	Watercourse		

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



### 1.3 Purpose and objectives

The Wetland Management Plan describes the potential impacts of the proposal on the two endangered ecological communities and *Melaleuca biconvexa* and documents an approach to managing impacts during construction. A program for monitoring the effectiveness of the construction mitigation measures is also outlined to provide a scope for corrective actions if required. The specific objectives of the plan are to provide:

- An effective wetland management plan that addresses the mitigation requirements of the Species Impact Statement.
- A suite of targeted management measures to be implemented during the pre-construction, construction and the first year of post construction and establishment stages of the project. These management measures are aimed at minimising the identified potential impacts on *Melaleuca biconvexa* and the Freshwater Wetlands and Swamp Sclerophyll Forest.
- A program to monitor the effectiveness of the proposed construction management actions (including initial landscaping and weed management) that will inform the need to apply corrective actions.

Avoidance and mitigation measures in this project already include a suite of design elements to improve drainage in the study area and are discussed in this plan. Roads and Maritime have conducted a thorough review of potential long term mitigation measures for this project. The review outcomes found that there are no reasonable and feasible measures available for long term mitigation. Consequently, Roads and Maritime have determined that any possibility of indirect impacts on habitat for threatened plant species, resulting from long term drainage changes, will be calculated conservatively based on the best available information. Possible impacts will be included in the project offset strategy along with direct and indirect construction impacts. This will ensure that these impacts are adequately considered in any project decision to proceed.

### 1.4 Management structure and plan updates

Management goals and actions have been prepared for the anticipated impacts of the proposal and would be monitored and evaluated using an appropriate threshold. If the monitoring and evaluation identifies poor performance below an identified threshold the intention is to identify corrective actions to be applied to improve mitigation performance. The management goals presented in the plan are based on the SMART principles being:

- **Specific.**
- **Measurable.**
- **Achievable.**
- **Results-based.**
- **Time-based.**

General responsibilities for environmental management during the project would be outlined in the Project specific Construction Environment Management Plan (CEMP) and sub-plans, including the Flora and Fauna Management Plan (FFMP). The FFMP will be prepared in accordance with the Roads and Maritime Services *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) (Biodiversity Guidelines) and Section 4.8 of *QA Specification G36 Environment Protection*, and *G38 Soil and Water Management* and *G40 Clearing and Grubbing*. These management plans would be prepared prior to the commencement of construction and this Wetland Management Plan would also form a sub-plan to the CEMP. Roads and Maritime and the construction contractor would be responsible for implementing the activities in this WMP and would include the engagement of suitably qualified specialists to undertake and oversee ecological and water monitoring activities.



The plan is intended to be a dynamic document subject to continual improvement as required. When received, all conditions and requirements from the Office of Environment and Heritage (OEH) SIS concurrence and subsequent reviews will be incorporated into an updated version of this Wetland Management Plan.

## 1.5 Authors and expert review

The qualifications and experience of the Jacobs ecologists responsible for preparing this Wetlands Management Plan are summarised in **Table 1-1**.

**Table 1-1 Qualifications and experience of authors of the Wetlands Management Plan**

Personnel	Qualifications	Experience
Chris Thomson	Bachelor of Applied Science (Coastal Management), University of New England. Graduate Certificate in Natural Resources, University of New England.	20 years' experience in biodiversity survey and assessment and preparation of ecological management and monitoring plans.
Andrew Carty	Bachelor of Environmental Science - University of Newcastle. Natural Area Restoration and Management Cert. IV Hunter Institute TAFE. Bush Regeneration Cert. II Hunter Institute TAFE.	Andrew is an Ecological Consultant with over 12 years' experience specialising in botany and flora ecology, including the preparation and implementation of ecological management and monitoring plans.
Lukas Clews	Master of Scientific Studies, University of New England). Diploma of Conservation and Land Management, Riverina Institute of TAFE. Graduate Certificate in Applied Science, Charles Sturt University. Bachelor of Science, University of Newcastle.	10 years' experience in biodiversity survey and assessment and preparing ecological management plans
Brenton Hays	Bachelor of Environmental Science and Management (Honours), University of Newcastle.	Graduated from Honours degree in 2014, has completed at least 4 years in flora and fauna survey

The draft version of the wetland management plan has been reviewed by an independent expert, Geoff Sainty, and any necessary changes that arose from that review as agreed with Roads and Maritime have been updated in the final plan. Geoff Sainty is recognised as a leading wetlands scientist in Australia and has over 40 years' experience specialising in wetlands and weed management. Geoff has spent 20 years working for the NSW Department of Water Resources and seven years working as a consultant for CSIRO Division of Land and Water. Since 1981, Geoff has been the director of Sainty and Associates Pty Ltd specialising in research in wetlands, wetland construction, terrestrial and aquatic weed control, pesticide residues, biological control, wetland and estuary and saltmarsh restoration and wetland management. Geoff has also co-authored more than 30 peer-reviewed technical papers on water plants and wetland management and environmental issues. Geoff has the following qualifications:

- Professional Wetland Scientist – (number 000786), Society of Wetland Scientists Wetland Certification Program, 1996.
- Diploma Agriculture (Wagga), 1955.
- Graduate Diploma in Extension, University of Western Sydney, 1980.
- Churchill Fellowship, wetland/weed management, USA, 1973.

- Honorary Research Associate, Royal Botanic Gardens, 1986 to present date.
- Fellow of Australian Institute of Agricultural Science (IAIST) 2003.
- CAWS Medal. Australian Weed Science Societies 2004.

## 2. Wetlands in the study area

### 2.1 Overview

The proposed Pacific Highway upgrade at Lisarow is currently surrounded by forested wetlands and semi-permanent open ponds. There has been considerable alteration of the natural surface hydrology in this location over a number of years associated with the network of roads, rail and urban development within the surrounding catchment. In particular the changes have likely caused more frequent periods of inundation and persistent soil waterlogging on the margins of the open water areas. This has caused a change in the structure of the vegetation over time from a swamp forest community to an open wetland in parts dominated by rushes and sedges in fringe areas with an observed loss of trees.

Filamentous algae (*Spirogyra* and *Rhizoclonium*) were observed in drainage areas adjacent to the highway at the northern end and adjacent to The Ridgeway. This indicates higher than normal nutrient availability in the system. These aquatic habitats were also observed to be impacted by large volumes of silt, rubbish, potential hydrocarbon slicks and invasion of weeds. The altered hydrology and influx of urban run-off has also changed the composition and structure of flowering plants in the wetter zones and in turn probably the aquatic life. There has been no long term measurements, coupled with reference sites, to establish the extent of the change that appears now.

Despite the degree of modification and degradation that is evident in the wetland habitats surrounding the study area, key ecological features persist, including:

The vegetation communities located within the low-lying areas of the study area are listed as Endangered Ecological Communities (EECs) under the TSC Act and include:

- *Freshwater wetlands on coastal floodplains of the NSW North coast, Sydney Basin and South East Corner bioregions.*
- *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.*

An important regional population of the threatened Biconvex Paperbark (*Melaleuca biconvexa*) listed as a vulnerable species under the TSC Act and EPBC Act.

Habitat for listed threatened fauna species including winter food resources for the Grey-headed Flying-fox (*Pteropus poliocephalus*), Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*) (EPBC Act and TSC Act) and Little Lorikeet (*Glossopsitta pusilla*) (TSC Act).

### 2.2 Freshwater wetland and swamp forest habitat

The location of the freshwater wetlands addressed in this management plan are identified on **Figure 1-5** and described in detail in **Sections 2.2.1 to 2.2.3**.

#### 2.2.1 Wetland A

This area includes the 'Lisarow Wetland' located at the south-western end of the study area in a vegetated corner between the Pacific Highway, The Ridgeway and Lisarow High School. The Lisarow High School has a bush regeneration program for areas of the EEC located near to the wetland. The Lisarow Wetland is part of a long-term key management site for the conservation of *Melaleuca biconvexa* as part of the Saving our Species program, further detail provided in **Section 2.3**.

Wetland A consists of a large open area of ponded water approximately 700 m<sup>2</sup>. The area has several standing dead trees around the perimeter and numerous fallen trees within the deep water section. The changed hydrology described previously has resulted in change in the temporary pooling of water in this

wetland and hence the aquatic plant composition within the wetland. The increased pooling has caused soil waterlogging around the perimeter of the pond resulting in dieback of the trees on the wetland margins. This wetland slowly overflows to the north underneath The Ridgeway into Wetland C where it drains again under the Pacific Highway into the downstream channel of Cut Rock Creek.

The surrounding habitat is swamp sclerophyll forest dominated by Swamp Mahogany (*Eucalyptus robusta*) and Biconvex Paperbark (*Melaleuca biconvexa*). Other small tree species in this community include Cheese Tree (*Glochidion ferdinandi*), Cabbage Tree Palm (*Livistona australis*) and Snow-in-summer (*Melaleuca linariifolia*). The understorey supports a low to moderate diversity of sedges and herbs including Tall Saw-sedge (*Gahnia clarkei*), Tall Sedge (*Carex appressa*), Spike-rush (*Eleocharis* sp.) and Harsh Ground-fern (*Hypolepis muelleri*). The surrounding swamp forest community is in a disturbed condition (refer to **Plate 2-1**) resulting from weed invasion, urban runoff and altered hydrology from surrounding development, and exhibits a moderate to high abundance of the exotic weeds Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*).



Plate 2-1 Open water section of Wetland A (fallen trees can be seen in central and rear)

### 2.2.2 Wetland B

This area consists of a shallow wetland located to the west of the Pacific Highway and east of the rail line. Wetland B occupies a large portion of the 'D-shaped' parcel of land between the Pacific Highway, Lisarow Station and the Lisarow Rail Overbridge. This wetland is ephemeral and dominated by tall Cumbungi (*Typha orientalis*) 2–3 metres in height. This native plant is well known to invade nutrient enriched shallow wetlands and out-compete most other native aquatic plants of similar height. Its dense growth will also limit light penetration into aquatic habitats in the wetland. Run-off from existing development around Wetlands A and C continues to drain to parts of Wetland B. This causes very shallow standing water to enter from a culvert to the south of the Pacific Highway. Additional inputs of stormwater also enter Wetland B from a culvert underneath the Main Northern Railway Line from Railway Crescent to the west. The wetland eventually drains to Cut Rock Creek at the northern end under the Pacific Highway, near the Lisarow Rail Overbridge and Pluim Park Reserve.



Cumbungi (*Typha orientalis*) and Tall Sedge (*Carex appressa*) (refer to **Plate 2-2**), cover the entire portion of the wetland and no areas of open water are present. Other plants present on the drier edges of the wetland include Harsh Ground Fern (*Hypolepis muelleri*) and Knotweed (*Persicaria* spp.). This wetland is in relatively good condition with limited weed invasion; however urban runoff and modified hydrology from past disturbance are likely to have resulted in some transition from a swamp forest community to a shallow treeless wetland. The wetland is ephemeral throughout and likely to regularly cycle between wet and dry depending on rainfall and local flooding. The deepest areas of water range from 0.5 to 1.0 metre and occur at the southern end in the adjoining swamp sclerophyll forest. Substantial pockets of *Melaleuca biconvexa* surround the fringes of Wetland B.



Plate 2-2 Portion of freshwater Wetland B between the highway and rail line dominated by Cumbungi and Tall Sedge, with *Melaleuca biconvexa* shown in the drier margins in the background

### 2.2.3 Wetland C

Wetland C is a small wetland directly opposite the Lisarow train station on the south-eastern side of the highway, which captures overflow from Wetland A and an unnamed creek running parallel to The Ridgeway which is piped below the sports field. The wetland eventually drains to the north along the highway to join Cut Rock Creek via a series of natural and artificial drainage lines. A small portion of the wetland drains into Wetland B via two culverts located to the north of the Pacific Highway and The Ridgeway intersection.

Wetland C is also likely ephemeral although water is expected to persist even in drier times similar to Wetland A. Its area is small in size approximately 800 m<sup>2</sup> and comprises the same suite of macrophytes, fringing vegetation and surrounding small sclerophyll plant species as the other two described wetlands. There are a higher proportion of weeds at this location, as well as sediment deposits, algal growth and small sections of open water. However, the site is predominately a swamp sclerophyll community including numerous occurrences of *Melaleuca biconvexa*, refer to **Plate 2-3**.



Plate 2-3 Southern end of Wetland B, comprising swamp sclerophyll forest with *Melaleuca biconvexa* and small areas of persistent water.

### 2.3 *Melaleuca biconvexa* population

*Melaleuca biconvexa* is widespread throughout the study area and occurs as a dominant mid-storey tree species within the dominant Alluvial Paperbark Forest vegetation community. A detailed description of the species profile, its habitat and life-cycle is provided in **Appendix A**.

The distribution and abundance of the population was identified from surveys conducted for the REF and SIS in habitats affected by the proposal. This included stem counts and estimates of projected foliage cover within eight 20 x 20 metre sample plots. The visual assessment and stem count methods were modified from Duncan (2001) and aimed at reporting on the density of plants. Further detail on the methodology and assumptions used in calculations can be found in the project REF and SIS.

Major habitats for *Melaleuca biconvexa* are shown in **Figure 1-3** and include:

- On the corner of the Pacific Highway and The Ridgeway surrounding Wetland A.
- East and west of the Pacific Highway through the central portion of the upgrade area and surrounding Wetland B and C. It is particularly present in the 'D-shaped' parcel of land between the highway and the rail corridor surrounding Wetland B and north of The Ridgeway surrounding Wetland C.

The extent of direct habitat removal due to the proposal will be up to 2.61 hectares of land currently occupied by the *Melaleuca biconvexa* population. The number of individual *Melaleuca biconvexa* impacted was calculated using the direct and indirect impact areas multiplied by the density of mature stems (as determined by plot assessments) and taking into consideration a likely survival threshold (refer Section 5.4.1 of the SIS for details on calculations). The number of individuals impacted equates to 2,575 (direct loss 2,153 + indirect loss 422).



The local population within the study area has been identified using GIS and based on mapping the patches in the direct impact area as well as proximal areas connected by spaces less than 500 metres apart. The local population is about 13.35 hectares in size. The proposal would have direct impacts to around 19.55 per cent of the local population.

The *Melaleuca biconvexa* population at Lisarow is considered an 'important population' according to the definition provided under the *Matters of National Environment Significance Significant Impact Guidelines 1.1 (SIG1.1) Environment Protection and Biodiversity Conservation Act 1999* (DoE 2013). According to the guidelines an 'important population' is a population that is necessary for a species long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

The portion of the *Melaleuca biconvexa* population located in the Lisarow Wetland (Wetland A) is also one of three populations identified by the OEH as eligible for receiving conservation investment under the NSW 'Saving our Species' program (refer to **Figure 2-1**). This program recognises it as critical for the long-term survival of the species and is important for maintaining a key source population for the recovery of the species in the NSW central coast region. The proposal will directly impact on around 0.68 hectares of the 54 hectare SOS conservation site, which includes Lisarow Wetland, located to the south east of the intersection of the Pacific Highway and The Ridgeway intersection.

## 2.4 Habitat for threatened and migratory fauna

Habitat for local fauna in the study area is associated with the open wetlands, in which a number of common amphibian, birds and mammals are known from surveys. These wetland habitats provide important food resources and refuge for nectivorous fauna including listed threatened species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Anthochaera phrygia*) and Little Lorikeet (*Glossopsitta pusilla*). This is largely due to the presence and abundance of Swamp Mahogany (*Eucalyptus robusta*), a winter-flowering eucalypt species important during resource bottlenecks in the cooler months.

The habitat would also provide only very marginal nesting and roosting habitat for migratory birds and does not constitute 'an important area of habitat' as defined in the EPBC Act policy 3.21.

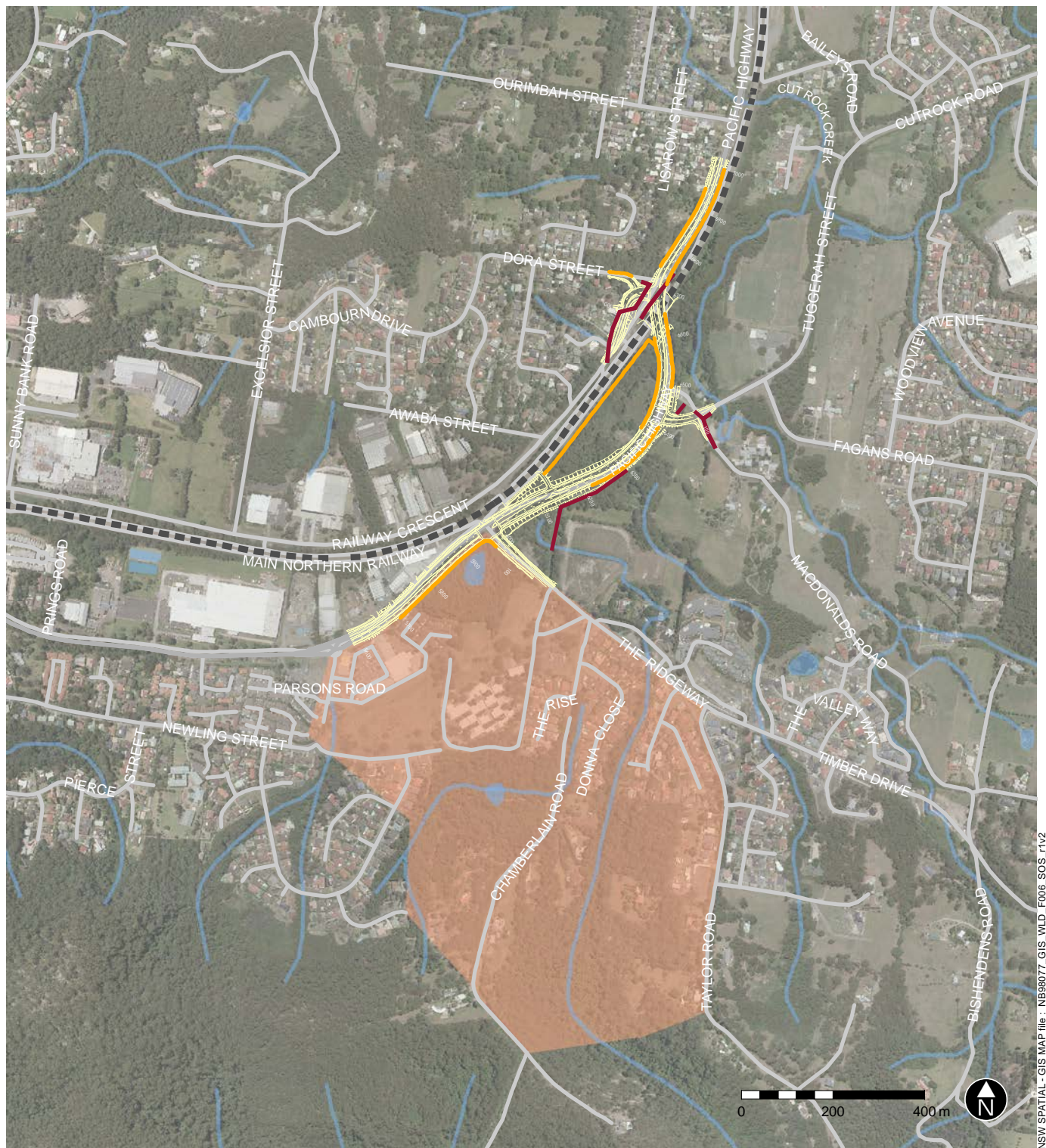








Figure 2-1 | Saving our Species site

### Legend

-  Concept design
-  Retaining wall
-  Power line
-  Watercourse
-  Highway/motorway
-  SOS site

Roads and Maritime Services 2014  
 AUSIMAGE 2014  
 LPI 2014  
 Jacobs 2014



### 3. Potential impacts on subject wetlands

#### 3.1 Existing threats to the wetland values

To provide some context to the cumulative impacts on the wetlands, it is important to identify existing threats to the EEC's and *Melaleuca biconvexa* in the study area, which include:

- Direct clearing of *Melaleuca biconvexa* and associated habitat for past urban and rural activities.
- Altered surface and groundwater hydrology regimes.
- Trampling and grazing by livestock.
- Increased pollution and nutrient influx from adjoining land uses.
- Weed invasion.

Most populations of *Melaleuca biconvexa* throughout its regional distribution are on private properties. Therefore, there is limited knowledge regarding the existing threats and associated management requirements.

The main threats on the wetlands in the immediate study area are associated with altered hydrology regimes and weed invasion, particularly competition with large trees and shrubs including Privet species (*Ligustrum* species), Camphor Laurel (*Cinnamomum camphora*) and Typha in wetland areas. Weed invasion in the study area is likely to be facilitated by previous clearing/disturbance as well as increased nutrient loads and weed seeds from urban runoff. Surrounding land uses include cattle grazing in habitat for *Melaleuca biconvexa*, which results in habitat degradation including reduced seedling recruitment, root damage and erosion.

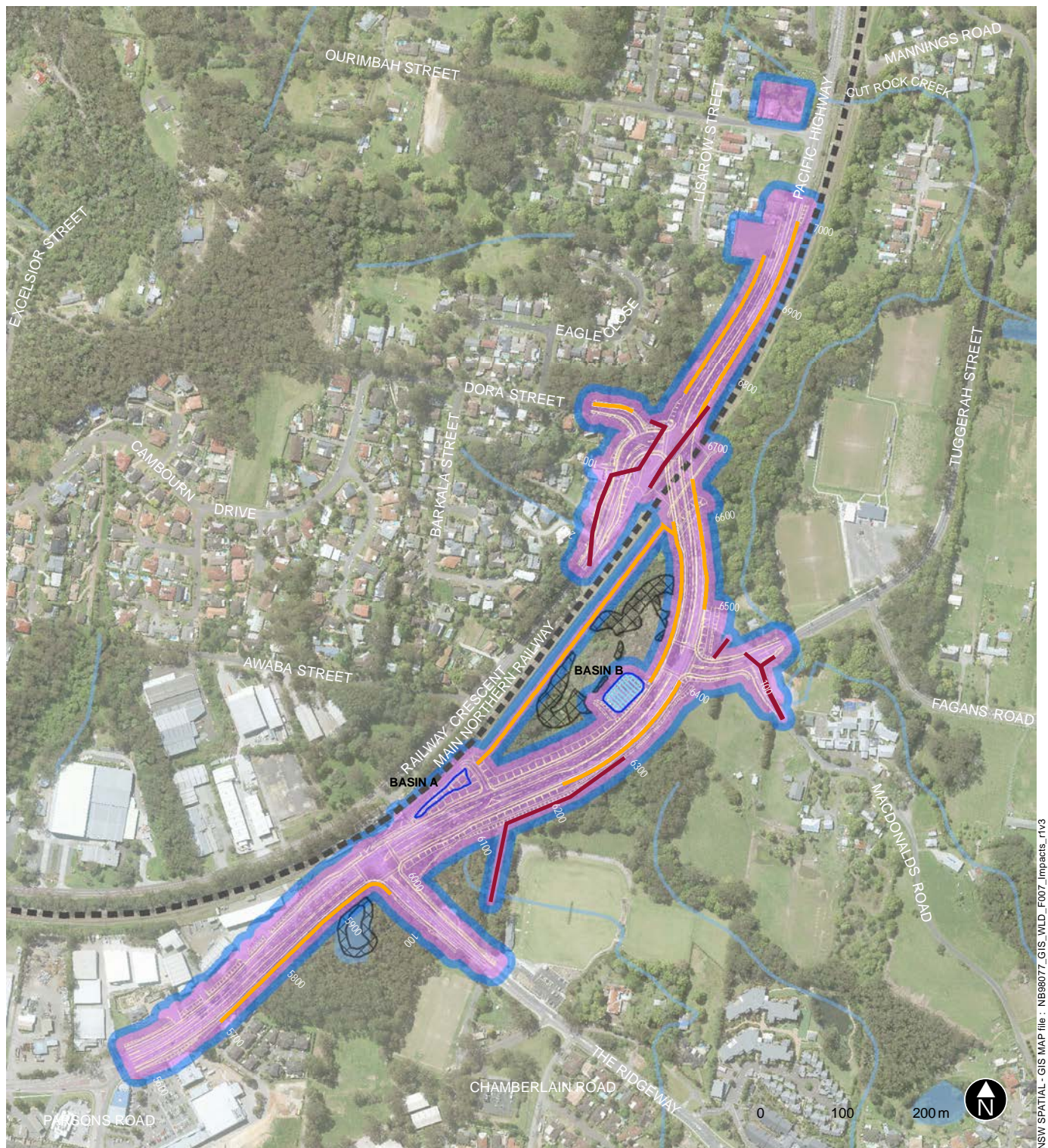
#### 3.2 Direct impacts

The area of land affected by direct clearing as part of the proposal and at risk of damage during construction was estimated in the REF (refer to **Figure 3-1**) based on the following criteria:

- The concept project footprint including drainage with a 10 metre construction buffer.
- Sediment and operational water quality basin/s with a 10 metre buffer.
- Retaining wall along the railway corridor between Lisarow railway Station and the Lisarow Rail Overbridge with a five metre buffer.
- Realigned power lines with a five metre buffer.
- Proposed ancillary facility sites including crane pad sites, stockpile sites and the compound site, although these would be placed in cleared areas when available and practical.

##### 3.2.1 Clearing of wetland vegetation











Based on the above criteria the potential direct loss of vegetation and habitat is presented in **Table 3-1** and includes the 10 metre construction buffer.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_WLD\_F007\_Impacts\_r1v3

Figure 3-1 | Areas of direct impact and indirect impact associated with the proposal

### Legend

	Concept design		Construction sediment basin		Permanent impact
	Retaining wall		Construction sediment basin and operational water quality basin		Indirect construction impact
	Power line				Indirect operational impact
	Railway				

Roads and Maritime Services 2016  
AUSIMAGE 2015  
LPI 2015  
Jacobs 2016



**Table 3-1 Likely loss of wetland vegetation and fauna habitat**

Vegetation zone	Biometric vegetation type	PCT ID	Status (TSC Act)	Habitat type	Direct impact (ha)
1: Alluvial Paperbark Sedge Forest	Melaleuca biconvexa - Swamp	1723	Endangered Ecological Community (EEC)	Swamp forest	1.48
2: Alluvial Paperbark Sedge Forest - Poor Condition	Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)		Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest)		1.30
<i>Paperbark / Sedge Forest Sub-total</i>					<i>2.78 ha</i>
3: Freshwater Wetland	Typha rushland (HU951)	1737	Endangered Ecological Community (EEC)	Open wetland	0.32
4: Freshwater Wetland - Poor Condition			Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South Basin and South East Corner Bioregions (Freshwater Wetlands)		0.03
<i>Freshwater wetland sub-total</i>					<i>0.35 ha</i>
<b>TOTAL WETLAND IMPACT</b>					<b>3.13 ha</b>

### 3.2.2 *Melaleuca biconvexa* population

Direct impacts from the proposal include the removal of the habitat currently occupied by the population through widening of the road, drainage infrastructure, relocation of utilities and intersection upgrades. The extent of direct impacts is around 2.61 hectares supporting up to 2,153 mature stems.

*Melaleuca biconvexa* is mainly associated with the low-lying swamp forest habitats in the study area, particularly in the margins of the wetlands, although the species also occurs on higher elevated island pockets within the freshwater wetland areas. Low numbers also occur in the ridge at the northern end of the project in Coastal Narrabeen Moist Forest. Surveys completed as part of the SIS confirmed that the local population of *Melaleuca biconvexa* within the study area (patches connected with <500 metres space) is about 13.35 hectares in size. The upgrade would therefore potentially directly impact on around 19.55 per cent of the local population that has been identified and mapped within 500 metres of the proposal.

## 3.3 Indirect impacts

### 3.3.1 *Melaleuca biconvexa* adjacent to the project

There is potential for further indirect impacts to *Melaleuca biconvexa* as a result of small modifications to hydrology regimes. To calculate the area of potential indirect operational impact it is hypothesised that the small changes in hydrology from the proposal may cause the areas of Freshwater Wetland to increase along its peripheries. This will in turn cause a change in species composition favouring other flood tolerant Swamp Sclerophyll plant species over *Melaleuca biconvexa*. Therefore a conservative indirect impact area during operation of the proposal has been calculated and the total area is around 0.73 hectares, and is based on:

- A 10 metre buffer on the inner edge of mapped *Melaleuca biconvexa* located within Wetland A.
- A 20 metre buffer on the inner edge of mapped *Melaleuca biconvexa* located within Wetland B as there is a larger hydrological change during flood events (ie 0.2 to <0.40 metres).
- Removal of all the areas already accounted for within the direct impact footprint.

A survival threshold has been applied to the area of *Melaleuca biconvexa* within the indirect operation impact area. This has considered that 30 per cent of the trees in the indirect impact area may continue to survive as healthy trees able to reproduce. Of the remaining 70 per cent, a proportion of these may die and a proportion will survive in poor health and low ability to reproduce, making them vulnerable to other anthropogenic and stochastic disturbance events. Potential indirect impacts have been estimated at 422 mature individuals.

Flood modelling in the REF has been used to predict the indirect impacts on the local population on *Melaleuca biconvexa* and the wetland EECs adjoining the upgrade. The model indicates there will be an increased depth of inundation under some of the flood scenarios assessed, which will potentially result in persistent ponds of water throughout swamp forest habitats and waterlogging of soils around the perimeter of the ponds. These hydrological modifications as a result of the proposal will potentially exacerbate the existing stresses to the system which is currently subject to indirect impacts from previous modifications to the original hydrology regime.

The change in depth of water from flood events during operation of the road within the three wetlands ranges from small to moderate (refer below) and in most cases are above the existing hydrological regime. The model of actual extent of flooding across the population indicates that these increased depths will not extend beyond the predicted existing extent of flooding and this is largely constrained by existing development.

Offsets have been proposed to compensate for the potential long term indirect impacts identified above. As such, this management plan focussed on the pre-construction and construction phases of the project.

### 3.3.2 Water quality impacts

The potential impact of unmitigated construction activities on the freshwater wetlands at the site may include:

- Increased sedimentation and elevated turbidity levels from exposed soil during site disturbance, clearing of vegetation and movement of construction vehicles, particularly following rainfall events.
- Increased sedimentation of downstream watercourses smothering aquatic life and affecting the ecosystems of downstream waterways and floodplains.
- Potential increased levels of nutrients, metals and other pollutants, transported via sediment directly into the wetland.
- Direct contamination from chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery.
- Increased levels of litter from construction activities entering the wetland.
- Tannin leachate from clearing and mulching.

Sediment is generated when rain or runoff comes into contact with exposed soils and stockpiles, becoming suspended and transported to receiving waters. Once sediment enters the wetland, it can directly and indirectly impact on the aquatic environment. Direct impacts include reduction in light penetration (limiting the growth of macrophytes), and smothering benthic organisms. Indirect impacts of increased sediments occur over the longer term and include an accumulation and the release of attached pollutants such as nutrients and heavy metals.



Once the project is complete and the highway is operational, the main risk to water quality is surface runoff from impervious surfaces and concentration of runoff by drains and kerbs. This can result in the build-up of contaminants on road surfaces, median areas and roadside corridors in dry weather which, during rainfall events, can be mobilised and transported to surrounding watercourses.

The contaminants of most concern relating to road runoff include:

- Suspended sediment from the paved surface and landscaped batters during the establishment period.
- Heavy metals attached to particles washed off the paved surface.
- Oil, grease and other hydrocarbon products.
- Litter from the road corridor.
- Nutrients from biological matter.
- Accidental spills.

In addition, nutrients such as nitrogen and phosphorus are also found in road runoff due to natural atmospheric deposits of fine soil particles.

### 3.3.3 Weeds

There is already a high diversity and abundance of exotic species in the study area, and those species that have specific relevance with respect to threatening processes at the site include:

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

Exotic aquatic weeds have a reasonably high probability of invasion. Some aquatic weeds are difficult to control, especially where the use of herbicides is not permitted or advisable. They are

- Alligator Weed (*Alternanthera philoxeroides*).
- Cabomba (*Cabomba caroliniana*).
- Dense Waterweed (*Egeria densa*).
- Glush Weed (*Hygrophila costata*).
- Longleaf Ludwigia (*Ludwigia longifolia*).
- Primrose Willow (*Ludwigia peruviana*).
- Parrots Feather (*Myriophyllum aquaticum*).
- Sagittaria (*Sagittaria platyphylla*).
- Salvinia (*Salvinia molesta*).
- Spiny Rush (*Juncus acutus*).
- Senegal Tea (*Gymnocoronis spilanthoides*).
- Water Hyacinth (*Eichhornia crassipes*).
- Yellow Waterlily (*Nymphaea mexicana*).

Of these 14 serious water weeds listed above all grow in the surrounding central coast region, and one, Parrots Feather (*Myriophyllum aquaticum*), has been recorded in the study area.

A total of 70 exotic terrestrial flora species were identified in the study area and reported in the draft REF/SIS. Of these seven are listed as noxious species in the Gosford LGA (refer to **Table 3-2**). In general the abundance of these species in the study is relatively low with patchy distribution in disturbed areas mainly on the edges of remnant vegetation. Pussy Willow (*Salix cinerea*) was recorded in moderate abundance around the edges of Wetland B along with Blackberry (*Rubus fruticosus*) occurring in low abundance concentrated mainly along the disturbed edges of Wetland B.

**Table 3-2 Noxious weed species (Gosford LGA) identified in the study area**

Species	Prevalence on site	Noxious class
Ground Asparagus <i>Asparagus aethiopicus</i>	Recorded at the northern end of the study area in the understorey of Coastal Narrabeen Moist Forest	Class 4: The plant must not be sold, propagated or knowingly distributed
Blackberry <i>Rubus fruticosus</i> aggregate species	Moderate to low abundance throughout study area mainly on edges of remnant vegetation and disturbed areas of Wetland B	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distribute. This is an All of NSW declaration
Crofton Weed <i>Ageratina adenophora</i>	Low abundance recorded in vicinity of cemetery at northern end of study area	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed
Fireweed <i>Senecio madagascariensis</i>	Low to moderate abundance in paddock areas to east of Pacific Highway.	The plant must not be sold, propagated or knowingly distributed. A weed of national environmental significance.
Giant Reed <i>Arundo donax</i>	Recorded in one location on northwest side of railway line.	Class 4: The plant must not be sold, propagated or knowingly distributed
Mistflower <i>Ageratina riparia</i>	Low abundance recorded in vicinity of cemetery at northern end of study area	Class 4: The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread
Pussy Willow ( <i>Salix cinerea</i> )	Recorded on the edges of freshwater wetlands. It dominates poor condition areas of freshwater wetland adjoining the rail corridor.	Class 4: The plant must not be sold, propagated or knowingly distributed. A weed of national environmental significance.

During construction there is potential to transport and disperse weed seeds and plant material into wetland areas. The most likely causes of weed transportation would be associated with clearing of vegetation and stockpiling of contaminated mulch and topsoil during earthworks, and movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery. There is also potential that new weed species could be introduced to the site area from other areas from movement of people, plant, equipment and/or materials.

## 4. Pre-construction management measures

### 4.1 Overview of pre-construction activities

Pre-construction activities would involve the following works:

- Detailed design and developing the Environment Management System and environmental management plans.
- Survey works.
- Water quality monitoring.
- Geotechnical investigations.
- Carry out site establishment including developing ancillary site compounds, fencing site compound boundaries and areas to be used for stockpiles
- Fencing the sensitive environmental areas.
- Installing sediment control outside identified environmental constraint areas and temporary sedimentation basins/controls.
- Completion of utility relocations.
- Construction of sites accesses.

### 4.2 Timing

Pre-construction works are to be carried out, up until the commencement of construction stage works.

### 4.3 Summary of potential pre-construction impacts

Most potential impacts to the wetland habitat and population of *Melaleuca biconvexa* and EECs would occur during the construction and operational phases. Pre-construction activities may involve habitat loss for the threatened species *Melaleuca biconvexa* from clearing. This may be associated with the early works described above, although this would be minor and manageable.

The pre-construction phase is an opportunity to reduce impacts on the wetlands, EECs, and individual threatened species and habitat. This could be achieved by identifying and implementing opportunities to reduce the construction footprint and establishing controls to maintain existing hydrological and water quality parameters that contribute to the wetlands health where possible.

