



Roads &  
Maritime

# Nowra Bridge Biodiversity Assessment

August 2018

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August 2018

Prepared by Snowy Mountains Engineering Corporation

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Prepared by	Liam Hogg
Reviewed by	Frank Lemckert
Approved by	Chris Masters

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## Executive summary

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SMEC was engaged by NSW Roads and Maritime Services (Roads and Maritime) to prepare a Biodiversity Assessment Report for the proposed construction of a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra (the proposal). The proposal would also include the upgrade of the Princes Highway in the vicinity of the bridge, as well as key intersection upgrades and modifications to the local road network. The proposal extends for about 1.6 kilometres along the existing Princes Highway in the Shoalhaven local government area (LGA).

The proposal would also include the upgrade of the Princes Highway at Nowra from a four-lane arterial highway to a six-lane arterial highway. The proposal would extend from about 150 metres north of the intersection with Bolong Road, Bomaderry, to about 75 metres north of the intersection of Moss Street, Nowra. The proposal would include intersection upgrades at Bolong Road, Illaroo Road, Bridge Road and Pleasant Way.

Previous studies, reports and documentation relevant to the proposal were reviewed during the current study. A search of relevant databases to obtain records on all threatened species, populations, and ecological communities previously recorded within a 10 kilometre search area was undertaken.

Flora surveys were carried out during March and November 2017. This included 30 person hours of flora survey effort with surveys undertaken to meet seasonal requirements for targeted flora. Existing vegetation mapping was validated and remapped as required using a combination of ground-truthing (rapid data points and one flora survey plot that incorporated a plot and transect, and a full floristic quadrat) and GIS updating of maps and vegetation types (including calculation of type extent and attribution of types to local, regional and Plant Community Types). Vegetation condition was also assessed as being in good, moderate or low condition according to the quality and intactness of the structure, the number and dominance of native species present, and the number of exotic species present.

Fauna surveys were undertaken during March and November 2017. Standard survey techniques were used to target threatened fauna, including diurnal bird census, diurnal reptile searches, nocturnal call playback, spotlighting, frog searches, and ultrasonic bat recording. Assessments of fauna habitat were also undertaken at various locations throughout the study area and a survey of the hollow-bearing trees completed.

A total of 11 threatened flora species were identified as potentially occurring in the locality. One threatened flora species, *Syzygium paniculatum*, listed as vulnerable under both the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), was found to occur within the study area. An additional two threatened species have a moderate likelihood of occurring within the study area.

A total of 39 threatened fauna species were identified as potentially occurring in the locality. The Grey-headed Flying-fox, listed as vulnerable under both the TSC Act and EPBC Act, was found to occur within the study area. The Eastern Freetail-bat and Varied Sittella, both listed as vulnerable under the TSC Act were also found in the study area as was the Rufous Fantail, which is listed as a migratory species under the EPBC Act. The White-bellied Sea-eagle, listed as vulnerable under the TSC Act, was recorded adjacent to the proposal during field surveys.

An assessment of likelihood of occurrence was conducted for all potentially occurring species. One species, Southern Myotis, was regarded as having high potential to occur. Twelve other threatened flora or fauna species were identified as having moderate potential to occur, including on a transient

basis. All other threatened species potentially present were identified as having a low potential to occur.

Searches of available databases for potentially occurring aquatic species, only the Australian Grayling has a previous record from the area.

The proposal would result in the clearing of about 2.18 hectares of native vegetation along Illaroo Road that consists of approximately 2.09 hectares of Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (PCT1206) and 0.09 of Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (PCT1236). The native vegetation to be removed is generally in moderate to good condition and consists of linear strips of small remnant patches.

In addition, a number of mixed native and exotic vegetation communities exist throughout other sections of the study area with about 3.46 hectares of these non-native communities being cleared to facilitate the proposal.

Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions meets the determination for the *Biodiversity Conservation Act 2016* listed Endangered Ecological Community Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions; however, given the presence of the Endangered Ecological Community is only in small remnant patches less than 0.5 hectares in size, it does not meet the determination of the Endangered Ecological Community under the EPBC Act.

A six metre indirect impact buffer has been applied to the construction footprint to encapsulate all indirect impacts, including edge effects, as a result of construction activities. As such, it is anticipated that up to 0.95 hectares of additional native and non-native vegetation may be subject to indirect impacts as a result of the proposal.

Fauna habitat within the study area includes native vegetation, exotic vegetation, rocky habitat and bridges. The proposal would require the removal of approximately 5.64 hectares of native and non-native vegetation suitable to support threatened fauna. Two hollow-bearing trees are to be cleared, accounting for one small (0-5 centimetre diameter) and three medium sized (5-10 centimetre diameter) hollows.

Approximately 12.18 hectares of the 19,064 hectares of the management site for the Green and Golden Bell Frog Population of Crookhaven River Floodplain are included as part of the study area. The 12.18 hectares contains potential feeding and shelter habitat, but only minimal breeding habitat, and represents the very northern extent of the Crookhaven River Floodplain management site. Records for this species are absent from the study area and anywhere to the north, indicating that this part of the Crookhaven River Floodplain management site is rarely if ever used by the Green and Golden Bell Frog.

Assessments of significance under the TSC Act and EPBC Act have been undertaken for threatened species and ecological communities that are known to occur within the study area or have a moderate likelihood of occurring or greater. The assessments of significance found that a significant impact on threatened biodiversity values is unlikely as a result of this proposal.

Mitigation measures have been recommended to minimise the impact of the proposal on threatened species, communities and their habitats. Mitigation measures recommended include, but are not limited to:

- Preparation of a Flora and Fauna Management Plan

- Implementing the Roads and Maritime Services Biodiversity Guidelines (2011a) for all stages including the pre-clearing process, establishment of exclusion zones, clearing of vegetation, weed management, re-establishment of native vegetation and re-use of habitat features (e.g. bush rock)
- Preparation of a Mulch Management Plan to be implemented before and during construction, should mulch be removed from site
- Management of weed species and pathogens on site.

It was found that there are no residual impacts of the project following implementation of the recommended mitigation measures for terrestrial ecology. However, in line with the Roads and Maritime Offsetting Guidelines (RMS, 2016) biodiversity offsetting is required to offset the impacts of the proposal on up to 0.09 hectares of Type 1 Fish Habitat.

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## Glossary of terms

Definitions	
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time. Refer to Clause 228(2) of the EP&A Regulation 2000 for cumulative impact assessment requirements.
Direct impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (ref <a href="http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf">http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf</a> ).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH 2014).
Indirect impact	Where an event or circumstance is a direct consequence of the action (ref <a href="http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf">http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf</a> ).
Matters of NES	A matter of national environmental significance (NES) protected by a provision of Part 3 of the EPBC Act.
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (OEH 2014).
Mitigation	Action to reduce the severity of an impact (OEH 2014).
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
Population	All the individuals that interbreed within a given area.
Proposal area/ Proposal site	The area of land that is directly impacted on by a proposed Major Proposal that is under the EP&A Act, including access roads, and areas used to store construction materials (OEH 2014).
Study area	The area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly (OEH 2014).
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.

Abbreviations	
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BC Act	<i>Biodiversity Conservation Act 2016 (NSW)</i>
BVT	Biometric Vegetation Type
CEMP	Construction Environmental Management Plan
DoEE	Commonwealth Department of the Environment and Energy
DP&E	Department of Planning and Environment
DPI	Department of Primary Industries
EEC	Endangered ecological community
EP&A Act	<i>Environment Planning and Assessment Act 1979 (NSW)</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Federal)</i>
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage
PCT	Plant Community Type
PEI	Preliminary Environmental Investigation
PMST	Protected Matters Search Tool
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy
TECs	Threatened Ecological Communities
TSC Act	<i>Threatened Species Conservation Act 1995 (NSW)</i>
TSPD	Threatened Species Profile Database

Abbreviations	
VIS	Vegetation information system



# 1 Introduction

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## 1.1 Proposal background

SMEC was engaged by NSW Roads and Maritime Services (Roads and Maritime) to prepare a Biodiversity Assessment Report for the proposed construction of a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra (the proposal). The proposal would also include the upgrade of the Princes Highway near the bridge, as well as key intersection upgrades and modifications to the local road network.

The proposal extends for about 1.6 kilometres along the existing Princes Highway in the Shoalhaven local government area (LGA). The location of the proposal is shown in **Figure 1-1**.

Studies have previously been commissioned by Roads and Maritime as part of the investigation into works associated with the existing crossing. These include:

- Nowra Bridge Project. Preliminary Environmental Investigation (AECOM 2014)
- Nowra Bridge Remediation Works: Biodiversity Assessment (Biosis 2016).

The Preliminary Environmental Investigation (PEI) identified potential environmental constraints and opportunities that may influence the development of design options for an alternative crossing of the Shoalhaven River at Nowra. The analysis focused on a broad study area that covered five options, given more refined alignments or engineering design requirements were still being developed.

Following the PEI, a preferred option and concept design for the proposal was produced and this concept design was utilised for this biodiversity assessment.

## 1.2 The proposal

Roads and Maritime proposes to construct a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra (the proposal). The proposal includes the construction of a new four lane bridge to the west (upstream) of the existing bridge crossings and the removal of vehicular traffic from the existing southbound bridge. The proposal would also include the upgrade of about 1.6 kilometres of the Princes Highway in the vicinity of the bridge, as well as providing key intersection upgrades and modifications to the local road network. The proposal would improve access to Nowra and the surrounding areas, improve southbound access for large freight vehicles, and improve traffic flows.

The proposal includes construction of a new bridge over the Shoalhaven River and upgrade of the Princes Highway from about 150 metres north of the Bolong Road intersection to about 75 metres north of the Moss Street intersection. The new bridge would be about 360 metres long and would accommodate four lanes of northbound traffic and a shared path.

Key features of the proposal include:

- Construction of a new bridge to the west (upstream) of the existing bridge crossings over the Shoalhaven River including:
  - Four northbound lanes including a dedicated left turn only lane from Bridge Road to Illaroo Road
  - A 3.5-metre wide shared use path on the western side of the bridge connecting the Illaroo Road intersection to the Bridge Road intersection
- Widening of the existing bridge over Bomaderry Creek

- Minor lane adjustments on the existing northbound bridge to convert it to three lanes of southbound traffic
- Removal of vehicular traffic and closure of the existing southbound bridge to undertake investigation, rehabilitation and repurposing work for adaptive reuse following opening of the new northbound bridge. Shared paths and maintenance access would be constructed up to the existing southbound bridge and work to prevent unauthorised access as part of the proposal. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to the proposal.
- Upgrading of the Princes Highway to provide three northbound and three southbound lanes from Bolong Road through to about 75 metres north of Moss Street
- Widening of Illaroo Road over a distance of about 270 metres
- Upgrading of the Princes Highway and Illaroo Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Illaroo Road
  - Three dedicated right turn lanes and one dedicated left turn lane from Illaroo Road to Princes Highway
  - Acceleration and merge lane for northbound traffic turning into Illaroo Rd from Princes Highway
- Upgrading of the Princes Highway and Bridge Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Bridge Road
  - One left turn lane from Bridge Road to the Princes Highway
- Local road adjustments including:
  - Closing the access between Pleasant Way and Princes Highway
  - Restricting turning movements at the intersection of Bridge Road and Scenic Drive
  - Construction of a new local road connecting Lyrebird Drive to the Princes Highway about 300 metres south of the existing Pleasant Way intersection
- Provision of pedestrian facilities at all intersections
- Dedicated off road shared paths and footpaths along the length of the proposal.
- Urban design and social amenity improvements, and landscaping including foreshore pedestrian links to the truss bridge
- Relocation and/or protection of utility services
- Drainage and water quality management infrastructure along the road corridor
- Property works including acquisition, demolition, and adjustments to accesses
- Temporary ancillary facilities during construction including site offices, construction compounds, and stockpile sites.

For the purposes of this report, the construction footprint is determined as the concept design and construction compounds. In addition, a six-metre buffer to account for indirect impacts because of edge effects has been considered as part of this assessment. The operational footprint is determined as the completed proposal detailed above. The study area encapsulates the biodiversity field studies detailed in **Section 2.4**.

**Figure 1-2** shows the extent of the proposal (construction and operational footprints).

### 1.3 Legislative context

The *Biodiversity Conservation Act 2016* (BC Act) and its supporting regulations commenced on 25 August 2017. The BC Act repeals the *Threatened Species Conservation Act 1995* (TSC Act) along with other natural resource management legislation.

The BC Act sets out the environmental impact assessment framework for threatened species, threatened ecological communities and Areas of Outstanding Biodiversity Value (formerly critical habitat) for Part 5 activities (amongst other types of development).

However, the transitional provisions of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* apply to the proposal because the environmental impact assessment of the activity began under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and so before the commencement of the new Act and is pending assessment under Part 5 (clause 29(1b)). Consequently, the proposal has been assessed in accordance with the TSC Act.

A Review of Environmental Factors (REF) has been prepared to satisfy Roads and Maritime's obligations under s.111 of the EP&A Act to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity" and s.112 in making decisions on the likely significance of any environmental impacts. This biodiversity impact assessment forms part of the REF being prepared for the Nowra Bridge proposal, and assesses the biodiversity impacts of the proposal to meet the requirements of the EP&A Act.

Under s.111 of the EP&A Act, Roads and Maritime must consider the effect of an activity on:

- Any conservation agreement entered into under the *National Parks and Wildlife Act 1974* (NP&W Act)
- Any plan of management adopted under the NP&W Act for the conservation area to which the agreement relates
- Any joint management agreement entered into under the TSC Act
- Any BioBanking agreement entered into under Part 7A of the TSC Act
- Any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality
- Critical habitat
- Threatened species, populations and ecological communities, and their habitats and whether there is likely to be a significant effect on any of these
- Any other protected fauna or protected native plants within the meaning of the NP&W Act.

Sections 5A and 5C of the EP&A Act requires that the significance of the impact on threatened species, populations and endangered ecological communities listed under the TSC Act or *Fisheries Management Act 1994* (FM Act) is assessed using a seven-part test. Where a significant impact is likely to occur, a species impact statement (SIS) must be prepared in accordance with the Director-General's requirements.

In September 2015, a "strategic assessment" approval was granted by the Federal Minister in accordance with the EPBC Act. The approval applies to Roads and Maritime activities being assessed under Part 5 of the EP&A Act with respect to potential impacts on nationally listed threatened species, ecological communities and migratory species. As a result, Roads and Maritime proposals assessed via an REF:

- Must address and consider potential impacts on nationally listed threatened species, populations, ecological communities and migratory species, including application of the "avoid, minimise, mitigate and offset" hierarchy
- Do not require referral to the Federal Department of the Environment for these matters, even if the activity is likely to have a significant impact.

Roads and Maritime must consider impacts to nationally listed threatened species, ecological communities and migratory species as part of the approval process under the strategic assessment. To assist with this, assessments are required in accordance with the *Matters of*

*National Environmental Significance: Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999 (DoE 2013).*