The pre-construction phase is also an opportunity to gather environmental baseline data such as hydrology, water quality, and vegetation types and composition that can inform the effectiveness of the mitigation used during construction. This data can be used to measure the performance of this management plan and project mitigation measures generally. A methodology for recording baseline condition is discussed later in **Section 6** of the management plan.

### 4.4 Main goals for management of pre-construction impacts

The main goals for management during pre-construction are:

- Recording key environmental baseline characteristics of the wetlands prior to project commencement. This could then be used in ongoing monitoring programs aimed at assessing the effectiveness of this plan and project mitigation measures generally.
- Further avoiding impacts on wetlands through detailed design mitigation measures.
- Facilitating revegetation measures early in the project.

Offset measures are outlined in a separate Biodiversity Offset Strategy, refer to Appendix E of the SIS.

#### **4.5 Pre-construction phase management actions**

Mitigation measures to manage impacts to the wetlands areas including EEC and *Melaleuca biconvexa* are summarised in **Table 4-1**. The mitigation measures for the proposal have been developed in accordance with the Roads and Maritime QA *Specification G36 Environment Protection* (refer to **Appendix B**) and G38 *Soil and Water Management* (refer to **Appendix C**).



Table 4-1 Summary of pre-construction management actions

Performance Criteria	Preconstruction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
<b>Objective 1: Key environmental baseline characteristics of the wetlands are recorded prior to project commencement to be used for assessing the effectiveness of this plan and project mitigation measures generally.</b>				
Baseline parameters for key environmental and ecological indicators established.	Monitoring plan or schedule developed (refer to <b>Section 6</b> ) that will be used as basis for establishing baseline hydrological and water quality parameters.	Pre-construction.	Do not commence construction until monitoring plan is approved and baseline survey work is completed.	Roads and Maritime Services.
	<p>Hydrology (water levels) and water quality, data is collected prior to construction to assess changes during construction phases. This includes</p> <ul style="list-style-type: none"> <li>Developing and implementing a baseline monitoring program for the key wetlands that: <ul style="list-style-type: none"> <li>Collects representative, pre-construction water quality and hydrology data.</li> <li>Establishes representative, pre-construction, water quality and hydrology parameters.</li> <li>Sets a 'baseline' for the wetlands to measure changes that may be attributable to the construction phases of the proposal.</li> </ul> </li> </ul>	Monitoring carried out as per the baseline monitoring program / Audit of implementation ( <b>Section 6</b> ).	<p>Should the background data not be gained prior to construction :</p> <ul style="list-style-type: none"> <li>Use data from adjoining wetlands.</li> <li>Interpolate hydrology from OEH weather station at Lisarow.</li> <li>Use historical aerial photography to assess vegetation types and cover.</li> </ul>	Roads and Maritime Services.
<b>Objective 2: Impacts on wetlands and ecology are avoided through design mitigation measures.</b>				
No additional increase in direct construction impacts to <i>Melaleuca biconvexa</i> , swamp sclerophyll forest and freshwater wetlands from those reported in the determined REF.	The detailed design is not to increase impacts on wetlands, EECs or threatened species from the total impact area identified in the project REF.	Detailed design / Audit of Implementation / Review at 50% and 100% Detailed Design.	Where additional impacts arise from the concept design then impact assessment will be carried out on the additions with additional mitigation measures	Roads and Maritime Services.

Performance Criteria	Preconstruction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
			implemented. Biodiversity offset strategies are to be revised and updated if impacts are outside of the direct construction footprint from the REF.	
Existing hydrological regime is considered in detailed design.	<p>Where possible, considering flooding constraints of the project, the design of inflow and outflow drainage for the wetland areas should be carried out so that wetland surface levels can be maintained or otherwise managed at levels that minimise the impact to the current ecosystem health of the wetlands.</p> <p>During detailed design the drainage works for the proposal will be designed to minimise the change in the hydrology regime with a particular focus on period of inundation.</p> <p>Collection of baseline monitoring data to be used to statistically assess changes within the wetland during construction.</p>	Detailed Design / Audit of implementation / Review at 50% and 100% Detailed Design.	Correct drainage levels to maintain existing wetlands hydrology where possible.	Roads and Maritime Services.
Construction and operational phase water quality controls for wetlands included in detailed design.	<p>Review the adequacy, type, location, sizing and nature of construction and operational phase water quality devices developed in the concept design. This includes reviewing the water quality controls, as proposed in the concept design for both the construction and operation phases.</p> <p>For the construction phase this includes the design of two temporary sediment basins (refer further to Section 3.4.1 of the REF) including:</p> <ul style="list-style-type: none"> <li>Basin A – 300 m3 sediment basin located at the southern end of Lot 1 Section 17 DP 2417 between the rail maintenance access road and the Pacific Highway next to the northbound carriageway (refer to Figure 1-2).</li> <li>Basin B – 740 m3 sediment basin around 130 metres south of the Pacific Highway and MacDonald's Road intersection next to the northbound carriageway next to the northbound carriageway.</li> </ul> <p>For the operation phase (refer further to Section 4.1.1 of the draft REF Submissions Report) this includes the following measures:</p>	Detailed design. / Audit of implementation / Review at 50% and 100% Detailed Design.	<p>Implement corrective action from reviews as required.</p> <p>Update and amend the size, location and type of operational water quality in the detailed design specification.</p>	Roads and Maritime Services.

Performance Criteria	Preconstruction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	<ul style="list-style-type: none"> <li>Converting the temporary sediment Basin A to a permanent water quality basin (740m<sup>3</sup>) around 130 metres south of the Pacific Highway and MacDonald's Road intersection next to the northbound carriageway next to the northbound carriageway.</li> <li>Construction of a vegetated swale that is around 300 metres long along the eastern side of the Pacific Highway between The Ridgeway and MacDonald's Street.</li> <li>Construction of a small vegetated swale at the downstream outlets of two culverts located at chainage 6180 sited to the north of the Lisarow Station rail maintenance access road.</li> </ul>			
	Engage a Soil Conservation Specialist to review the construction Erosion and Sediment Control Plan (ESCP) and sediment basins developed in the concept design stage.	Detailed Design Audit of implementation.	Undertake prior to substantial commencement of construction if not completed during the detailed design phase.	Roads and Maritime Services.
Reduction in direct ecological impacts where possible from that predicted in the concept design.	<p>During the detailed design phase opportunities to reduce the requirement for clearing will be identified and carried out where possible. Note that as a precaution the direct construction footprint has been assumed to be lost and is fully offset so opportunities are more likely in indirect impact areas.</p> <p>This may include:</p> <ul style="list-style-type: none"> <li>Reducing the width of the footprint subject to design and safety requirements in areas where the road adjoins EECs and/or <i>Melaleuca biconvexa</i>.</li> <li>Use of temporary or permanent retaining walls and/or dry stone walls in place of batters around individual native trees and around stands of <i>Melaleuca biconvexa</i> in order to protect vegetation and avoid loss.</li> <li>Minimising the size of the project footprint and subsequent removal of vegetation. Specific measures include: <ul style="list-style-type: none"> <li>Avoiding threatened flora species where possible, particularly areas of <i>Melaleuca biconvexa</i> this may include replacing batters in some locations</li> </ul> </li> </ul>	Detailed design.	Biodiversity offset strategy are to be revised and updated if changes occur to the direct construction impact footprint.	Roads and Maritime Services.

Performance Criteria	Preconstruction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	<p>with retaining walls.</p> <ul style="list-style-type: none"> <li>– Minimise impacts to areas of higher condition terrestrial and aquatic habitats.</li> <li>– Minimise impacts to threatened ecological communities.</li> <li>– Individuals of <i>Melaleuca biconvexa</i> within the project footprint will be retained where possible.</li> </ul>			
	As part of this process, the G36 Environment contract specification (refer to <b>Appendix C</b> ) is to clearly identify any the additional areas to be protected during construction using exclusion zones	Detailed design – contract specification preparation. Audit of implementation.	Amend Contract Specifications to include additional areas to be protected.	Roads and Maritime Services.
Landscaping design/ Construction specifications developed at the detailed design phase that provides appropriate buffers to EEC and <i>Melaleuca biconvexa</i> .	<p>The landscape design would provide specific details for the re-establishment of native vegetation within areas disturbed by construction, such as batters and bare areas to provide protection for adjoining <i>Melaleuca biconvexa</i> and the two EECs - Freshwater Wetland and Swamp Sclerophyll Forest. Methods for topsoiling, seeding, planting and weed control would be in accordance with the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA Projects</i> (RTA, 2011).</p> <p>The design would contain specific revegetation measures adjacent to wetland vegetation, comprised of the two EECs - Freshwater Wetland and Swamp Sclerophyll Forest, to ensure these sites are adequately buffered with fast growing native species to prevent weeds becoming dominant.</p> <p>The designs would contain a maintenance schedule for two years. Revegetation would commence immediately upon completion of the construction activities within each section of the project or may commence earlier in the construction period if applicable.</p>	Detailed design. Audit of implementation.	Landscape plan to be updated in the Detailed Design phase where issues are not adequately considered.	Roads and Maritime Services.



Performance Criteria	Preconstruction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
Landscape Management Plan completed in pre-construction phase.	<p>A Landscape Management Plan will be developed for the project to manage impacts from the removal of vegetation. The Landscape Management Plan will cover all areas of vegetation remaining under Roads and Maritime control, including any retained EEC and <i>Melaleuca biconvexa</i> not directly impacted by construction of the project. The plans will include but not be limited to the following:</p> <ul style="list-style-type: none"> <li>• Use of local provenance native species for use in rehabilitation which may include important nectar resources for fauna such as <i>Eucalyptus robusta</i>.</li> <li>• Replanting species complementary to the natural ecological communities of the immediate area including EECs</li> <li>• Where practical it will also include replanting of foraging species for the Grey-headed Flying Fox.</li> <li>• Re-establishment of habitat will take into account Guide 3 of the Biodiversity Guidelines (RTA 2011).</li> <li>• Swales will be planted with native plants.</li> </ul>	Detailed Design.	Prepare Landscape Management Plan prior to substantial commencement of construction.	Roads and Maritime Services.
<b>Objective 3: Offset measures are facilitated early in the project.</b>				
Offset strategy completed.	Prepare a Biodiversity Offset Strategy which incorporates offset requirements and a strategy for offsetting impacts of the project on <i>Melaleuca biconvexa</i> , EECs and habitat for threatened fauna.	Detailed Design.	Complete offset strategy prior to construction if not completed during the detailed design phase.	Roads and Maritime Services.

## 5. Construction management measures

### 5.1 Overview of construction activities

Construction activities are summarised in **Table 5-1** and described in detail in the REF.

Table 5-1 Construction phase activities with potential to impact on biodiversity

Construction phase	Activities with potential to impact on the wetlands
Site preparation	<ul style="list-style-type: none"> <li>Remove and mulch vegetation in stages, and grub along the new section of the alignment and along the section of the Pacific Highway to be widened.</li> <li>Strip and stockpile topsoil in stages.</li> <li>Prepare surface using graders, dozers, scrapers and other equipment.</li> <li>Establish access tracks.</li> <li>Establish temporary and permanent crossovers.</li> <li>Erect traffic barriers.</li> <li>Carry out temporary road surface widening.</li> </ul>
Earthwork	<ul style="list-style-type: none"> <li>Excavate cuttings.</li> <li>Fill embankments.</li> <li>Place select materials.</li> <li>Construct roadside cuts and fill batters.</li> <li>Prepare batter treatments.</li> <li>Erect retaining walls.</li> </ul>
Road surface	<ul style="list-style-type: none"> <li>Lay gravel base/sub-base layers and asphaltic concrete paving.</li> <li>Apply asphaltic concrete road surface using pavers and rollers.</li> <li>Remove redundant highway road surface and rehabilitate.</li> </ul>
Other work	<ul style="list-style-type: none"> <li>Provide access to properties.</li> <li>Work on service roads and local roads.</li> <li>Tie in the proposal to adjoining highway sections. Specific activities would be determined during detailed design and may include milling and re-sheeting to create consistent levels between existing and new road surface.</li> </ul>
Finishing work	<ul style="list-style-type: none"> <li>Install noise mitigation measures (if required).</li> <li>Install safety barriers and safety screens (if/where required).</li> <li>Install kerbs, gutters and verges.</li> <li>Carry out landscape and re-vegetation work.</li> <li>Install line marking, signs and guide posts.</li> <li>Decommission temporary facilities (eg site compounds).</li> <li>Clean up the site and dispose of all surplus waste materials.</li> </ul>
<b>Drainage</b>	
Extension of pipe culverts	<ul style="list-style-type: none"> <li>Establish sediment and erosion controls downstream of the culvert.</li> <li>Remove existing headwalls.</li> <li>Excavate for new pipe.</li> <li>Compact subgrade.</li> <li>Place and compact bedding material.</li> <li>Place pipe.</li> <li>Place headwalls.</li> <li>Fill and compact material around the pipe.</li> <li>Place erosion protection at the entry/exit of pipe.</li> </ul>

Construction phase	Activities with potential to impact on the wetlands
Water quality control basins	<ul style="list-style-type: none"> <li>Establish sediment and erosion controls downstream of the basin.</li> <li>Clearing and grubbing of the area.</li> <li>Excavation of basin and overflow channel.</li> <li>Placement of erosion and sediment controls in the overflow channel.</li> </ul>

## 5.2 Timing

Construction works are expected to continue for about 24 months. Construction of the proposal is anticipated to be carried out in four stages to minimise impacts to road and rail traffic and property owners located next to the proposal, refer further to the project REF.

## 5.3 Overview of potential construction impacts

The direct construction impacts anticipated with the proposal include:

- Direct removal and loss of habitat for *Melaleuca biconvexa* from clearing and grubbing associated with construction works.
- During construction, machinery moving around *Melaleuca biconvexa* plants and within or surrounding the wetlands has potential to cause direct damage to the plants or plants may be damaged by materials that fall on them.
- Machinery moving around *Melaleuca biconvexa* plants and through the wetland habitat also has the potential for indirect impacts through soil compaction leading to root compression, suppressed seed germination and changing water infiltration in these areas.
- Machinery may also introduce and/or spread weeds and pathogens, contaminating the soil and/or water and generating dust that could coat the foliage of plants.
- Sediment from construction activities, including ground disturbance and the importation of fill for road formation, are a threat to the wetlands with potential to smother adjoining and downstream habitats.
- Initiation of edge effects through increased light penetration and weed penetration into residual areas of remnant vegetation adjacent to the construction footprint.

## 5.4 Objectives for construction management

The main objectives for management during construction are as follows:

1. To protect *in situ* *Melaleuca biconvexa* plants and EECs outside of and adjacent to the direct construction footprint and within the identified exclusion areas.
2. To prevent the introduction and spread of weed species and pathogens during construction into EEC exclusion zones.
3. Minimise impacts to *Melaleuca biconvexa* populations and EECs caused by excessive dust deposits during construction.
4. Minimise the impacts to EECs / wetlands caused by temporarily altered water levels, run-off and sedimentation and weed incursion during construction.
5. Minimise edge effects by revegetating / landscaping and weed maintenance in cleared edges at the end of construction and monitoring the success of the revegetation until performance criteria are met.
6. Operational water quality controls are maintained at design operational capacity.

## 5.5 Construction Phase Management Actions

A program of mitigation measures for the construction phase of the project on *Melaleuca biconvexa* and surrounding wetlands / EECs would be implemented. The main strategy would be to avoid directly impacting *Melaleuca biconvexa* and surrounding EECs using:

- The establishment of exclusion zones (temporary fencing) adjacent to the direct construction footprint.
- Implementing procedures to reduce the spread and introduction of weeds and pathogens.
- Avoiding sediment run-off and treating surface water run-off into the areas outside the direct construction footprint.

Responsibilities for general environmental management during construction will be outlined in Roads and Maritime construction specification including *G36 Environmental Protection* (refer to **Appendix B**), *G38 Soil and Water Management (Soil and Water Management Plan)* (refer to **Appendix C**) and the approved Construction Environmental Management Plan (CEMP).

Mitigation measures to manage impacts during construction to the wetlands area including areas of EEC and *Melaleuca biconvexa* retained beside the direct construction footprint are summarised in **Table 5-2**.



Table 5-2 Summary of construction management actions

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
<b>Objective 1: To prevent or reduce impacts <i>Melaleuca biconvexa</i> plants, EECs and wetlands during construction.</b>				
100% incorporation of construction requirements in G36, G38 and /or other construction contractor specifications and management plans.	Construction phase actions of this plan that are the responsibility of the contractor are incorporated in construction contracts Roads and maritime QA specifications G36 and G38.	Prior to construction and via preparation of construction documents / ongoing during construction 6 monthly to 12 monthly audits.	No construction until G36 CEMP Hold Point released. Incorporate into construction requirements.	Roads and Maritime Services.
	Auditing of the implementation of construction phase actions that are the responsibility of the contractor during construction. This includes internal audits (carried out by the contractor) and independent audits carried out by Roads and Maritime Services.	At the start of construction / ongoing during construction 6 monthly to 12 monthly audits.	Implement corrective actions as identified in audits.	Contractor Roads and Maritime Services.
	Inspection and audit checklists and schedules developed under G36 and G38 by the contractor are to include the requirements in this plan.	Prior to construction commencing / ongoing during construction 6 monthly and 12 monthly.	Update inspection and checklist as required to incorporate requirements of this plan.	Contractor.
	Incorporate the contractor requirements of the Landscaping Plan into the construction contract.	Prior to construction via preparation of construction documents ongoing during construction 6 monthly and 12 monthly.	Incorporate into construction requirements.	Roads and Maritime Services.

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
Pre-clearing survey for <i>Melaleuca biconvexa</i> completed.	Prior to the commencement of any work in or adjoining the subject wetland, a survey would be carried out to mark the location and extent of <i>Melaleuca biconvexa</i> along the edges of the direct construction footprint to identify and protect plants <i>in situ</i> during the construction phase within a formal exclusion zone. This will involve marking the perimeter of the population where it occurs adjacent to the area required for construction (as per the detailed design) with a Global Positioning System (GPS) and flagging tape that can be easily recognised and then erecting a temporary barrier fence.	Prior to clearing/ Weekly inspections during works in <i>Melaleuca biconvexa</i> . 6-12 monthly audits.	Stop works immediately and install exclusion zone fencing.	Contractor.
No damage or mortality of <i>Melaleuca biconvexa</i> , EECs or wetland habitat within identified exclusion areas attributable to the project as a result of direct or indirect impacts during construction.	The contractor is to develop and implement an induction package which focuses education on the wetlands, EECs, and identification of <i>Melaleuca biconvexa</i> . It is to include : <ul style="list-style-type: none"> <li>Importance, location and identification of <i>Melaleuca biconvexa</i> and EECs.</li> <li>Exclusion zones including the importance of, marking, fencing, location,</li> <li>Procedures : <ul style="list-style-type: none"> <li>- To access areas outside of exclusion zones.</li> <li>- To report unapproved incursion into exclusion zones.</li> </ul> </li> <li>Water quality devices, weeds identification, weeds hygiene, water quality devices identification and maintenance reporting.</li> </ul>	Prior to-construction. Persons to be inducted prior to commencing works on site. / 3-6 monthly audits of induction list.	Develop and update induction package where found to be deficient. Remove persons found to not be inducted during audit and ensure they attend next induction before recommencing work.	Contractor.
	Specific environmental work method statements (EWMS) to be prepared or specific works in the vicinity of <i>Melaleuca biconvexa</i> stands and for wetland areas along the proposal. This is to be carried out prior to the commencement of identified activities.	EWMS prepared prior to relevant works / 3-6 monthly audits.	Halt activities until EWMS prepared and relevant persons inducted.	Contractor.
	Existing trees, plants, and other vegetation that are to remain within or adjacent to the direct construction footprint are to be preserved using	Prior to clearing in subject areas.	Halt activities and Implement required	Contractor

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	<p>every precaution necessary to prevent damage or injury.</p> <p>The boundaries of the wetland exclusion zones and areas of retained vegetation as noted in the REF and final surveys are to be documented in the CEMP as exclusion zones.</p> <p>The exclusion zones will be in place before construction begins and will be maintained during the construction period.</p>	<p>Inspection to check that the exclusion measures have been implemented /</p> <p>6-12 monthly audits.</p>	<p>exclusion zones prior to works commencing.</p>	
	<p>The relevant protocols for exclusion zones include:</p> <ul style="list-style-type: none"> <li>• Exclusion zones to be identified and marked out prior to clearing works near <i>Melaleuca biconvexa</i> mapped by the targeted surveys.</li> <li>• Exclusion zones to be identified and marked out prior to clearing works near areas of the two EECs Freshwater Wetlands and Swamp Sclerophyll Forest</li> <li>• Details of known sensitive areas requiring exclusion zones will be provided for the project and developed in accordance with Guide 2 of the <i>Roads and Maritime Services Biodiversity Guidelines</i>. The maps will include details of temporary fencing requirements.</li> <li>• Exclusion zone fencing would be placed outside the tree protection zone (drip zone) and in accordance with Australian Standard AS 4970-2009 Protection of trees on development sites.</li> <li>• Appropriate signage would be erected to inform personnel about the purpose for the exclusion zone fencing. Signage needs to be clearly visible from a distance of 20 metres (subject to vegetation density) and be consistent in wording i.e. Exclusion Zone.</li> <li>• All construction materials or equipment outside the exclusion zone should be stored in accordance with Australian Standard</li> </ul>	<p>Prior to clearing in subject areas /</p> <p>Weekly inspection of exclusion zones when works are adjoining the area covered by this plan.</p>	<p>Immediately remove any materials, equipment or persons identified in exclusion zones.</p> <p>Immediately report any damage to vegetation or habitat outside of exclusion zones in accordance with Roads and Maritime Environment Incident reporting procedures.</p> <p>Reinstate the exclusion zones fencing and signage where required.</p>	Contractor.

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	<p>AS 4970-2009 Protection of trees on development sites i.e. outside of the tree drip line.</p> <ul style="list-style-type: none"> <li>All exclusion zones would be marked on a site plan used for construction with an aerial image underlay.</li> <li>Indicate on the site plan construction stations or distance markers where the exclusion zones would be located.</li> <li>Exclusion zones would be clearly labelled on the site plan, including the type of fencing to be used and installation and maintenance requirements.</li> <li>The exclusion zones will be in place before construction begins and will be maintained during the construction period.</li> </ul> <p>Further detail on exclusion zone establishment and maintenance can be found in the <i>Biodiversity Guidelines</i> (RTA 2011).</p>			
	<p>Vegetation removal would be detailed in the CEMP / FFMP and would be carried out in accordance with <i>Roads and Maritime Services Specification G40 Clearing and Grubbing</i> and in accordance with clearing requirements included in the <i>Biodiversity Guidelines Guide 1</i> (RTA, 2011). The following clearing requirements apply to threatened plant species:</p> <p>All <i>Melaleuca biconvexa</i> trees identified to be retained at the edge of the clearing limits/construction zone (<i>in situ</i>) would be protected during construction.</p> <p>Where individual <i>Melaleuca biconvexa</i> trees occur on the edge of a planned clearing zone and the clearing cannot be avoided, pruning of the trees or cutting tree trunks and leaving stumps in the ground, to regrow or sucker from the base, would be done where possible.</p> <p>All relevant construction staff would be made aware of the presence of <i>Melaleuca biconvexa</i> trees and wetland habitat which comprises the</p>	<p>Prior to clearing in applicable areas / audit after clearing has finished.</p>	<p>No construction until G36 CEMP Hold Point released.</p> <p>Halt clearing activities in subject area until actions completed.</p>	Contractor.



Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	<p>two EECs - Freshwater Wetland and Swamp Sclerophyll Forest and the importance of protecting and avoiding impacts during construction. Only individual plants marked for removal would be removed. All relevant staff would be made aware of the colour coding of flagging tape / paint.</p> <p>In the event of an unexpected discovery of a threatened and/or rare plant species, the construction staff is required to follow the <i>Unexpected Threatened Species Finds Procedure (within CFFMP)</i>. If the plant individual is a new species discovery it will need to be added to the Construction Flora and Fauna Management Plan (CFFMP).</p>			
	Erosion and sediment control, water quality management, and water quality control devices are installed and operated in accordance with the requirements of G36 and G38.	Prior to construction commencing / weekly inspection.	Corrective actions will be implemented as per G36 and G38 and derived CEMP.	Contractor.
	An independent Soil Conservation Specialists is to be engaged to monitor the effectiveness of erosion and sediment controls implemented by the contractor under G36 and G38.	Inspection prior to construction / Fortnightly to monthly inspections by Soil Conservation Specialist.	Implement recommendations of specialist	Contractor.
<b>Objective 2: To prevent the introduction and spread of weed species and pathogens into wetland areas during construction.</b>				
No new weeds or pathogens spread into project area.	Weed Management Plan to be prepared in accordance with Roads and Maritime G36 as part of the CEMP.	Prior to construction / audit prior to construction.	No construction until G36 CEMP Hold Point released.	Contractor.
	All machinery used in earthmoving and clearing is to be cleaned and free of soil and mud prior to entering site.	Inspections are to be taken of all earthmoving equipment	Earthmoving equipment that has not been cleaned prior to entering the site is	Contractor.

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
		brought onto the site that they have been satisfactorily cleaned prior to commencing works / daily audit of any new machinery brought to site.	to be prevented from entry until washed down.	
	Prior to construction commencing a risk assessment is to be carried out of pathogens present in the locality. If pathogens are identified as a risk than pathogen procedures will be developed in accordance with <i>Guide 7 Pathogen Management of the Roads and Maritime Biodiversity Guidelines</i> (RTA 2011).	Pathogen testing and risk assessment prior to construction commencing / follow up testing at 3 and 6 monthly intervals.	No construction until G36 CEMP Hold Point released. Stop work and implement pathogen management plan if found to occur	Contractor.
<b>Objective 3: Minimise impacts to <i>Melaleuca biconvexa</i> population and EECs caused by excessive dust deposits during construction.</b>				
No visible dust exiting the project area. Minimal dust deposits on vegetation adjoining the project area.	Dust control measures will be implemented as specified in : <i>Roads and Maritime Services QA Specification G36 – Environmental Protection (Management System).</i> <i>Roads and Maritime Services QA Specification G38 – Soil and Water Management (Soil and Water Management Plan).</i> <i>Roads and Maritime Services QA Specification G40 – Clearing and Grubbing.</i>	Prior to construction / Weekly to fortnightly inspections carried out in consistency with G36, G38, CEMP, SWMP, ESCP, EWMS. 6-12 monthly audits.	No construction until G36 CEMP Hold Point released.	Contractor.
	The CEMP, SWMP, ESCP and EWMS prepared to address dust mitigation measures are to address dust control and potential impacts on vegetation and water quality.	Weekly to fortnightly visual inspections of the presence of dust on <i>Melaleuca biconvexa</i> on areas adjoining exposed work sites.	Depending on rainfall, <i>Melaleuca biconvexa</i> patches retained in close proximity to the project may require periodical wash down, to remove dust	Contractor.

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
			if accumulation becomes excessive.	
	Clearing, staging and rehabilitation is to be carried out to reduce the amount of disturbed soil, and subsequently dust risk, at any time.	Weekly to fortnightly inspections carried out in consistency with G36, G38, CEMP, SWMP, ESCP, and EWMS. 6-12 monthly audits.	Areas that will be left exposed for extended periods are to be provided temporary cover.	Contractor.
<b>Objective 4: Minimise impacts to <i>Melaleuca biconvexa</i>, EECs, wetlands and downstream environments caused by altered water levels, water quality and sedimentation during construction.</b>				
Water quality parameters measured downstream are consistent with the requirements of G36, G38.	A Water Quality Monitoring Plan will be prepared as part of G36 and in accordance with Roads and Maritime's Guideline for Construction Water Quality Monitoring (RTA, 2003). The plan will focus on the water quality of receiving waterways to measure construction phase impacts. It will include water quality monitoring to immediately detect any environmental degradation as a result of construction work. The water quality monitoring plan is to note baseline water quality parameters measured during the pre-construction phase.	As required by the Water Quality Monitoring Plan. 6-12 monthly audits	No construction until G36 CEMP Hold Point released.	Contractor.
	Construction phase water quality management measure to manage water quality, erosion and sediment control, contaminants, spills and incidents including the preparation, implementation and monitoring of Soil and Water Management Plans, Erosion and Sediment Control Plans, CEMP's and subsidiary plans, EWMS and environmental management and incident procedures. will be managed in accordance with Roads and Maritime specifications:	Inspection of water quality control measures will be implemented in accordance with measures implemented under G36 and G38. 6-	No construction until G36 CEMP Hold Point released.	Contractor.

Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	<i>Roads and Maritime Services QA Specification G36 – Environmental Protection (Management System).</i> <i>Roads and Maritime Services QA Specification G38 – Soil and Water Management (Soil and Water Management Plan).</i> <i>Roads and Maritime Services QA Specification G40 – Clearing and Grubbing.</i> Soil and Water management principles will be implemented as per the <i>Blue Book (Volume 1 and 2): Managing Urban Stormwater-Volume 2D Main Road Construction</i> (DECC, 2008b) and <i>Managing Urban Stormwater-Soils and Construction, Volume 1, 4th Edition</i> (Landcom, 2004).	12 monthly audits.		
	An independent Soil Conservation Specialist will be engaged for the construction phase to monitor the effectiveness and implementation of erosion and sediment control measures; and provide recommendations for continuous improvement	6-12 monthly audits.	Implement recommendations of specialist.	Contractor.
<b>Objective 5: Minimise edge effects by revegetating / landscaping and weed maintenance in cleared edges at the end of construction and monitoring the success of the revegetation until performance criteria are met</b>				
Establishment of 80% groundcover of suitable species in disturbed areas.	Implement revegetation of disturbed areas in accordance with G36, the Landscape Management Plan	As per the monitoring requirements of the landscape plan.	Provide and maintain new plantings until the required groundcover is successfully established.	Contractor.
	Revegetation maintenance would be planned in consultation with a sub-contractor who possesses the following skills: <ul style="list-style-type: none"> <li>Experienced in identification of the local flora, so that damage to planted tubestock does not occur during maintenance activities (these plants will be monitored).</li> <li>Experienced with using bush regeneration techniques and</li> </ul>	Inspect immediately after planting has occurred / specialist to conduct monthly audits during construction.	Replanting of dead tubestock as per thresholds and specifications in the landscape plan.	Contractor.



Performance Criteria	Construction Phase Actions	Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	planting to restore and maintain EEC habitat.			
Maintenance planning to incorporate appropriate expertise.	Revegetation maintenance would be planned in consultation with a sub-contractor who possesses the following skills: Experienced in identification of the local flora and particularly <i>Melaleuca biconvexa</i> , so that damage to individual <i>Melaleuca biconvexa</i> and wetland vegetation in general does not occur during maintenance activities particularly weed spraying.	Review of professional service provider engagement at end of construction.	Engage a suitably experienced person to advice on on-going maintenance.	Roads and Maritime Services.
80 per cent survival of areas revegetated after two years from end of construction	Regular maintenance activities such as watering, mulching, weed control and supplementary plantings as required. Maintenance activities will continue for a period of 2 years post construction to allow revegetation to establish. Plants may be slow to establish and maintenance works therefore must continue after construction has ceased and the road is operational. Maintenance activities would include: <ul style="list-style-type: none"> <li>Watering as necessary,</li> <li>Removal of damaging debris after storm events</li> <li>Plantings to replace mortalities</li> <li>Removal of bags and stakes (if used) when the plants overtop them</li> <li>Mulch cover and weed control as necessary.</li> </ul> Fertilisers and herbicides are to be avoided if possible. Where required they are to be used in accordance with label conditions and sparingly in locations in or adjoining drainage lines and wetlands.	Timing and monitoring frequency of maintenance work as per schedule below which may be revised in the landscape plan.	Any failed revegetated areas (>20%) are to be replaced. Ongoing monitoring and maintenance carried out until plant health and/or ecological condition of habitat has been maintained over two years. Review and update maintenance methods and schedule as required. Identify any other potential threats and implement corrective actions as required.	Roads and Maritime Services.
	Maintenance of revegetation area is to be carried out in accordance with the following recommendations unless specified in another plan or specification for the project.			

Performance Criteria	Construction Phase Actions			Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	Maintenance	Timing	Criteria			
	Site preparation	Commencement	Weeds and grass controlled within 2 metres of planting locations.			
	Watering weekly	First month	No plants wilting or with dried foliage.			
	Weed control. Mulching and fertilising of plants	3 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.			
	Weed control. Mulching and fertilising of plants	6 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.			
	Weed control. Mulching and fertilising of plants	9 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.			
	Monitoring weeds and plant health	12 months	Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage.			
	Weed control. Mulching and fertilising of	12 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched			

Performance Criteria	Construction Phase Actions			Timing / Monitoring / Frequency	Corrective actions.	Responsibility
	plants		and fertilised.			
<b>Objective 6: Operational water quality controls are maintained at design operational capacity.</b>						
Operational water quality controls, such as basins, are maintained at design operational capacity or 60% volume where not specified otherwise.	Inspections of operational water quality controls to remove sediment, excess organic matter, rubbish and debris. Reinstate the capacity of basin type devices as based on observation of capacity.			12 monthly inspections.	Water quality devices maintained and fixed as required to ensure maintenance of water quality.	Roads and Maritime Services.
	Emptying of spills from the basins by emergency response team.			Event based.	Pump out basins and transport liquid material to licensed waste facility for treatment and disposal.	Roads and Maritime Services.

## 6. Monitoring program

Ongoing monitoring is required during construction of the upgrade. This would monitor and assess the effectiveness of the mitigation measures outlined in this plan. Monitoring will also provide a means of detecting when performance criteria have or have not been reached during construction, and to identify if corrective measures need to be implemented.

The monitoring program focuses on the health of the *in situ* wetland habitats during construction, as well as the distribution and abundance of weeds in edge, disturbed habitats and the success of landscape plantings and revegetation. The monitoring methods are adaptive and may be reviewed and amended as required. The program consists of the following components:

1. **Monitoring Water Quality during Construction.** This monitoring program applies to the preconstruction and construction phases of the proposal. The program will evaluate the success of the water quality and sediment mitigation measures and provide input into management and corrective actions as required. It is aimed at identifying any new changes to water quality within the adjoining wetland from the existing baseline which may impact on *Melaleuca biconvexa* or wetland vegetation at the site scale.
2. **Monitoring Compliance with the Construction Environmental Management Plan (CEMP).** It applies to the construction phase and construction footprint area only. It will be developed by the Contractor during construction only to monitor that construction activities are carried out in accordance with the requirements of this plan, and G36 and G38. It is a program to monitor compliance of the construction contractor with environmental mitigation measures for construction of the project.
3. **Monitoring Success of Revegetation / Landscape.** This program applies to monitoring the success of landscape plantings and revegetation in areas cleared for construction along the road fringe. Monitoring would occur in the initial stages of operation, until the success of the revegetation is determined against performance criteria.

### 6.1 Monitoring Water Quality during Construction

#### 6.1.1 Timing and responsibility for implementation

Roads and Maritime Services are responsible for management of the water quality monitoring program during construction.

#### 6.1.2 Objectives

Water quality monitoring would aim to provide reliable information to assist the management of the *Melaleuca biconvexa* population and wetland EECs during construction. Monitoring would be undertaken during the pre-construction (baseline), and construction phases. The objectives are as follows:

- Undertake environmental monitoring to comply with commitments in the project REF and project environmental approvals.
- Gather data on pre-construction (baseline) water quality to assist design of environmental drainage and water quality controls in detailed design.
- Assess the impact of construction activities on water quality in locations adjacent to the direct impact area.



### 6.1.3 Review of program

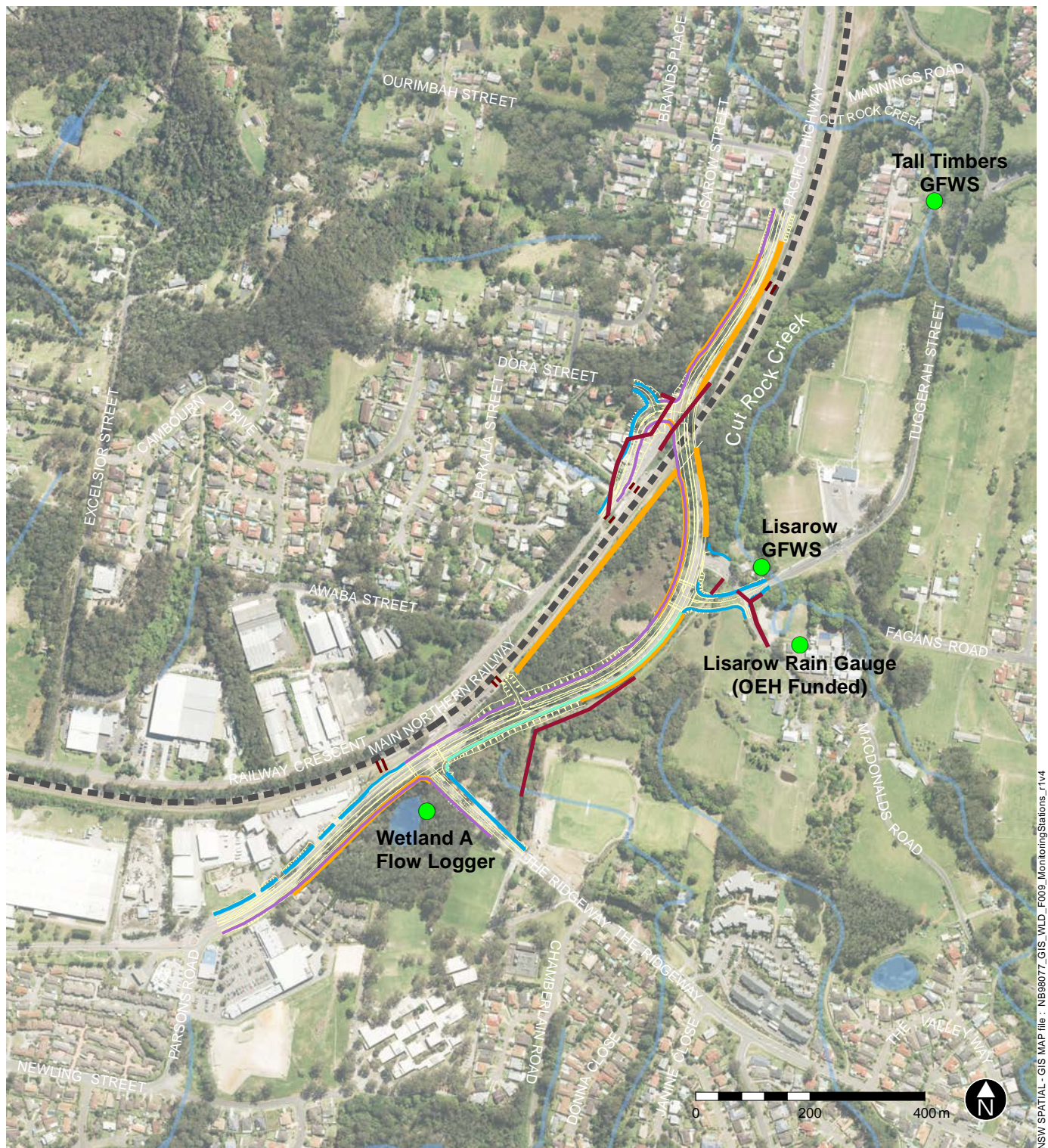
The monitoring methods and approach may need to be reviewed as required in response to events such as:

- Changes to the project conditions of approval and other environmental mitigation measures.
- Major changes to the project scope during detailed design
- Following completion of the construction stage.
- Following handover of any components of the project outside of Roads and Maritime.

### 6.1.4 Access to existing hydrology monitoring data

Existing climate and stream flow monitoring locations operated by Gosford City Council and OEH are located in the study area. The data is publically available and provides important background climatic data to be considered in analysing and interpreting and trends on the wetlands in the study area. These are described below and their location mapped on **Figure 6-1**.

1. Lisarow rain gauge. This is an existing weather station operated by OEH. It will be accessed to provide local weather data or use in interpreting monitoring data from the wetlands.
2. Tall Timbers GFWS. This is an existing stream flow monitoring site operated by Gosford City Council. It will be accessed to provide local hydraulic data for use in interpreting monitoring data from the wetlands.
3. Lisarow GFWS. This is an existing stream flow monitoring site operated by Gosford City Council. It will be accessed to provide local hydraulic data for use in interpreting monitoring data from the wetlands.
4. Wetland A Flow Logger. This is a flow and height monitor installed by Roads and Maritime in early 2016. There is a short period of data available from this site.



NSW SPATIAL - GIS MAP file : NB98077\_GIS\_WLD\_F009\_MonitoringStations\_11v4

Figure 6-1 | Existing hydrology monitoring locations

### Legend

	Concept design		Existing footpath		Existing monitoring locations
	Retaining wall		New footpath		
	Existing rail gate		Shared pedestrian and cycle path		
	Power line		Watercourse		

Road Design 150424\_2D MX.dwg  
Roads and Maritime Services 2014  
AUSIMAGE 2014  
LPI 2014  
Jacobs 2014



### 6.1.5 Monitoring locations

The following provides details of the proposed water quality monitoring stations. The location of these sites is mapped on **Figure 6-2**. A background summary of the sampling proposed at each of the three wetlands (A, B and C) is provided below and details on each of the survey sites are included in **Table 6-1**

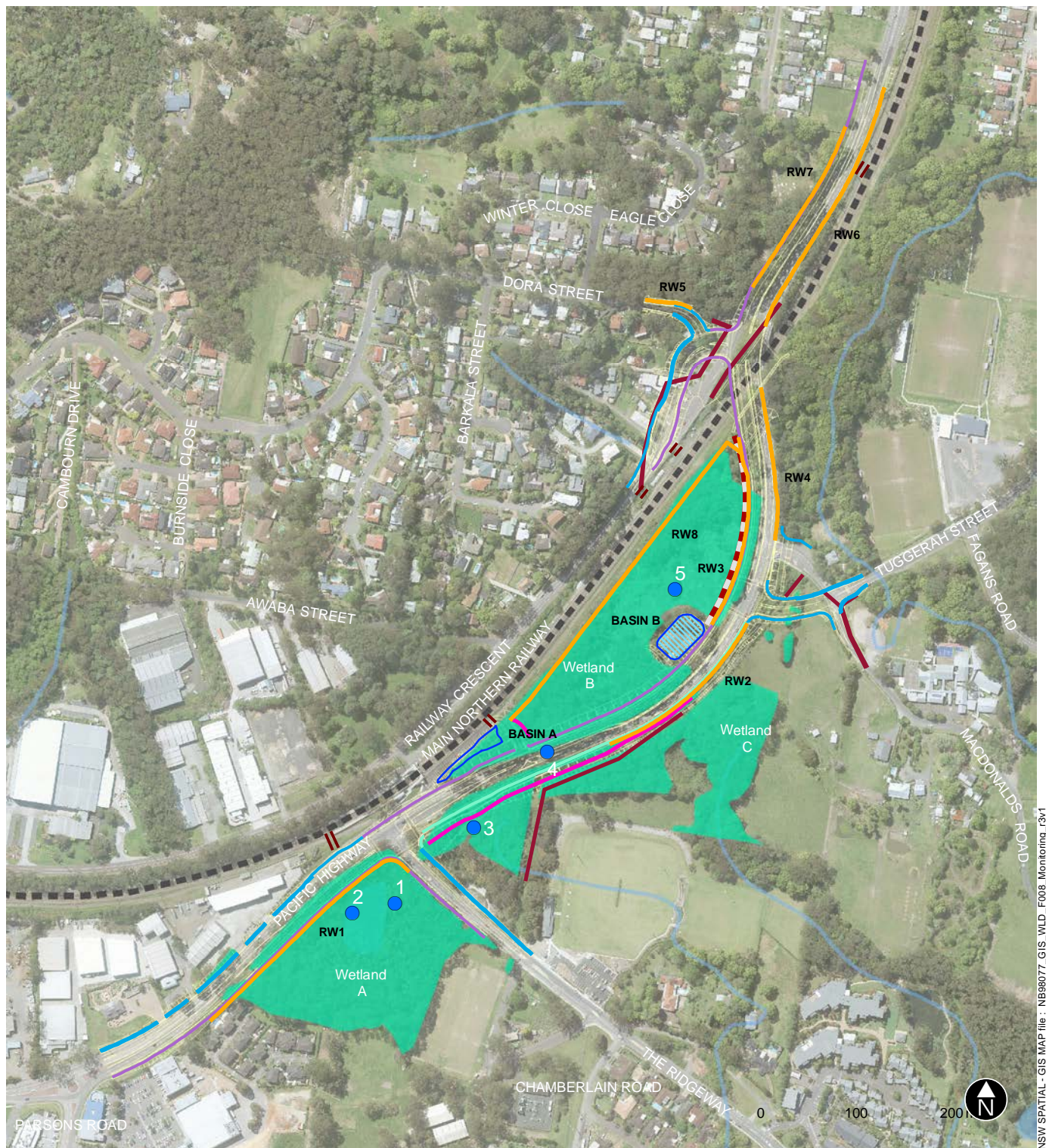
- **Wetland A.** This wetland contains a larger area of ponded water than the other wetlands and will benefit from additional water quality sampling. Sampling of this wetland will involve the measurement of surface water levels (one site), water quality parameters (two sites).
- **Wetland B.** Monitoring of this wetland will consist of sampling of water quality parameters at a single site.
- **Wetland C.** This wetland also has less standing water than Wetland A. Monitoring will consist of water quality grab sampling at one site.
- **Existing drainage pipe under Pacific Highway** (flows to Wetland B), refer to **Figure 6-2**. Water quality grab samples will be obtained immediately downstream of the outlet.

Table 6-1 Description of the water monitoring stations

Wetland	Site	General description	Sampling methods
A	1	Located on the south-western side of the westbound carriageway of The Ridgeway on Lot 5 DP 809307. This property is owned by Gosford City Council (GCC) and is part of the Office of Environment and Heritage (OEH) Saving Our Species (SOS) conservation program. The property is zoned as Public Recreation in the GCC Local Environment Plan (LEP). The site is located in an area of Freshwater Wetland.	<ul style="list-style-type: none"> <li>• Surface water level monitoring station.</li> <li>• Grab sampling for water quality testing.</li> <li>• Access to the site may require the temporary installation of a series of "stepping stones" each with an approximate footprint of 60 cm<sup>2</sup> to avoid minor disturbance during sampling.</li> </ul>
	2	Located on the southern side of the southbound carriageway of the Pacific Highway on Lot 5 DP 809307. This property is owned by Gosford City Council (GCC) and is part of the Office of Environment and Heritage (OEH) Saving Our Species (SOS) conservation program. The property is zoned as Public Recreation in the GCC Local Environment Plan (LEP). The site is located in an area of Freshwater Wetland.	<ul style="list-style-type: none"> <li>• Grab sampling for water quality testing.</li> <li>• Access to the site may require the temporary installation of a series of "stepping stones" each with an approximate footprint of 60 cm<sup>2</sup> to avoid minor disturbance during sampling at the water quality testing site and the cutting down of two dead trees to provide safe access.</li> </ul>
B	5	Located on the western side of the northbound carriageway of the Pacific Highway opposite the intersection of the Pacific Highway and MacDonald's Road. The site is located on Lot 1 DP2417 which is private property zoned as Environmental Conservation.	<ul style="list-style-type: none"> <li>• Grab sampling for water quality testing.</li> <li>• Access to the site may require the temporary installation of a series of stepping stones each with a footprint of 60 cm<sup>2</sup> to avoid minor disturbance during sampling.</li> </ul>
Pipe flowing into Wetland	4	Located on the western side of the northbound carriageway of the Pacific Highway at the outlet of an existing culvert which passes underneath the Pacific	<ul style="list-style-type: none"> <li>• Grab sampling for water quality testing.</li> <li>• Access to the site may require the temporary installation of a series of each with an approximate footprint of 60 cm<sup>2</sup> to</li> </ul>

Wetland	Site	General description	Sampling methods
B		Highway. The site is situated on the edge of a road corridor zoned as Infrastructure and Lot 1 DP2417, which is private property and zoned as Environmental Conservation.	avoid minor disturbance during sampling. This location may need to be moved once new drainage under the highway is installed.
C	3	Located in an area of Freshwater Wetland to the southeast of intersection of the Pacific Highway and the Ridgeway. The site is located on Lot 1 DP 559426 which is owned by Gosford City Council and zoned as Public Recreation.	<ul style="list-style-type: none"> <li>• Grab sampling for water quality testing.</li> <li>• Access to the site may require the creation of a footpath through an area of fill that is vegetated with disturbed regrowth and weeds. The track will be mown throughout the duration of the monitoring work. Access to the site may also require the temporary installation of a series of stepping stones each with an approximate footprint of 60 cm<sup>2</sup> to avoid minor disturbance during sampling.</li> </ul>














NSW SPATIAL - GIS MAP file : NB98077\_GIS\_WLD\_F008\_Monitoring\_r3v1

Figure 6-2 | Monitoring locations

### Legend

- |   |   |   |  |
|---|---|---|--|
|  | Concept design  |  | Vegetated swale  |
|  | Retaining wall  |  | Railway  |
|  | Power line  |  | Wetland (comprised of Alluvial Paperbark Sedge Forest and Freshwater Wetlands) |
|  | Construction sediment basin                                     |  | Water monitoring sites   |
|  | Construction sediment basin and operational water quality basin |   |  |

Roads and Maritime Services 2016  
AUSIMAGE 2015  
LPI 2015  
Jacobs 2016

### 6.1.6 Sampling methodology

Water quality sampling will involve taking grab samples on a fortnightly basis at each of the five sites during construction. The sampling will include testing to allow for analysis of a basic analytical suite or an extended analytical suite. The basic analytical suite testing will be comprised of acidity (pH), dissolved oxygen (DO), turbidity, electrical conductivity (EC), total nitrogen (Total N), total phosphorous (Total P), total suspended sediment (TSS), Kiel Dahl Nitrogen (TKN), Nitrate and Nitrite). The sampling program will vary, however it is anticipated that the monitoring activity would start at least one year prior to construction. This would establish baseline conditions and extend until one year after the upgrade of the Pacific Highway at Lisarow is completed.

Stepping stone pavers will be placed in the wetland areas to allow access to all sites and to reduce turbidity issues associated with walking through the swamping areas next to the testing sites. These stepping stone pavers will be removed at the end of the monitoring activities. Site 2 will require the removal of some dead trees that have fallen to access the equipment easily.

### 6.1.7 Data analysis

Water quality at the construction phase is to be compared against the baseline data gained during the pre-construction phase. Construction phase water quality should also consider the results of any construction water quality monitoring carried out by the contractor during construction as this may be done more frequently.

Climate data from the OEH and Gosford City Council stations will be used to identify changes that may be attributable to climate variability rather than the project. Water flow and height data from the station installed in Wetland A in 2016 will also be used.

### 6.1.8 Monitoring program

A preliminary monitoring program is provided in the following, the program is subject to change and refinement depending on the choice of contractor, equipment availability and land access. A program for activities to be carried out pre-construction and construction are presented in **Table 6-2**. The following key applies to the tables.

Key	Description
	This monitoring method is not proposed at this site.
	This monitoring method is proposed for this site.
	This monitoring method will be subject to site conditions (such as surface water conditions), or the monitoring method is optional as it is additional to other measures proposed (such as continuous water monitoring at locations with grab sampling)
<b>Continuous</b>	Continuous refers to data captured at 15 minutes time steps
<b>Logger</b>	Refers to a site that has a continuous data logger to monitor and record data.
<b>Manual</b>	Refers to a site where monitoring and measurement will be recorded manually.



**Pre-construction and construction phase**

Table 6-2 Preconstruction monitoring activities

Parameter	Frequency	Type	Lisarow rain gauge  (OEH)	Tall Timbers GFWS  (Council)	Lisarow GFWS (Council)	Wetland A (Site 1)	Wetland A (Site 2)	Wetland C (Site 3)	Pipe Flowing into Wetland B (Site 4)	Wetland C (Site 5)
<b>Climate</b>										
Rainfall and climate data	Continuous	OEH Weather station								
Stream flow	Continuous	GCC station								
<b>Water Quality</b>										
Basic Analytical Suite (acidity (pH), dissolved oxygen (DO), turbidity, electrical conductivity (EC), total nitrogen (Total N), Total phosphorous (Total P), total suspended sediment (TSS), Kiel Dahl Nitrogen (TKN), Nitrate and Nitrite)	Monthly	Manual								
<b>Hydrology</b>										
Surface Water Level	Continuous	Logger								
Volumes (Flow)	Continuous	Logger								

### 6.1.9 Reporting

A baseline water quality condition report would be presented for project tender. Following this, data reporting would be presented quarterly during the construction period. Monitoring data would be collected every three months and stored in a database. The final report at the end of construction will include a summary of the data analysis, discussion on potential impacts identified during construction to verify success of construction stage mitigation, any corrective actions that were taken during construction and stabilisation of the site at the immediate end of construction.

## 6.2 Monitoring Compliance with the CEMP

### 6.2.1 Timing

The CEMP and monitoring will be finalised prior to construction commencing. CEMP monitoring will be the responsibility of the construction contractor as part of the requirements of construction specifications G36 and G38.

### 6.2.2 Objectives

Activities by the main construction contractor during construction pose various risks to the wetlands such as run-off, sediment, acid sulfate soils, direct clearing impacts, and introduction of weeds. The construction activities and environmental management requirements of the contractor under this management plan will be implemented by construction specifications G36 and G38. These are in turn implemented by mechanisms such as the contractors CEMP. The contractor will be required to prepare plans outlining the monitoring approach, methods and program proposed to be implemented as part of the CEMP.

The specific management goals of the CEMP monitoring program are as follows:

- To monitor construction activities to ensure they comply with the requirements of this plan.
- To monitor water quality from construction water quality controls including discharges from sediment basins.
- To monitor for any excessive dust deposits during construction.
- To monitor and assess the compliance with weed and pathogen management controls.
- CEMP monitoring will include:
  - Inspections.
  - Audits.
  - Water quality monitoring.

### 6.2.3 Inspections

Inspections will be carried out to ensure compliance with the mitigation measures under this plan and the CEMP including:

- Maintenance of exclusion zones and protection of *Melaleuca biconvexa*, EEC's and vegetation generally outside of the construction areas.
- Capacity and adequacy of water quality devices including sediment basins.
- Inspection of the perimeter of works area for evidence of damage, weeds, disease, dust deposits on *Melaleuca biconvexa*.



Inspections will be carried out by Roads and Maritime and the construction contractor. Inspections carried out by Roads and Maritime will be taken weekly to monthly depending on the state of construction.

#### **6.2.4 Audits**

Audits will be carried out to ensure the contractors compliance with *G36 Environmental Management* and *38 Soil and Water Management* specification which will include the requirements of the plan. The audits will consist of external environmental audits arranged by Roads and Maritime on the construction contractor, and independent environmental audits carried out by the construction contractor.

#### **6.2.5 Water Quality Monitoring**

Water quality monitoring is to focus on:

- Sediment basins prior to discharge.
- Downstream waters flowing from construction during in stream works or events.
- Water quality monitoring will be as per the specifications of G36 and G38 and may consist of parameters such as:
  - Turbidity.
  - Dissolved Oxygen.
  - pH.
  - Oils and greases (sediment basins adjoining construction areas only).

### **6.3 Landscape / Revegetation Monitoring Program**

#### **6.3.1 Timing and implementation**

The landscape / revegetation monitoring plan will need to be refined after the completion of detailed design and construction when the extent of the project impact area and landscape/revegetation requirements will be defined more clearly. Some, or all, monitoring components may be carried out by the construction contractor during the construction phase. Post construction may be carried out by Roads and Maritime Services or the construction contractor.

#### **6.3.2 Monitoring objectives**

The objective of the landscape/revegetation monitoring program is to monitor and assess the survival of landscape plantings and weed abundance in landscaped/revegetated areas adjacent to the upgrade.

#### **6.3.3 Monitoring methods**

Monitoring of landscape/revegetation areas would occur until success of the revegetation has been achieved and confirmed from three successive monitoring events. The following information would be collected at each inspection:

- Photographs of the roadside revegetation / landscape areas from permanent photographic points.
- Site-based vegetation attributes from permanent monitoring plots.
- Slope and erosion.
- Any failure of landscaping / works (total numbers and percentage loss).

- Any excessive dust accumulations on vegetation.
- Weed monitoring to identify and treat any weed infestation that may impact on the success of revegetation.

The success, or otherwise, of the revegetation areas would be reported in the annual monitoring report, and compared with the triggers for supplementary planting (i.e. 80% survival).

## 6.4 Reporting, timing and scope

The requirements for reporting the results of all monitoring works described in this plan are summarised in **Table 6-4**.

Table 6-3 Timing and scope of monitoring reporting

Monitoring Program	Report timing and scope
Monitoring Water Quality during Construction ( <b>Section 6.1</b> )	Compiled into a summary report every six months during construction. This is to compare the data from monitoring locations during the construction stage with the baseline data set for any change whilst recognising external influences such as climate variability and to inform adaptive management as required.
CEMP Monitoring Program ( <b>Section 6.2</b> )	Report 6 monthly during construction period. This is to report on aspects such as: <ul style="list-style-type: none"> <li>• Any impacts on wetlands and <i>Melaleuca biconvexa</i> outside of the project approvals as a result of construction contractor activities.</li> <li>• Summarise water quality measured during the life of the project.</li> <li>• Any changes to the design of operational drainage levels that flow in or out of the wetlands from the detailed design.</li> <li>• Any change to post-construction water quality controls from the detailed design phase.</li> </ul>
Landscaping / Revegetation Monitoring ( <b>Section 6.3</b> )	Report 6 monthly during construction and continue for 2 years after the completion of revegetation. This report would recommend any provisional measures (if deemed necessary) to facilitate an appropriate buffer for the on-going survival of the threatened species in the adjacent areas and address mortality of planted tubestock.

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## Appendix A. *Melaleuca biconvexa* (Biconvex Paperbark) species profile



### Conservation Status

- NSW TSC Act: Vulnerable
- Commonwealth EPBC Act: Vulnerable
- Lisarow Wetland, located in the south western end of the proposal area, is 54.2 hectares and a key management site identified by the OEH. Population size is likely similar to the proposal area, which was estimated at 925 mature stems per hectare for the REF (Jacobs, 2015).
- The Office of Environment and Heritage has established three management sites where conservation activities need to take place to ensure the conservation of this species (Porters Creek, Ourimbah and St Georges Basin).
- The amount of this species distribution occurring on conservation reserves is unknown.
- Investigations carried out for this proposal confirmed that approximately half of the mapped distribution of *Melaleuca biconvexa* within the Wyong and Gosford LGAs occurs within lands zoned for environmental protection (E2).

### Description

Biconvex Paperbark is a shrub or small tree, usually up to 10 metres tall, though occasionally as high as 20 metres. The bark is that of a typical paperbark. The leaves are small, to 18 millimetres long and 4 millimetres wide; each leaf has a centre-vein in a groove and the leaf blade curves upwards on either side of this centre-vein. Leaf placement is distinctive, with each pair of leaves emerging at right angles from the branch. Each pair is offset at right angles to the previous pair so the branch has a squarish appearance when looked at 'end-on'. This species' white flowers are usually clustered in dense heads and the fruit is urn-shaped and 3 - 5 millimetres in diameter (OEH, 2015).

### **Distribution and Habitat**

The Biconvex Paperbark occurs in coastal districts and adjacent tablelands in NSW, from Jervis Bay to Port Macquarie (Harden 1991). The species occurs within the Hawkesbury-Nepean, Northern Rivers, Hunter-Central Rivers and Southern Rivers NSW Natural Resource Management (NRM) regions (Threatened Species Scientific Committee (TSSC) 2008). The Biconvex Paperbark occurs in damp areas, often near watercourses, on alluvium soils over shale (Terrigal formation) (Benson and McDougall 1998). The species may form a dense stand in a narrow strip adjacent to a watercourse. The vegetation communities in which the Biconvex Paperbark generally occurs include 'Eucalypt open-forest' with Sydney Blue Gum (*Eucalyptus saligna*), Swamp Mahogany (*Eucalyptus robusta*) and Mountain Cedar Wattle (*Acacia elata*) and in 'Paperbark scrub' with Prickly-leaved Paperbark (*Melaleuca styphelioides*), Snow-in-summer (*Melaleuca linariifolia*), White Feather Honey-myrtle (*Melaleuca decora*), Sieber's Paperbark (*Melaleuca sieberi*) and *Melaleuca nodosa*.

### **Life History**

The Biconvex Paperbark flowers in summer (Harden 1991) and are likely to be pollinated by nectarivorous animals (insects, birds and bats) as well as wind pollination over shorter distances. Capsules support tiny seeds which are shed soon after maturity and are locally dispersed around the parent plant, and there is possibly a dormancy factor for germination of seeds (Benson & McDougall 1998).

It is known to resprout from rootstock in response to fire (Benson & McDougall 1998), and suckers grow from the base of plants and exposed roots in areas where subject to soil disturbance or areas that are frequently inundated for extended periods. Multiple stems may arise from single rootstocks so that an estimate of population size is not possible from visual inspection of stands (NSW Scientific Committee, 2002).

### **Key Threats (OEH, 2015)**

- It is likely Biconvex Paperbark has evolved to cope with infrequent fires. Burning for hazard reduction and other unnatural ignitions have increased fire frequency and may threaten the species' survival.
- Clearing for residential development.
- Most populations are on private land and there is poor threats knowledge about the species and its requirements by land managers.
- Alterations to the drainage hydrology of low-lying floodplains and swamps including swamp reclamation.
- Increased pollution and nutrients through adjoining developments and rubbish dumping.
- Grazing and trampling by stock causing root damage, prevention of seedling establishment and erosion.
- Potentially affected by Myrtle Rust.
- Increased pollution and nutrients through adjoining developments and rubbish dumping.
- Competition from noxious aquatic weeds particular *Sagittaria platyphylla*.

### **Conservation advice, recovery plans and threat abatement plans**

- Commonwealth Conservation Advice on *Melaleuca biconvexa* (TSSC, 2008)
- No recovery plan or threat abatement plan relates to this species. A targeted strategy for managing this species has been developed under the Saving Our Species program. This species has been assigned to the Site-managed species management stream under the Saving Our Species program.

### **Limits to distribution and representation in conservation reserves**

There are four main known populations of *Melaleuca biconvexa*, comprising:

- Jervis Bay.
- Central Coast (Wyang, Gosford and Lake Macquarie LGAs).
- Myall Lakes.
- Port Macquarie.

The local population is within the Central Coast population which is the largest extending from north of Brisbane Water to south-west Lake Macquarie. The study area is within the central area of this population towards the western extent of the population distribution.

The amount of this species occurring on conservation reserves is unknown. However, investigations carried out for this proposal confirmed that approximately half of the mapped distribution of *Melaleuca biconvexa* within the Wyong and Gosford LGAs occurs within lands zoned for environmental protection (E2). An additional 30 per cent of the mapped population occurs in areas zoned for environmental management (E3), environmental living (E4) and recreation (state forests and council parks).

### **Local and regional abundance**

The Central Coast population of *Melaleuca biconvexa* extends from north of Brisbane Water to south-west Lake Macquarie. Surveys across a large majority of this distribution in the Wyong and Gosford LGAs confirmed the presence of a large population. The mapped area of occupied habitat within the locality comprises 258 hectares (around 131,000 stems) and the entire mapped area in the Gosford and Wyong LGAs is around 358 hectares (around 161,000 stems). The area of occurrence for the entire Central Coast population is estimated to be greater than 400 hectares including the remaining area of the population within Lake Macquarie LGA (not mapped). There are at least 218 records of *Melaleuca biconvexa* in the southwest Lake Macquarie LGA (Mandalong area) consisting of at least 500 stems. Refer to **Section 2.3** for further details regarding the local and regional distribution and abundance of *Melaleuca biconvexa*.

### **Extent of habitat removal**

The extent of habitat removal will be up to 2.61 hectares of occupied habitat supporting up to 3,000 stems. In comparison to the entire distribution of the species in the Gosford and Wyong LGA this represents around 0.7 per cent of the mapped population, and around one per cent of the mapped population within the locality (10 km radius). Considering it is unlikely the entire population has been captured in the mapping exercise within the Wyong and Gosford LGAs, and the remaining area of the population within Lake Macquarie LGA as not been included this proportion of impact to the local population is likely to be minor.

### **Consideration of corridors**

Vegetation in the study area is currently fragmented by the existing highway and adjacent rail corridor which provide major barriers to some species. Although these barriers potentially affect seed dispersal and pollinator movements, it is likely that substantial cross pollination occurs across these barriers through wind pollination and animal pollinators (insects, birds, bats). Seed dispersal for *Melaleuca biconvexa* is generally limited to the area surrounding the parent plant, with seeds not being well adapted for dispersal by wind, water or animals.



## **Appendix B. QA Specification G36 Environment Protection**

# ROADS AND MARITIME SERVICES (RMS)

## QA SPECIFICATION G36

### ENVIRONMENTAL PROTECTION

#### NOTICE

This document is a Roads and Maritime Services QA Specification. It has been developed for use with roadworks and bridgeworks contracts let by Roads and Maritime Services or by local councils in NSW. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

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#### REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 4/Rev 0	Global	Specification title changed. Clauses rearranged and rewritten to improve clarity. “OEH” changed to “EPA”.	GM, IC	26.06.13
	Guide Notes	Rewritten.		
	1.3	Definitions of “Aquatic habitat” and “Physical Work on Site” added. Reference to relevant RMS publication for environmental incident added.		
	2	Retitled “General Requirements”. Further general environmental protection requirements added.		
	3	Previously clause 4. Previous clause 3 and related sub-clauses on CEMS requirements replaced by statement to comply with NSW Government EMS guidelines.		
	3.1	Previously clause 4.1, retitled “Preparation and Submission of CEMP” and rewritten. Previous subclause headings deleted. Comment inserted that lead time for submission in Hold Point may be increased to 15 working days where approval of CEMP by statutory authority is required.		
	3.2	New clause “Planning”, incorporating requirements from previous clauses 6.2 “Legislation” and 6.3 “Approvals, Licences and Permits”.		
	3.2.1	New sub-clause “Environmental Risk Assessment Workshop” added.		

<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 4/Rev 0 (cont'd)	3.2.2	New sub-clause grouping together previous clause 6.2 “Legislation” and clause 6.3 “Approvals, Licences and Permits”. Requirement to include and maintain a compliance tracking program in CEMS added. Lead time of 5 working days for submission added to Hold Point.		
	3.2.3	New sub-clause “Environmental Objectives and Targets” added.		
	3.3	Previously clause 4.2, retitled “Resources, Responsibility and Authority”. ESR qualification specified.		
	3.4	Previously subclause 4.6, retitled “Selection and Management of Subcontractors”. Monitoring requirements condensed and relocated to clause 3.9.		
	3.5	Previously clause 4.5.		
	3.6	Previously clause 4.9, retitled “Working Hours”. Requirements necessary for undertaking work outside specified working hours moved to clauses 3.7.2 and 4.9.		
	3.7	Previously clause 4.3, expanded to incorporate previous clauses: - 4.7 “Liaison with OEH”, - 4.8 “Community Liaison and/or Notification”, and - 4.10 “Complaints”.		
	3.7.1	Previously clause 4.7, retitled “Liaison with EPA”.		
	3.7.2	Previously clause 4.8.		
	3.7.3	Previously clause 4.10, retitled “Complaints Management”.		
	3.8	Previously clause 4.4, retitled “Emergency Planning” retaining only contents of previous subclause 4.4.1 “General”.		
	3.8	Requirements to induct staff and subcontractors about environmental risks and train them to deal with environmental risks added.		

<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 4/Rev 0 (cont'd)	3.9	New clause “Contractor’s Monitoring, Inspection and Auditing”, containing the rewritten contents of previous clauses 4.13 “Checking Performance” and 4.14 “Environmental Auditing” and the condensed monitoring requirement content from previous clause 4.6.		
	3.10	Previously clause 4.12, retitled “Environmental Nonconformities”.		
	3.11	Previously clause 4.11.		
	3.12	New clause “Management Review” added.		
	4	New clause, grouping together previous clauses: - 4.4.2 “Environmental Incident Notification and Reporting”, - 5 “Environmentally Sensitive Areas”, - 6.5 “Soil and Water Management”, - 6.6 “Air Quality”, - 6.7 “Noise Control”, - 6.8 “Ground Vibration and Airblast”, - 6.9 “Flora”, - 6.10 “Fauna”, - 6.11 “Fire Precautions”, - 6.12 “Chemicals, Dangerous Goods and Other Potential Contaminants”, - 6.13 “Aboriginal Heritage”, - 6.14 “Non-Aboriginal Heritage”, - 6.15 “Contaminated Land”, - 6.16 “Waste Avoidance and Management”, and - 6.18 “Restoration of Site”.		
	4.1	Previously clause 6.5.1, retitled “Soil and Water Quality Management”.		
	4.4	Previously clause 6.5.4. Requirements for work in waterways expanded.		
	4.5	Previously clause 6.15. Requirements on management of contaminated land expanded.		
	4.6	Previously clause 6.12.1, retitled “Spill Prevention and Response” and incorporating previous clause 6.12 on requirements for dealing with chemicals, dangerous goods and other potential contaminants.		
	4.7	Previously clause 6.6. Detailed requirements on dust control measures deleted.		



Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 4/Rev 0 (cont'd)	4.8	Previously clause 6.11, retitled “Fire Safety and Burning Off”. Previous sub-clause headings deleted. Statement on responsibility for fire damage deleted. 24 hours notice inserted in Hold Point for submission of proposals for burning off.		
	4.9	Previously sub-clause 6.7. Cross reference to clause 3.7.2 on approval for undertaking work outside specified working hours added.		
	4.10	Previously clause 6.8, reworded to improve clarity. Examples of measures to minimise the impact of vibration and airblast deleted.		
	4.11	New sub-clause “Biodiversity”, grouping together previous clause 6.9 “Flora” and clause 6.10 “Fauna”, and reworded. Reference to RMS Guideline added. Requirement for Flora and Fauna Management Plan added.		
	4.12	Previously clause 6.13. Detailed requirements for management of unexpected finds of Aboriginal objects replaced by reference to RMS Procedure.		
	4.13	Previously clause 6.14. Detailed requirements for management of unexpected archaeological relics replaced by reference to RMS Procedure.		
	4.14	Previously clause 6.16, retitled “Waste Management and Resource Recovery” and incorporating previous clauses 4.15 and 6.17 on recycling. Previous subclause headings deleted. Requirements contained in <i>POEO Act</i> deleted. Requirements relating to “s.143 Notices” condensed.		
	4.15	Previous clause 6.12.2 retitled “Use of Pesticides”.		
	4.16	Previous clause 5, retitled “Work in Environmentally Sensitive Areas”, requirements expanded. Example clause on environmentally sensitive areas inserted as boxed text.		
	4.17	Previous clause 4.4.2. Detailed requirements replaced by reference to RMS Procedure.		

<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 4/Rev 0 (cont'd)	4.18	Previous clause 6.18. Requirements for site restoration consolidated. Reference to spec R178 and R179 added.		
	5	Previous clause 7. Individual sub-clauses rearranged and reworded. Reference to RMS Guidance Note added.		
		Previous clause 6.4 titled "Site Facilities" deleted.		
	Annex B	Statement in boxed text added to include pay items for remediation of known areas of contamination.		
	Annex C, D Annex M	Schedules updated. Referenced documents updated.		
Ed 4/Rev 1	Global	References to "Determination" and "Decision Report" changed to "Submissions Report" and "planning consent/approval" respectively. References to "inserting relevant EA documents" changed to a general reference to Annexure G36/A.	GM, IC	16.08.13
	1.3	Definitions of "Fish" and "Sensitive area maps" added. List of acronyms added.		
	3.1	Discrepancy on lead time for submission of CEMP corrected to ten (10) working days consistent with that in Hold Point. Reference to "Environmental Commitments" changed to "safeguards and management measures".		
	3.6	Cross reference to clause 4.9 added.		
	3.7.2.2	Reference to Practice Note vii of "Environmental Noise Management Manual" added.		
	3.7.2.4	References to "Interim Construction Noise Guideline" and Practice Note vii of "Environmental Noise Management Manual" added.		
	3.10	Failure to safeguard against Category 1 incident added as cause for Hold Point to apply.		
	4.1	Requirement to prepare and implement a SWMP and/or ESCP as part of the CEMP added.		