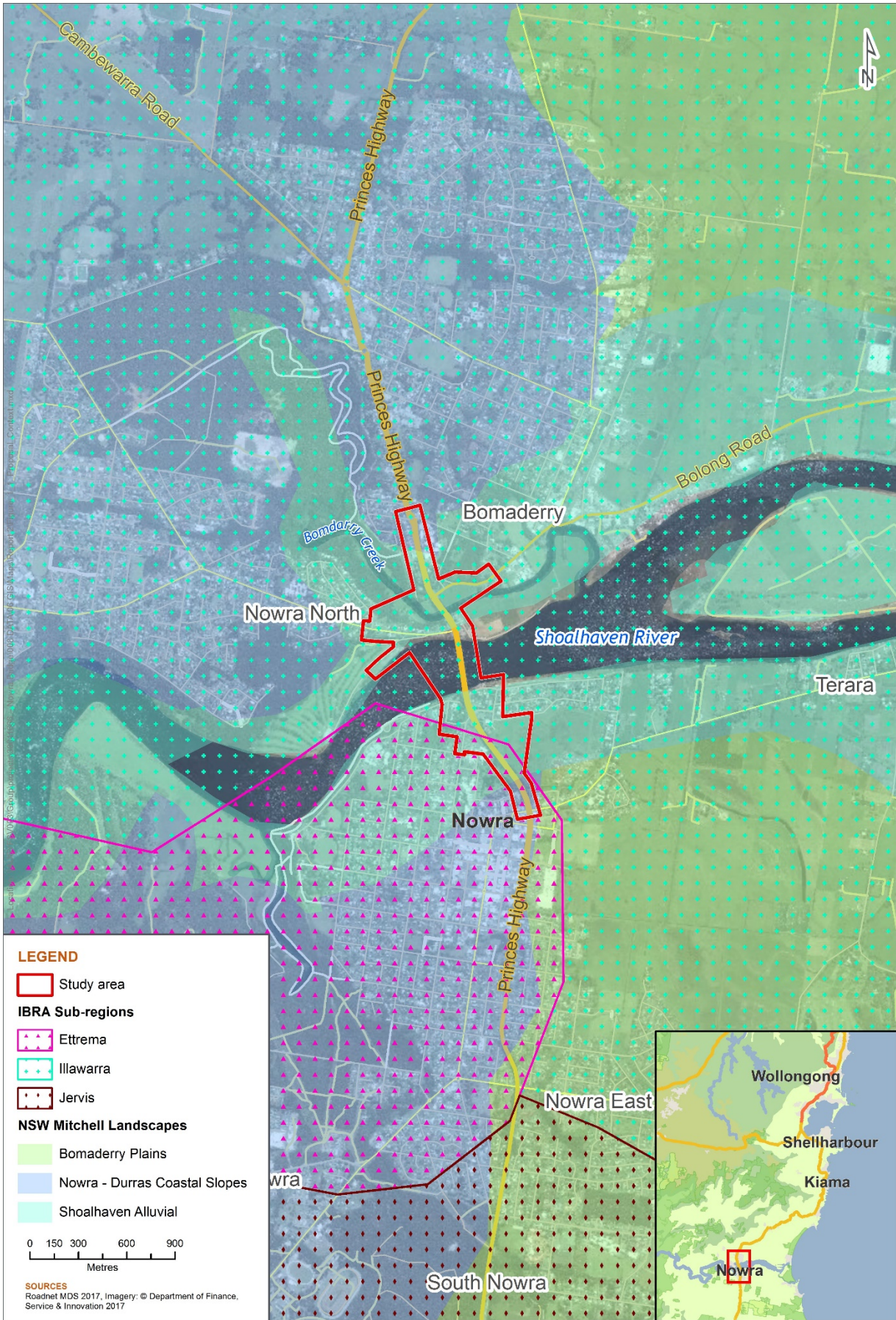
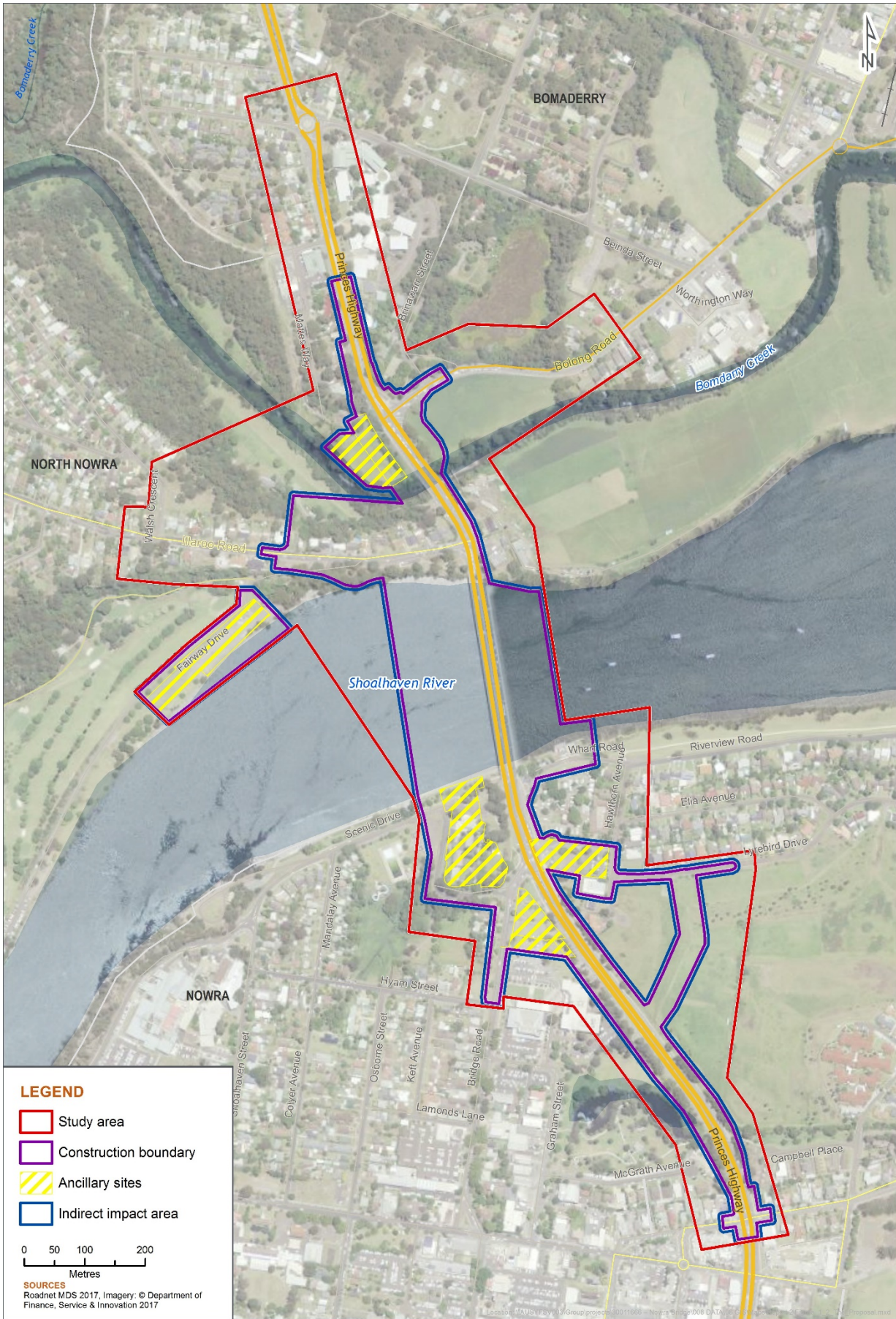


Figure 1-1 Proposal context





**Figure 1-2 The proposal**

## 2 Methods

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### 2.1 Personnel

The following personnel were involved in undertaking this assessment.

**Liam Hogg** is the ecology team leader in the SMEC Environment Group with more than 12 years' experience of managing and undertaking ecological survey works and with special expertise in undertaking the BioBanking Assessment Methodology (BBAM) and Biodiversity Assessment Reporting. He has specialist skills in botanical surveys, threatened fauna and flora habitat assessments, BioBanking field assessment techniques and habitat condition assessment.

Liam has been involved in over 300 ecological impact assessments of threatened species and endangered ecological communities and routinely assesses projects in response to state and Commonwealth threatened species legislation. He has had experience in a broad range of environmental impact assessment projects, including REFs, EISs, SISs and more than 100 biodiversity technical reports covering infrastructure, mining, residential, port and renewables developments. In regard to direct experience with infrastructure proposals for NSW Roads and Maritime, Liam was the principal author of the Species Impact Statement for the Mona Vale Road West upgrade proposal which received concurrence from the Office of Environment and Heritage (OEH) in November 2017. He was also the lead ecologist for the M1 Princes Highway upgrade Picton to Bulli Tops Stage 1 and was the senior reviewer of the Narara to Lisarow Stage 4b Pacific Highway upgrade.

Liam is an accredited assessor in accordance with s142B(1)(c) of the TSC Act and in accordance with the BC Act.

**Rachel Musgrave** is an Associate Ecologist in the SMEC ecology team. Rachel has over seven years' experience in flora and fauna surveys, bushland management, fire management, environmental legislation and environmental impact assessments. As such, she has a strong working knowledge of the relevant legislation and planning guidelines relating to biodiversity within NSW. Rachel has been involved in over 50 ecological impact assessments of threatened species and endangered ecological communities in accordance with State and Commonwealth threatened species legislation. She has had experience in a broad range of environmental impact assessment proposals, including REFs, EISs and biodiversity technical reports for large infrastructure, residential, and renewables developments. She has been the primary author of a number of SISs including for NSW Coastal Walk Upgrade, Tuggerah Sports and Recreation Centre, and the Sub-development of B2 Lands in Turramurra.