<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 4/Rev 1 (cont'd)	4.5	Subheadings added to form new subclauses 4.5.1 to 4.5.4. Individual clauses rearranged to be consistent with likely sequencing of requirements. Note added to Hold Point to clarify that HP only applies when Remedial Action Plan is to be prepared by the Contractor.		
	4.6	Hold Point on site storage and use of chemicals, fuels and lubricants deleted.		
	4.8	Hold Point on commencement of burning off operations deleted.		
	4.9	Individual clauses rearranged and edited. Hold Point on noise generation above permitted noise levels deleted.		
	4.11	References to “Fish” and Fisheries Management Act added.		
	4.14	References to “RMS Waste Fact Sheets” and additional requirements for sampling and testing and verification of licenses, permits and appropriate planning consent added.		
	4.16	“Sensitive Area Diagrams” amended to “Sensitive Area Maps” and requirements for updating and ensuring their availability expanded. New Hold Point included requiring working in or near the environmentally sensitive areas.		
	4.18	New “Site Facilities” added		
	4.19	Previous clause 4.18.		
	Annex A2	New section added for listing of “information only” environmental assessment documents.		
	Annex C, D	Schedules updated.		
	Annex M	Referenced documents and legislation updated.		
Ed 4/Rev 2	Global	Subsidiary plans to CEMP now called “Sub-plans”.  Clauses rearranged and reworded to improve clarity.  “waterways” replaced by “waters”.  1.3.1 Definitions of “Environmental Work Method Statement” and “waters” added.  “EWMS” added to list of acronyms. “FFMP” and “SWMP” deleted from list of acronyms.	GM, CPS (Peter Letts)	28.03.14

<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 4/Rev 2 (cont'd)	3.1	Within boxed text, “Sedimentation Basin Management” and “Dewatering” replaced by “Work in Environmentally Sensitive Areas”.		
	3.2.1	Minor editing to improve clarity.		
	3.2.4	New clause on “Environmental Work Method Statement” added.		
	3.6	Note added clarifying circumstances where work outside of normal working hours without Principal’s approval is permitted.		
	4.1	Soil and water management requirements cross-referred to spec G38.		
	4.2, 4.3 and 4.4	Previous clauses 4.2, 4.3 and 4.4 on water extraction, construction site dewatering, and work in waterways deleted (moved to spec G38). Subsequent clauses renumbered.		
	4.2.5	New sub-clause on dealing with surface runoff at contaminated land moved here from clause 4.1.		
	4.3	“Work Method Statement” changed to “procedures” for spill prevention.		
	4.4	“Air Quality Management Sub-Plan” added.		
	4.7	Note added that, if no blasting, vibration mitigation measures may be incorporated into a combined Noise and Vibration Management Sub-Plan.		
	4.7, Annex C1	“Dilapidation Report” changed to “Building Condition Inspection Report”.		
	4.9, 4.10	Added comment in boxed text that combined Aboriginal and Non-Aboriginal heritage management sub-plan may be used.  Management of unexpected finds changed to a procedure.		
	4.11.1	New item added to Waste Management Sub-Plan to minimise consumption of consumables, electricity and water.		
	Annex A2	New table listing environmental sub-plans, with “Yes/No” options.		
	Annex B	Guide notes within boxed text amended.		
	Annex C3	Schedule of Identified Records updated.		
	Annex D	Planning Documents updated.		
	Annex M	Reference documents updated.		



<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 4/Rev 3	4.7	Statement added to comply with R44 for vibration and airblast.	GM, CPS	06.08.14
		Verification of compliance with ANZECC criteria to be in accordance with AS 2187.2 Appendix J, moved here from R44.		
	4.15.2	New clause on pre-construction land condition assessment.		
	4.15.3	New clause on post-construction land condition assessment.		
	Annex B	New suggested pay items G36P3.1 and G36P3.2 for land condition assessment added.		
	Annex C	Schedules of Hold Points and Identified Records updated.		
	Annex M	Referenced Documents updated.		
Ed 4/Rev 4	1.3.2	Acronym “GREP” added.	GM, CB	22.01.16
	4.4	Heading added to form new sub-clause 4.4.1.		
	4.4.2	New subclause on reporting on air emissions performance of mobile non-road diesel plant and equipment.		
	4.11.1	GREP added to guidance documents for preparing Waste Management Sub-Plan. Reference to waste hierarchy inserted.		
	4.11.3	New sub-heading inserted for clause on waste avoidance and resource recovery reporting. Reporting periods changed.		
	4.11.4, Annex F2	Details on obtaining “s.143 Notice” cross referenced to ETD 2015/20. Letter template in Annex F2 (now in ETD 2015/20) deleted.		
	4.12	Additional condition for exemption from completing Records Sheet inserted.		
	Annex F	Definitions of materials for purpose of waste avoidance and resource recovery reporting amended. Forms amended. Annex F2 deleted.		
	Annex H1	Ferry wharves added to list of public places requiring notification when pesticides are applied.		
	Annex M	Referenced documents updated.		

## GUIDE NOTES

(Not Part of Contract Document)

### G36 Edition 4 Revision 0

In G36 Edition 4 Revision 0, the structure of the document has been changed, and the requirements on the contractor's environmental management system (CEMS) in previous versions have been replaced by a single statement that the CEMS must comply with the NSW Government Environmental Management System Guidelines.

G36 Edition 4 Revision 0 is suitable for use on Minor Works, and accordingly G35 is withdrawn.

### Using Specification G36

G36 is a model specification that must be customised by the TENDER DOCUMENTER for each particular project. Customisation requires insertion of the various environmental requirements from the EIS, REF, Submissions Report, planning consent/approval and other associated information into the body of G36. It is recommended that G36 be customised in conjunction with preparation of the RMS project environmental management plan.

In customising the document, prescriptive description of particular work methods is to be avoided.

Notes on how to customise particular section of the document are shown in boxed text, as illustrated below:

*Detail here any specific Aboriginal heritage requirements and safeguards, such as from the EIS, REF, Submissions Report, planning consent/approval or Office of Environment and Heritage approval.*

**Example:**

*Protect the Aboriginal artefact scatter (Site Name HB-24) located on the banks of Shark River approximately 50 m upstream of the bridge site from construction related activities by erecting a temporary pedestrian safety fence around a 10 metre buffer zone from the recorded site perimeter.*

If any issue is not relevant for your project, delete the boxed text.

If an issue is relevant, remove the borders around the text, modify the text to suit your circumstances, adjust the margins so the customised paragraphs line up with the general text, match the font size and set the customised paragraphs in ***bold italic***.

After completing the customisation, check the pagination of the whole document and insert page breaks if necessary to achieve continuity within clauses. Then return to the CONTENTS page to update the clause listing and page numbers.

This customisation must be done carefully because tenderers will rely on G36 to price their environmental obligations for the project.



## ENVIRONMENTAL PROTECTION

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## FOREWORD

### RMS COPYRIGHT AND USE OF THIS DOCUMENT

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### REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification RMS G36 Edition 4 Revision 3.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

### PROJECT SPECIFIC CHANGES

Any project specific changes have been indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.





## **RMS QA SPECIFICATION G36**

### **ENVIRONMENTAL PROTECTION**

## **1 GENERAL**

### **1.1 SCOPE**

This Specification describes an environmental protection management process which you must implement, as a minimum, to provide environmental protection during execution of the Work Under the Contract. It also identifies environmental safeguards and management measures or conditions of planning consent/approval for the project which you must satisfy.

Undertake your activities in such a manner that damage to the environment is limited to that which is unavoidable.

When carrying out the Work Under the Contract, apply:

- (a) your corporate Contractor's Environmental Management System (CEMS) (refer to Clause 2);
- (b) your project specific Contractor's Environmental Management Plan (CEMP) (refer to Clause 3);

which must be developed in accordance with this Specification, and guided by AS/NZS ISO 14001 Annexure A.

The environmental protection requirements in this Specification, together with the Conditions of Contract, are complementary to, and not in substitution for any statutory requirements or any of the technical requirements of the Specifications and Drawings.

Ensure compliance with all relevant environmental statutory requirements and procedures defined within the CEMP and all supplementary plans.

### **1.2 STRUCTURE OF THE SPECIFICATION**

This Specification includes a series of annexures that detail additional requirements and information.

#### **1.2.1 Supplementary Project Information**

Supplementary Project Information is shown in Annexure G36/A.

#### **1.2.2 Measurement and Payment**

The method of measurement and payment is detailed in Annexure G36/B.

#### **1.2.3 Schedules of HOLD POINTS and Identified Records**

The schedules in Annexure G36/C list the **HOLD POINTS** that must be observed. Refer to Specification RMS Q for the definition of **HOLD POINTS**.

The records listed in Annexure G36/C are **Identified Records** for the purposes of RMS Q Annexure Q/E.

#### **1.2.4 Referenced Documents and Legislation**

Unless specified otherwise or specifically supplied by the Principal, the applicable issue of a referenced document is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure G36/M.

Environmental legislation which may be relevant to the Work Under the Contract is listed in Annexure G36/M. The list may not be current or complete for this Contract.

### **1.3 DEFINITIONS AND ACRONYMS**

#### **1.3.1 Definitions**

References to Acts include any amendments to Acts together with a reference to Regulations and instruments made under them.

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

The following definitions apply to this Specification:

- (a) The definitions contained in AS/NZS ISO 14001, clauses 3.1 to 3.4 and 3.6 to 3.10.
- (b) “Aboriginal object” as defined in *National Parks and Wildlife Act 1974 (NSW)*, refers to any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.
- (c) “Aquatic habitat” includes all areas of land submerged by water, permanently or intermittently, and includes both artificial and natural bodies of water. It includes wetlands, creeks, lakes, dry river beds and estuaries.
- (d) “Contaminated land” is land with the presence of a substance in, on or under the land at a concentration above that which it is normally found in that locality, such that there presents a risk of harm to human health or to the environment.
- (e) “Controlled access road” and “main road” have the same meaning as that within the *Roads Act 1993 (NSW)*.
- (f) “Dangerous goods” has the same meaning as that within the *Dangerous Goods (Road and Rail Transport) Act 2008 (NSW)*.
- (g) “Environment” means the natural and the built environment and all aspects of the surroundings of human beings (including physical, biological and aesthetic aspects).
- (h) “Environmental incident” means a discrete (one-off) occurrence that may result in an adverse impact (or impacts) on the environment or a breach of a legislated requirement(s), as defined in RMS publication “Environmental Incident Classification and Reporting Procedure”.
- (i) “Environmental Work Method Statement” (EWMS) means a component of the CEMP and/or CEMS that addresses environmental management issues relevant to a specific site and/ or activity.

- (j) “Fish” has the same meaning as that within the *Fisheries Management Act 1994 (NSW)*.
- (k) “Physical Work on Site” means any work on or in the vicinity of the Site carried out in connection with construction of the Works. It also includes alteration, conversion, fitting-out, commissioning, renovation, repair, maintenance, decommissioning, and demolition of a structure.
- (l) “Pesticide” has the same meaning as within the *Pesticides Act 1999 (NSW)*, and includes herbicide.
- (m) “Pollution incident” as defined in *Protection of the Environment Operations Act 1997 (NSW) (POEO Act)* means an incident or set of circumstances during or as a consequence of which there is or is likely to be a leak, spill or other escape or deposit of a substance, as a result of which pollution has occurred, is occurring or is likely to occur.
- It includes an incident or set of circumstances in which a substance has been placed or disposed of on the premises, but it does not include an incident or set of circumstances involving only the emission of any noise.
- (n) “Relic” as defined within *Heritage Act 1977 (NSW)* refers to any deposit, artefact, object or material evidence that relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and is of State or local significance.
- (o) “Sensitive Area Maps” are a consolidation of environmental and socially sensitive areas, sites or places shown on a series of map-based sheets that extend the length of the Site, used to assist with the planning and management of Work Under the Contract.
- (p) “Sensitive place” is defined within Clause 11J of the *Pesticides Regulation 2009 (NSW)* to be any:
- School or pre-school;
  - Kindergarten;
  - Childcare centre;
  - Hospital;
  - Community health centre;
  - Nursing home;
  - Place declared to be a sensitive public place by the Environment Protection Authority (EPA) by notice in the NSW Government Gazette.
- (q) “Work Under the Contract” means the work which you are or may be required to execute under the Contract and includes all variations, remedial work, constructional plant and temporary work, design and design documentation.
- (r) “Waters”, as defined in the *POEO Act*, means the whole or any part of:
- any river, stream, lake, lagoon, swamp, wetlands, unconfined surface water, natural or artificial watercourse, dam or tidal waters (including the sea), or
  - any water stored in artificial works, any water in water mains, water pipes or water channels, or any underground or artesian water.

### 1.3.2 Acronyms

CEMP	Contractor’s Environmental Management Plan
CEMS	Contractor’s Environmental Management System
EIS	Environment Impact Statement
ENM	Excavated Natural Material
EPA	Environment Protection Authority

EPL	Environment Protection Licence
ESR	Environmental Site Representative
EWMS	Environmental Work Method Statement
GREP	NSW Government Resource Efficiency Policy
<i>POEO Act</i>	<i>Protection of the Environment Operations Act 1997 (NSW)</i>
REF	Review of Environmental Factors
VENM	Virgin Excavated Natural Material
WMS	Work Method Statement

## **2 GENERAL REQUIREMENTS**

At all times, exercise any necessary and reasonable precautions appropriate to the nature of the Work Under the Contract to protect the environment.

Develop, implement and maintain for the duration of the Contract, a Contractor's Environmental Management System (CEMS) that meets the requirements of the NSW Government Environmental Management System Guidelines.

You may, with the Principal's approval, substitute environmental control measures included in this Specification with other environmental control measures which achieve the same, or better, environmental outcomes.



Your environmental protection management process must include the following tasks:

- |  |  |
|--|--|
| 1. Operate an effective CEMS to control the planning and implementation of environmental protection measures for the Contract.   |  |
| 2. Identify statutory requirements, compliance limits and adverse environmental effects which could occur during execution of the Work Under the Contract (refer to Clause 3.2.2).   |  |
| 3. Plan work activities and environmental protection measures to minimise environmental risks and comply with specified environmental protection requirements (refer to Clause 3.2). The CEMP is the outcome of this planning process. |  |
| 4. Set up the planned environmental protection measures (refer to Clause 4) and train site personnel to be environmentally aware (refer to Clause 3.5).  |  |
| 5. Monitor the effectiveness of the environmental protection measures (refer to Clause 3.9).   |  |
| 6. Set up response procedures which will initially contain, then remedy, any environmental damage that does arise (refer to Clause 4.3).   |  |
| 7. Improve environmental protection measures and revise the CEMS and the CEMP promptly when deficiencies are identified (refer to Clauses 3.1 and 3.9).  |  |

### **3 CONTRACTOR'S ENVIRONMENTAL MANAGEMENT PLAN (CEMP)**

#### **3.1 PREPARATION AND SUBMISSION OF CEMP**

Prepare a Contractor's Environmental Management Plan (CEMP) for the Work Under the Contract. The CEMP must be prepared in accordance with NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) publication "Guideline for the Preparation of Environmental Management Plans". Your CEMP must be consistent with, and incorporate, all relevant elements of your CEMS.

Your CEMP must:

- (i) include an Environmental Policy that contains a commitment to the principles of Ecologically Sustainable Development as detailed in the *Protection of the Environment Administration Act 1991 (NSW)*;
- (ii) describe all relevant elements of, and include references to, the CEMS documentation and how these will apply to the Work Under the Contract;
- (iii) address all aspects and stages of the Work Under the Contract.

Include any Sub-Plans specified in Annexure G36/A2 that are required to address specific issues.

The CEMP must also include the following elements:

*Detail here any specific CEMP requirements, such as from the EIS, REF, Submissions Report or planning consent/approval. It may be useful to include here an itemised schedule of safeguards and management measures that clearly describe the respective responsibilities of RMS and the Contractor for meeting project approval.*

The CEMP may be either incorporated as a discrete and readily identifiable part of the PROJECT QUALITY PLAN (refer RMS Q), or separate from but consistent with the PROJECT QUALITY PLAN. Include in the CEMP appropriate cross-referencing to your Quality Management System and PROJECT QUALITY PLAN.

*List here the CEMS documents that are essential and must be provided by the Contractor together with the CEMP prior to commencement of any Physical Work on Site, such as:*

- *Incident Reporting and Investigation procedure;*
- *Nonconformity and Corrective and Preventive Action procedure;*
- *Complaints Handling procedure;*
- *Environmental Monitoring and Site Inspections procedure;*
- *EWMS such as Clearing and Grubbing, Work in Environmentally Sensitive Areas, etc.*

If agreed to by the Principal, you may submit the CEMP and any supporting CEMS documentation progressively in stages to suit the construction, similar to that in RMS Q for the staged submission of the PROJECT QUALITY PLAN.

If the CEMP is submitted progressively, submit the CEMP documents for each stage of the Work Under the Contract at least ten (10) working days prior to the commencement of that stage.

## **HOLD POINT**

Process Held:	Commencement of Work not previously addressed by CEMS and CEMP documents and authorised by earlier Hold Point release.
Submission Details:	At least ten (10) working days prior to the proposed commencement of the stage of Work Under the Contract nominated in the submission by you, submit the CEMP and associated Sub-Plans and/or EWMS, as well as the CEMS documents listed in Clause 3.1.
Release of Hold Point:	The Principal will consider the documents prior to authorising the release of the Hold Point. The Principal may request additional information for inclusion in the CEMP before authorising the release of the Hold Point.

*The lead time for submission of CEMP in Hold Point may be increased to fifteen (15) working days where the CEMP has to be forwarded to a statutory authority for approval.*

Where submission of the CEMP to a statutory authority is nominated in Annexure G36/A or directed by the Principal, submit to the Principal an additional copy of the CEMP at each stage, including any proposal for staged submission, for forwarding to each of the nominated statutory authority. The

staging of CEMP submissions must comply with the requirements of the nominated statutory authority.

The CEMP submissions at each stage must contain sufficient information and details to enable the nominated statutory authority to understand the proposed environmental protection measures. Delay to acceptance of the CEMP by a nominated statutory authority due to inadequate details being provided in the CEMP will be deemed to be a delay within the control of the Contractor.

*Detail here any specific requirements for submission of documents identified from the EIS, REF, Submissions Report or planning consent/approval.*

## **3.2 PLANNING**

### **3.2.1 Environmental Risk Assessment Workshop**

The environmental impacts of the proposed construction activities have been identified and assessed in the Environment Assessment documents listed in Annexure G36/A3.

If nominated in Annexure G36/A, and prior to commencement of any work on Site, carry out an environmental risk assessment workshop to identify all the environmental constraints associated with the Work Under the Contract and address the environmental risks associated with the constraints and activities you propose to undertake.

Use the environmental risk assessment workshop to develop risk mitigation and management strategies to eliminate or reduce the risk exposure. These risk mitigation strategies must be consistent with the environmental safeguards and management measures listed in the Environment Assessment documents listed in Annexure G36/A3. Incorporate these risk mitigation strategies into your CEMP.

Use the workshop to raise general awareness of good environmental management practices among your staff and subcontractors working on the Site and to develop ideas and actions to improve environmental practices.

Participants must include your site management staff, your Environmental Site Representative (refer Clause 3.3) and any other personnel including subcontractors who will be performing the Work Under the Contract. Provide the Principal at least ten (10) days prior to the workshop with an agenda and any supporting information to allow for representatives of the Principal to also attend the workshop.

*List here any specific requirements or additional objectives for the environmental risk assessment workshop such as expedition of the production and submission of the CEMP, development of ESCP (refer Specification RMS G38), etc.*

Review the environmental risk assessment regularly to ensure it remains relevant for the duration of the Work Under the Contract.

### **3.2.2 Regulatory Requirements and Compliance**

The CEMP must identify your obligations under environmental legislation that are relevant to the Work Under the Contract, including those listed in Annexure G36/M.

The following approvals, licences and permits will be obtained by the Principal:

*List here any approvals, licences and permits obtained by the Principal, or insert NIL.*

Ascertain from the appropriate authorities what other approvals, licences and permits are required for the Work Under the Contract.

If you are required to hold an Environment Protection Licence (EPL) for the Work Under the Contract and the Principal has been issued with an EPL prior to award of the Contract, you must not commence work on site until the EPL has been transferred to your name. The Hold Point in Clause 14.3 of Specification RMS G2 applies.

Obtain each necessary approval, licence and permit not obtained by the Principal prior to the commencement of any work which relates to that approval, licence, notification or permit. Include copies of such approvals, licences and permits in the CEMP.

Include in your CEMS a compliance tracking program and keep the program up to date.

### **HOLD POINT**

Process Held:	Commencement of any activity requiring an approval, licence and/or permit from an appropriate authority.
Submission Details:	At least five (5) working days prior to the activity, provide to the Principal evidence of receipt of the approval, licence and/or permit from the relevant authority.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

### **3.2.3 Environmental Objectives and Targets**

Include in the CEMP environmental objectives and targets for the Work Under the Contract which must be consistent with RMS Environment Policy Statement.

The environmental objectives and targets must be measurable where practicable, are realistic and relevant to the Work Under the Contract, and include a commitment to continuous improvement of your CEMS.

When establishing environmental objectives and targets, take into account the following:

- (i) the environmental outcomes for the project as described in the Environment Assessment documents listed in Annexure G36/A3;
- (ii) the results of the environmental risk assessment workshop;
- (iii) any applicable legal and other requirements;
- (iv) any technological, operational or other constraints or limitations.

### **3.2.4 Environmental Work Method Statement**

In addition to those specified elsewhere in Specifications RMS G36, G38 and/or G40, prepare EWMS and implement them as part of the Work Under the Contract for the following activities:



*List here any EWMS required that are not already nominated in RMS G36, G38 and/or G40. Include any specific requirements.*

The EWMS must include at least the following elements:

- (a) Description of the work activity, including any plant and equipment to be used;
- (b) Outline of the sequence of tasks for the activity, including interfaces with other construction activities;
- (c) Identification of any environmental and/or socially sensitive areas, sites or places;
- (d) Identification of potential environmental risks/impacts due to the work activity;
- (e) Mitigation measures to reduce the identified environmental risk, including assigned responsibilities to site management personnel;
- (f) Process for assessing the performance of the implemented mitigation measures.

Develop the EWMS in consultation with the relevant site management personnel to ensure that all issues are addressed, methods and activities are practical and all personnel are aware of their commitments and responsibilities. Review the EWMS periodically to ensure its effectiveness and proper implementation and incorporate any improvements or changes identified into subsequent revisions.

### **3.3 RESOURCES, RESPONSIBILITIES AND AUTHORITY**

Provide sufficient resources, including site personnel, for the effective implementation of the CEMP for the duration of the Work Under the Contract.

The CEMP must indicate the names, responsibilities and authority of your site management personnel who have primary responsibility for developing, implementing and maintaining the CEMS and the CEMP for the Work Under the Contract, and rectifying any environmental nonconformities identified by you or the Principal.

Nominate in the CEMP a full-time Environmental Site Representative (ESR) who will be the authorised contact person for communications with the Principal and the EPA on all environmental matters.

The ESR must have tertiary qualification in Environmental Science, Environmental Engineering or equivalent, and a minimum of five (5) years experience in environmental management on road construction or other equivalent works.

Where your designated Environmental Management Representative will be based mainly off-site, detail in the CEMP the relationship between the Environmental Management Representative and the ESR.

The ESR's responsibilities and authority include the following:

- (a) advising on environmental matters specified in this Specification;
- (b) liaison with the Principal and with all relevant authorities on environmental matters;
- (c) maintaining a register of all environmental management documents for the Contract;
- (d) ensuring that the CEMP is established, implemented and maintained in compliance with this Specification, including all Sub-Plans, procedures and supplementary EWMS, and upgrades to these documents (as needed) to remain current with the progress of the Works;

- (e) overall responsibility for the establishment, management, monitoring and maintenance of erosion and sediment controls within the Site;
- (f) carrying out regular inspections and auditing of the works to ensure that environmental safeguards are being followed;
- (g) identifying where the implemented environmental measures are not meeting the targets set, and identifying areas where improvement can be achieved;
- (h) preparing monthly reports outlining the works that have been undertaken and the achievements that have been met, as well as identifying those areas where improvements were made;
- (i) facilitating environmental induction and toolbox talks for all site personnel;
- (j) specific authority to stop work on any activity where the ESR deems it necessary to prevent environmental nonconformities;
- (k) notification to the relevant parties of any environmental incidents.

The CEMP must include details of the role, qualifications and responsibilities of the ESR and any critical site activities that require the presence of the ESR.

*Detail here any specific requirements for resources, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.4 SELECTION AND MANAGEMENT OF SUBCONTRACTORS**

When complying with the purchasing requirements of RMS Q, include environmental management requirements in the planning, selection and management of subcontractors.

Include a requirement to comply with the CEMP in all contractual arrangements with your subcontractors.

For subcontracted work, include in the CEMP the procedures that you will implement for ensuring subcontractor compliance, including details of:

- (a) the duties of each subcontractor for planning, implementing and monitoring environmental protection measures and for keeping environmental records;
- (b) the duties you will retain for environmental protection of subcontracted work;
- (c) how environmental protection measures on subcontracted work interact with adjacent work areas, as applicable; and
- (d) your surveillance program to monitor the effectiveness of each subcontractor's environmental protection measures together with the relevant project documentation.

*Detail here any specific requirements for control of subcontractors, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.5 COMPETENCE, TRAINING AND AWARENESS**

Provide to all your staff and subcontractor personnel working on the Site with environmental training to achieve a level of competence and awareness appropriate to their assigned activities before they commence their assigned activities. Do not permit anyone who has not undergone the appropriate environmental training to work on the Site.

The CEMP must include a site-specific environmental induction and training plan that describes the minimum level of training, experience and/or qualifications required for staff and subcontractors working on the Site, the names of the persons to be trained, the proposed frequency of training and the procedures for training.

Environmental induction training must cover all elements of the CEMP and must include, as a minimum, the following:

- (i) purpose and objectives of the CEMP;
- (ii) requirements of due diligence and duty of care;
- (iii) conditions of environmental licences, permits and approvals;
- (iv) potential environmental emergencies on Site and the emergency response procedures;
- (v) reporting and notification requirements for pollution and other environmental incidents;
- (vi) high-risk activities and associated environmental safeguards, e.g. earthworks, vegetation clearing, night works, operation and maintenance of concrete washouts, and washing, refuelling and maintenance of plant and equipment; and
- (vii) working in or near environmentally sensitive areas.

Establish and maintain a register of environmental training carried out, including dates, names of persons trained and trainer details.

*Detail here any specific training requirements, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.6 WORKING HOURS**

In the context of this clause, normal working hours are from Monday to Friday between 7.00 am to 6.00 pm and Saturday between 8.00 am to 1.00 pm inclusive, but excluding public holidays.

The CEMP must include a procedure for notifying the Principal, all relevant Authorities and the community, in advance of any proposal to work outside of these working hours. Such changes in working hours must comply with all licences, permits, approvals, consents, notification, statutory requirements, etc and have been appropriately justified and assessed.

Any approval by the Principal to work outside of normal working hours is conditional on you liaising with the community (refer to Clause 3.7) and complying with the requirements of Clause 4.6.

Work outside of normal working hours is permitted without prior approval by the Principal in the following circumstances:

- (a) delivery of materials outside of normal working hours, where delivery at such times is required by the Police or other authorities for reasons of safety or otherwise; or
- (b) work during an emergency, where such work is necessary to avoid the loss of lives, property and/or prevent environmental harm.

*List here any additional restrictions on working hours such as from the EIS, REF, Submissions Report or planning consent/approval.*

### 3.7 COMMUNICATION

Describe in the CEMP the processes for external and internal communication in relation to the environmental aspects of the Work Under the Contract.

Make all staff and subcontractors working on the Site aware of these external and internal communications procedures and are properly trained in their application.

#### 3.7.1 Liaison with EPA

The CEMP must identify at least two persons (together with their contact telephone numbers) who will be available to be contacted by the EPA on a 24 hour basis and who have authority to take immediate action to shut down any activity, or to effect any pollution control measure, as directed by an authorised officer of the EPA.

Immediately notify the Principal of any visit to the Site by the EPA. Prepare a report for each occasion when the Site is visited by the EPA, notifying the Principal of the purpose and outcome of the EPA visit, and of all actions taken by you in response to the EPA visit. Submit this report to the Principal within one (1) working day of the EPA site visit.

*Detail here any specific requirements for liaison with EPA, such as from the EIS, REF, Submissions Report or planning consent/approval.*

#### 3.7.2 Community Liaison and/or Notification

##### 3.7.2.1 New or Changed Construction Activities

Notify local residents about any new or changed construction activities which will affect access to their properties or otherwise disrupt the residents' use of their premises, at least five (5) working days before commencing work affecting residents.

Such notification must state the nature of the work, why it is necessary, the expected duration, details of any changes to the traffic arrangements or property access and the name and contact telephone number of your representative who can respond to any resident concerns.

Address any concerns raised by residents in accordance with the complaints procedure as required under Clause 3.7.3, or in accordance with any licence or approval held by you.

*Detail here any specific requirements for liaison with the community, such as from the EIS, REF, Submissions Report or planning consent/approval.*

##### 3.7.2.2 Extended Working Hours - No Environment Protection Licence

*Delete this clause if the construction activities are to be regulated by an Environment Protection Licence.*

Following approval from the Principal on each instance to extend working hours, inform affected residents by letter of the location, nature, scope and duration of the proposed work outside normal working hours, not less than 5 working days and not more than 10 working days, before commencing such work.



Include the name and contact telephone number of your representative so that residents can contact him over any concerns about extended working hours and any other information required by any licence or approval held by you.

Refer to Practice Note vii of RMS publication “Environmental Noise Management Manual” when preparing the letter and notifying the affected residents.

**3.7.2.3 Extended Working Hours - Environment Protection Licence Held by Contractor**

*Delete this clause if the construction activities are not to be regulated by an Environment Protection Licence held by the Contractor.*

Inform the Principal, and the residents of the proposed work outside normal working hours in accordance with the Environment Protection Licence held by you.

**3.7.2.4 Extended Working Hours - Environment Protection Licence Held by Principal**

*Delete this clause if the construction activities are not to be regulated by an Environment Protection Licence held by the Principal.*

When proposing to undertake work outside the hours approved under an Environment Protection Licence held by the Principal, provide to the Principal the following information in writing at least fifteen (15) working days before commencing the work, for the Principal to seek approval from EPA:

- (a) the reason that the work is required to be undertaken outside the hours specified in Clause 3.6;
- (b) a diagram that clearly identifies the locations of the proposed works in relation to nearby cross streets and local landmarks;
- (c) details of any relevant time restrictions and special conditions that apply to the proposed works;
- (d) the locations, nature, scope and duration of the proposed works;
- (e) the expected noise impact of the works on noise sensitive receivers; and
- (f) how complaints may be made and additional information obtained.

Refer to EPA publication “Interim Construction Noise Guideline” and Practice Note vii of RMS publication “Environmental Noise Management Manual” in addressing the above requirements.

**3.7.3 Complaints Management**

Within one (1) working day of receiving a complaint about any environmental issue, including any pollution incidents, arising from the Work Under the Contract, submit a written report to the Principal detailing the complaint and the action taken to remedy the problem. A final report together with your proposed measures to prevent the recurrence of such incidents must be submitted to the Principal within five (5) working days.

Keep a register of all complaints, which must include the following details:

- (a) date and time of complaint;
- (b) method by which the complaint was made (telephone, letter, meeting, etc);

- (c) name, address, contact telephone number of complainant (if no such details were provided, a note to that effect);
- (d) nature of complaint;
- (e) action taken in response including follow up contact with the complainant.;
- (f) any monitoring to confirm that the complaint has been satisfactorily resolved; and
- (g) if no action was taken, the reasons why no action was taken by you.

*Detail here any specific requirements for responding to complaints, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.8 EMERGENCY PLANNING**

The CEMP must include details of:

- (a) your key emergency response personnel, their respective responsibilities and contact details including all-hours contact telephone numbers;
- (b) emergency services (e.g. ambulance, fire brigade, spill clean-up services);
- (c) your communication strategy, both internal and external (refer to Clause 3.7), during emergencies;
- (d) any identified potential environmental emergencies that may occur on Site, and the response procedures for these emergencies; and
- (e) frequency of tests of the emergency response procedures.

Induct all staff and subcontractors working on the Site about the potential environmental emergencies, and provide training in implementing the relevant environmental safeguards and risk mitigation measures.

*Detail here any specific requirements for emergency planning, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.9 CONTRACTOR'S MONITORING, INSPECTION AND AUDITING**

Include in the CEMP procedure(s) to monitor and measure, on a regular basis, your environmental management performance and to evaluate compliance with this Specification. The procedures must contain the scope, methodology and responsibilities for its implementation.

Undertake regular site environmental inspections to assess the adequacy and effectiveness of your environmental controls. The site environmental inspections must cover the following:

- (i) high risk activities and processes;
- (ii) work in environmentally sensitive areas; and
- (iii) site preparedness for adverse weather conditions, including adequacy of environmental controls and availability of emergency equipment.

The Principal will undertake periodic inspections of the Site. Where these inspections identify environmental nonconformities, you must address them within the time specified by the Principal.

*Detail here any specific environmental performance requirements, such as from the EIS, REF, Submissions Report or planning consent/approval.*

Include in the CEMP a risk-based auditing program to verify that the Work Under the Contract meets the requirements of this Specification. The program must specify the type of audits to be conducted, their scope and their frequency.

Conduct all your internal and external environmental audits for the Work Under the Contract in accordance with AS/NZS ISO 19011.

*List here any additional requirements for Contractor auditing where RMS is the Environment Protection Licence holder for the Works, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.10 ENVIRONMENTAL NONCONFORMITIES**

If you fail to meet your environmental obligations under the Contract, including:

- (i) failure by you or your subcontractors to conform to any requirements of this Specification, your CEMS and CEMP; or
- (ii) failure by you to act promptly when you, the Principal, or any statutory authority having jurisdiction over the Work Under the Contract, observe that the implemented environmental controls are not effective; or
- (iii) failure by you to provide safeguards against a Category 1 incident as detailed in the RMS “Environmental Incident Classification and Reporting Procedure”,

a Hold Point may apply.

#### **HOLD POINT**

Process Held:	Any activity that causes or has the potential to cause harm to the environment due to your failure to meet your environmental obligations under the Contract.
Submission Details:	Verification that the failure has been rectified, and details of the measures implemented to prevent recurrence.
Release of Hold Point:	The Principal will consider the submitted documents and may inspect the relevant work prior to authorising the release of the Hold Point. The Principal may request additional information in respect of the submitted documents.

### **3.11 RECORDS OF ENVIRONMENTAL ACTIVITIES**

Maintain, as part of the project records in accordance with RMS Q Annexure Q/E, legible environmental records of all environmental activities associated with Work Under the Contract to demonstrate compliance with the CEMS and CEMP. The records must include:

- (i) site environmental inspection reports;
- (ii) environmental monitoring data and reports;

- (iii) internal and external audit reports;
- (iv) reports of environmental incidents, environmental complaints, associated actions taken, and follow-up actions;
- (v) minutes of management review meetings; and
- (vi) induction and training records.

You must hold these records for at least five years after the Actual Completion Date, and must make these records available to the Principal and authorised EPA officers upon request.

*Detail here any specific record keeping requirements, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.12 MANAGEMENT REVIEW**

Develop a documented process to periodically review the effectiveness and proper implementation of the CEMP. The management review process must identify opportunities for continual improvement of your environmental management processes and practices, and ensure that the CEMS and CEMP remain relevant to the Work Under the Contract.

The management reviews must be undertaken at least quarterly and must include the Principal's participation. The management reviews must comprise as a minimum the following:

- (i) identification of areas of opportunity for improved environmental performance;
- (ii) analysis of the causes of nonconformities and deficiencies, including those identified in environment inspections and audits;
- (iii) verification of the effectiveness of corrective and preventative actions;
- (iv) highlighting any changes in procedures resulting from process improvement.

## **4 OPERATIONAL CONTROL**

### **4.1 SOIL AND WATER MANAGEMENT**

Comply with the requirements of Specification RMS G38 for soil and water management.

### **4.2 CONTAMINATED LAND**

#### **4.2.1 Areas of Known Contamination**

Areas of known contamination within the Site are shown in the Environmental Assessment documents listed in Annexure G36/A3.



*List here other relevant documents relating to the known contamination, such as:*

- *preliminary desktop investigation reports;*
- *site investigation reports;*
- *notifications to NSW EPA or Council under s60 of the Contaminated Land Management Act 1997 (NSW);*
- *remediation validation reports and/or site audit statements prepared.*

*Where a Contaminated Land Management Plan and/or Remediation Action Plan has been prepared, include the documents as an attachment.*

*Provide in Annexure G36/B pay items for remediation of the areas of known contamination.*

#### **4.2.2 Contaminated Land Management Sub-Plan**

Include in your CEMP a Contaminated Land Management Sub-Plan, which must comply with the *Contaminated Land Management Act 1997 (NSW)*, RMS publication “Contaminated Land Management Guideline”, RMS “Environmental Incident Classification and Reporting Procedure”, and EPA guidelines on contaminated land management.

The Contaminated Land Management Sub-Plan must provide for dealing with:

- (i) areas of known contamination (if applicable);
- (ii) unexpected contamination finds;
- (iii) any land contamination caused by you.

#### **4.2.3 Unexpected Contamination Find**

Promptly notify the Principal of any suspected or potential contamination exposed during construction activities, and cease all work activities within the vicinity of actual or suspected contaminated land.

The Principal may at its discretion choose to take over the investigation and management of an unexpected contamination find, and directly appoint an EPA accredited contaminated site auditor.

#### **4.2.4 Remediation Action Plan**

Where the contamination is known or an unexpected contamination find has been identified, a Remediation Action Plan may be provided by the Principal.

If a Remedial Action Plan is not provided by the Principal, prepare a Remediation Action Plan for remediating the known areas of contamination or an unexpected contamination find, and areas of potential contamination in their immediate vicinity.

The Remediation Action Plan must be prepared in accordance with EPA guidelines on contaminated land management, and must include the following:

- (a) testing requirements for any contaminated material prior to its disposal off site;
- (b) validation plan, which must include the area in the immediate vicinity of (both below and adjacent to) the known contamination;
- (c) implications of the validation results on the waste classification for material that may be excavated in the vicinity of the known contamination.

<b>HOLD POINT</b>	(Where the Remedial Action Plan is to be prepared by the Contractor)
Process Held:	Activities within the vicinity of actual or suspected contaminated land.
Submission Details:	At least five (5) working days prior, submit your Remediation Action Plan to be prepared by you, and relevant procedures.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point. The Principal may request additional information in respect of the submitted documents.

Carry out remediation of the contaminated material, or its removal and disposal, in accordance with the Remediation Action Plan. Any changes to the Plan must be agreed to by the Principal.

#### **4.2.5 Surface Runoff**

Implement relevant control measures to divert any surface runoff away from the contaminated land, and capture and treat any surface runoff contaminated by exposure to the contaminated land.

### **4.3 SPILL PREVENTION AND RESPONSE**

Plan and execute the Work Under the Contract so as to minimise the possibility of pollution of the Site and adjoining areas by chemicals, dangerous goods and other potential contaminants.

Comply with the requirements in the following:

- relevant legislation and Australian Standards;
- EPA “Bunding and Spill Management Guidelines” contained within EPA “Environmental Protection Manual for Authorised Officers”;
- RMS “Code of Practice for Water Management”.

Store chemicals, fuel and lubricants in suitably located and bunded areas to minimise the impact of any spillage or contamination on the Site and adjoining areas. Do not locate these storage areas within 50 m of any aquatic habitat, flood prone areas, or on slopes steeper than 1:10.

Do not refuel or maintain plant and equipment, mix cutting oil with bitumen, or carry out any other activity which may result in spillage of a chemical, fuel or lubricant at any location which drains directly to waters or environmentally sensitive areas, without the appropriate temporary bunding being provided. Do not leave refuelling operations unattended.

As part of the CEMP, prepare a procedure(s) for the following activities, as a minimum, to minimise the possibility of pollution of the Site:

- (a) refuelling or maintenance and cleaning of plant and equipment including concrete agitators, bitumen spray bars and asphalt pavers;
- (b) on-site batching of concrete and asphalt;
- (c) mixing of bitumen with cutting oil and additives;
- (d) application of liquid membranes, including paint and thermoplastic, resin, emulsion, precoat agent and curing compound;
- (e) bulk fuel or chemical deliveries;

- (f) removal and disposal of excess chemicals and water used for washing down of equipment;
- (g) pumping out of oil and grease collection pits; and
- (h) decanting operations such as for fuel, chemicals and bitumen.

Include in the procedure(s) the following, as a minimum:

- (i) details of the management of the bunded areas including monitoring of the bunded areas, drainage requirements and measures to ensure that bund capacities are maintained;
- (ii) details of the management associated with the removal and transportation of chemical drums from bunded areas;
- (iii) routine maintenance requirements of machinery, pumps and other equipment to prevent and/or minimise leaks; and
- (iv) installation of controls for the capture and filtering of all chemicals that may runoff in storm events, for example wax and hydrocarbon curing compounds, bitumen tack coat and saw cutting material.

Keep adequate quantities of suitable material to counteract spillage readily available. Clean up all chemical spills immediately. If spills result in an environmental incident, report the incident in accordance with Clause 4.14.

Prepare and implement a Spill Response Procedure as part of the CEMP to minimise the impact of spills including details on the requirements for managing, cleaning up and reporting.

## **4.4 AIR QUALITY**

### **4.4.1 General**

Prepare and implement an Air Quality Management Sub-Plan as part of the CEMP, or include mitigation strategies within the CEMP, to minimise the impact of dust, offensive odour, and other air pollutants on the surrounding environment, including adjacent properties and sensitive places.

Comply with the requirements of the *POEO Act* and any conditions of licences, notifications, approvals or permits in relation to maximum air pollutant levels (refer to Clause 3.2.2).

Plan and carry out all your construction activities to avoid where practicable, or minimise, the generation of dust and vehicle emissions. Include in the Air Quality Management Sub-Plan or mitigation strategies the procedures for effective dust control, including dust monitoring and reporting procedures.

*Detail here any specific environmental management requirements for air quality, from the REF, EIS, Submissions Report, planning consent/approval, EPA licence or other relevant sources.*

Where air quality monitoring is required, it must comply with the EPA publication “Approved Methods for Sampling and Analysis of Air Pollutants in NSW”. Monitoring data must include reporting of insoluble solids in accordance with the EPA publication “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW”.

#### 4.4.2 Air Emissions Performance Requirements of Mobile Non-road Diesel Plant and Equipment

Report on the conformity, or otherwise, of mobile non-road diesel plant and equipment used for the Work Under the Contract with the relevant United States Environmental Protection Agency, European Union (EU) standards or approved equivalent emission standards.

Once a year, submit to the Principal such reports at the following dates:

- (a) before 31 July, for the reporting period ending 30 June for the previous 12 months;
- (b) at Actual Completion Date, for the final reporting period.

Prepare the report in accordance with the GREP “Clean Air data management tool”. The types of diesel plant and equipment that are to be included, or excluded, from the report are given in this document, which is available at: <http://www.rms.nsw.gov.au/documents/about/environment/grep-clean-air-data-management-tool.xlsm>.

#### 4.5 FIRE SAFETY AND BURNING OFF

Comply with the requirements of the Rural Fires Act 1997 (NSW), and the Local Government Act 1993 (NSW) and be guided by the NSW Rural Fire Service publication “Equipment and Machinery Use in Bush Fire Prone Areas”.

Provide fire fighting equipment as required for the safety of persons and property.

All items of plant used during proclaimed high fire danger periods that could discharge sparks must be fitted with spark arresters. Do not undertake cutting, welding, grinding or other activities likely to generate fires in the open on days when a total fire ban is proclaimed.

When there is a risk of fire being caused by work such as welding, thermal or oxygen cutting, heating or other fire producing or spark producing operations or when burning off is proposed, provide training to all personnel in fire prevention, fire safety and basic fire fighting skills. Provide all personnel and vehicles involved in such activities with fire fighting equipment.

*Detail here any specific requirements to minimise the risk of fires, such as from the EIS, REF, Submissions Report or planning consent/approval.*

Annexure G36/A indicates whether the Principal will allow disposal of cleared and grubbed vegetation by burning off, subject to the requirements of the *Protection of the Environment Operations (Clean Air) Regulation 2002 (NSW)*.

Where burning off has been assessed, approved and planned, obtain a fire permit from the relevant Statutory Authorities and comply with the requirements of the Statutory Regulations and be guided by the EPA guideline “Regulation of Open Burning in NSW”.

On receipt of a fire permit, notify the Principal and occupiers of adjoining properties of the proposed burning off operation at least 24 hours before carrying out the burning off. Control the burning off operation so that:

- (a) vegetation outside the limits of clearing is not damaged;
- (b) fences, buildings or other property are not damaged;
- (c) smoke does not cause a traffic hazard, or nuisance nor contravene air quality requirements.



*Detail here any specific requirements for burning off, such as from the EIS, REF, Submissions Report or planning consent/approval.*

#### **4.6 NOISE CONTROL**

*Detail here any specific environmental management requirements for noise, from the EIS, REF, Submissions Report, planning consent/approval, EPA licence or other relevant sources.*

Prepare and implement a Noise Management Sub-Plan as part of the CEMP, or include mitigation strategies within the CEMP, to minimise the impact of noise from your operations on adjacent properties. The Noise Management Sub-Plan or mitigation strategies must include proposed environmental control measures for all significant noise generating activities.

Refer to the requirements of the EPA publication “Interim Construction Noise Guideline” and RMS publication “Environmental Noise Management Manual”, and in particular Practice Note vi, when considering the environmental control measures and practices to be included in the Noise Management Plan.

Where works are proposed to be undertaken outside of normal working hours, comply with the requirements of Clause 3.7.2.

All construction plant and equipment used on Site must be, in addition to other requirements:

- (a) fitted with properly maintained noise suppression devices in accordance with the manufacturer’s specifications;
- (b) maintained in an efficient condition;
- (c) operated in a proper and efficient manner.

#### **4.7 GROUND VIBRATION AND AIRBLAST**

Implement all measures to prevent damage to adjacent public utilities, structures and buildings resulting from construction vibration and airblast.

Comply with the requirements of Specification RMS R44 for vibration and airblast from blasting, unless overridden by other more stringent requirements set out in this Specification.

For any blasting activities, comply with the requirements of the ANZECC publication “Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration - September 1990”. Where the amenity guidelines are likely to be exceeded, manage the impacts in consultation with, and in accordance with, the requirements stipulated by EPA.

The measurement process for determining verification of compliance with the ANZECC criteria will be in accordance with AS 2187.2 Explosives - Storage, Transport and Use, Appendix J - Ground Vibration and Airblast (Informative).

Meet the requirements of EPA “Environmental Noise Management Assessing Vibration: A Technical Guideline”. Where the requirements are likely to be exceeded, manage the impacts in consultation with, and in accordance with, the requirements stipulated by EPA.

To avoid structural damage, carry out construction activities in accordance with the requirements of BS 7385.

*Detail here any specific environmental management requirements for ground vibration and airblast, from the EIS, REF, Submissions Report, planning consent/approval, EPA licence or other relevant sources. Alternatively, insert such requirements in Specification RMS R44 and insert a cross reference in RMS G36.*

Where there is a risk that vibration or airblast activities may cause damage to nearby structures and buildings or if these are located within the distance from the construction activity specified in Annexure G36/E, undertake a building condition inspection and prepare a Building Condition Inspection Report for every property or structure likely to be affected.

The Building Condition Inspection Reports must contain photographs of the inspected properties and include details of the inspectors' qualification and expertise, together with a list of any indentified defects, where relevant. The reports must be submitted to the owner of each property and to the Principal before the commencement of any activities as outlined in the Hold Point below.

Prepare, as part of the CEMP, a Vibration and Airblast Management Sub-Plan as part of the CEMP, or include mitigation strategies within the CEMP, that describes the environmental controls to be implemented during construction to minimise the impact of vibration and airblast on adjacent properties and residents.

The Vibration and Airblast Management Sub-Plan or mitigation strategies must detail how construction vibration and airblast will be managed for various plant items working adjacent to buildings. Keep records as evidence of compliance with these construction vibration and airblast restrictions.

Where blasting is not required for the Work Under the Contract, vibration mitigation and management measures may be incorporated into a combined Noise and Vibration Management Sub-Plan.

## **HOLD POINT**

Process Held:	Commencement of blasting, pile driving, excavation by hammering or ripping, dynamic compaction, demolition operations, or any other activity which may cause damage through vibration or airblast.
Submission Details:	At least ten (10) working days prior, submit to the Principal a copy of the Building Condition Inspection Reports and the Vibration and Airblast Management Sub-Plan or the combined Noise and Vibration Management Sub-Plan (where blasting is not required).
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point. The Principal may request additional information in respect of the proposal and/or submitted documents.

You are liable for any accident or damage to any property, person, or thing resulting from vibration and airblast from construction activity.

## **4.8 BIODIVERSITY**

Prepare and implement a Flora and Fauna Management Sub-Plan as part of the CEMP, or include mitigation strategies within the CEMP, to provide effective environmental controls to protect all native flora, fauna, and fish from the impact of your construction activities.

The Flora and Fauna Management Sub-Plan or mitigation strategies must include, as a minimum, the following:

- (a) Provisions for compliance with statutory requirements applicable to flora, fauna and fish management, in *National Parks and Wildlife Act 1974 (NSW)*, *Native Vegetation Act 2003 (NSW)*, *Environmental Planning and Assessment Act 1979 (NSW)*, *Threatened Species Conservation Act 1995 (NSW)*, *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* and *Fisheries Management Act 1994 (NSW)*;
- (b) Fauna and flora management strategies for pre-construction, construction and post-construction activities including environmental control measures for pre-clearing process;
- (c) Fauna rescue and release procedure. Handling of injured fauna must be carried out by licensed fauna handler such as fauna ecologist or wildlife carer. If native fauna are captured during vegetation clearing, they must be released into a suitable nearby location that has been identified as such by an ecologist. Keep records of fauna captured and relocated. Report any injury or death of threatened species to the Principal. The fauna rescue and release procedure must include management measures for aquatic fauna and fish;
- (d) Procedure for controlling the introduction and spreading of weeds and pathogens caused by the Work Under the Contract, including hygiene protocols and the arrangements for monitoring;
- (e) Proposed strategies for re-use of coarse woody debris and bushrock;
- (f) Procedure for dealing with unexpected threatened species finds that may be discovered by you when undertaking Physical Work on Site. The procedure must include, as a minimum, the following:
  - (i) stop work arrangements in the immediate area of the threatened species;
  - (ii) notification and communication protocol;
  - (iii) consultation with the specialists to assess the significance of the find; and
  - (v) a list of approvals, licences or permits that may need to be obtained before the works can recommence.

Prepare and include an EWMS, for clearing and grubbing that meets the requirements of Specification RMS G40 and RMS publication “RMS Biodiversity Guidelines: Protecting and Managing Biodiversity on RMS Projects”, in the Flora and Fauna Management Sub-Plan or CEMP.

Refer to the RMS Biodiversity Guidelines when preparing the Flora and Fauna Management Sub-Plan.

*Detail here any specific flora and fauna management requirements, such as from the EIS, REF, Submissions Report or planning consent/approval.*

Preserve existing trees, plants, and other vegetation that are to remain within or adjacent to the Site and use every precaution necessary to prevent damage or injury thereto. Identify and protect areas of vegetation to be retained showing them as exclusion zones in accordance with the RMS Biodiversity Guidelines.

*Detail here any specific requirements for preservation of vegetation, such as from the EIS, REF, Submissions Report or planning consent/approval. Alternatively, insert such requirements in Specification RMS G40 and insert a cross reference in RMS G36.*

## 4.9 ABORIGINAL HERITAGE

*Detail here any specific Aboriginal heritage requirements and safeguards, such as from the EIS, REF, Submissions Report, planning consent/approval or Office of Environment and Heritage approval.*

*A Heritage Management Sub-Plan combining both Aboriginal and Non-Aboriginal heritage requirements may be used.*

**Example:**

*Protect the Aboriginal artefact scatter (Site Name HB-24) located on the banks of Shark River approximately 50 m upstream of the bridge site from construction related activities by erecting a temporary pedestrian safety fence around a 10 m buffer zone from the recorded site perimeter.*

*The fence type and construction must be in accordance with Specification RMS R201.*

*Measurement and payment for the fencing will be made in accordance with RMS R201.*

Prepare an Aboriginal Heritage Management Sub-Plan as part of the CEMP or include mitigation strategies within the CEMP to manage any areas of the Site where known Aboriginal objects, places and/or culturally sensitive areas have been identified on Site.

The Aboriginal Heritage Management Sub-Plan or mitigation strategies must also include a procedure for the management of unexpected potential Aboriginal objects discovered by you during construction. The management of unexpected potential Aboriginal objects must be in accordance with the RMS publication “RMS Unexpected Archaeological Finds Procedure”.

The procedure for unexpected finds must include the following steps:

- (a) cease work in the immediate area of the identified potential Aboriginal object immediately;
- (b) notify the Principal immediately;
- (c) provide access to the Site to any heritage specialist required to assess the finds;
- (d) provide temporary exclusion (pedestrian) fencing;
- (e) implement additional safeguards as required.

Provide for all personnel working on the Site training on their responsibilities pertaining to the Aboriginal Heritage provisions of the *National Parks and Wildlife Act 1974 (NSW)*. Make the personnel working on Site aware of all Aboriginal archaeological sites and areas of cultural sensitivity identified in the Cultural Heritage Assessment Report or the Environment Assessment documents listed in Annexure G36/A3 that must be preserved.



## **4.10 NON-ABORIGINAL HERITAGE**

*Detail here any specific requirements for non-Aboriginal heritage requirements and safeguards, such as from the EIS, REF, Submissions Report or planning consent/approval.*

*A Heritage Management Sub-Plan combining both Aboriginal and Non-Aboriginal heritage requirements may be used.*

**Example:**

*Protect the heritage well (Site Name BS-25) located on the south east corner of the Smith's homestead approximately 20 m from the current road alignment by erecting a temporary pedestrian safety fence around a 10 m buffer zone from the physical site perimeter.*

*The fence type and construction must be in accordance with Specification RMS R201.*

*Measurement and payment for the fencing will be made in accordance with RMS R201.*

**Example:**

*Where vibration impacts to heritage structures are likely, implement vibration monitoring of the heritage structures.*

Prepare a Non-Aboriginal Heritage Management Plan as part of the CEMP or include mitigation strategies within the CEMP to manage any areas of the Site where any known heritage items/s and/or archaeological sites have been identified.

The Non-Aboriginal Heritage Management Sub-Plan or mitigation strategies must also include a procedure for the management of unexpected potential archaeological relics discovered by you during construction. The management of unexpected potential archaeological relics must be in accordance with the RMS publication "RMS Unexpected Archaeological Finds Procedure". The procedure for unexpected finds must include the steps (a) to (e) listed in Clause 4.9.

Provide for all personnel working on the Site training on their responsibilities under the *Heritage Act 1977 (NSW)*. Make the personnel aware of all non-Aboriginal heritage sites/areas, including cultural plantings, and areas of archaeological potential, which are identified in the Environment Assessment documents listed in Annexure G36/A3.

## **4.11 WASTE MANAGEMENT AND RESOURCE RECOVERY**

### **4.11.1 Waste Management Sub-Plan**

Prepare a Waste Management Sub-Plan as part of the CEMP, or include mitigation strategies within the CEMP, to manage and minimise the generation of waste and encourage reuse of materials. Be guided by the following publications when preparing the Waste Management Sub-Plan or mitigation strategies:

- NSW Government Resource Efficiency Policy (GREP).
- EPA "Waste Classification Guidelines";
- RMS Waste Fact Sheets.

Use the concept of the waste hierarchy to set priorities for the efficient use of resources, consistent with the objectives of the *Waste Avoidance and Resource Recovery Act 2001 (NSW)*. Further details of the waste hierarchy may be obtained from:

<http://www.epa.nsw.gov.au/wastestrategy/waste-hierarchy.htm>.

The Waste Management Sub-Plan or mitigation strategies must:

- (a) identify the waste streams that will be generated during the Contract;
- (b) provide details, for each of the identified waste streams, of the following:
  - (i) the waste classification (refer to EPA's "Waste Classification Guidelines" and RMS Waste Fact Sheets);
  - (ii) how and where the waste is to be reused, recycled, stockpiled or disposed of;
  - (iii) the receptacles that will be used for storing identified waste materials prior to reuse, recycling, stockpiling or disposal;
  - (iv) how, and by whom, will the waste be transported between generation, storage and point of reuse, recycling, stockpiling or disposal;
  - (v) sampling and testing requirements (refer to RMS Waste Fact Sheet "Waste Sampling");
  - (vi) licensing requirements under the *POEO Act* and/or relevant NSW Resource Recovery Orders and Exemptions;
  - (vii) procedures for verifying licenses and permits for handling, transportation and disposal of waste;
- (c) provide controls for minimising consumption of fuel, oil and other consumables, on-site electricity and water required for construction;
- (d) include methods for monitoring the implementation of the Waste Management Sub-Plan or mitigation strategies;
- (e) identify the need or otherwise for "s.143 Notices" (see Clause 4.11.4) or any other additional approval, licence and/or permit from an appropriate authority or the Principal;
- (f) comply with the requirements of the *POEO Act* for any non-licensed as well as licensed waste activities that involve the storage, transport, treatment and/or disposal of waste.

*Detail here any specific waste management requirements, such as from the EIS, REF, Submissions Report or planning consent/approval.*

#### **4.11.2 Waste Management Register**

Maintain a Waste Management Register until the Actual Completion Date, to record the type, amount and location of waste reused, recycled, stockpiled and disposed of. The Waste Management Register must include the following details:

- (a) type of waste and its classification (according to the *POEO Act* and Waste Classification Guidelines);
- (b) quantities of waste, measured in tonnes;
- (c) how and where the waste was reused, recycled, stockpiled or disposed of;
- (d) date when the waste was reused, recycled, stockpiled or disposed of; and
- (e) name and waste transport licence (if applicable) of the transporter used.

**4.11.3 Waste Avoidance and Resource Recovery Reporting**

Once a year, submit to the Principal a Waste Avoidance and Resource Recovery Report containing information relating to wastes generated or recycled in accordance with Annexure G36/F, at the following dates:

- (i) within one month from 1 July of the current calendar year, for the previous 12 months of the contract period, or part thereof if the contract commenced after 1 July of the previous calendar year
- (ii) at Actual Completion Date, for the final reporting period.

**4.11.4 Offsite Waste Disposal**

Prior to transporting wastes generated by or for RMS to a place that is not owned by RMS and is not a licensed waste facility (the “Waste Site”), submit to the Principal a completed and signed notice under section 143(3A) of the *POEO Act* (“s.143 Notice”). This includes waste transported for reuse, recycling, disposal or stockpiling.

Waste in this context includes spoil, Virgin Excavated Natural Material (“VENM”), Excavated Natural Material (“ENM”), crushed rock, reclaimed asphalt pavement, mulched vegetation, waste concrete, etc.

Further details, including the steps to be taken to obtain the “s.143 Notice” from the landholder, and the template (or proforma) letter to the landholder, can be found in RMS Environment Technical Direction ETD 2015/020 “Legal offsite disposal of Roads and Maritime Services waste”, available at: <http://www.rms.nsw.gov.au/documents/about/environment/rms-environment-offsite-waste-disposal.pdf>.

Provide an accurate description of the waste on the “s.143 Notice”, include evidence that the Waste Site has the appropriate planning consent and confirm the waste delivery arrangements with the landholder prior to transporting materials to the Waste Site.

*Detail here any proposed stockpile or disposal sites for which a “s.143 Notice” will be required.*

**HOLD POINT**

Process Held:	Transport of waste to a place that is not owned by RMS and is not a licensed waste facility.
Submission Details:	Completed and signed original copy of “s.143 Notice” received from the landholder receiving the waste with evidence that the Waste Site has the appropriate planning consent.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point. The Principal may request additional information in respect of the submitted documents.

**4.12 USE OF PESTICIDES**

Use of pesticides must be in accordance with the *Pesticides Act 1999 (NSW)*, other relevant legislation, label directions and any relevant industry codes of practice.

Complete a Records Sheet within 24 hours of applying the pesticide and submit a copy to the Principal. For guidance when preparing pesticide application records, you may use the “Sample Pesticides Application Records Sheet” shown in Annexure G36/G.

You are exempt from completing the Records Sheet, when all of the following are satisfied:

- (a) The pesticide is, or is part of a product that is widely available to the general public at retail outlets.
- (b) The pesticide is only applied by hand or by using hand-held equipment.
- (c) If applied outdoors on any single occasion, in quantities of no more than 5 litres/5 kilograms of concentrated product or 20 litres/20 kilograms of the ready-to-use product; or if applied indoors, in quantities of no more than 1 litre/1 kilogram of concentrated product or 5 litres/5 kilograms of the ready-to-use product.

All personnel managing and using pesticides must receive appropriate training and hold appropriate licence prior to commencing work. Only pesticides registered for use near water may be used near water.

Public notification of pesticide use must be in accordance with Annexure G36/H. Implement the following measures whenever pesticides are to be used adjacent to, or across the road from, a “sensitive place” (refer to Clause 1.3 for definition):

- Use of mechanical means of pest control (such as mowing or slashing) where feasible; or
- Use of hand-held application of pesticides where mechanical means of pest control are not feasible.

Avoid applying pesticides:

- (i) on hot days when plants are stressed;
- (ii) after the seed has set;
- (iii) within 24 hours of rain or when rain is imminent;
- (iv) when winds will cause drift of pesticides into non-target areas.

*Detail here any specific requirements for chemical storage, handling, transporting and pollution control procedures.*

*List any other specific requirements from EIS, REF, Submissions Report or planning consent/approval.*

#### **4.13 WORK IN ENVIRONMENTALLY SENSITIVE AREAS**

The Principal has identified the following environmentally sensitive areas:



*List here any environmentally sensitive areas or sensitive places identified in EIS, REF, Submissions Report or planning consent/approval.*

*Environmentally sensitive areas may include Aboriginal and non-Aboriginal heritage sites (taking into account privacy implications), records of threatened species or populations, threatened ecological communities, retained threatened species habitat (e.g. hollow-bearing trees), waters, mangroves, National Parks, Nature Reserves, potential or actual acid sulphate soil areas, contaminated sites or a “sensitive place” as defined in Clause 1.3.*

Clearly show all identified environmentally sensitive areas and sensitive places on Sensitive Area Maps, submitted as part of the CEMP. Review and update regularly the Sensitive Area Maps to include environmentally sensitive areas identified during the Work Under the Contract. Make the Sensitive Area Maps available to all personnel working on the Site.

Prepare and include in the CEMP an EWMS for working in or near the environmentally sensitive areas. Include in the EWMS environmental protection measures that are effective for minimising the risk of impacting the environmentally sensitive areas. Review these measures regularly to ensure that they are effective.

At least five (5) days prior to commencing Physical Work on Site in or near an environmentally sensitive area, prepare an EWMS which includes the details of the environmental protection measures to be implemented at that location. Clearly delineate the environmentally sensitive area and signpost the locations and boundaries.

## **HOLD POINT**

Process Held:	Working in or near environmentally sensitive areas.
Submission:	At least five (5) working days prior, provide to the Principal a copy of the EWMS for working in or near the environmentally sensitive areas and written notice that the environmentally sensitive areas are clearly delineated with locations and boundaries signposted.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

As part of the environmental induction (refer Clause 3.5) to your staff and subcontractors working on the Site, provide an understanding of the risks associated with working in or near environmentally sensitive areas, and training on implementing the relevant environmental protection measures.

Clearly delineate and signpost the locations and boundaries of all environmentally sensitive areas on Site.

## **4.14 ENVIRONMENTAL INCIDENT NOTIFICATION AND REPORTING**

If required by an EPL, prepare and include in the CEMP an environmental incident reporting and investigation procedure, including Pollution Incident Response Management Plan, as required by Part 5.7 of the *Protection of the Environment Operations Act 1997 (NSW) (POEO Act)*.

Manage and report environmental incidents, including “pollution incidents”, in accordance with the RMS “Environmental Incident Classification and Reporting Procedure” and RMS “Environmental Incident Report”.

Notify the Principal verbally immediately and in writing within 24 hours, of any pollution incidents which have been reported to the EPA under Part 5.7 of the *POEO Act*.

Report all other environmental incidents to the Principal verbally immediately and in writing within 24 hours of the incident coming to your attention. Notify the Principal when any environmental incidents have been reported to the relevant authorities as required under the relevant NSW environmental legislation.

The Principal may request additional information in relation to any environmental incident. You must provide the Principal with all information requested within the agreed timeframe but no later than 3 working days.

## **4.15 SITE FACILITIES**

### **4.15.1 General**

Locate and manage your site facilities (refer to Specification RMS G2) to minimise impacts on the environment and the community.

*Detail here any specific requirements for site facilities, e.g. proximity to waters, access requirements, etc.*

*List any other specific requirements from EIS, REF, Submissions Report or planning consent/approval.*

### **4.15.2 Pre-construction Land Condition Assessment**

Prior to taking possession of any area of land nominated by the Principal as available for use by you for locating your site facilities, including areas for construction materials storage and stockpiling, arrange for a pre-construction land condition assessment of each area you intend to occupy.

The purpose of the pre-construction land condition assessment is to identify any existing waste or stored materials on the land prior to the area being occupied by you. The pre-construction land condition assessment must be undertaken by an independent environmental consultant approved by the Principal, with experience in site environmental inspections and construction waste management.

Where the Principal has authorised the use of other areas of the Principal's land, additional to those nominated, carry out the pre-construction land condition assessment of each area. Obtain, at your own cost, the necessary statutory and environmental planning approvals for the intended use of the land.

Submit to the Principal a report of the pre-construction land condition assessment for each area of land, prior to the Principal granting approval for you to take possession of the area(s). The report must be in the format detailed in the RMS publication "Management of Wastes on Roads and Maritime Services Land". (A copy of this procedure is available at: <http://www.rms.nsw.gov.au/documents/about/environment/environment-waste-on-rms-land-procedure.pdf>)

Allow in your construction program the time required to carry out the land condition assessment and submit the report, and to obtain any necessary approvals.

Payment for the pre-construction land condition assessments and reports for areas nominated by the Principal will be made under Pay Item G36P3.1. Payment for the land condition assessment of any additional areas not nominated by the Principal will be at your own cost.

### **HOLD POINT**

Process Held:	Taking possession of any land nominated or authorised by the Principal for use for the Contractor's site facilities.
Submission:	Pre-construction land condition assessment report for each area which you intend to use for the Contractor's site facilities, and evidence of any necessary statutory and environmental approvals.
Release of Hold Point:	The Principal will consider the submitted report, and may inspect the site or request additional information in respect of the submitted report, prior to authorising the release of the Hold Point.

#### **4.15.3 Post-construction Land Condition Assessment**

When the areas of Principal's land used for the Contractor's site facilities are no longer required, and after restoration of the areas in accordance with Clause 4.16, arrange for a post-construction land condition assessment for each area that has been used.

The purpose of the post-construction land condition assessment is to verify that that no unauthorised project waste remain on the land to be returned to the Principal. The land condition assessment must be undertaken by an independent environmental consultant approved by the Principal.

Submit to the Principal a report of the post-construction land condition assessment for each area of land used, prior to the Principal accepting those areas of land. The report must be in the format detailed in the RMS publication "Management of Wastes on Roads and Maritime Services Land".

Where the post-construction land condition assessment report identifies unauthorised waste attributable to your activities left behind on the areas of land, carry out any further work required in accordance with the recommendations of the report and Clause 4.16.

Payment for the post-construction land condition assessments and reports for the Principal's nominated area(s) will be made under Pay Item G36P3.2. Payment for the land condition assessment of any additional areas not nominated by the Principal will be at your own cost.

#### **4.16 RESTORATION OF SITE**

Prior to Completion, restore at your own cost any areas disturbed by you (such as areas for site compounds, material storage, access and haul roads and the provision of the Principal's project accommodation) to a condition similar to that existing before disturbance, unless authorised otherwise by the Principal.

Restoration includes spill clean up and soil remediation where applicable, topsoiling of the area, weed control and seeding, planting, watering and maintenance. Refer to Specifications RMS R178 and RMS R179 as applicable.

*Detail here any specific requirements, such as from the EIS, REF, Submissions Report or planning consent/approval, for site restoration.*

## 5 PRINCIPAL'S SURVEILLANCE AND AUDITS

The Principal may conduct regular surveillance and inspections of the Site at any time. The Principal may authorise environmental specialists as agents of the Principal to enter the Site for the purposes of surveillance or inspection and to attend site meetings to discuss environmental aspects of the Work Under the Contract.

If surveillance, inspection or audit indicates that the environmental controls are not in place or are not properly maintained as required by the CEMP, the Principal may conduct a CEMP compliance audit at 24 hours' notice to you; otherwise the Principal will give you at least five (5) days' notice that a CEMP compliance audit is to be conducted and will advise you on the scope of this audit.

Surveillance and inspections of Site by the Principal will be in accordance with RMS "Guidance Note: Environmental Inspection Report".

Provide necessary resources, including site personnel and facilities at the Site to accommodate the audit team nominated by the Principal. The cost of providing such resources will be borne by you.

Respond to the issues raised during these inspections in writing within seven (7) working days and address the issues within agreed timeframes. Follow RMS "Guidance Note: Environmental Inspection Report" when preparing and closing out environmental inspection actions.

*Detail here any specific requirements, such as from the EIS, REF, Submissions Report or planning consent/approval.*

At least ten (10) working days prior to Completion, the Principal may carry out an audit to verify that all environmental obligations listed in this Specification have been met by you.



**ANNEXURE G36/A – SUPPLEMENTARY PROJECT INFORMATION**

*NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure G36/A)*

*Where “Yes / No” options are shown below, delete whichever is not applicable.*

**A1 GENERAL**

Clause	Details	
3.1	Submission of the CEMP to the Principal is required for forwarding to: (a) Department of Planning and Infrastructure (b) Environment Protection Authority (c) <i>[insert others as applicable]</i>	Yes / No Yes / No <i>[Yes]</i>
3.2.1	Environmental Risk Assessment Workshop is required	Yes / No
3.7.1	Notification to the EPA Regional Manager of at least two persons and their contact telephone numbers, who will be available to be contacted by the EPA on a 24 hour basis, is required	Yes / No
4.5	Disposal of cleared and grubbed vegetation by burning off is conditionally allowed by the Principal	Yes / No

**A2 ENVIRONMENTAL MANAGEMENT SUB-PLANS**

Clause	Details	Required
4.1	Soil and water management sub-plans	refer G38
4.2.2	Contaminated Land Management Sub-Plan	Yes / No
4.4	Air Quality Management Sub-Plan	Yes / No
4.6	Noise Management Sub-Plan	Yes / No <sup>(1)</sup>
4.7	Vibration and Airblast Management Sub-Plan	Yes / No <sup>(1)</sup>
4.8	Flora and Fauna Management Sub-Plan	Yes / No
4.9	Aboriginal Heritage Management Sub-Plan	Yes / No <sup>(2)</sup>
4.10	Non-Aboriginal Heritage Management Sub-Plan	Yes / No <sup>(2)</sup>
4.11	Waste Management Sub-Plan	Yes / No

**Notes:**

<sup>(1)</sup> May be combined together into Noise and Vibration Management Sub-Plan, if no blasting.

<sup>(2)</sup> May be combined together into Heritage Management Sub-Plan.

**A3 ENVIRONMENT ASSESSMENT DOCUMENTS**

The following documents are FOR INFORMATION ONLY, and do not form part of the Contract:

<p><i>List here the Environment Assessment documents, such as the Environment Impact Statement (EIS), Review of Environmental Factors (REF), Submissions Report, Conditions of Approval, etc.</i></p>
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## **ANNEXURE G36/B – MEASUREMENT AND PAYMENT**

Refer to Clause 1.2.2.

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Unless specified otherwise, a lump sum price for any of these items will not be accepted.

*NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising RMS G36)*

*Include Pay Items for specific items such as monitoring of dust, monitoring of water quality, building condition inspections, etc. Note that water quality monitoring is paid under RMS G38.*

*Examples are shown below:*

-----

***Pay Item G36P1 - Building Condition Inspections***

***Pay Item G36P1.1 – Residential***

***Pay Item G36P1.2 – Commercial***

***Pay Item G36P1.3 – Heritage***

*The unit of measurement is “each” building inspected.*

*The rate covers all costs associated with performing and reporting building condition inspections in accordance with Clause 4.7.*

***Pay Item G36P2 - Site Environmental Monitoring***

***G36P2.1 Air Quality***

***G36P2.2 Noise***

***G36P2.3 Ground Vibration***

*These are Lump Sum items.*

*The rates cover all costs associated with the measurement and provision of records associated with the site monitoring required under Clauses 4.4, 4.6 and 4.7.*

*Progress payments will be made on a pro-rata basis having due regard to the duration of the Contract.*

***Pay Item G36P3 – Land condition assessments reports for Principal nominated area(s) used for Contractor’s facilities***

***G36P3.1 Pre-construction land condition assessment reports***

*This is a Lump Sum item.*

*The rate covers all costs associated with the preparation of pre-construction land condition assessment reports, in accordance with Clause 4.15.2.*

**G36P3.2    Post-construction land condition assessment reports**

*This is a Lump Sum item.*

*The rate covers all costs associated with the preparation of post-construction land condition assessment reports, in accordance with Clause 4.15.3.*

**NOTES TO TENDER DOCUMENTER:** *(Delete this boxed text after customising RMS G36)*

***Remediation of Contaminated Land***

*Refer to Clause 4.2.*

*Where areas of known contamination are present at the Site, and a Remediation Action Plan has been prepared by the Principal and included as part of the Tender Documents, provide relevant Pay Items for remediation of the contaminated areas.*

## **ANNEXURE G36/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS**

Refer to Clause 1.2.3.

### **C1 SCHEDULE OF HOLD POINTS**

<b>Clause</b>	<b>Description</b>
3.1	Submission of CEMP and selected CEMS documents
3.2.2	Evidence of approvals, licences and permits obtained
3.10	Verification that environmental nonconformities has been rectified
4.2	Submission of Remediation Action Plan for contaminated land
4.7	Building Condition Inspection Reports and Vibration and Airblast Management Sub-Plan
4.11	Copy of “s.143 Notice”
4.13	Working in or near environmentally sensitive areas
4.15.2	Submission of pre-construction land condition assessment report for each area you intend to occupy for your site facilities

### **C2 SCHEDULE OF IDENTIFIED RECORDS**

The records listed below are Identified Records for the purposes of RMS Q Annexure Q/E.

<b>Clause</b>	<b>Description of the Identified Record</b>
2	Alternative environmental control measures
3	Contractor’s Environmental Management Plan (CEMP), Sub-Plans, procedures and EWMS
3.2.2	Approvals, licences and permits
3.5	Records of environmental induction training
3.6	Extended working hours and associated advice to Principal and relevant authorities
3.7.3	Reports on complaints about any environmental issue and actions
3.8	Records of emergency responses
3.9	Records of environmental management performance monitoring and measurement
3.9	Environmental audit reports
3.10	Records of corrective and preventative measures to address nonconformities of environmental obligations
3.11	CEMS and CEMP compliance records
3.12	Records of review of effectiveness and proper implementation of CEMP
4.3	Records of spill prevention measures and responses
4.7	Building Condition Inspection Reports



<b>Clause</b>	<b>Description of the Identified Record</b>
4.11	Waste Management Register
4.11	“s.143 Notices” for transporting and depositing of waste
4.12	Pesticide Records Sheets
4.14	Environmental incident and investigation reports
4.15.2	Pre-construction land condition assessment reports
4.15.3	Post-construction land condition assessment reports

## **ANNEXURE G36/D – PLANNING DOCUMENTS**

The CEMP and its references must, as a minimum, include the following – refer to the relevant Clause in the Specification for complete details of requirements:

<b>Clause</b>	<b>Summary of Required Planning Documents or Reference</b>
3.1	CEMP for Work Under the Contract, including Environmental Policy and Sub-Plans
3.2.2	Compliance tracking program
3.2.3	Environmental objectives and targets
3.2.4	Environmental Work Method Statements
3.3	Names, responsibilities and authority of site management personnel, including ESR, with responsibility for implementing CEMP. Where applicable, the relationship between Environmental Management Representative and ESR.
3.4	Procedures to ensure subcontractor compliance
3.5	Environmental induction and training plan
3.6	Procedure for notifying the Principal and all relevant Authorities in advance of any proposed extension to working hours
3.7	Details of processes for external and internal communication in relation to environmental aspects of work
3.8	Emergency planning and response procedures
3.9	Procedure(s) to monitor and measure environmental management performance and to evaluate compliance
3.9	Environmental monitoring and auditing program
4.1	Soil and water management sub-plans (refer RMS G38)
4.2	Contaminated Land Management Sub-Plan and Remediation Action Plan
4.3	Procedure(s) for spill prevention and response
4.3	Procedures for controlling and removing chemical, fuel and lubricant spillage on the Site and adjoining areas
4.4	Air Quality Management Sub-Plan and procedures for effective dust control, including dust monitoring and reporting procedures
4.6	Noise Management Sub-Plan

<b>Clause</b>	<b>Summary of Required Planning Documents or Reference</b>
4.7	Vibration and Airblast Management Sub-Plan
4.8	Flora and Fauna Management Sub-Plan and EWMS for clearing and grubbing
4.9	Aboriginal Heritage Management Sub-Plan and procedure for the management of unexpected potential archaeological relics
4.10	Non-Aboriginal Heritage Management Sub-Plan and procedure for the management of unexpected potential archaeological relics
4.11	Waste Management Sub-Plan and Waste Management Register
4.13	Sensitive Areas Maps and EWMS for working in or near environmentally sensitive areas
4.14	Environmental incident reporting and investigation procedure
	Any other documents or information required to be included in the CEMP

## **ANNEXURE G36/E – DISTANCE FROM CONSTRUCTION ACTIVITY FOR BUILDING CONDITION INSPECTION**

Refer to Clause 4.7.

Carry out a Building Condition Inspection for each public utility, structure and building within the distance from the appropriate activity listed below; however, where the risk of damage to an item is assessed to be very low, the requirement for a Building Condition Inspection may be waived with the Principal's agreement.

<b>Activity</b>	<b>Distance</b>
Blasting Operations	<i>(e.g. 500 metres)</i>
Pile Driving	<i>(e.g. 200 metres)</i>
Excavation by hammering or ripping	<i>(e.g. 100 metres)</i>
Vibrating Compaction > 7 tonne plant	<i>(e.g. 50 metres)</i>
Vibrating Compaction < 7 tonne plant	<i>(e.g. 25 metres)</i>
Demolition of Structures	<i>(e.g. 50 metres)</i>

*NOTES TO TENDER DOCUMENTER: Delete this boxed text after drafting RMS G36*

*The documenter must ascertain from the EIS, REF, Submissions Report or planning consent/approval if any structures are potentially susceptible to damage from construction vibration or airblast and amend the distances in the table for actual site circumstances.*

## ANNEXURE G36/F – WASTE AVOIDANCE AND RESOURCE RECOVERY REPORTING

Refer to Clause 4.11.

### F1 ANNUAL WASTE AVOIDANCE AND RESOURCE RECOVERY REPORT

Submit the Waste Avoidance and Resource Recovery report by 31 July for the preceding financial year and by the Actual Completion Date.

#### F1.1 Definitions of Waste and Purchasing Materials

The following definitions can be used to assist in completing the Waste Avoidance and Resource Recovery Report.

Descriptions of vegetation, construction and demolition materials are sufficiently broad to encompass the range of activities undertaken by RMS contractors. If the materials used or the wastes generated are not described exactly below, EITHER list it under the category that it fits into best and briefly describe it in the comments section, OR else list it as an “Other” category with a description.

**DO NOT DOUBLE COUNT MATERIALS** by including them in more than one reporting category. For example, if reporting on total tonnes of concrete used in the Works, do not also separately report the tonnes of aggregate and sand contained in the concrete.

Material	Description
Aggregates	Rock or other hard materials such as concrete, crushed stone or bricks, between 4.25 mm and 100 mm particle size.
Asphalt	A dense continuously graded mixture of coarse and fine aggregates, mineral filler and bitumen. May contain additives.  Do not recycle or reuse coal tar asphalts in accordance with RMS Environment Technical Direction ETD 2015/21 “Coal tar asphalt handling and disposal”, available at: <a href="http://www.rms.nsw.gov.au/documents/about/environment/rms-environment-coal-tar-asphalt.pdf">http://www.rms.nsw.gov.au/documents/about/environment/rms-environment-coal-tar-asphalt.pdf</a> .
Building and demolition materials	Unsegregated material (other than material containing asbestos waste) resulting from construction, replacement, repair or alteration of infrastructure but excluding excavated soil.
Concrete	Mixture of cement, sand (natural and/or manufactured) and aggregates. May include additives or substitutes such as fly ash.
Fill	Material excavated from either on-site or off-site.
Glass	Sheet glass used for doors, windows, partitioning etc.
Non-ferrous metal	Metal building products and materials other than steel or other ferrous metals e.g. aluminium, brass, copper etc.
Steel	Steel building products and materials e.g. reinforcing steel, sheet roofing, structural columns and beams etc.
Timber	Wood materials used for formwork or other construction purposes.

<b>Material</b>	<b>Description</b>
Vegetation	Vegetation such as leaves, grass clippings, branches and logs. Includes materials that have been processed e.g. sawn, chipped, mulched or composted. Does not include putrescible waste such as food scraps.
Virgin excavated natural material (VENM)	Natural material such as clay, gravel, sand, soil or rock fines that; <ul style="list-style-type: none"> <li>(i) has been excavated or quarried from areas which are not contaminated with manufactured chemicals, or with process residues as a result of industrial, commercial, mining or agricultural activities; and</li> <li>(ii) does not contain sulfidic ores or soils, or any other waste.</li> </ul>
Other materials	Waste stream not described exactly in this table, including site office waste.



**WASTE AVOIDANCE AND RESOURCE RECOVERY REPORT**

Contract No:

Principal:

Contract Description:

Reporting Period:

Report Contact \*:

*\* Name and contact details of person completing this report*

There are two sections in this Waste Avoidance and Resource Recovery Report. Confirm the completion of each section of the Waste Avoidance and Resource Recovery Report by signing below.

REPORT SECTION	INSTRUCTIONS	SIGNATURE CONFIRMING COMPLETION
Part A – Waste and Recycling Data	Table 1 is used to enter data on the amount of material landfilled and reused/recycled in the course of completing Work Under the Contract.	
Part B – Project Initiatives and Barriers	Table 2 is used to provide information on the <b>initiatives</b> taken to reduce waste, recycle resources and purchase recycled content materials in the course of completing Work Under the Contract.	

## PART A – WASTE AND RECYCLING DATA

Enter data on the amount of material **LANDFILLED and REUSED/RECYCLED** by you in the course of completing Work Under the Contract in Table 1. This includes materials either transported to an off-site facility for landfilling, reuse or recycling or reused/recycled on-site. DO NOT include the quantities of materials purchased for use in the Works.

TABLE 1: WASTE AND RECYCLING DATA							
Material Generated	Total quantity landfilled <sup>(1)</sup>	Unit	Total quantity reused/recycled <sup>(2)</sup>	Unit	Total quantity generated <sup>(3)</sup>	Unit	Comments
Aggregates		tonnes		tonnes		tonnes	
Asphalt		tonnes		tonnes		tonnes	
Building and demolition materials (mixed)		tonnes		tonnes		tonnes	
Concrete		tonnes		tonnes		tonnes	
Fill		tonnes		tonnes		tonnes	
Glass		tonnes		tonnes		tonnes	
Non-ferrous metals		tonnes		tonnes		tonnes	
Steel		tonnes		tonnes		tonnes	
Timber		tonnes		tonnes		tonnes	
Vegetation		tonnes		tonnes		tonnes	
VENM		tonnes		tonnes		tonnes	
Other materials: .....		tonnes		tonnes		tonnes	

**Notes:**

<sup>(1)</sup> Enter the quantity of material that is disposed of to an off-site landfill facility.

<sup>(2)</sup> Enter the quantity of material that is reused on-site or taken off-site for reuse/recycling.

<sup>(3)</sup> Enter the total quantity of material generated in the course of undertaking Work Under the Contract. This must equal total landfilled (column 1) + total recycled (column 2).

## PART B – PROJECT INITIATIVES AND BARRIERS

Provide details of any initiatives taken to reduce waste and recover resources. Also identify and provide details on any barriers that were encountered when undertaking the initiative, or that prevented undertaking a considered initiative.

**Note:** “Initiatives” are actions taken that are not standard industry practice. “Barriers” are things that restrain or obstruct the undertaking of an initiative and may include, for example, cost, technical or logistical constraints.

1	Design, construction and work practice initiatives undertaken to reduce waste generation:	
2	Initiatives taken to recycle or reuse waste materials:	
3	Barriers or obstacles to recycling or reusing waste materials:	
4	Initiatives taken to purchase materials containing recycled content:	
5	Barriers or obstacles to purchasing materials containing recycled content:	

## **ANNEXURE G36/G – SAMPLE PESTICIDES APPLICATION RECORDS SHEET**

Refer to Clause 4.12.

Information to be Recorded	Brief Description	Enter Data Here
1. Date and time	Start Date and Time: Finish Date and Time:	
2. Who applied the pesticide	Full operator name: Operator contact address: Operator contact phone:	
3. Who owns/occupies the land	Full owner/occupier's name: Owner/occupier's contact address: Owner/occupier's contact phone:	
4. Boundaries of treated area and order of treatment	List treated areas and order of treatment, preferably with reference to a map: List order of treatment:	
5. Problem treated	Identify the pest or problem treated (e.g. controlling of spot weed infestation):	
6. Product used	Record either the full name, or a product code if a list of full product names of pesticides you use is kept at the front of your logbook:	
7. Equipment used	Describe the equipment used (e.g. boom-spray, hand-held backpack sprayer etc):	
8. Quantity applied and dilution	Total amount of pesticide product mix used: Write down whether the mix was concentrated product or a diluted mixture (note down rate of dilution):	
9. Area covered by application	Area of application (in square metres or hectares):	
10 Wind speed and direction	Estimate of wind speed and direction (only if the pesticide is applied through the air): Write down any changes in weather during application:	
11 Other weather details	Record any weather details such as temperature, humidity and/or rainfall where the pesticide product label requires you to assess these:	

## ANNEXURE G36/H – PUBLIC NOTIFICATION OF PESTICIDE USE

### H1 PESTICIDE USES REQUIRING PUBLIC NOTIFICATION

Pesticide uses in the following public places require notification, unless notification exemptions apply (refer to Annexure G36/H3):

Public places # where pesticides will be applied on behalf of RMS	Minimum Notification Methods
Urban and rural roadsides, including: <ul style="list-style-type: none"> <li>• Median strips</li> <li>• Road shoulders</li> <li>• Kerb and guttering</li> <li>• Roundabouts</li> <li>• Traffic islands</li> <li>• Roadside cycleways/footpaths</li> <li>• Traffic management devices</li> <li>• Stockpile sites</li> </ul> Freeways and controlled access roads	<b>Signs on vehicle</b> concurrent with spraying activity. <b>Internet-based notification</b> required as per Annexure G36/H2 below.
Road construction sites	<b>Signs on vehicle</b> concurrent with spraying activity.
Roadside rest areas, including facilities such as: <ul style="list-style-type: none"> <li>• Picnic/BBQ areas</li> <li>• Toilets</li> <li>• Playgrounds</li> </ul> Weigh stations and heavy vehicle inspection stations Vacant lands owned by RMS, including pesticide applications around built property (excluding lands that are leased for private occupation and without public access). Motor registries, including: <ul style="list-style-type: none"> <li>• Buildings and surrounds</li> <li>• Carparks</li> <li>• Lawn/landscaping.</li> </ul> Administration sites, including regional and district offices. Depots Rider/driver training schools Public places over which persons or organisations hold an existing lease on RMS land Ferry wharves	<b>Signs on vehicle</b> concurrent with spraying activity. <b>Portable signs</b> will be erected at locations where most likely to be seen immediately prior to use and remain until operation is completed, unless label requires a longer period. Reasonable efforts must be made to replace signs removed or vandalised.
Bridges, vehicular ferries and associated infrastructure.	<b>Portable signs</b> will be erected at locations where most likely to be seen immediately prior to use and remain until operation is completed, unless label requires a longer period. Reasonable efforts must be made to replace signs removed or vandalised.

#### # Notes:

- (a) Pesticide uses on land where RMS shares maintenance responsibilities with others is also captured by the above notification requirements; e.g. rail crossings, electricity easements or travelling stock reserves that overlap with land under RMS maintenance control.
- (b) Pesticide uses are also captured by the above notification requirements if:
  - (i) the pesticides are applied on land that is not under RMS control or ownership; and
  - (ii) the land is immediately adjacent to land that is under RMS control or ownership; and
  - (iii) there are no physical boundaries (such as fences) between the two pieces of land; and



- (iv) the application of pesticides on the land not under RMS control or ownership is incidental to pesticide application activities being undertaken on the land owned or controlled by RMS.  
e.g. roadside pesticide applications where RMS and councils may own/control adjacent areas of land without any physical boundaries such as fences.

**Signs on vehicle and portable signs** must:

- (a) alert the public that pesticide spraying activities are being undertaken;
- (b) include a phone number (at least A3 size, i.e. 300 mm x 420 mm) for the public to contact an officer responsible for the pesticide activity.

The following information either must be shown on the signs or can be obtained by contacting the phone number listed on the signs:

- (a) full product name of the pesticide as it is listed on the label (e.g. "Roundup Biactive");
- (b) purpose of the application (e.g. "Control of roadside weeds");
- (c) proposed date or date range of the pesticide application;
- (d) places of pesticide use;
- (e) any warnings regarding re-entry to the place of application specified on the product label or the Australian Pesticides and Veterinary Medicines Authority (APVMA) permit for use.

## **H2 INTERNET-BASED PUBLIC NOTIFICATION BY LOCAL COUNCILS OR THE CONTRACTOR**

Where:

- (i) a local council or you will use pesticides under the Contract;
- (ii) the local council has or you have an Internet site; and
- (iii) RMS does not control the time and place of the pesticide use;

the local council or you will, before use of the pesticide, display the following information on its Internet site:

- (a) the full product name of the pesticide as it is listed on the label (e.g. "Roundup Biactive");
- (b) the purpose of the application (e.g. "Weed control");
- (c) the proposed date or date range of the pesticide application;
- (d) the places of pesticide use;
- (e) a contact number for the public to seek more detailed information. All reasonable requests for information must be answered within a timely manner;
- (f) any warnings regarding re-entry to the place of application specified on the product label or the APVMA permit for use.

Dates and locations published on the Internet site may be general to accommodate delays caused by inappropriate weather conditions and other unplanned circumstances.

## **H3 EXEMPTIONS FROM PUBLIC NOTIFICATION**

During emergency pesticide applications, only portable signs may be displayed on site. Internet notification and vehicle signs are not mandatory in these situations.

Pesticide uses are exempt from all notification requirements in the following cases:

- (a) The use of pesticides that are readily available to the general public at retail outlets and used in a manner and in quantities that do not require formal record keeping under the *Pesticides Regulation 2009 (NSW)*; such as in the following cases:
  - (i) e.g. small quantities of glyphosate and metsulfuron herbicides applied by a hand-held applicator, or by cut-and-paint or stem injection techniques;
  - (ii) e.g. minor control of indoor and outdoor pests using baits or hand-held aerosols.
- (b) Pesticide uses in public places that have been closed temporarily to the public where the closure is unrelated to the pesticide use;
- (c) Pesticide uses in remote areas where there is little likelihood of the pesticides being encountered by the public; e.g. in areas where there is no vehicular access and low public visitation.

## **ANNEXURES G36/I TO G36/L – (NOT USED)**

**ANNEXURE G36/M – REFERENCED DOCUMENTS AND LEGISLATION****M1 REFERENCED DOCUMENTS**

Refer to Clause 1.2.4.

**RMS Specifications**

RMS G2	General Requirements
RMS G38	Soil and Water Management
RMS G40	Clearing and Grubbing
RMS Q	Quality Management System
RMS R44	Earthworks
RMS R178	Vegetation
RMS R179	Landscape Planting
RMS R201	Fencing

**RMS Publications**

	Biodiversity Guidelines: Protecting and Managing Biodiversity on RMS Projects
	Code of Practice for Water Management
	Contaminated Land Management Guideline
	Environment Policy Statement
ETD 2015/020	Environment Technical Direction “Legal offsite disposal of Roads and Maritime Services waste”
ETD 2015/021	Environment Technical Direction “Coal tar asphalt handling and disposal”
	Environmental Incident Classification and Reporting Procedure
	Environmental Noise Management Manual
	Guidance Note: Environmental Inspection Report
	Management of Wastes on Roads and Maritime Services Land (Draft)
	Unexpected Archaeological Finds Procedure
	Waste Fact Sheets

**Australian Standards**

AS 2187.2	Explosives – Storage, Transport and Use
AS/NZS/ISO 14001	Environmental management systems – Requirements with guidance for use
AS/NZS ISO 19011	Guidelines for quality and/or environmental management systems audits

**British Standards**

BS 7385                      Evaluation and measurement for vibration in buildings

**NSW Government Publications**

Approved Methods for Sampling and Analysis of Air Pollutants in NSW

Approved Methods for the Modelling and Assessment of Air Pollutants in NSW

Bunding and Spill Management Guidelines

Environmental Management System Guidelines

Environmental Noise Management Assessing Vibration: A Technical Guideline

Environmental Protection Manual for Authorised Officers

EPA guidelines on contaminated land management (multiple documents)

Equipment and Machinery Use in Bush Fire Prone Areas

Government Resource Efficiency Policy (GREP)

Guideline for the Preparation of Environmental Management Plans

Interim Construction Noise Guideline

Regulation of Open Burning in NSW

Waste Classification Guidelines

**ANZECC Publication**

Technical Basis for Guidelines to Minimise Annoyance Due to Blasting  
Overpressure and Ground Vibration

**M2      LEGISLATION**

Refer to Clauses 1.2.4 and 3.2.2.

**Environmental Legislation**

Contaminated Land Management Act 1997 (NSW)

Environmental Planning and Assessment Act 1979 (NSW) (and instruments made under it)

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

Fisheries Management Act 1994 (NSW)

Heritage Act 1977 (NSW)

Local Government Act 1993 (NSW)

National Parks and Wildlife Act 1974 (NSW)

Native Vegetation Act 2003 (NSW)

Pesticides Act 1999 (NSW)

Pesticides Regulation 2009 (NSW)

Protection of the Environment Administration Act 1991 (NSW)

Protection of the Environment Operations Act 1997 (NSW)

Protection of the Environment Operations (Clean Air) Regulation 2002 (NSW)

Threatened Species Conservation Act 1995 (NSW)

Waste Avoidance and Resource Recovery Act 2001 (NSW)

**Other Legislation**

Dangerous Goods (Road and Rail Transport) Act 2008 (NSW)

Roads Act 1993 (NSW)

Rural Fires Act 1997 (NSW)



## **Appendix C. QA Specification G38 Soil and Water Management**

# ROADS AND MARITIME SERVICES (RMS)

## QA SPECIFICATION G38

### SOIL AND WATER MANAGEMENT

#### NOTICE

This document is a Roads and Maritime Services QA Specification. It has been developed for use with roadworks and bridgeworks contracts let by Roads and Maritime Services or by local councils in NSW. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

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#### REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		New specification replacing RTA R1, also applies to bridgeworks	GM, RNIC	22.10.03
Ed 1/Rev 1	Various	Conversion to direct imperative language and minor editorial changes.	GM, RNIC	13.09.04
Ed 1/Rev 2	Global  4.1  Annex M	Titles of Government Authorities updated.  “Specification for EARTHWORKS” changed to “Specification RTA R44”.  Referenced documents updated.	GM, IC (W Stalder)	04.07.11
Ed 1/Rev 3	Annex B	Measurement and Payment - cost of maintenance of environmental control measures deleted from rates and prices generally; paid under new Pay Item G38P8.	GM, IC (W Stalder)	12.08.11
Ed 2/Rev 0	Global   Guide Notes 1  1.2  1.3	New edition, combining previous specs G38 and G39.  Clauses rearranged, combined and edited to improve clarity and remove duplication.  References made to various RMS Environmental Direction and Guideline.  Guide Notes rewritten.  Scope of spec reworded.  Related specs referenced.  Previous sub-clauses 1.2.4 to 1.2.6 deleted.  Heading title changed to include “Acronyms”.	GM, CPS (Peter Letts)	04.04.14

<b>Ed/Rev Number</b>	<b>Clause Number</b>	<b>Description of Revision</b>	<b>Authorised By</b>	<b>Date</b>
Ed 2/Rev 0 (cont'd)	1.3.1	Heading added to form new sub-clause 1.3.1.  Definitions of “Contractor’s Environmental Management Plan”, “Erosion and Sediment Control Plan”, “Soil and Water Management Plan” deleted.  Definition of “Dewatering” added, and definition of “Construction sediment retention basin” amended.		
	1.3.2	List of acronyms added as new sub-clause.		
	2	Clause heading title changed to “Management Plans”, comprising new clauses 2.1 to 2.5.		
	2.1	New clause titled “Soil and Water Management Plan”, incorporating part of previous clause 2, and Annex D.		
	2.2	New clause titled “Erosion and Sediment Control Plan”, incorporating part of previous clauses 2 and 3.1.		
	2.3	New clause titled “Water Quality Monitoring Program”, incorporating previous clauses 3.3, 3.4 and Annex A1.		
	2.4	New clause titled “Design Guide”, incorporating part of previous clause 2.		
	3	Previous clauses 3.3 and 3.4 on water quality moved to and consolidated under clause 2.3. Subsequent clauses renumbered.		
	3.1	New clause titled “Erosion and Sediment Control”, comprising remaining part of previous clause 3.1.		
	3.3	New clause titled “Tannin Management”.		
	3.4	Previously clause 3.4 on water extraction, incorporating related clauses in spec G36.		
	3.5	New clause on construction site dewatering, moved here from spec G36.  “Work Method Statement” for dewatering changed to “procedure”.		
	3.6	New clause on work in waterways, moved here from spec G36.		
	3.6.2	New sub-clause on temporary waterway crossings.		



<p style="text-align: center;"><b>GUIDE NOTES</b> (Not Part of Contract Document)</p>
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### **Specification G38 Edition 2 Revision 0**

G38 Edition 2 Revision 0 replaced the previous G38 “Soil and Water Management (Soil and Water Management Plan)”, and G39 “Soil and Water Management (Erosion and Sediment Control)”. Some requirements previously in G36 “Environmental Protection” have also been moved over to G38 and merged with similar clauses in G38. G39 is consequently withdrawn.

### **Using Specification G38**

G38 is required for Contracts where the area disturbed by the construction works is more than 250 m<sup>2</sup>, in accordance with the NSW Department of Housing manual “Managing Urban Stormwater: Soils and Construction”.

Under G38, an Erosion and Sediment Control Plan (ESCP) must always be prepared for the Work Under the Contract.

Where the disturbed area exceeds 2,500 m<sup>2</sup>, or where there is a high risk of polluting the receiving waters downstream of the disturbed areas, a Soil and Water Management Plan (SWMP) must also be prepared.







## SOIL AND WATER MANAGEMENT

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VERSION FOR: DATE:
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## FOREWORD

### RMS COPYRIGHT AND USE OF THIS DOCUMENT

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### REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification RMS G38 Edition 2 Revision 1.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

### PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

# **RMS QA SPECIFICATION G38**

## **SOIL AND WATER MANAGEMENT**

### **1 GENERAL**

#### **1.1 SCOPE**

This Specification sets out the requirements for preventing water pollution, minimising soil erosion and controlling sedimentation on work sites.

Other specifications cover related matters on environmental protection (Specification RMS G36), clearing and grubbing (Specification RMS G40), earthworks (Specification RMS R44) and revegetation (Specification RMS R178).

#### **1.2 STRUCTURE OF THE SPECIFICATION**

This Specification includes a series of annexures that detail additional requirements.

##### **1.2.1 Project Requirements**

Details of Project Requirements are shown in Annexure G38/A.

##### **1.2.2 Measurement and Payment**

The method of measurement and payment is detailed in Annexure G38/B.

##### **1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records**

The schedules in Annexure G38/C list the **HOLD POINTS** and **WITNESS POINTS** that must be observed. Refer to Specification RMS Q for the definitions of **HOLD POINTS** and **WITNESS POINTS**.

The records listed in Annexure G38/C are **Identified Records** for the purposes of RMS Q Annexure Q/E.

##### **1.2.4 Planning Documents**

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure G38/D and must be implemented.

##### **1.2.5 Frequency of Testing**

Your Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item, which must not be less than the frequency specified in Annexure G38/L.

Where a minimum frequency is not specified, nominate an appropriate frequency.

Frequency of testing must conform to the requirements of RMS Q.



### 1.2.6 Referenced Documents

Unless specified otherwise, the applicable issue of a referenced document, other than an RMS Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure G38/M.

## 1.3 DEFINITIONS AND ACRONYMS

### 1.3.1 Definitions

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

The following definitions apply to this Specification:

<b>Catch drain</b>	An open channel constructed along the high side of a road cutting or embankment, outside the batter, to intercept and redirect surface water.
<b>Construction sediment retention basin</b>	Temporary ponds or impoundments designed to intercept sediment-laden runoff and retain most sediment and other materials, thereby protecting downstream waterways from pollution. The retention is generally achieved by the settling of the suspended sediment from the stormwater flow, combined with the interception of bedload material.
<b>Dewatering</b>	Any activity that involves the removal of ponded stormwater or infiltrated groundwater from any location on Site and the subsequent reuse or discharge of that water.
<b>Diversion bank</b>	A bank constructed to provide an open channel without excavation.
<b>Diversion drain</b>	An excavated open channel that leads water away from a given area.
<b>Earth bank</b>	Temporary open channel constructed at a low gradient across a slope in the form of a ditch with a bank on its lower side to intercept and divert runoff from the site to nearby stable areas at non-erosive velocities.
<b>Level spreader (or level sill)</b>	A flat stabilised area at the outlet of an open drain which spreads the water over a sufficient width to reduce the velocity and energy of the water and prevent downstream erosion.
<b>Open drain</b>	An open channel constructed to intercept and redirect surface runoff water including catch drains, diversion banks and drains, earth banks, batter drains and inlet and outlet drains.
<b>Operational basin</b>	A permanent structure provided to capture a significant proportion of the sediment and other pollutants which may enter the stormwater system from the road environment following construction and opening to traffic. May also be designed to trap chemical spills. Usually shown on the Drawings and their locations and design are not necessarily satisfactory for construction sediment retention purposes.

**Sediment traps and filters** Temporary measures used to trap or filter sediment in runoff from small areas. Examples include straw bales and filter fences.

### **1.3.2 Acronyms**

<b>CEMP</b>	Contractor's Environmental Management Plan
<b>ESCP</b>	Erosion and Sediment Control Plan
<b>EPA</b>	Environment Protection Authority
<b>EWMS</b>	Environmental Work Method Statement
<b>NTU</b>	Nephelometric Turbidity Unit
<b>SWMP</b>	Soil and Water Management Plan
<b>TSS</b>	Total Suspended Solids
<b>WQMP</b>	Water Quality Monitoring Program

## **2 MANAGEMENT PLANS**

### **2.1 SOIL AND WATER MANAGEMENT PLAN**

#### **2.1.1 General**

If specified in Annexure G38/A, prepare a Soil and Water Management Plan (SWMP) for the Work Under the Contract. The SWMP will form part of the Contractor's Environmental Management Plan (CEMP) specified in RMS G36, and incorporates the Erosion and Sediment Control Plan (ESCP) (refer Clause 2.2).

The SWMP must be prepared by a person with demonstrated skills and experience in preparing the SWMP in accordance with the guidelines in the publication "Managing Urban Stormwater: Soils and Construction Volumes 1 and 2d" (the BLUE BOOK).

#### **2.1.2 Plan Requirements**

The Soil and Water Management Plan (SWMP) must identify all risks relating to soil erosion, and pollution caused by sediments and other materials, and describes how these risks will be addressed during construction.

The SWMP must include details of the following, where relevant:

- (a) Purpose and objectives of SWMP.
- (b) Approvals, licence requirements and relevant legislation.
- (c) Site investigation and assessment of the following:
  - (i) soil properties (including dispersion properties and presence of acid sulphate soils);
  - (ii) rainfall records and design parameters;
  - (iii) waterways and other water related sensitive environments;
  - (iv) groundwater;
  - (v) possibilities of, and limitations on, water extraction.
- (d) Environmental control measures, including:

- (i) responsibility for its implementation, including the names and contact details of the person(s) responsible;
  - (ii) resources required for its construction, monitoring, maintenance and removal;
  - (iii) implementation schedule for the measures, related to construction activities;
  - (iv) monitoring and maintenance of the environmental controls.
- (e) Other associated plans, Environmental Work Method Statements (EWMS) and procedures.
- (f) Construction sediment retention basins, including details of the following:
  - (i) design of the construction sediment retention basins, including any temporary modifications to the operational basins, providing details of the approach, standards, criteria and references used in the design of the basins;
  - (ii) management of the basins;
  - (iii) procedures for testing, treatment and discharge of water from the basins;
  - (iv) procedures for the periodic removal and disposal of the sediment collected within the basins.
- (g) Training, including:
  - (i) site induction;
  - (ii) environmental training;
  - (iii) toolbox training.
- (h) Inspection and auditing.

In addressing items (g) and (h) above, refer to RMS G36.

*Detail here any specific SWMP requirements, such as from the EIS, REF, Submissions Report or planning consent/approval. Include any requirements for preparation of the plan in consultation with a Government agency.*

## **2.2 EROSION AND SEDIMENT CONTROL PLAN**

### **2.2.1 General**

Prepare an Erosion and Sediment Control Plan (ESCP) for the Work Under the Contract. The ESCP will form part of the CEMP, and where a SWMP is also required, the ESCP will be incorporated in the SWMP.

The ESCP must be prepared by a person with demonstrated skills and experience in preparing the ESCP in accordance with the BLUE BOOK guidelines.

### **2.2.2 Plan Requirements**

The ESCP must identify all erosion and sediment control risks and describe how these will be addressed during construction.

The ESCP must include details of the following where relevant:

- (a) erosion and sediment control measures required:
  - (i) before clearing and grubbing of the Site;
  - (ii) before removal of topsoil and commencement of earthworks within the catchment area;
- (b) how upstream water will be managed so it is not polluted by the construction activities;

- (c) method of tree removal in intermittent watercourses, leaving grasses and small understorey species undisturbed wherever possible;
- (d) scour protection measures for haul roads and access tracks when these are an erosion hazard due to either their steepness, soil erodibility or potential for concentrating runoff flow;
- (e) measures for stabilising temporary drains;
- (f) measures to minimise erosion during construction of embankments;
- (g) measures to minimise erosion and control sedimentation from stockpiles;
- (h) methods of constructing batters to assist the retention of topsoil on the batter slopes;
- (i) measures to temporarily trap sediment in median areas at regular intervals;
- (j) controls in runoff flow paths to reduce flow velocities and minimise the potential for erosion;
- (k) measures for controlling waste water discharge on or around the Site from dewatering (refer to Clause 3.5), surface washing, grit blasting, saw cutting, drilling, washing vehicles and plant and any other activities which add pollutants to water;
- (l) measures to be put in place during an extended shut-down of the Site or when rainfall above a certain trigger level is predicted;
- (m) maintenance of erosion and sediment control structures including measures to restore their capacity;
- (n) inspection and auditing program for all erosion and sediment controls to ensure that no disturbed area is left without adequate erosion and sediment controls.

In addressing item (k) above, refer to RMS G36.

*Detail here any specific ESCP requirements, such as from the EIS, REF, Submissions Report or planning consent/approval. Include any requirements for preparation of the plan in consultation with a government agency.*

### **2.2.3 Plan Preparation**

When preparing the ESCP, subdivide the site into sections based on the separate catchment areas, or alternatively into high risk areas, that will be affected by Work Under the Contract.