Rachel is highly experienced in field assessments, including botany, fauna habitat assessment, fauna trapping and monitoring programs, BioBanking field assessment techniques and habitat condition assessment. Rachel is also experienced in preparing Biodiversity Conservation Strategies, Conservation Management Plans, Bushland Management Plans, and Vegetation Management Plans for Councils and Government Agencies. Prior to being an ecological consultant, Rachel worked as a bush regenerator, as such she possesses on ground restorations and rehabilitation experience. With regards to infrastructure proposals, Rachel has been the project ecologist for Boco Rock Wind Farm and Taralga Wind Farm, managing ecologists undertaking large scale threatened species pre-clearance and translocation, and preparing impact assessments and consistency analyses where required. On the Frederickton to Eungai Pacific Highway Upgrade, she oversaw the installation of over 300 nest boxes in accordance with relevant management plans.

Rachel is an accredited assessor in accordance with s142B(1)(c) of the TSC Act.



**Rebecca Carman** is an ecologist with post-graduate qualifications in Wildlife Management. She has experience in a broad range of environmental impact assessment proposals, including REFs, EISs and biodiversity technical reports for large road infrastructure. Rebecca has skills in ecological assessment, including botany, fauna habitat assessment, fauna trapping and monitoring programs, BioBanking field assessment techniques, community consultation and habitat condition assessment. Specific experience with Roads and Maritime projects includes completing Squirrel Glider monitoring for the Olympic Highway Upgrade at Kapooka and Hume Highway Bypasses at Holbrook, Tarcutta and Woomargama, input into a Species Impact Statement for the Mona Vale Road West Upgrade including surveys for the Eastern Pygmy-possum and Southern Brown Bandicoot, threatened fauna surveys and habitat assessment for the Upgrade of the Pacific Highway between Narara and Lisarow and Eastern Pygmy-possum and threatened flora surveys for the Re-alignment of M1 Princes Highway at Mt Ousley.

**Mark Davey** is Senior Associate Environmental Scientist with SMEC, with post-graduate qualifications in aquatic ecology. He has over 20 years' experience in aquatic ecology assessments, impact assessment, mitigation and management. Mark has specialist skills in water and sediment quality, and hydrodynamics. He has completed a broad range of environmental impact assessments, including EIS, REF and technical studies, for infrastructure, mining, oil and gas, energy, and coastal developments. Specific recent experience for Roads and Maritime projects includes Belmore Road Ramps, Mona Vale Road West Upgrade, and Woolgoolga to Ballina Pacific Highway Upgrade.

## 2.2 Background research

Prior to field surveys, a search of relevant databases to obtain records on all threatened species, populations, and ecological communities previously recorded within a 10-kilometre search area was undertaken. Furthermore, a database search of additional listed areas of ecological importance, key habitat features, vegetation communities, and aquatic habitat was undertaken. All current and preliminary listings under the TSC Act, FM Act, and EPBC Act were considered. A list of all databases, date accessed, and search area is shown in **Table 2-1**.

The OEH BioNet Atlas search identified 1,460 records of 49 threatened species and seven Endangered Ecological Communities (EECs). A point search of the Protected Matters Search Tool using a five-kilometre buffer (10-kilometre search area) around the study area was also conducted, which returned a result containing three threatened ecological communities, 69 listed threatened species and 47 listed migratory species. The full list of database search results has been included in Appendix B – Habitat assessment table.

The full list of potentially occurring threatened entities were then reviewed, and species, populations, and communities were generally discounted if no suitable habitat was present, such as in the case of fully marine or pelagic species. Additionally, species with no nearby records and no clear vector of propagation or travel were discounted. Likelihood of occurrence tables have been prepared for both threatened flora and fauna. The likelihood of occurrence table includes consideration of the proximity and age of records, and the suitability of habitat on site for each species. This table is provided in Appendix B – Habitat assessment table. Previous studies, reports and documentation relevant to the Nowra Bridge proposal were reviewed during the current study and are summarised below:

- Nowra Bridge Project Preliminary Environmental Investigation (AECOM 2014)
- Nowra Bridge Remediation Works: Biodiversity Assessment (Biosis 2016).



**Table 2-1 Database searches**

Database	Date accessed	Search area
Atlas of NSW Wildlife	28 November 2017	10-kilometre search area (five-kilometre radius) centred on the study area
Department of Environment's Protected Matters Search Tool	5 December 2017	5-kilometre point buffer search
Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE)	28 November 2017	Study area and locality
NSW Department of Primary Industries (DPI) Fisheries Fish Records Viewer	28 November 2017	Shoalhaven LGA
OEH Critical Habitat Register	28 November 2017	Study area and locality
NSW Department of Primary Industries (DPI) database for aquatic TECs	28 November 2017	Study area and locality
NSW Department of Planning's SEPP 14 wetlands	28 November 2017	Study area and locality
Department of Environment's Directory of Important Wetlands	28 November 2017	Study area and locality
OEH preliminary determinations	28 November 2017	NSW

### 2.2.1 Spatial data and imagery

In addition to the database searches, the following spatial data sources were used in the initial assessment and preliminary investigations to delineate the study area:

- Shoalhaven Biometric
- Shoalhaven EEC
- SE\_LLS Biometric
- Cadastral and property data (NSW Land and Property Information).

### 2.3 Habitat assessment

An assessment of the available habitat for each threatened species, population or community identified as known or potentially present through the database searches and the review of past reports was then completed to guide requirements for a site survey. The habitat assessment considered the likelihood of each species occurring in habitat of the study area based on recent records, known distribution and the likely availability and quality of suitable habitat.

The likelihood of occurrence table was updated following a site visit to part of the study area and provided a final assessment of the likelihood of threatened entities to be present on site. This table is presented as Appendix B – Habitat assessment table.

## 2.4 Field survey

As discussed above, database searches, literature review, vegetation mapping methodologies, ecological assessments and advice, and previous impact assessments informed the level of field survey required to be conducted to verify the ecological values of the study area. All surveys have been conducted in accordance with the relevant guidelines and these approaches have been described below. The relevant guidelines for the surveys conducted are:

- Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011)
- Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (DPI, 2013)
- BioBanking Assessment Methodology (OEH, 2014)
- NSW Guide to Surveying Threatened Plants (OEH, 2016)
- Draft NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC, 2004).

### 2.4.1 Vegetation surveys

SMEC conducted site specific vegetation surveys to revise and update the existing vegetation mapping for the proposal. The vegetation within the site was assessed to examine and verify the mapping of the condition and extent of the different vegetation communities. The following methods, based on the *NSW Threatened Biodiversity Survey and Assessment Guidelines* (2004) and the *BioBanking Assessment Methodology (BBAM)* (OEH, 2014), were used for the vegetation mapping process:

- Transects and traverses using a hand held Global Positioning System (GPS) device to record boundaries of, and variation within stratification units not apparent from aerial imagery
- Collection of data from Rapid Mapping Points (RMP) to obtain information on vegetation community structure and distribution, to accurately assign stratification units to vegetation communities.

Flora plot sampling was conducted in accordance with the TSC Act and utilised the BBAM that includes the establishment of a 20 metre x 50 metre plot within which the following data was collected:

- Native species richness recorded within each stratum of a 20 metre x 20 metre plot
- Native over-storey projected foliage cover recorded at 10 points along a 50 metre transect
- Native mid-storey projected foliage cover recorded at 10 points along a 50 metre transect
- Native groundcover projected foliage cover recorded at 10 points along a 50 metre transect for three life forms (shrubs, grasses and other)
- Weed species projective foliage cover expressed as a percentage of over-storey, mid-storey and ground cover along a 50 metre transect
- Number of trees with hollows where entrance width is more than five centimetres and hollow is at least one metre above ground within the 20 metre x 50 metre plot
- The percentage of regenerating canopy species within the vegetation zone
- The total length in meters of fallen logs more than 10 centimetres in diameter within the 20 metre x 50 metre plot.

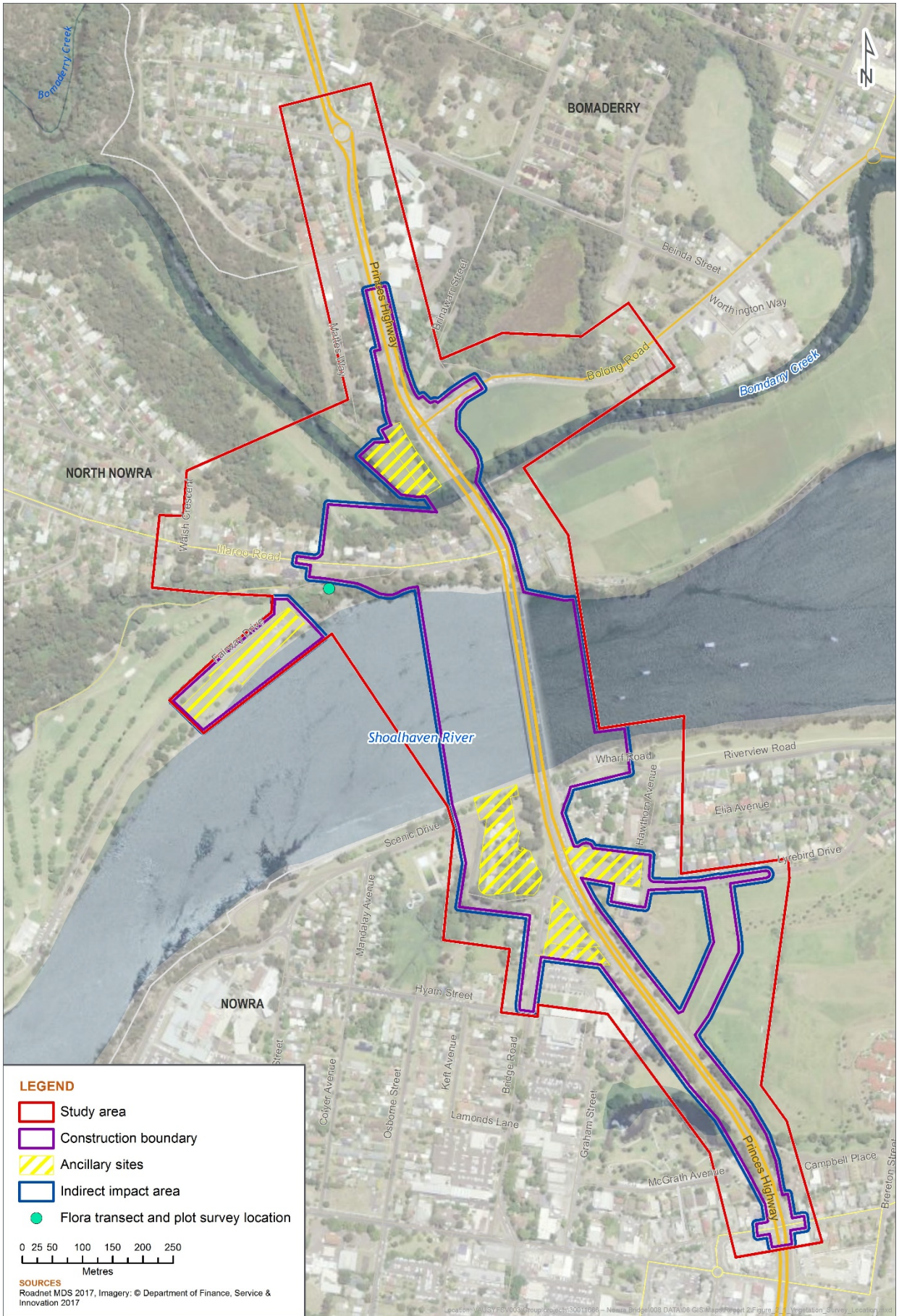
In addition to collection of native plant species richness within a 20 metre x 20 metre plot, full floristic data was also collected to enable classification of each vegetation zone to the best fit Plant Community Type (PCT).

The following information was collected at each of the 20 metre x 20 metre full floristic plots in accordance with BBAM:

- Stratum (and layer): stratum and layer in which each species occurs
- Growth form: growth form for each recorded species
- Species name: scientific name and common name
- Cover: a measure or estimate of the appropriate cover measure for each recorded species; recorded from 1–5 per cent and then to the nearest 5 per cent. If the cover of a species is less than one per cent and the species is considered important, then the estimated cover should be entered (e.g. 0.4)
- Abundance rating: a relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals; numbers above about 20 are estimates only: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, or 1,000, or specify a number greater than 1,000 if required.

The locations of the full floristic plots were determined by pacing a random distance into the vegetation zone that would enable an appropriate assessment of expected environmental variation. Areas considered not suitable for assessment include ecotones, vehicle tracks and their edges, and disturbed areas which are readily distinguishable from the broad condition state of the vegetation zone.





**Figure 2-1 Vegetation survey locations**

## 2.4.2 Targeted flora surveys

Field traverses were undertaken by SMEC ecologists to assess any changes to habitat within the study area and any changes in potential to support threatened flora. Targeted threatened flora surveys were conducted in adherence to the NSW Guide to Surveying Threatened Plants (2016) and the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004*.

**Table 2-2** below details the survey effort for threatened flora.

**Table 2-2 Threatened flora surveys**

Scientific name	Common name	Required survey period	Survey effort and timing
<i>Hibbertia puberula</i>		September to February	10 hours 20-21 November 2017
<i>Hibbertia stricta</i> subsp. <i>furcatula</i>		October to March	20 hours 13-17 March 2017 20-21 November 2017
<i>Eucalyptus langleyi</i>	Albatross Mallee	Year round	30 hours 13-17 March 2017 20-21 November 2017 3-4 April 2018
<i>Solanum celatum</i>		September to November	10 hours 20-21 November 2017
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	Year Round	30 hours 13-17 March 2017 20-21 November 2017 3-4 April 2018
<i>Triplarina nowraensis</i>	Nowra Heath Myrtle	Year round	30 hours 13-17 March 2017 20-21 November 2017 3-4 April 2018

Scientific name	Common name	Required survey period	Survey effort and timing
<i>Zieria baeuerlenii</i>	Bomaderry Zieria	Year round	30 hours 13-17 March 2017 20-21 November 2017 3-4 April 2018
<i>Zieria tuberculata</i>	Wary Zieria	Year round	30 hours 13-17 March 2017 20-21 November 2017 3-4 April 2018
All other threatened flora	N/A	Year round	30 hours 13-17 March 2017 20-21 November 2017 3-4 April 2018

### 2.4.3 Targeted fauna surveys

Baseline and targeted threatened fauna and habitat surveys were undertaken by SMEC ecologists on 13-17 March 2017 and on 20-21 November 2017, as outlined below. The locations of the different survey sites are illustrated in **Figure 2-2** and a summary of the threatened fauna survey effort can be found in **Table 2-3**.

#### Habitat assessment

The fauna habitat assessment was conducted over a five-day period (13-17 March 2017) to assist in determining the likelihood of presence of threatened fauna species. Habitat characteristics considered include the presence of hollow bearing trees, fallen logs, leaf litter and other ground debris, drainage lines, ponds, the structure of vegetation communities and the presence of fruiting/flowering plant species to assess the habitat suitability for a range of fauna species.

Using the random meander technique, searches were carried out for signs of fauna activity such as tracks, scats, scratches and notches on trees, as well as any opportunistic sightings, to identify the presence of common and threatened fauna species.

Habitat information recorded at each sampling site included: height and density of vegetation layers, leaf litter, fallen timber, tree hollows (position on tree and size), stags, rock shelves, soil type, presence of water and any human-made habitats.

A hollow bearing tree assessment was conducted on 20-21 November 2017 and 3-4 April 2018 within the construction footprint. The information recorded included: GPS location of the tree, species name, size and type of hollow classified as small (<5 centimetre diameter), medium (5-10 centimetre), Large (10-20 centimetre) and extra-large (>20 centimetre), approximate height of hollow, and presence of fissures and photograph of each tree. The results of this survey



are summarised in Section 3.6.1 and the location of recorded hollow bearing trees recorded in **Figure 3-3**.

#### Ultrasonic bat detection

Acoustic surveys were undertaken with a Song Meter SM4 (Wildlife Acoustics, USA). Surveys were undertaken all night (eight hours) for two nights per site at four different sites. These sites were chosen as having suitable flyways to maximise the potential for bat detection. Calls were converted to zero crossing using Kaleidoscope (Version 4.1.0a, Wildlife Acoustics, USA) and sonograms were viewed with AnalookW (Version 4.2g, C. Corbin) and identified using the guidelines and reference library in Pennay *et al.* (2004).