Progressively, before work begins on any section of the Site, prepare a drawing for that section showing all controls required to avoid erosion and sedimentation of the Site, surrounding areas, watercourses, drainage systems, water bodies and wetlands.

Update each drawing regularly as the site conditions changes during the progress of Work Under the Contract. Include as part of the ESCP a procedure for updating the drawings, and keep a register of all such drawings with the dates of submission, approval, and commencement of work on that section.

Include on the drawings locations of all ancillary activities and/or areas that may impact on water quality, such as:

- (a) access and haulage tracks;
- (b) borrow pits;
- (c) stockpile and storage areas;
- (d) temporary work areas;
- (d) materials processing areas;
- (e) compound areas;

- (f) concrete and asphalt batching areas.

## **2.3 WATER QUALITY MONITORING PROGRAM**

If specified in Annexure G38/A, prepare a Water Quality Monitoring Program (WQMP), as a supplement to the ESCP, in accordance with the RMS Guideline for Construction Water Quality Monitoring and EPA publication “Approved Methods for the Sampling and Analysis of Water Pollutants in NSW.”.

Include the following in the WQMP:

- (a) objectives of the monitoring (including EPA licence requirements);
- (b) map showing the water sampling locations;
- (c) sampling protocol, including sample collection, chain of custody information and sample preservation;
- (d) parameters to be monitored;
- (e) method for interpretation of field results and identifying exceedance of water quality criteria;
- (f) accountabilities, responsibilities and training required to meet the monitoring objectives;
- (g) method of comparison of results between sampling locations (e.g. upstream and downstream) and any water quality criteria and/or targets;
- (h) reporting and recording of the monitoring results;
- (i) responsibility for planning, implementing, checking and reviewing each element of the monitoring;
- (j) methodology for using monitoring results to assess and manage identified problems;
- (k) reporting requirements in the case the monitoring results exceed the set criteria.

Laboratories used in the monitoring program must be accredited by the National Association of Testing Authorities (NATA).

## **2.4 DESIGN GUIDE**

In preparing the SWMP and/or ESCP, be guided by the BLUE BOOK.

Comply with the following requirements:

- (i) estimate peak flows and other parameters needed to design drains and drainage structures using the methods described in Australian Rainfall and Runoff;
- (ii) use the Average Recurrence Interval (ARI) shown in Annexure G38/E for the design of erosion and sediment control measures, unless site conditions or risks to life, property or the environment suggest that other values are applicable;
- (iii) superimpose the drawings accompanying the plans on A3 sized drainage drawings of the Works.

You do not need to submit the calculations carried out during preparation of the SWMP or ESCP with the plan, but you must retain them as an Identified Record. You must forward a copy to the Principal upon request.



**2.5 MANAGEMENT REVIEW**

Develop a documented process to periodically review the effectiveness and proper implementation of the SWMP and ESCP. The management review process must identify opportunities for continual improvement of your environmental management processes and practices, and ensure that the SWMP and ESCP remain current and relevant to the Work Under the Contract.

**3 SOIL AND WATER MANAGEMENT MEASURES****3.1 EROSION AND SEDIMENT CONTROL****3.1.1 Implementation**

In addition to the erosion and sediment control measures stated in Clause 2.2, implement the following:

- (i) placing the locations of site compounds, access tracks, stockpile sites and temporary work areas to minimise erosion;
- (ii) staging of work and programming of construction activities to minimise the duration and extent of soil that is left exposed. This includes minimising the time between clearing and initial earthworks and commencement of subsequent works in intermittent and permanent watercourses;
- (iii) temporary modification of operational basins during the construction period for additional capture of stormwater runoff;
- (iv) installing and lining catch drains and diversion banks in accordance with the requirements of Specification RMS R11 before earthworks commence;
- (v) installing scour protection at the base of permanent and temporary drainage outlets;
- (vi) constructing drains to direct runoff from disturbed areas to sediment basins or to areas with adequate sediment trapping/filtering devices and away from watercourses;
- (vii) filtering of sediment prior to water entering any pit and management of stormwater discharge through any pit;
- (viii) staged re-vegetation of the Site as work proceeds, progressively undertaking topsoiling and vegetation work as specified in RMS R178.

**HOLD POINT**

Process Held:	Commencement of work requiring the installation of erosion control and sediment capture measures not previously addressed by ESCP and authorised by earlier Hold Point release.
Submission Details:	Drawings prepared progressively for sections of the Site where work is to commence. The drawing(s) must be submitted at least ten working days before disturbance of the surface of the section of the Site.
Release of Hold Point:	The Principal will consider the submitted drawing(s) prior to authorising the release of the Hold Point.

**WITNESS POINT**

Process Witnessed:	Disturbance of the existing surface on a section of the Site, other than for the installation of erosion and sediment capture measures.
Submission Details:	Written advice that the measures described in the ESCP and included on the drawing submitted progressively for that section of the Site have been implemented or the date by which implementation will be completed. The advice must be forwarded at least five working days before the works are to commence.

**3.1.2 Register**

Maintain a register of inspection and maintenance of erosion control and sediment capture measures, dates of discharge, water treatment (flocculation) performed, discharge water quality as defined in Clause 2.3, volumes of sediment removed from each device and daily rainfall.

**3.2 STOCKPILE MANAGEMENT**

Establish erosion control and sediment capture measures, and maintain them regularly, to divert offsite stormwater, manage onsite stormwater runoff and stabilise stockpiles in accordance with RMS Technical Guideline EMS-TG-010: Stockpile Site Management and the BLUE BOOK guidelines.

Install erosion control and sediment capture measures prior to stockpiling material.

Comply with the following:

- (a) Locate stockpiles outside of the tree protection zone of trees or native vegetation identified for retention. Delineate the tree protection zone in accordance with AS 4970.
- (b) Locate stockpiles at least 5 m from likely areas of concentrated water flows and at least 10 m from waterways that are classified as Class 1 and Class 2 from the DPI Fisheries guideline “Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings”.
- (c) Keep stockpile heights to no greater than 2 m, unless otherwise approved by the Principal, and slopes to no steeper than 2:1.
- (d) Cover, or otherwise protect from erosion, stockpiles that will be in place for more than 20 days as well as any stockpiles that are susceptible to wind or water erosion, within 10 days of forming each stockpile.
- (e) Keep topsoil that is not contaminated by noxious weeds in stockpiles for later spreading on fill batters and other areas. Other material may also be stockpiled but kept separated from the topsoil stockpiles.
- (f) Implement measures to prevent the growth of weeds in topsoil stockpiles.

If any stockpile site is to be located on private land, obtain from the landholder an approved notice under s.143 of the *Protection of the Environment Operations Act 1997* prior to commencement of stockpiling.

**3.3 TANNIN MANAGEMENT**

Prepare a procedure to manage the use and stockpiling of mulch on Site and to reduce the risk of tannin leachate from mulch flowing into waterways, and include this within the SWMP or ESCP.

Prepare the procedure in accordance with RMS Environmental Direction 25: Management of Tannins from Vegetation Mulch.

### **3.4 WATER EXTRACTION**

Where relevant, describe in the SWMP or ESCP the proposed water source(s) intended for use for construction activities. Obtain all necessary approvals and licences from the New South Wales Office of Water, the Local Council and/or any other persons or authorities having responsibility for the chosen source(s) before commencing extraction.

If the proposed source is other than a town water supply or natural water source, include procedures for regular testing to ensure that the water is suitable for the purpose and is not hazardous to health and the environment.

The use of reclaimed water must comply with the requirements of RMS Environmental Direction 19: Use of Reclaimed Water.

*Detail here any specific requirements or exclusions for water extraction, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.5 CONSTRUCTION SITE DEWATERING**

#### **3.5.1 General**

Conduct any dewatering activities in a manner that does not cause erosion and/or pollute the environment.

#### **3.5.2 Procedure**

Prepare a procedure for all identified dewatering activities as part of the SWMP or ESCP. Further guidance for the preparation of a dewatering procedure is provided in RMS Technical Guideline EMS-TG-011: Environmental Management of Construction Site Dewatering.

*Detail here any specific requirements for dewatering, such as from the EIS, REF, Submissions Report or planning consent/approval.*

#### **3.5.3 Personnel**

The personnel responsible for approval and/or carrying out dewatering activities must be adequately trained and inducted on the use of the dewatering procedure.

#### **3.5.4 Implementation**

Prior to the commencement of dewatering, inspect the entire system, including intakes and outlets, pumping and discharge locations.

Wherever possible, supervise any dewatering activities directly. If you choose not to directly supervise dewatering, carry out a risk assessment and implement mitigation measures to eliminate the risks of pollution and to prevent the occurrence of the following:

- (i) intake suction placed within the deposited sediments resulting in discharge of sediment laden waters;

- (ii) erosion at discharge locations and downstream areas;
- (iii) inadvertent or intentional controlled discharge of untreated waters.

### **3.5.5 Records**

Keep records of the following:

- (i) dewatering procedure;
- (ii) date and time for each discharge at each location;
- (iii) water quality test results for each discharge;
- (iv) personnel approving the dewatering activities;
- (v) evidence of discharge monitoring, or risk assessment and mitigation measures used to eliminate the risks of pollution or erosion;
- (vi) any other EPA licence requirements where issued.

## **3.6 WORK IN WATERWAYS**

### **3.6.1 Environmental Work Method Statement**

Where work is required within waterways, prepare an Environmental Work Method Statement (EWMS) for the work(s). Refer to RMS G36 for guidance on preparing an EWMS.

The EWMS for work in waterways must detail the control measures to avoid or minimise erosion and any adverse impact on water quality and riparian fauna and flora, and must include the following:

- (a) plan the Work Under the Contract to avoid, where practicable, any activities in aquatic habitats and riparian zones;
- (b) properly protect and signpost as environmentally sensitive areas, all waterways areas in or adjacent to the Site which are excluded from the work areas. Refer to RMS G36 for the requirements for working in environmentally sensitive areas;
- (c) minimise riparian vegetation removal where practicable, and restrict access to the waterways to the minimum amount of bank length required for the activity;
- (d) retain stumps in riparian zones and aquatic habitats, where practicable, to reduce the potential for bank erosion;
- (e) carry out any refuelling of plant and equipment, chemical storage and decanting at least 50 m away from aquatic habitats unless otherwise approved by the Principal;
- (f) operate your boats or other watercraft in a manner that prevent boat wash which could cause erosion of the banks, and propeller damage to seagrass beds.

### **3.6.2 Temporary Waterway Crossings**

Provide temporary waterway crossings if required to maintain the flow in the waterway. To minimise impacts on the waterways, take into consideration the following:

- (a) design, construct and maintain the crossing in accordance with the requirements of the BLUE BOOK;
- (b) maintain fish passage in accordance with DPI Fisheries guideline “Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings”;

- (c) use material that will not result in fine sediment material entering the waterway. Rock used must be hard, sound, durable rock, free of fine particles and not contaminated with foreign materials;
- (d) provide erosion and sediment controls at entry/exits points of the crossing to minimise mudtracking on the crossing.

*Detail here any specific requirements for work in waterways, such as from the EIS, REF, Submissions Report or planning consent/approval.*

### **3.7 SEDIMENT BASINS**

#### **3.7.1 Operational Basins**

Construct operational basins in accordance with the Drawings or as directed by the Principal.

Clear and grub the entire storage and embankment foundation area of operational basins and strip the area of topsoil. Remove unsuitable material under embankments in accordance with RMS R44.

Prepare the Site under proposed embankments by ripping to a depth of 100 mm and excavating a trench at least 600 mm deep by 1200 mm wide along the centreline of the proposed embankment.

Backfill the trench and construct the embankment in layers not exceeding 200 mm and compacted so that the relative compaction, determined by Test Method RMS T166, is not less than 95.0 per cent using material with a Plasticity Index not less than 15 and not more than 30, and a grading such that at least 20 per cent by mass of material passes the 425 micron sieve.

Where material from excavations is unsuitable for the embankments and trench backfill, materials may be borrowed or imported in accordance with RMS R44. Dispose of surplus materials in accordance with RMS R44.

Install pipes and fittings for draining the sediment basins as shown on the Drawings. You may propose alternative methods of draining the sediment basins for the removal of sediment, subject to the agreement of the Principal.

Stabilise with vegetation the area disturbed by the construction of the operational sediment basins (except the inner surfaces below the spillway levels and the areas covered by rock mattresses) as specified in RMS R178 or as shown on the Drawings.

Clean out all operational basins and drainage structures before Actual Completion.

#### **3.7.2 Construction Sediment Retention Basins**

Design the construction sediment retention basins in accordance with the BLUE BOOK guidelines.

Construct the basins in accordance with the requirements of Clause 3.7.1 for operational basins, unless alternative designs using alternative materials and construction methods are proposed.

If such alternative designs are used, provide details of the alternative design in the ESCP. The alternative design must be prepared by a suitably qualified engineer experienced in the type of work, and its use is subject to the agreement of the Principal.



If you propose to use operational basins for sedimentation control during the duration of the Contract, the environmental requirements specified for any discharge must be complied with.

### **3.7.3 Inlets, Outlets and Spillways**

Construct inlets, outlets and spillways as soon as possible using rock filled woven galvanised steel mattresses laid on a needle punched, mechanically bonded, non-woven geotextile filter fabric. The rock filled mattresses must comply with Specification RMS R55 and the geotextile must comply with the requirements of Specification RMS R63 for Application Category G4, unless shown otherwise on the Drawings.

You may propose alternative methods for constructing the inlets, outlets and spillways, subject to the agreement of the Principal.

### **3.7.4 Flocculation**

Where flocculation is necessary to settle suspended sediments in the basins, apply calcium sulphate (gypsum) as the flocculating agent to settle the sediments within 24 hours of the conclusion of each rain event causing runoff.

You may propose the use of an alternative flocculating agent, subject to the agreement of the Principal. Provide supporting documentation, including analytical test results from a NATA accredited laboratory, confirming that the flocculating agent has a 48-hour EC50\* (immobilisation) for water fleas and a 96-hour EC50 (imbalance) for fish greater than 100 milligrams per litre.

Before using any flocculating agent, determine the amount of the agent that is appropriate for the volume to be treated, the sediment type and the prevailing weather conditions.

Before discharging water from a basin, test the water to ensure that it meets the following criteria:

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\* EC50 is the statistically derived concentration of a substance that is expected to produce a certain effect in 50% of the test organisms, after a specified exposure period in hours.

*Insert all water quality compliance limits as for discharges from a point source. Where the EPA has issued a licence, the criteria will be specified in the licence. Where no criteria have been specified in a license or another document, the following default values may be used:*

- total suspended solids      50 mg/L
- pH                                      6.5 – 8.5, and
- oil and grease                      no visible trace

*Insert also the following clauses:*

If a statistical correlation is developed between turbidity (NTU) and Total Suspended Solids (TSS) through the construction phase for discharge water, turbidity measurements may be used to allow discharge from sediment basins before laboratory data is available.

Provide a copy of the statistical correlation assessment methodology and results to the Principal before using turbidity in place of TSS for approval.

Following approval from the Principal, include in the dewatering procedure a method of ongoing verification of the relationship between turbidity measurements and TSS that includes notification to the Principal of any amendments made to the statistical correlation as a result of the ongoing verification before using the revised statistical correlation.

### **3.7.5 Maintenance of Sediment Basins**

Clean out sediment basins, at minimum, whenever the accumulated sediment exceeds 60% of the sediment storage zone.

Remove accumulated sediment from sediment basins and traps in such a manner as not to damage the structures. Dispose of the sediment removed in such locations that the sediment will not be conveyed back into the construction areas, into watercourses or off site.

Provide and maintain suitable access to sediment basins and sediment traps to allow cleaning out in all weather conditions.

### **3.7.6 Removal of Basins**

Remove all construction sediment retention basins and sediment traps before Completion, but not before all upstream areas have been vegetated or otherwise stabilised in accordance with BLUE BOOK.

Restore the ground disturbed by the construction of the sediment basins/traps to a similar condition to that previously existing. Include the following in the restoration work:

- (a) removal of all redundant mattresses from the inlets and spillway(s) and their subsequent burial into the basin area or their use as scour protection or their removal from Site;
- (b) spreading and compaction of the embankment material into the basin area;
- (c) removal of access roads.

Compact the disturbed ground to at least the relative density of the material in the ground adjacent to it.

**ANNEXURE G38/A – PROJECT REQUIREMENTS**

Refer to Clause 1.2.1.

*NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure G38/A)**Where “Yes / No” options are shown below, delete whichever is not applicable.*

Clause	Details	
2.1	Soil and Water Management Plan (SWMP) required	Yes / No <sup>(1)</sup>
2.2	Erosion and Sediment Control Plan (ESCP) required	Yes <sup>(2)</sup>
2.3	Water Quality Monitoring Program (WQMP) required	Yes / No
3.3	Tannin Management Procedure required	Yes / No
3.6	EWMS for Work in Waterways required	Yes / No

**Note:**

- <sup>(1)</sup> SWMP is required when:
- (a) the area disturbed by construction exceed 2,500 m<sup>2</sup>; or
  - (b) there is a high risk of polluting the receiving waters downstream of the disturbed areas.
- <sup>(2)</sup> ESCP is always required.

## **ANNEXURE G38/B – MEASUREMENT AND PAYMENT**

Refer to Clause 1.2.2.

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Unless specified otherwise, a lump sum price for any of these items will not be accepted.

### **Pay Item G38P1      Soil and Water Management Control Measures**

#### **Pay Item G38P1.1      Establishment of Soil and Water Management Control Measures**

This Pay Item covers all costs associated with the design including plan preparation, provision of measures to control soil erosion and prevent pollution of water, and their subsequent removal.

This is a Lump Sum item.

#### **Pay Item G38P1.2      Maintenance of Soil and Water Management Control Measures**

This Pay Item covers all costs associated with maintenance of measures to control soil erosion and prevent pollution of water.

The unit of measurement is the “week”. The rate is an average cost for maintenance of the measures at all stages during the Contract.

Payment will be measured from the time of completion of the first of the measures on site until the time of removal of the last of the measures from the site or until the Contractual Completion Date, whichever occurs first.

### **Pay Item G38P2      Site Water Quality Monitoring**

Payment is made where monitoring is required by Annexure G38/A.

The unit of measurement is lump sum.

### **Pay Item G38P3      Operational Basins**

The unit of measurement is “each” operational sediment basin shown on the Drawings.

The schedule rate must cover all work required for the construction of the basin, including excavation in all types of materials, embankment construction and disposal of surplus materials.

The cost of excavating and transporting material for embankment construction that is obtained from within cuttings or from borrow or imported must not be included in this Pay Item. It must be included in the schedule rates for earthworks under RMS R44.

## **ANNEXURE G38/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS**

Refer to Clause 1.2.3.

### **C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS**

<b>Clause</b>	<b>Type</b>	<b>Description</b>
3.1	Hold	Submission of an ESCP(s) and, where required, WQMP for a section of the Work Under the Contract.
3.1	Witness	Submission of written notice that measures set out in the ESCP for a section of the work have been installed.

### **C2 SCHEDULE OF IDENTIFIED RECORDS**

The records listed below are Identified Records for the purposes of RMS Q Annexure Q/E.

<b>Clause</b>	<b>Description of Identified Record</b>
3.1.2	Register of inspection and maintenance measures
3.2	Approval notices to locate stockpiles on private land
3.4	Approvals and licences to extract water
3.5	Dewatering records

## **ANNEXURE G38/D – PLANNING DOCUMENTS**

Refer to Clause 1.2.4. The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

<b>Clause</b>	<b>Description</b>
2.1	Soil and Water Management Plan (SWMP) and associated plans, EWMS and procedures
2.2.3	Register of drawings for ESCP submitted progressively
2.4	Design calculations and drawings involved in preparation of SWMP and ESCP



**ANNEXURE G38/E – DESIGN AVERAGE RECURRENCE INTERVALS**

Refer to Clause 2.4.1.

Control Measure	Estimated Design Life	
	0 – 12 months	> 12 months
	Design Average Recurrence Interval (ARI) (years)	
<b>Diversion bank</b>	10	20/100 *
<b>Level spreader</b>	10	20/100 *
<b>Waterway</b>	10	20/100 *
<b>Sediment basin:</b>		
Primary outlet	5	10
Emergency outlet (overflow)	20	100
<b>Sediment trap</b>	5	10
<b>Outlet protection</b>	20	50
<b>Grade stabilising structure</b>	20	50
<b>Detention basin:</b>		
Primary outlet	5	10
Emergency outlet (overflow)	20	100
Waterway diversion	2	5/100 *

\* **Note:** Where two ARI values are shown, the first number refers to the minor flow and the second to the major flow as defined in ARR.

**ANNEXURES G38/F TO G38/K – (NOT USED)****ANNEXURE G38/L – MINIMUM FREQUENCY OF TESTING**

Refer to Clause 1.2.5.

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
3.7	Compaction of embankments	RMS T166	One test per 500 m <sup>3</sup> with a minimum of 2 per basin/trap

**ANNEXURE G38/M – REFERENCED DOCUMENTS**

Refer to Clause 1.2.6.

**RMS Specifications**

RMS G36	Environmental Protection
RMS Q	Quality Management System
RMS R11	Stormwater Drainage
RMS R44	Earthworks
RMS R55	Rock Filled Gabions and Mattresses
RMS R63	Geotextiles (Separation and Filtration)
RMS R178	Vegetation

**RMS Test Methods**

RMS T166	Determination of Relative Compaction
RMS T215	Wet/Dry Strength Variation

**RMS Publications**

Guideline for Construction Water Quality Monitoring  
 Environmental Direction 19: Use of Reclaimed Water  
 Technical Guideline EMS-TG-010: Stockpile Site Management  
 Technical Guideline EMS-TG-011: Environmental Management of Construction Site Dewatering  
 Environmental Direction 25: Management of Tannins from Vegetation Mulch

**Australian Standards**

AS 3706.9	Geotextiles – Methods of test – Determination of permittivity, permeability and flow rate
AS 4970	Protection of trees on development sites
AS/NZS 5667.1	Water Quality – Sampling - Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples

**NSW Government Publications**

BLUE BOOK	Managing Urban Stormwater: Soils and Construction Volume 1 (2004) by NSW Department of Housing Volume 2d - Main Road Construction (2008) by NSW Office of Environment and Heritage Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003)
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Approved Methods for the Sampling and Analysis of Water Pollutants in NSW  
(NSW Environment Protection Authority)

**Engineers Australia**

Australian Rainfall and Runoff (ARR)

## **Appendix E. Biodiversity Offset Strategy**

# Upgrade of Pacific Highway HW10 Ourimbah Street to Parsons Road, Lisarow

ROADS AND MARITIME SERVICES

Biodiversity Offset Strategy

Final

28 June 2016



**JACOBS®**



## Upgrade of Pacific Highway HW10, Ourimbah Street to Parsons Road, Lisarow

Project no: IA032900  
 Document title: Biodiversity Offset Strategy  
 Document no: Final  
 Revision: v3  
 Date: 28 June 2016  
 Client name: Roads and Maritime Services  
 Client no:  
 Project manager: Tony Daley  
 Authors: Andrew Carty and Chris Thomson  
 File name: \\NTLFIL01\Projects\NBIF\Projects\NB98077\Deliverables\Reports\Ecology\BOS\201605  
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## Document history and status

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Draft v1	14/05/2015	Environmental lead review	A.Carty	R.Vazey	T.Daley
Draft v 1	20/05/15	Technical review	A.Carty	C.Thomson	T.Daley
Final	28/07/2015	Technical review Final Draft	A.Carty	C.Thomson	T.Daley
Final v1	19/01/2016	Update following offset meeting	A.Carty	C.Thomson	T.Daley
Final	17/02/2016	Final review	A.Carty	C.Thomson	T.Daley
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## Appendix A. BioBanking credit report

## Executive Summary

The proposal being assessed comprises upgrade to around 1.6 kilometres of the Pacific Highway between Ourimbah Street to Parsons Road, Lisarow. The proponent is Roads and Maritime Services. As identified through a Species Impact Statement the proposal will impact on two endangered ecological communities and one threatened plant species listed under the NSW *Threatened Species Conservation Act*, 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act*, 1999 (EPBC Act) as well as habitat for threatened fauna species. In accordance with the Director Generals Requirements (DGRs) offsets are required to compensate for the loss of biodiversity.

Specifically, the impacts proposed to be offset by Roads and Maritime Services include:

- Loss of 0.35 hectares of *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (Endangered Ecological Community TSC Act).
- Loss of 2.78 hectares of *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (Endangered Ecological Community TSC Act).
- Direct and indirect impacts to an estimated 2,575 mature *Melaleuca biconvexa* (vulnerable species TSC Act and EPBC Act).

The quantum of biodiversity impacts was calculated using the BioBanking Assessment Methodology (BBAM). A total of 79 ecosystem credits are required to adequately offset the impacts from the proposed upgrade and 33,475 species credits are required to offsets impacts on *Melaleuca biconvexa*. The ecosystem credits to be offset are considered to adequately compensate for the loss of habitat for threatened fauna species, in particular critical foraging habitat for the Grey-headed Flying-fox and important winter-flowering food resources for other nectivorous fauna.

This report is Stage 1 of the delivery of biodiversity offset for the proposal. As such, it does not include site survey data for prospective offset properties. This Stage 1 assessment identifies 37 priority sites from 16 clusters of private properties, which adequately compensate for the biodiversity impacts predicted in terms of land area and credit requirements.

The short-list of potential offset properties identified in this offset strategy are in Table 3-2 of this report. Appropriate offsets to compensate for the project's impacts will be secured by Roads and Maritime during Stage 2 of the process. This work will happen in consultation with the Office of Environment and Heritage (OEH), to confirm and finalise an offset package, and formalise a conservation mechanism for each selected property.

Stage 2 will include:

- Approaching owners of priority sites to identify interest in offsetting.
- Undertaking rapid field assessments on priority sites to confirm the ecological values and habitat condition, to ensure the offset areas provide equivalent or greater values – i.e. improve or maintain biodiversity values.
- Progressing negotiations with owners and complete detailed BioBanking Assessment at priority sites.
- Identifying site specific management actions for long-term management of the biodiversity offsets.
- Obtaining agreement and approval from OEH for the proposed offset package.
- Securing offset properties under an appropriate conservation mechanism.

# 1. Introduction

## 1.1 Background

The NSW State Infrastructure Strategy outlines the progressive upgrading of the Pacific Highway to four-lane urban arterial road standard between North Gosford and the M1 Pacific Motorway. This was divided into five progressive stages by NSW Roads and Maritime Services (Roads and Maritime), two stages have been completed and another stage is under construction as of March 2016.

As a part of the upgrade to the Pacific Highway on the Central Coast, Roads and Maritime proposes to upgrade 1.6 kilometres of the Pacific Highway between Ourimbah Street and Parsons Road at Lisarow (the proposal). The study area is illustrated on Figure 1-1.

The review of environmental factors (REF) identified a significant impact on a population of *Melaleuca biconvexa* (Biconvex Paperbark) listed as vulnerable under the *Environmental Planning and Biodiversity Conservation Act, 1999* (EPBC Act) and the *NSW Threatened Species Conservation Act 1995* (TSC Act). The loss of habitat for threatened fauna species and two endangered ecological communities (EECs) listed under the (TSC Act) was also identified. Accordingly a Species Impact Statement (SIS) was prepared and this offset strategy is a component of the SIS.

The SIS identifies a mitigation strategy to avoid and minimise biodiversity impacts associated with the proposal. Despite these avoidance and mitigation measures, it is acknowledged the proposal would result in residual impacts to a population of *Melaleuca biconvexa* and two EECs which occur in moderate to good condition. In consideration of these residual impacts and in accordance with the *Roads and Maritime Guideline for Biodiversity Offsets* (Roads and Maritime 2011) and Director General's Requirements for a SIS, a biodiversity offset is required.

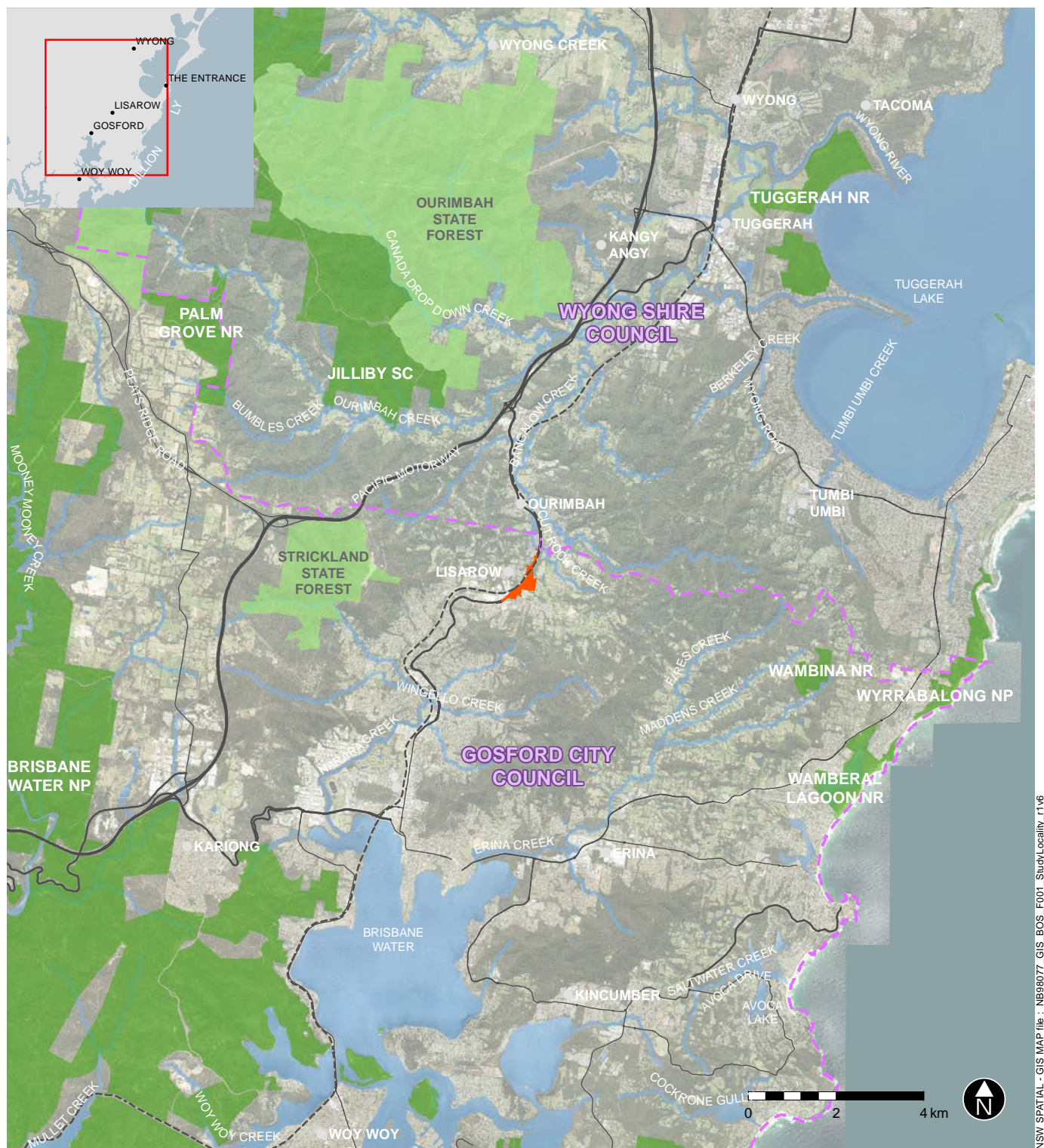
## 1.2 Objectives and scope

The aim of this Biodiversity Offset Strategy is to satisfy the following key objectives:

- Briefly summarise the species and ecosystems credits required as detailed in the SIS.
- Provide initial results of investigations into offset availability.
- Determine if land-based offsets will be available to compensate for the proposal's impacts on threatened species and ecological communities.
- Identify and prioritise potential offset sites for the proposal.
- Identify potential options for securing a suitable offset.

Roads and Maritime proposes to develop the Biodiversity Offset Strategy in two stages. This report satisfies Stage 1 where the scope is to present results of a desktop assessment and to report on the availability of offsets in the locality. Stage 1 does not include site surveys or detailed calculations of species and ecosystem credits available at prospective offset properties. This would be completed in Stage 2 where Roads and Maritime would update the Biodiversity Offset Strategy with input from further targeted threatened species surveys. Further detail about the approach is described in Section 4.





NSW SPATIAL - GIS MAP file : NB98077\_GIS\_BOS\_F01\_StudyLocality\_11v6

Figure 1-1 | Regional locality

### Legend

<span style="display:inline-block; width:15px; height:15px; background-color:orange; border:1px solid black;"></span> Study area	<span style="display:inline-block; width:20px; border-bottom:2px solid lightblue;"></span> Watercourse	<span style="display:inline-block; width:20px; height:15px; background-color:lightgreen; border:1px solid black;"></span> National Parks and Reserves
<span style="display:inline-block; width:20px; border-bottom:2px solid black;"></span> Road	<span style="display:inline-block; width:20px; height:15px; background-color:lightblue; border:1px solid black;"></span> Water body	<span style="display:inline-block; width:20px; border-bottom:2px dashed magenta;"></span> Local Government Area
<span style="display:inline-block; width:20px; border-bottom:2px dashed black;"></span> Railway	<span style="display:inline-block; width:20px; height:15px; background-color:lightgreen; border:1px solid black;"></span> State forest	

Roads and Maritime Services 2016  
AUSIMAGE 2015  
LPI 2015  
Jacobs 2016



### 1.3 Relevant biodiversity offset policies, guidelines and requirements

The requirements for offsetting impacts on the proposal have been determined through consideration of the policies, guidelines and requirements in the following:

- Director Generals Requirements for Species Impact Statement for Upgrade of Pacific Highway, Ourimbah Street to Parsons Road, Lisarow (Section 7.1.2).
- *EPBC Act Strategic Assessment Approval* (2015).
- *Roads and Maritime Guideline for Biodiversity Offsets* (2011).

The Director Generals Requirements for the Species Impact Statement specify in Section 7.1.2 the requirement to provide compensatory offsets for unavoidable impacts. Offset requirements to compensate for the proposal's impact on biodiversity values, are also identified in accordance with the *Roads and Maritime Guideline for Biodiversity Offsets* (Roads and Maritime 2011). The policy provides guidance to determine if offsets should be required for a proposal assessed under Part 5 of the EP&A Act. With reference to the identified impacts with the assessed proposal, the Roads and Maritime guidelines state that an offset is required if the proposal includes:

*Works involving clearing of native vegetation of high conservation value including:*

- *A vegetation type more than 70% cleared in NSW or.*
- *Threatened Ecological Communities in moderate to good condition.*
- *Contains threatened species or their habitat that cannot withstand any loss in the Catchment Management Authority region as defined in OEH Threatened Species Profile database.*

In accordance with this policy and the result of the surveys conducted for the SIS offsets are required for the following TECs and threatened species:

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North coast, Sydney Basin and South East Corner Bioregions (vegetation zones 1 and 2).
- Freshwater wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (vegetation zones 3 and 4).
- *Melaleuca biconvexa*.

Impacts on these biodiversity values were quantified using the BioBanking Assessment Methodology (BBAM) in accordance with the Species Impact Statement and DGRs and the output of the BioBanking Credit Calculator (BBCC) are provided below.

### 1.4 Credits required to offset impacts

The BBCC results are provided below including the ecosystem credits and species credits that are required to offset the residual and significant impacts of the proposal.

#### 1.4.1 Ecosystem credits

A total of 79 ecosystem credits are required to adequately offset the impacts from the proposed upgrade as specified by the BBCC and input variables detailed above. The final credit report specifies four credit groups are summarised in Table 1-1.

Table 1-1 Ecosystem credits required for the proposal

Veg Zone	Biometric Vegetation Type	Red Flag	Area (ha)	Ecosystem credits required
1	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	Yes	1.48	42
2	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast (HU937)	Yes	1.30	25
3	Typha rushland (HU951)	Yes	0.32	11
4	Typha rushland (HU951)	Yes	0.03	1
TOTAL				79

#### 1.4.2 Species Credits

One species credit species *Melaleuca biconvexa* has been identified as requiring offsetting. The ecosystem credits to be offset are considered to adequately compensate for the loss of habitat for threatened fauna species, in particular critical foraging habitat for the Grey-headed Flying-fox and important winter-flowering food resources for other nectivorous fauna.