To ensure reliable and accurate results:

- Recordings containing less than three pulses were not analysed (Law *et al.* 1999)
- Only search phase calls were analysed (McKenzie *et al.* 2002)
- Three categories of confidence in species identification were used (adapted from Mills *et al.* 1996):
  - Definite – identity not in doubt
  - Probable – low probability of confusion with species of similar calls
  - Possible – medium to high probability of confusion with species with similar calls.

#### Call playback

Call playback of recordings was undertaken at two sites. The survey aimed to illicit a call response from specific nocturnal animals. The survey included two call playback events at each location on separate nights and was preceded by a 10-minute listening period before any calls were played. Recorded calls were then broadcast for five minutes using a loud speaker and followed by a 10-minute period of listening for a response. This was followed by localised spotlight searches and subsequent intermittent call playback to check for individuals that may have moved closer to investigate but had not audibly responded.

Calls played during the survey included four owl species: Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*) as well as Yellow-bellied Glider (*Petaurus australis*).

#### Birds

Surveys were undertaken for both woodland and wading birds. Dawn bird surveys were undertaken within three hours of sunrise by two observers. Six sites were surveyed, each on two consecutive days. Surveys lasted 30 minutes in a random meander from the start point where suitable habitat occurred within a two-hectare area. Species were identified visually or by vocalisations.

#### Amphibians

Day and night habitat searches were conducted over four separate nights in March 2017 at two sites, with nocturnal call playback and aural searches. There had been 21 millimetres of rainfall one week prior to survey and rain recorded on second, third and fourth nights of the survey. The species specifically targeted was the Green and Golden Bell Frog (*Litoria aurea*).

**Table 2-3 Threatened fauna surveys**

Target species/group	Habitat	Required survey period	Survey method	Survey effort and timing
Green and Golden Bell Frog	<p>Foraging habitat is amongst emergent aquatic or riparian vegetation and amongst vegetation, fallen timber nearby to and within 500 metres of breeding habitat, including grassland, cropland and modified pastures.</p> <p>Breeding habitat includes any still, slow flowing natural water bodies with some aquatic emergent vegetation such as <i>Typha</i> spp., <i>Phragmites</i> spp., <i>Eleocharis</i> spp, etc. Will use artificial water bodies and non-native emergent vegetation.</p> <p>Shelter habitat includes vegetation, rocks, fallen timber, leaf litter, man-made groundcover, debris and in soil cracks up to one kilometre from water bodies.</p>	August to March	Four nights of call playback, spotlighting, and diurnal searches from August to March; during or immediately after substantial rain in this period.	<p>16 hours</p> <p>13-17 March 2017</p>
Forest Owls	As per suitable vegetation types listed in NSW Atlas of Wildlife (BioNet).	Year round	Four nights of call playback and spotlighting. Diurnal searches for hollow-bearing trees and whitewash.	<p>16 hours</p> <p>13-17 March 2017</p>
Woodland Birds, Estuarine Wading Birds, Black Bittern and Australasian Bittern	As per suitable vegetation types listed in NSW Atlas of Wildlife (BioNet).	September to March	Two mornings of diurnal surveys in suitable habitat between September and March.	<p>12 hours</p> <p>13-17 March 2017</p>
Threatened bats	Bridges, cliff lines, culverts and hollow-bearing trees in close proximity to watercourses.	September to March	Diurnal inspections of bridge structures and two nights' ultrasonic call recording next to watercourses in suitable weather conditions between September and March.	<p>64 hours</p> <p>13-17 March 2017</p>
Grey-headed Flying-fox	As per suitable vegetation types listed in NSW Atlas of Wildlife (BioNet) land within 40 metres of rainforest, coastal scrub, riparian or estuarine communities	Year round	Diurnal inspection of nationally significant camp present within study area to confirm extent of the camp	<p>4 hours</p> <p>13-17 March 2017</p>



Target species/group	Habitat	Required survey period	Survey method	Survey effort and timing
Yellow-bellied Glider	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils	Year round	Hollow-bearing tree assessment and two nights nocturnal spotlighting surveys, if suitable habitat is present.	10 hours 13-17 March 2017 and 20-21 March 2017

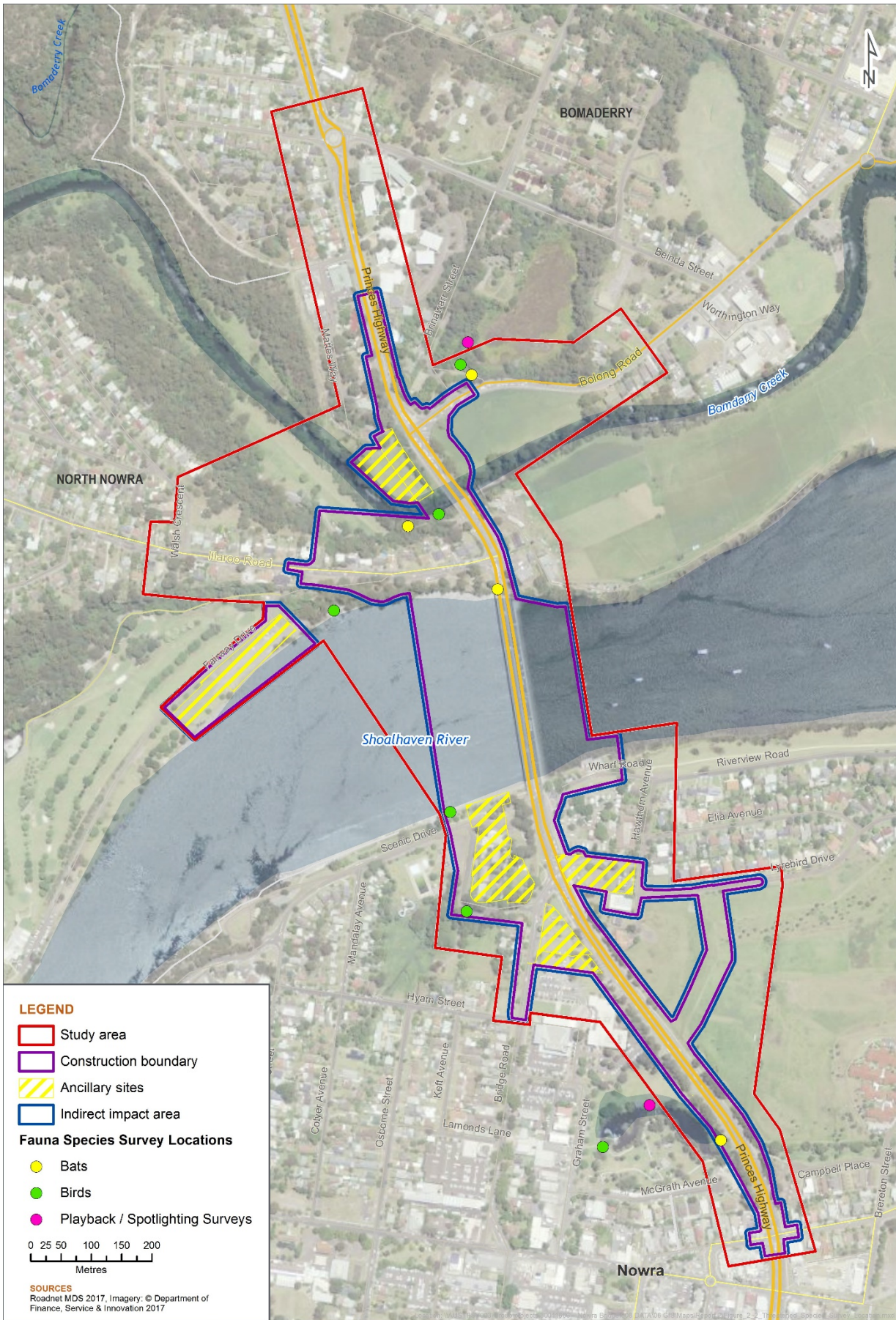


Figure 2-2 Threatened species survey locations

#### 2.4.4 Aquatic Surveys

Aquatic ecology surveys were undertaken in general accordance with the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013). Surveys were conducted over 11 and 12 December 2017, coinciding with two low, and one high tide, and 4 April 2018.

Prior to field surveys, a search of relevant databases (**Table 2-1**) was undertaken to determine the likely occurrence of threatened aquatic species within the proposal area.

Aquatic ecology surveys at the sites indicated in **Figure 2-3** included:

- Description of habitat features
- Water quality profiles
- Collection of water samples
- Collection of sediment samples
- Visual surveys and underwater photography of bed substrates (e.g., rocks, gravel, sand mud)
- Species composition of riparian vegetation including the type of vegetation present (e.g., macrophytes, snags, seaweeds, seagrasses, mangroves, saltmarsh) and condition
- Qualitative assessment of aquatic fauna.

##### Water and sediment quality

Water and sediment quality samples were obtained from sites along the proposed alignment. Water samples were collected using a Van Dorn water sampling bottle, while sediment samples were collected using a Ponar Grab. All equipment was rinsed and decontaminated prior to use. Sampling and laboratory quality assurance and quality control measures were followed.

Water samples were analysed for:

- Total suspended solids (TSS)
- Metals – arsenic, cadmium, chromium, copper, nickel, lead, zinc and mercury
- Total phosphorus (TP), filterable reactive phosphorus (FRP)
- Total nitrogen (TN), ammonia (NH<sub>3</sub>)
- Total petroleum hydrocarbons (TPH)
- Total recoverable hydrocarbons (TRH)
- Biological oxygen demand
- Chemical oxygen demand.

Sediment samples were analysed for:

- Particle size distribution
- pH
- Total organic carbon (TOC)
- Sulphides
- Metals – arsenic, cadmium, chromium, copper, nickel, lead, zinc and mercury
- Polycyclic aromatic hydrocarbons (PAH)
- Total petroleum hydrocarbons (TPH)
- Benzene, toluene, ethylbenzene and xylene (BTEX).

Water quality profile depths were recorded using a YSI ProDSS (digital sampling system) multiparameter water quality meter. Parameters measured included:

- Temperature (°C)
- Dissolved oxygen (optical)
- Turbidity (NTU)
- pH
- Conductivity
- Oxidation reduction potential (ORP).

Sampling was conducted in general accordance with:

- Handbook of Sediment Quality Assessment (Simpson et al., 2005)
- An Interim Approach for Water Monitoring in NSW (NSW EPA, 2003)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

#### Seagrass extent and distribution

The extent and distribution of seagrass within the proposal area was mapped using high-resolution digital imagery sourced from NearMaps. Seagrass extent and distribution was determined from images taken in 2014, 2016 and 2017. The extent and distribution of seagrass within the study area was then validated during field surveys using visual observations and underwater photography.

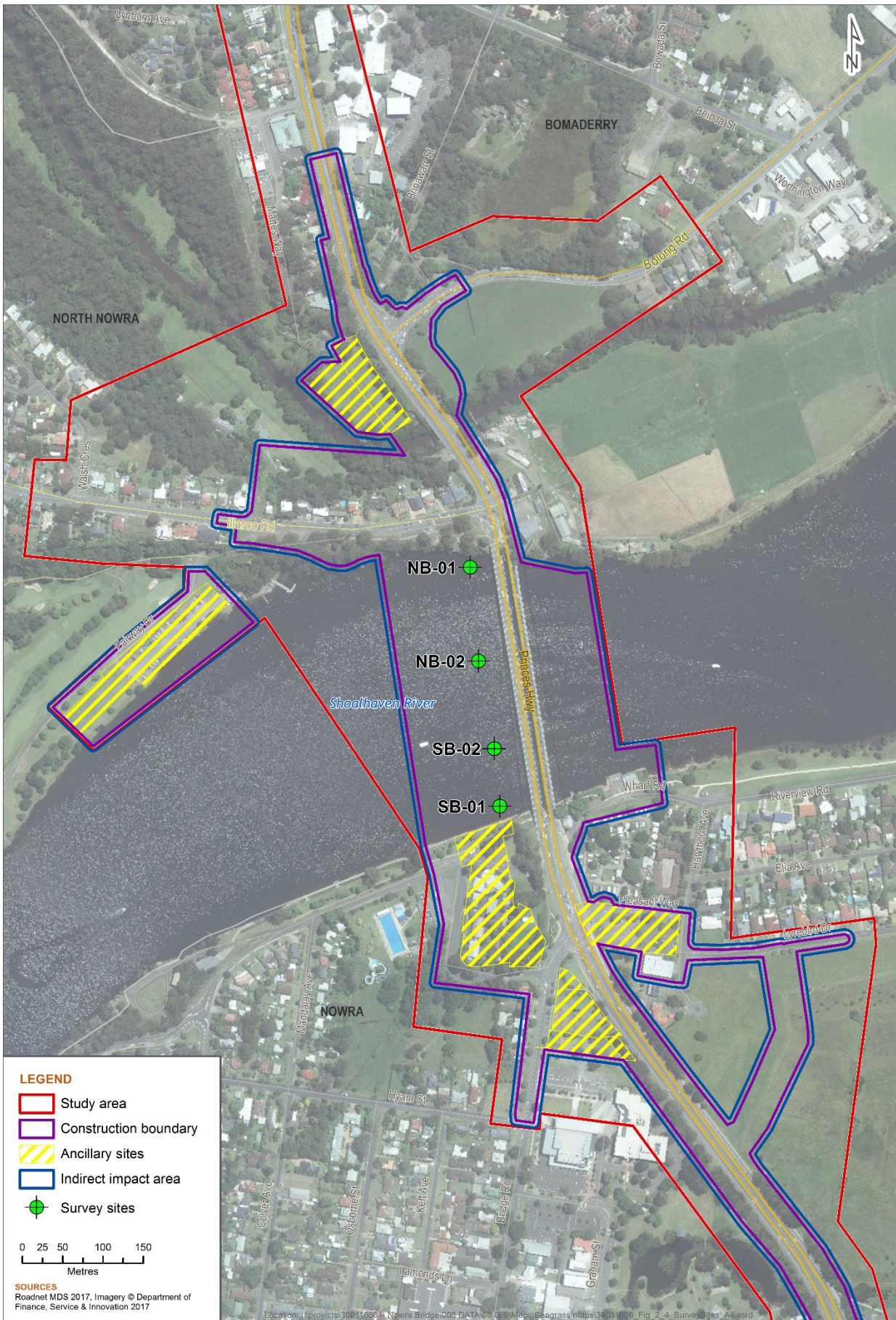
The general condition of seagrass was observed and recorded, as well as any evident seasonal effects, noxious weeds, current management works, and existing impacts.

#### Riparian vegetation and habitat features

A qualitative assessment of riparian vegetation and general aquatic habitat features was undertaken. This included conducting meandering transects along each riverbank along the extent of the study area, making visual observations, and taking digital still photographs. Meandering transects perpendicular to the riverbank were also undertaken to the east and west of the existing bridges.

The general condition of riparian vegetation was observed and recorded, as well as any evident seasonal effects, noxious weeds, current management works, and existing impacts.





**Figure 2-3 Aquatic survey locations**



## 2.4.5 Summary of survey effort

The targeted surveys summarised below that directly relate to the proposal, broadly adhere to the methods described in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (DEC 2004) and were conducted in largely suitable weather conditions for the target species. **Table 2-4** summarises the weather conditions during field surveys and **Table 2-5** summarises the survey effort for surveys used to inform this report.