The loss of mature stems of *Melaleuca biconvexa* was used to calculate species credits required with immature and juvenile stems being excluded from calculations. The number of individual *Melaleuca biconvexa* impacted was calculated using the direct and indirect impact areas multiplied by the density of mature stems (as determined by plot assessments) and taking into consideration a likely survival threshold (refer Section 5.4.1 of the SIS for details on calculations). The number of individuals requiring offset equates to 2,575 (direct loss 2,153 + indirect loss 422). The potential impacts, offset multiplier and species credit requirements are specified in Table 1-2.

Table 1-2 Species credits required for the proposal

Species	Red flag	Threatened species offset multiplier	No. mature stems (direct and indirect loss)	Species credits required
Biconvex Paperbark ( <i>Melaleuca biconvexa</i> )	Yes	1.3	2,575 individuals	33,475

## 2. Offset Approach

### 2.1 Stage 1

This report is the Stage 1 of the delivery of biodiversity offset for the proposal. As such, it does not include site survey data for prospective offset properties. This work will be completed in Stage 2 of the offset delivery after approval for the proposal is obtained and concurrence granted from the NSW Office of Environment and Heritage (OEH) for the SIS.

Key activities for Stage 1 of the offset delivery include:

- Identifying if the ecosystem and species credits required for offset are available for purchase on the open market.
- Publishing an expression of interest on the BioBanking credits wanted register.
- Where credits are not available identify a shortlist of candidate offset sites based on desktop assessment with input from relevant stakeholders (OEH / local councils / the National Parks and Wildlife Service (NPWS)).
- Determining if land-based offsets will be achievable for the biodiversity values requiring offsetting. Where land-based offsets are not likely to be available, investigate indirect and supplementary offset options (noting the EPBC Act-listed biodiversity will require 'like for like' offsets with only a maximum of 10% of the offsets being provided by supplementary measures).
- Prioritise shortlisted offset sites for further investigation as part of Stage 2.

### 2.2 Stage 2

Roads and Maritime will continue to liaise with the OEH while undertaking these further investigations of potential offset properties. The key activities associated with Stage 2 are:

- Reviewing the availability of credits to purchase on the open market.
- Approaching owners of priority sites to identify interest in offsetting.
- Undertaking rapid field assessments on priority sites to confirm the ecological values and habitat condition. This is to ensure the offset areas provide equivalent or greater values that improve or maintain biodiversity values.
- Progress negotiations with owners and complete detailed BioBanking Assessment at priority sites.
- Identifying site specific management actions for long-term management of the biodiversity offsets.
- Obtaining agreement and approval from OEH for the proposed offset package.
- Securing offset properties under an appropriate conservation mechanism.

### 3. Assessment of offset availability

#### 3.1 Available credits

A search of the BioBanking Credit Register was done on the 28 April 2016 to determine if required ecosystem and species credits are available for purchase on the BioBanking Public Register. The results of the search indicate that none of the required credits are available for purchase.

A search of the BioBanking Expressions of Interest (EOI) register was done on the 29 April 2016. This was to determine if the required ecosystem and species credits have been listed for the Hunter-Central River major catchment area. The results of the search indicate that none of the ecosystem credits are listed. An expression of interest has been listed for a property expected to contain credits for *Melaleuca biconvexa*, details in Table 3-1. The register does not include an estimate of the credits available for these species, but does include the property size. The threatened species described are assumed to be present by the landowner and have not been verified by a threatened species survey.

Table 3-1 Results of the search of the BioBanking EOI register

Species	EOI ID	IBRA sub-region	Local Government Area (LGA)	Vegetation formation	Area
<i>Melaleuca biconvexa</i>	EOI – 16: Biodiversity Land Pty Ltd	Karuah Manning	Great Lakes Council	Wet sclerophyll forests (shrubby) and others	436.0 ha

In addition to the searches conducted, Roads and Maritime placed an expressions of interest onto the Credits Wanted Register in early 2015.

#### 3.2 Desktop assessment

An assessment of potential biodiversity offset sites for the proposal was undertaken using the following spatial data and literature sources:

- Bell SAJ (2009) *'The Natural Vegetation of the Gosford Local Government Area, Central Coast, New South Wales Revised & Updated'*, Gosford City Council, 445.
- Bell SAJ (2002), *'The Natural Vegetation of the Wyong Local Government Area, Central Coast, New South Wales'*, Wyong Shire Council, 386.
- *Melaleuca biconvexa* mapping from Wyong City Council (2015).
- *Melaleuca biconvexa* records from the NSW Atlas of Wildlife
- Ground-truthed *Melaleuca biconvexa* mapping (Jacobs 2015).
- Local Environment Plans (Gosford, Wyong and Lake Macquarie).

The desktop assessment has focused on sourcing offsets for *Melaleuca biconvexa* and the two Endangered Ecological Communities (HU937 and HU951). The spatial datasets were overlaid over cadastral boundaries to identify lot/DPs for potential offsets sites. This was also used to identify ownership of each site.

#### 3.3 Assessment of potential offset sites

Much of the study area surrounding the proposal consists of a mosaic of small lots. Therefore clusters of separate lots containing the target biodiversity values were identified and assessed to develop a list of offset options. The list comprised a total of 43 clusters identified across almost 300 individual lots in the Wyong and Gosford Local Government Area (LGA). Two sites owned by Roads and Maritime in the Lake Macquarie LGA have also been identified as potential offset sites.

Potential offset sites were prioritised from the list of 43 clusters based on the following

- Size (larger lots in un-fragmented patches of vegetation were considered more viable over the long-term and were given priority.
- Location in relation to distance from the impacted area and degree of surrounding human impacts
- Land use and zoning with priority for environmental protection zones, or parks and recreation areas
- Vegetation types matching the offset requirements.

### 3.3.1 Priority sites

This prioritisation process resulted in the identification of a short list of 37 priority sites from 16 clusters, which are listed in Table 3-2. This is along with a summary of the ecological attributes based on spatial data sources.

The figures identified in Table 3-2 demonstrate that there are sufficient biodiversity credits to adequately provide offsets for *Melaleuca biconvexa* and the Swamp Sclerophyll Forest Endangered Ecological Community. The Freshwater Wetland Endangered Ecological Community is also likely to be present at a number of the short-listed properties, however the broad-scale vegetation mapping spatial data layers do not provide sufficient fine-scale mapping to identify smaller open wetlands within the mosaic of other floodplain vegetation types, and therefore these will need to be ground-truthed to confirm. Nevertheless, requirements for offsetting of this wetland EEC are small in comparison to the other habitats and communities and are not predicted to be a risk.

The identification of suitable credits for Swamp Sclerophyll Forest, are expected to compensate for the loss of fauna habitat such as that for the Grey-headed Flying Fox, for which Swamp Mahogany (*Eucalyptus robusta*) or other winter-flowering eucalypt species comprise critical foraging habitat.



Table 3-2 Short-list properties identified as potential offset options

Cluster ID	LGA	Credit Type 1	Area (ha)	Likely credits generated	Confidence	Credit Type 2	Area (ha)	Likely credits generated	Credit Type 3	Area (ha)	Likely credits generated	Total vegetation (ha)
12	Wyong	Melaleuca biconvexa	2.83	22627	Not ground-truthed	Swamp Sclerophyll Forest	5.62	52	Disturbed Swamp Sclerophyll Forest	0.14	1	5.76
	Wyong	Melaleuca biconvexa	2.01	16071	Not ground-truthed	Swamp Sclerophyll Forest	3.3	31	Disturbed Swamp Sclerophyll Forest	0.65	6	3.95
13	Wyong	Melaleuca biconvexa	3.32	26545	Not ground-truthed	Swamp Sclerophyll Forest	2.11	20	River-flat Eucalypt Forest	2.2	20	4.31
	Wyong	Melaleuca biconvexa	3.14	25106	Not ground-truthed	Swamp Sclerophyll Forest	7.6	71	River-flat Eucalypt Forest	1.54	14	9.22
	Wyong	Melaleuca biconvexa	2.29	18310	Edge confirmed	Swamp Sclerophyll Forest	5.35	50	River-flat Eucalypt Forest	0.63	6	5.98
15	Wyong	Melaleuca biconvexa	5.68	45415	Not ground-truthed	Swamp Sclerophyll Forest	6.98	65	Non-threatened Vegetation	1.44	13	8.42
	Wyong	Melaleuca biconvexa	4.84	38698	Not ground-truthed	Swamp Sclerophyll Forest	4.15	39	Non-threatened Vegetation	0.01	0	4.16
	Wyong	Melaleuca biconvexa	3.26	26065	Not ground-truthed	Swamp Sclerophyll Forest	4.72	44	Non-threatened Vegetation	0.15	1	4.87
	Wyong	Melaleuca biconvexa	2.63	21028	Not ground-truthed	Swamp Sclerophyll Forest	2.96	28			0	2.96
	Wyong	Melaleuca biconvexa	4.84	38698	Not ground-truthed	Swamp Sclerophyll Forest	4.15	39	Non-threatened Vegetation	0.01	0	4.16
17	Wyong	Melaleuca biconvexa	0.08	640	Edge confirmed	Swamp Sclerophyll Forest	6.65	62			0	6.65
	Wyong	Melaleuca biconvexa	1.85	14792	Edge confirmed	Swamp Sclerophyll Forest	2.06	19			0	2.06
	Wyong	Melaleuca biconvexa	1.71	13672	Edge confirmed	Swamp Sclerophyll Forest	2.32	22			0	2.32
	Wyong	Melaleuca biconvexa	1.75	13992	Edge confirmed	Swamp Sclerophyll Forest	2.24	21	Disturbed Swamp Sclerophyll Forest	0.1	1	2.34
	Wyong	Melaleuca biconvexa	2.25	17990	Edge confirmed	Swamp Sclerophyll Forest	1.9	18	Disturbed Swamp Sclerophyll Forest	1.07	10	2.97
	Wyong	Melaleuca biconvexa	0.08	640	Edge confirmed	Swamp Sclerophyll Forest	6.65	62			0	6.65
18	Wyong	Melaleuca biconvexa	11.36	90829	Edge confirmed	Swamp Sclerophyll Forest	10.14	94	Disturbed Swamp Sclerophyll Forest	0.73	7	10.87
	Wyong	Melaleuca biconvexa	4.36	34861	Edge confirmed	Swamp Sclerophyll Forest	7.6	71	Non-threatened Vegetation	0.33	3	7.93
21	Wyong	Melaleuca biconvexa	2.32	18550	Edge confirmed	Swamp Sclerophyll Forest	4.42	41	Disturbed Swamp Sclerophyll Forest	1.47	14	8.43
	Wyong	Melaleuca biconvexa	2.09	16711	Edge confirmed	Swamp Sclerophyll Forest	4.05	38	Non-threatened Vegetation	4.5	42	8.55
22	Wyong	Melaleuca biconvexa	2.98	23827	Confirmed	Swamp Sclerophyll Forest	1.72	16	Non-threatened Vegetation	9.58	89	11.3
	Wyong	Melaleuca biconvexa	1.38	11034	Edges confirmed and Atlas records	River-flat Eucalypt Forest	1.94	18			0	1.94
23	Wyong	Melaleuca biconvexa	16.38	130967	Edge confirmed	River-flat Eucalypt Forest	3.06	28	Non-threatened Vegetation	120.14	1117	123.2
28	Wyong	Melaleuca biconvexa	5.1	40777	Not ground-truthed	Swamp Sclerophyll Forest	7.6	71			0	7.6
30	Wyong	Melaleuca biconvexa	3.92	31343	Edge confirmed	Swamp Sclerophyll Forest	3.97	37	Freshwater Wetlands	0.66	6	4.63
31	Wyong	Melaleuca biconvexa	0.02	160	Confirmed	Swamp Sclerophyll Forest	4.43	41	Freshwater Wetlands	1.61	15	7.01
32	Wyong	Melaleuca biconvexa	3.14	25106	Confirmed	Swamp Sclerophyll Forest	3.52	33	Non-threatened Vegetation	2.23	21	5.75
33	Wyong	Melaleuca biconvexa	4.19	33501	Atlas records	Swamp Sclerophyll Forest	6.35	59	River-flat Eucalypt Forest	0.38	4	6.73
34	Wyong	Melaleuca biconvexa	1.76	14072	Atlas records	Swamp Sclerophyll Forest	15.69	146	Non-threatened Vegetation	0.7	7	16.39
	Wyong	Melaleuca biconvexa	3.33	26625	Atlas records	Swamp Sclerophyll Forest	6.04	56			0	6.04
	Wyong	Melaleuca biconvexa	0.6	4797	Atlas records	Swamp Sclerophyll Forest	7.27	68	Disturbed Swamp Sclerophyll Forest	2.25	21	9.52
	Wyong	Melaleuca biconvexa	3.71	29663	Atlas records	Swamp Sclerophyll Forest	7.18	67	River-flat Eucalypt Forest	2.19	20	9.37
	Wyong	Melaleuca biconvexa	1.44	11514	Atlas records	Swamp Sclerophyll Forest	1.04	10	Disturbed Swamp Sclerophyll Forest	7.52	70	8.56
37	Wyong	Melaleuca biconvexa	3.95	31582	Not ground-truthed	Swamp Sclerophyll Forest	1.19	11	River-flat Eucalypt Forest	4.18	39	6.73
	Wyong	Melaleuca biconvexa	12.07	96506	Not ground-truthed	Swamp Sclerophyll Forest	3.59	33	River-flat Eucalypt Forest	5.12	48	11.65
41	Wyong	Melaleuca biconvexa	2.23	17830	Not ground-truthed	Swamp Sclerophyll Forest	15.21	141	River-flat Eucalypt Forest	2.64	25	26.29
	Wyong	Melaleuca biconvexa	1.38	11034	Not ground-truthed	Swamp Sclerophyll Forest	1.85	17	Non-threatened Vegetation	13.51	126	15.36
		<b>Total</b>	<b>130.27</b>	<b>1,041,580</b>		<b>Total</b>	<b>186.62</b>	<b>1,736</b>	<b>Total</b>	<b>187.68</b>	<b>1,745</b>	<b>390.63</b>

## 4. Offset outcomes

### 4.1 Ecosystem credits

A search of the BioBanking Credit Register for the availability of the required ecosystem credits confirmed that the required credits are not currently available for purchase in the Hunter-Central Rivers CMA region.

The background search of available vegetation types in the locality identified there are sufficient sites available to progress BioBanking Agreements to generate the required biodiversity credits for impacted threatened ecological communities, particularly Swamp Sclerophyll Forest. Freshwater Wetlands are also likely to be present within a number of the clusters identified. However these are not possible to distinguish from the broad-scale vegetation mapping spatial data layer available. The approximate offset area required for vegetation communities are identified in Table 4-1 comprising around 7.7 hectares of swamp sclerophyll forest and 1.5 hectares of freshwater wetland. The area of offset potentially required was calculated using the credit converter which is based on a median of 9.3 ecosystem credits per hectare. Table 4-1 also indicates the approximate area of land available for offset from the total number of priority sites assessed.

Table 4-1 Summary of ecosystem credit offset outcomes

Veg zone	Threatened Ecological Community	Credits required	Approximate offset area required	Approximate area available at priority sites	Can land-based offsets be achieved
1/2	Swamp Sclerophyll Forest	67	7.7 ha	187 ha	Yes
3/4	Freshwater Wetlands	12	1.3 ha	Not able to be confirmed from desktop	Yes likely, to be confirmed

### 4.2 Species credits

A search of the BioBanking Credit Register for the availability of the required species credits confirmed that there are no confirmed species credits currently available for *Melaleuca biconvexa*. However an expression of interest has been listed for a single property potentially expected to contain credits for *Melaleuca biconvexa*, refer to Table 3-1. The BioBanking expression of interest register does not include an estimate of the credits available for this species, but does however include the property size. These threatened species are assumed to be present by the landowner and have not been verified by a threatened species survey.

Considering the substantial impact on *Melaleuca biconvexa*, a relatively large number of species credits (i.e. 33,475) are required to offset the impacts to the species according to the BioBanking Credit Calculator. An offset supporting 5,000-6,000 *Melaleuca biconvexa* mature stems is likely to be sufficient to generate the required species credits to offset the direct and indirect impacts to 2,575 mature *Melaleuca biconvexa* stems. An offset supporting around 3.5 hectares of occupied habitat with similar densities of *Melaleuca biconvexa* (around 825 mature stems per hectare) is needed to sufficiently achieve the required species credits.

Table 4-2 identifies the species credits required and the approximate area of land available for offset from the total number of priority sites assessed.

Table 4-2 Summary of species credit offset outcomes

Threatened species	Credits required	Approximate area required to meet credit requirements (ha)*	Approximate area available at priority sites	Can land-based offsets be achieved
<i>Melaleuca biconvexa</i>	33,475	3.5 hectares	130.3 ha	Yes

\* Note – this has been calculated assuming that densities are similar to those identified in the study area.

### 4.3 Next steps

The biodiversity offset strategy documents the outcomes of the Stage 1 of developing an offset package, by presenting the results of a desktop assessment investigating the availability of offsets meeting the required ecosystem and species credits in the locality. The assessment has identified a short-list of 37 priority sites from 16 clusters all on private and public property considered to adequately compensate for the predicted impacts in terms of land area and credits required. The next steps are to identify and secure a final list of offset properties include:

- Updated searches of credit registers and EOI registers for available credits throughout the biodiversity offset package process.
- Liaison with owners of priority sites to identify potential interest in entering into a BioBanking Agreement. This would be followed by site investigations to confirm vegetation, species and habitat types. Consultation with property owners and site investigations will progress through the approval process.
- Following approval and concurrence of the SIS the refined list of offset properties will be secured by Roads and Maritime and a formal conservation mechanism established for each selected property in consultation with the Office of Environment and Heritage. The process is planned to take two years following approval of the proposal.

## 5. References

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Roads and Maritime Services, 2011. *Guideline for Biodiversity Offsets*. NSW government.

## **Appendix A. BioBanking credit report**



# BioBanking Credit Calculator

## Ecosystem credits

Proposal ID :0087/2015/2023D

Proposal name :Lisarow\_V3

Assessor name :Andrew Carty

Assessor accreditation number :0087

Tool version :v4.0

Report created :19/05/2016 11:59

Assessment circle name	Landsc ape score	Vegetation zone name	Vegetation type name	Condition	Red flag status	Management zone name	Management zone area	Current site value	Future site value	Loss in site value	Credit required for bio diversity	Credit required for TS	TS with highest credit requirement	Average species loss	Species TG Value	Final credit requirement for management zone
1	1.60	HU591_Moderate/Good	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast	Moderate/Good	Yes	1	1.33	42.00	0.00	42.00	42	26	Little Lorikeet	100.00	1.80	42
1	1.60	HU951_Moderate/Good	Typha rushland	Moderate/Good	Yes	3	0.32	43.41	0.00	43.41	11	9	Black-tailed Godwit	0.00	2.60	11
1	1.60	HU591_Moderate/Good_Poor	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast	Moderate/Good_Poor	No	2	1.28	26.00	0.00	26.00	25	15	Little Lorikeet	100.00	1.80	25
1	1.60	HU951_Moderate/Good_Poor	Typha rushland	Moderate/Good_Poor	Yes	4	0.03	34.11	0.00	34.11	1	1	Great Knot	0.00	2.60	1

# BioBanking Credit Calculator

## Species credits

Proposal ID : 0087/2015/2023D  
Proposal name : Lisarow\_V3  
Assessor name : Andrew Carty  
Assessor accreditation number : 0087  
Tool version : v4.0  
Report created : 19/05/2016 11:59

Scientific name	Common name	Species TG value	Identified population?	Can Id. popn. be offset?	Area / number of loss	Negligible loss	Red flag status	Number of credits
Melaleuca biconvexa	Biconvex Paperbark	1.30	No		2,575.00	5.00	Yes	33,475

## **Appendix F. Curriculum vitae**



## Chris Thomson

### ASSOCIATE ECOLOGIST

#### Summary of Competencies

Chris is Jacobs practice leader for terrestrial ecology with twenty years professional experience managing biodiversity assessments and scientific reporting. He is a highly experienced ecologist with extensive experience on biodiversity and infrastructure projects, having worked widely throughout NSW, Queensland, Victoria and Tasmania as the technical lead on a range of environmental assessments associated with major road, water, rail and power projects.

Chris has comprehensive knowledge of Commonwealth and NSW threatened species legislation, policies and guidelines relating to biodiversity assessments. He has extensive experience in developing and managing offset strategies, offset status reports and offset site investigations with a high level of experience and success in liaison with State and Commonwealth Government Departments on infrastructure projects.

#### Recent Project Experience

##### Woolgoolga to Ballina – Threatened Biodiversity Offset Assessments

**Client:** Roads and Maritime Services, Pacific Highway Office

**Role:** Project Director / Technical Review

##### Key achievements:

- Biodiversity field assessments undertaken across 3000 hectares undertaking vegetation mapping, targeted searches for threatened species and identifying management requirements.
- Delivery of 20 separate reports including 19 biodiversity offset assessments and an EPBC Act Offset Status Report summarising the findings across all properties.

##### Bolivia Hill Biodiversity Peer Review, Roads & Maritime, NSW, 2014

**Role:** Biodiversity Specialist

- Jacobs were engaged by Roads and Maritime to undertake the independent peer review of the options report prepared for the Bolivia Hill Upgrade on the New England Highway, and provide specific advice regarding the likely significance of impacts and potential for a referral in terms of the Environmental Protection and Biodiversity Conservation (EPBC) Act. As Biodiversity Specialist Chris prepared the peer review and provided specialist recommendations and assessment of potential impacts.

##### Pacific Highway Glenugie Upgrade, EA, NSW

**Client:** RMS Pacific Highway Office

**Role:** Technical Lead – Biodiversity investigations, and project development of the Glenugie Biodiversity Offset Strategy and Spotted-tailed Quoll Management Plan

##### Key achievements:

- Delivery and approval of the project and development of approved connectivity strategy

#### QUALIFICATIONS

Bachelor of Applied Science  
(Coastal Management) University of  
New England

Graduate Certificate in Natural  
Resources, University of New  
England

Accredited Biobanking Assessor  
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#### CURRENT POSITION

Associate Ecologist

Technical Lead Ecology for NSW,  
Queensland and NZ

#### PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

Ecological Consultants Association  
of New South Wales

Royal Zoological Society of New  
South Wales

Birdlife Australia

#### EXPERTISE

- Fauna survey and identification, particularly birds, large forest owls, mammals and frogs
- High level understanding and experience with legislation and EIA guidelines relating to biodiversity impact assessments for major infrastructure projects
- Liaison with Government and public stakeholders
- Design and implementation of ecological monitoring programs and threatened species management plans

## Chris Thomson

ASSOCIATE ECOLOGIST

### Various water infrastructure projects 2002-2016

**Client:** Water authorities

**Role:** Ecologist

- Windale Stage 2 upgrade flora and fauna assessment for REF for Hunter Water Corporation
- Kurri Kurri STP upgrade flora and fauna assessment for REF for Hunter Water Corporation
- Kurri Kurri STP expansion flora and fauna assessment for REF for Hunter Water Corporation
- Raymond Terrace STP upgrade - assessment of impacts on Groundwater Dependent Ecosystems for Hunter Water Corporation
- Sydney Water Sewerfix program, ecological site surveys and impact assessment for over 30 SPS sites throughout the Blue Mountains, and western and southern Sydney
- Sydney Water Recycled Water Initiative – St Marys and Penrith
- Hoxton Park sewerage scheme – Sydney Water

### Various Department of Defence projects 2004-2016

**Client:** Department of Defence

**Role:** Lead Ecologist

- Kangaroo Population Impact Monitoring for the Majura Training Area in ACT (Technical lead for projects conducted in 2006/07, 2008/09, 2009/10, 2011/12, 2013/14, 2014/15, and 2015/16).
- Kangaroo Population Impact Monitoring for the Singleton Training Area (Technical lead for 2011-12 monitoring period)
- Flora and Fauna Fire Monitoring and Database: Defence Estate Orchard Hills. Engaged to prepared monitoring program and delivery on first 3 years of the program
- Prepared Conservation Management Plan for the Singleton Training Area 2007. Project manager and team leader. Department of Defence
- Baseline fauna study of Beecroft Weapons Range, Shoalhaven. Project Manager, team leader. Department of Defence.
- Threatened Species Management Strategy for five Defence properties in the Shoalhaven Defence Estate. Project Manager, team leader. Department of Defence.
- Conducted Baseline Fauna Study for the Singleton Training Area. Project Manager. Department of Defence.
- Conducted Baseline Fauna Studies for Defence Shoalhaven Properties, HMAS Albatross, HMAS Creswell and Jervis Bay Range Field. Project Manager. Department of Defence.
- Design and implementation of a monitoring program for threatened woodland birds on the Singleton Training Area. Project Manager. Department of Defence.
- Survey Report and Management Recommendation for Migratory Shorebirds of the 12-Mile Creek Estuary, Salt Ash Air Weapons Range, Port Stephens





## Andrew Carty

### SENIOR BOTANIST

#### Summary of Competencies

Andrew is an Ecological Consultant with over 11 years' experience specialising in botany and flora ecology. His experience includes flora and fauna field survey design and implementation, species identification, habitat evaluation and assessment, weed management and natural resource management. Andrew has comprehensive knowledge and experience with State and Commonwealth legislation regarding environmental impact assessment, threatened species protection and noxious weed management for Australia.

Andrew is qualified to undertake BioBanking assessments in accordance with the NSW DECCW BioBanking assessment methodology. Andrew is licensed by the appropriate authorities to undertake flora and fauna investigations, and work on construction sites, as well have having a first aid certificate.

#### Relevant Project Experience

##### **Deniliquin to Moama Power Easement Route Selection Study and Impact Assessment**

**Client:** Essential Energy

**Role:** Biodiversity Specialist

**Key achievements:** Ecological investigations and impact assessment undertaken across a large study area. Identification and successful management of threatened flora and fauna populations identified in the study area.

##### **Mt Piper Power Station Upgrades**

**Client:** Delta Electricity

**Role:** Biodiversity Specialist

**Key achievements:** Ecological investigations, impact assessment and advice provided for various projects including Western Rail Coal Unloader, Conveyor Options Assessment, Power Station Extension and Ash Placement.

##### **330 kV Network Connection for the Bamarang Gas Turbine Project**

**Client:** Delta Electricity

**Role:** Biodiversity Specialist

**Key achievements:** Flora and fauna impact assessment undertaken successfully. Offset options investigated and assessed.

##### **Feeder Powerline Kurri Kurri to Neath**

**Client:** Energy Australia

**Role:** Biodiversity Specialist

**Key achievements:** Identification and management/avoidance of threatened flora species and ecological communities.

#### CURRENT POSITION

Senior Botanist

#### QUALIFICATIONS

Bachelor of Environmental Science  
- University of Newcastle

Natural Area Restoration and  
Management Cert. IV Hunter  
Institute TAFE

Bush Regeneration Cert. II Hunter  
Institute TAFE

DECCW BioBanking Assessors  
Course

#### PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

Birds Australia (Royal Australasian  
Ornithologists Union)

Ecological Society of Australia

Ecological Consultants of Australia

#### EXPERTISE

- Flora identification
- Flora ecology
- Biodiversity offsets
- Ecological monitoring
- BioBanking

## Andrew Carty

SENIOR BOTANIST

### **Woolgoolga to Ballina – Threatened Biodiversity Offset Assessments**

**Client:** RMS Pacific Highway Office

**Role:** Project Manager/Lead Ecologist

**Key achievements:**

- Biodiversity field assessments undertaken across 3000 hectares undertaking vegetation mapping, targeted searches for threatened species and identifying management requirements
- Delivery of 20 separate reports including 19 biodiversity offset assessments and an EPBC Act Offset Status Report

### **Woolgoolga to Ballina – Pre-construction baseline monitoring and targeted surveys for threatened flora**

**Client:** RMS Pacific Highway Office

**Role:** Project Manager/Lead Ecologist

**Key achievements:**

- Detailed survey and mapping for 21 threatened flora species in and adjacent to the project area
- Establishment of 89 permanent monitoring locations for threatened flora populations and collection of baseline data

### **Dignams Creek Princes Highway Upgrade Offset Assessment**

**Client:** Roads and Maritime Services

**Role:** Biodiversity surveys and reporting

**Key achievements:**

- Identification of key ecological constraints
- Biodiversity offset assessments for the project using the Biobanking methodology

### **Great Western Highway Upgrades - Mt Victoria to Lithgow Alliance**

**Client:** Roads and Maritime Services

**Role:** Technical Lead – Biodiversity investigations

**Key achievements:**

- Delivery of several technical documents including biodiversity impact assessments for geotechnical investigations and safety upgrades, as well as corridor investigations to identify key ecological constraints
- Delivery of the Forty Bends biodiversity assessment for the REF

### **Flora and Fauna Protection Database at Defence Estate Orchard Hills, NSW**

**Client:** Department of Defence

**Role:** Senior Botanist

**Key achievements:**

- Threatened species surveys
- Vegetation monitoring



## Brenton Hays

### ECOLOGIST

#### Summary of Competencies

Brenton is one of the newest members of the Jacobs eastern environmental science team. He has three years of experience working on a diverse range of research projects conducted by the University of Newcastle. His experience includes project design and management, fauna and flora surveying, habitat assessment and species identification. Brenton designed and executed a year-long reptile study at Uluru-Kata Tjuta National Park (UKTNP) for his honours project, receiving first class.

Brenton has been with Jacobs for over a year and has worked on a range of infrastructure projects. He has developed a sound understanding of environment law and processes involved around listed threatened species. In the field, Brenton has experience in ecological assessments for infrastructure projects between Sydney and the North Coast of NSW. He has conducted targeted flora and fauna surveys, fauna habitat assessment and BioBanking investigations. Brenton is licensed to undertake flora/fauna surveys, rescue native wildlife, enter rail corridors and holds a current certificate in Apply First Aid.

#### Recent Project Experience

##### **Pacific Highway Upgrade Program: M1 Motorway Extension to Raymond Terrace EIS**

**Client:** Roads and Maritime Services

**Role:** Ecologist

##### **Key Achievements**

- Threatened fauna habitat assessment and targeted surveys
- Verification of vegetation mapping, BioBanking assessment and threatened species surveys

##### **Upgrade of Pacific Highway HW10 Lisarow SIS**

**Client:** Roads and Maritime Service

**Role:** Ecologist

##### **Key Achievements**

- Targeted threatened fauna surveys
- Mapping distribution of threatened flora and fauna habitat
- Impact assessment of subject species

##### **New Grafton Prison EIS**

**Client:** Infrastructure NSW

**Role:** Ecologist

##### **Key Achievements**

- Threatened fauna habitat assessment and targeted surveys
- Impact assessment and mitigation

#### CURRENT POSITION

Ecologist

#### QUALIFICATIONS

Bachelor of Environmental Science and Management (Hons), University of Newcastle

#### PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

Ecological Consultants Association of NSW

Royal Zoological Society of NSW

Native Animal Trust Fund

#### EXPERTISE

Authorised Wildlife Rescuer

Reptile Catch and Release (inc. venomous snakes)

4WD Driver Training (NSW)

Apply First Aid Certificate

Construction White Card (WHS)

Rail Safety Worker Card

Australian Government Baseline Security Clearance

## Brenton Hays

### ECOLOGIST

#### **Demolition of Former RZM Site at Tomago, NSW**

**Client:** Roads and Maritime Services

**Role:** Ecologist – Fauna Surveys and habitat assessment

**Key Achievements**

- Microbat surveys in derelict buildings
- Targeted threatened amphibian surveys
- Aquatic habitat assessment

#### **Pacific Highway Upgrade Program: Woolgoolga to Ballina EIS and monitoring programs, NSW**

**Client:** Roads and Maritime Services

**Role:** Ecologist – Biodiversity offset investigations

**Key Achievements**

- Flora surveys for biodiversity offset sites.
- Mapping of vegetation distribution and habitat condition.

#### **Bells Line of Road Improvement Program**

**Client:** Roads and Maritime Service

**Role:** Ecologist and Fauna Handler

**Key Achievements**

- On-site fauna management during clearing of habitat trees
- Capture and relocation of fauna in clearing area

#### **NACC Project, Williamstown RAAF Base, NSW**

**Client:** Lend Lease

**Role:** Ecologist – Flora surveys

**Key Achievements**

- Verification of vegetation mapping
- Targeted threatened species surveys
- Reporting of survey results

#### **Lord Howe Island Solar Facility Biodiversity Investigation**

**Client:** Lord Howe Island Board

**Role:** Ecologist

**Key Achievements**

- Desktop based biodiversity investigation of threatened species and habitat
- State and commonwealth assessment of significance

## Appendix G. Fauna survey data

### Location of survey sites

Survey	Survey Site	Precinct	Vegetation type	Easting (GDA)	Northing (GDA)
Site 1	1	School	Swamp Forest	348440	6305020
Site 2	2	School	Swamp Forest	348362	6304918
Site 3	3	Lisarow Wetland	Swamp Forest	348465	6305139
Site 4	4	Lisarow Wetland	Swamp Forest	348650	6305210
Site 5	5	D section	Swamp Forest	348515	6305186
Site 6	6	D section	Swamp Forest	349050	6305207
Site 7	7	Graveyard	Moist Turpentine / Ironbark	348692	6305436

### Bird survey details

Surveys	Date	Hrs	Site	Time	Weather 8am (Williamstown)			Raining?	Notes
					Temp	Wind	Rainfall last 48 hours		
Winter 2015 Survey 1	12/08/2015	4	1	7:40 AM	3.6	0	0	No	E.robusta flowering.
			2	8:05 AM	10.9	0	0	No	
			3	8:20 AM	11.2	4	0	No	
			4	8:45 AM	11.2	4	0	No	
			5	9:30 AM	15.7	9	0	No	
Winter 2015 Survey 2	20/08/2015	4	1	7:40 AM	7.5	0	0	No	Less E.robusta flowering than 1st survey.
			2	8:05 AM	9.3	0	0	No	
			3	8:30 AM	11.4	2	0	No	
			4	8:50 AM	12.6	2	0	No	
			5	9:15 AM	13.9	0	0	No	
			6	9:15 AM	13.9	0	0	No	New site. Only 1 survey here
Spring 2015	20/10/2015	1	1	8:20 AM	21.6	6	0	No	
			2	8:45 AM	22.7	2	0	No	
	21/10/2015	1	3	9:30 AM	28.3	4	1.8	No	
			4	9:00 AM	26.6	6	1.8	No	
	22/10/2015	2	5	8:30 AM	18.9	0	4.6	Yes	
			6	9:00 AM	18.8	4	4.6	Yes	
			7	9:30 AM	19.7	2	4.6	No	New site. Only 1 survey here



## Reptile data

Species	Common name	Open wetlands			Swamp Forests				
		Site 1	Site 3	Site 6	Site 2	Site 4	Site 5	Site 7	
<i>Lampropholis delicata</i>	Dark-flecked Garden Skink	X	X	X	X	X	X	X	1
<i>Lampropholis guichenoti</i>	Pale-flecked Grass Skink							X	1
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle		X						1
<i>Cryptoblepharus virgatus</i>	Fence Skink					X			1
<i>Egernia major</i>	Land Skink	X							1
<i>Eulamprus quoyii</i>	Eastern Water Skink	X	X	X	X	X	X		1
<i>Intellagama lesueurii</i>	Eastern Water Dragon		X						1
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake						X		1
Total species									7

## Mammal trapping

Site	Capture date	Species	Common name	Sex
1	23/10/2015	<i>Rattus rattus</i>	Black Rat	M
5	23/10/2015	<i>Antichinus stuartii</i>	Brown Antichinus	F

## Bat trapping

Trap no.	Site	Date	Species	Common name	Sex	Weight (g)	Forearm (mm)
Harp 1	3	22/10/2015	<i>Vespadelus pumulus</i>	Eastern Forest Bat	M	4.10	31.00

## Bat call analysis

Species	Possible	Probable	Positive
Mormopterus species 2	21	4	
Mormopterus norfolcensis	1		
Miniopterus australis		9	
Scoteanax rueppellii, Scotorepens orion, or Falsistrellus tasmaniensis		17	
Vespadelus spp	2	2	
Miniopterus schreibersii oceanensis	1	1	
Chalinolobus gouldii	1	17	
Chalinolobus morio	2		
Total	28	50	0