**Table 2-4 Weather conditions during surveys**

Date	Temp. (°C)		Rainfall (mm)	Max. wind gust	
	Min.	Max.		Direction	Speed (km/hr)
13 March 2017	17.9	27.1	0	ENE	48
14 March 2017	18.8	24.5	7.8	ESE	41
15 March 2017	19.1	25.8	60.2	NE	46
16 March 2017	18.8	23.7	6.8	NE	35
17 March 2017	17.5	20.0	68.0	S	56
20 November 2017	13.2	24.1	0	ENE	35
21 November 2017	13.7	23.6	0	NE	35
11 December 2017*	13.2	26.9	0	E	41
12 December 2017*	18.2	28.0	0	ENE	41
3 April 2018**	16.9	21.8	0.2	ENE	22
4 April 2018**	13.7	24.4	0	ENE	30

\*Aquatic ecology surveys

\*\* Flora survey and seagrass mapping

**Table 2-5 Summary of survey effort for targeted surveys**

Species	Minimum survey requirements	Survey completed
FLORA		
Hibbertia puberula	In suitable habitat between September to February	Systematic day search in accordance with NSW Guide to surveying threatened plants covering all areas of the study area.  Dates: 13-17 March 2017 and 20-21 November 2017
Hibbertia stricta subsp. furcatula	In suitable habitat between October to March	
Eucalyptus langleyi	In suitable habitat year-round	
Solanum celatum	In suitable habitat between September to November	
Syzygium paniculatum	In suitable habitat year-round	
Triplarina nowraensis	In suitable habitat year-round	
Zieria baeuerlenii	In suitable habitat year-round	
Zieria tuberculata	In suitable habitat year-round	
Hibbertia puberula	In suitable habitat between September to February	
AMPHIBIANS		
Green and Golden Bell Frog	Four nights of call playback, spotlighting, and diurnal searches from August to March; during or immediately after substantial rain in this period.	16 hours of diurnal searches, call playback and spotlighting at two sites over four nights.  Dates: 13-17 March 2017
NOCTURNAL BIRDS		
Masked Owl	In suitable habitat year-round	

Species	Minimum survey requirements	Survey completed
Powerful Owl		Surveys for all species conducted over four separate nights at two sites. Initial 10 minutes listening followed by a 10-minute spotlight search for all species. Intermittent call playbacks for each target species of three minutes, followed by a 7-minute listening period and another seven minutes spotlighting and listening. Diurnal searches of hollow-bearing trees and whitewash.  Dates: 13-17 March 2017
Sooty Owl		
Barking Owl		
<b>DIURNAL AND WADING BIRDS</b>		
Woodland Birds, Estuarine Wading Birds, Black Bittern and Australasian Bittern	Two mornings of survey within suitable habitat between September and March	Area search (species-time curve approach): 30-minute observation and listening search within a two hectare (50 x 200 metre) area. Undertaken within two different patches of each vegetation type repeated on two different days. Undertaken at dawn and dusk.  Dates: 13-17 March 2017
<b>MAMMALS</b>		
Yellow-bellied Glider	Year-round surveys in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils	Call playback: Call play back conducted twice at each site on two separate nights. Spotlighting: 2 x 20 minute searches for four nights for each vegetation type.  Dates: 13-17 March 2017 and 20-21 November 2017
Grey-headed Flying-fox	Year-round inspections of locations of camps	Spotlight observations Daytime roost observations and extent of camp.  Dates: 13-17 March 2017 and 20-21 November 2017
<b>MICROCHIROPTERAN BATS</b>		
Southern Myotis Eastern False Pipistrelle Greater Broad-nosed Bat Eastern Bentwing-bat Eastern Freetail-bat Large-eared Pied Bat	Diurnal inspections of bridge structures and two nights of ultrasonic call recording next to watercourses in suitable weather conditions between September and March.	Ultrasonic detection using SM4+FS BAT: For a duration of two entire nights at four locations. One location within each vegetation type and one located along each waterbody (to detect Southern Myotis).  Dates: 13-17 March 2017

Species	Minimum survey requirements	Survey completed
AQUATIC ECOLOGY		
Australian Grayling	December through to April when water flows are lower and migratory species (such as the Australian Grayling) are more likely to be collected.	Not required. Design does not include removal of any key habitat for the species, other impacts (e.g., water quality) are unlikely to have an impact on this species.  Dates: 11-12 December 2017

## 2.5 Limitations

Over 140 millimetres of rain was experienced during the March 2017 surveys; however, most of this rain fell in the afternoon and overnight so it did not affect dawn bird surveys. Survey conditions for microchiropteran bats were slightly unfavourable due to the significant rainfall; however, microchiropteran bat activity was still recorded on all nights, therefore the survey effort was still considered suitable for these target species.

Aquatic ecology surveys were only undertaken during one season – summer. While previous aquatic ecology assessments were referenced and, where appropriate, findings summarised within this report, it is important to note that aquatic ecological values display temporal and spatial variability. For example, the extent and distribution of seagrass is known to vary seasonally. Similarly, water quality can display temporal variation in response to, for example, tides, climatic conditions, and anthropogenic influences.



### 3 Existing environment

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The study area is located within the Sydney Basin Bioregion and occurs entirely within the Shoalhaven Alluvial Plain Mitchell landscape (V3). It is located within the Sydney Basin Bioregion in the Illawarra IBRA subregion, and within the Nowra and Shoalhaven Local Land Services areas.

Most of the study area comprises undulating landforms associated with the Shoalhaven River and floodplain and Bomaderry Creek. Low to medium density residential development generally occurs along the length of the study area along the existing road alignment.

The study area is predominantly cleared of native vegetation with current land uses including public open space, boat ramps and the Shoalhaven River.

Terrestrial habitats of the study area been modified by past and current infrastructure, however there is a small stand of bushland located on the north-western bank forming part of the boat ramp and a park.

The remaining bushland contains substantial fauna habitat features including several large sandstone overhangs. The study area is located immediately south of Bomaderry Creek which connects to Bomaderry Creek Regional Park. This corridor is known to host a number of threatened biota including Yellow-bellied Glider, Powerful Owl and Gang-gang Cockatoo. While this important reserve is located close to the study area, the Princes Highway and Illaroo Road form a barrier to ground-dwelling fauna and those species sensitive to urban landscapes that may attempt to use it.

The study area includes the Shoalhaven River, which in this location is an open mature estuary. The proposal activities are approximately 15.4 kilometres upstream from the river estuary at Shoalhaven Heads. The Shoalhaven River provides a variety of habitat including mud flats, seagrass, mangroves, and estuarine, many of which may be used by threatened species. As such, the river is considered to provide key fish habitat as defined by the NSW DPI Fisheries, and in accordance with criteria outlined in the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013), the river is classified as a type 1 highly sensitive key fish habitat and class 1 major fish habitat.

The study area is mapped as occurring on the Shoalhaven and Nowra Soil Landscapes by the Soil Landscapes of the Kiama 1:100 000 Sheet (Hazelton, 1992). The Shoalhaven Soil Landscape occurs mainly throughout the northern parts of the study area, with the Nowra Soil Landscape occurring through both the northern and southern parts of the study area.

The Shoalhaven landscape is level to gently undulating with present river bed and banks, active floodplain with levees and backwater swamps on alluvium. It includes the flat to undulating terrace surfaces of the Shoalhaven River:

- The soils are moderately deep to Prairie Soils that occur on levees. Red Earths and Yellow and Red Podzolic Soils occur on terraces. Alluvial Soils and Gleyed Podzolic Soils occur on the floodplain
- Limitations include flood hazard, seasonal waterlogging, permanently high water table, hardsetting, acid sulphate potential, strongly acid and sodicity.

The Nowra landscape contains moderately to gently undulating rises to low hills on Nowra Sandstone. Benched sandstone outcrops occur adjacent to drainage lines. Vegetation in the landscape is extensive to moderately cleared tall open-forest:

- Soils are moderately deep Brown Podzolic Soils that occur on crests and upper slopes. Soloths and/or Yellow Earths occur midslope and Yellow Podzolic Soils occur on lower slopes and drainage lines
- Limitations include run-on, rock outcrop, shallow soil, stoniness, hardsetting, sodicity, low permeability and low wet bearing strength.

### 3.1 Plant community types

Within the proposal study area 28 native species and six exotic species were recorded from one plot. Two native vegetation community exists in the proposal area, that being Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion and Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South-East Corner Bioregion. In addition, several mixed native and exotic vegetation communities exist throughout the study area. Key species of these communities were also recorded. A full floristic list recorded from the proposal study area is provided in Appendix A.

The Shoalhaven LGA vegetation mapping was used to provide the initial vegetation map for the study area. This was subsequently refined, following field investigations, using ESRI ArcMap (**Figure 3-1**).

Summary profiles or descriptions of the native vegetation communities recorded in the study area during the present investigations are provided below.

**Table 3-1 Plant community types**

Plant community type (PCT)	Condition class	Threatened ecological community?	Area (ha) in proposal area	Area (ha) in indirect impact area	Area (ha) in study area
Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (1206)	Moderate/ Good	No	2.09	0.34	6.52
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South-East Corner Bioregion (1236)	Poor	Yes	0.09	0.03	0.46
Planted Mixed Native	N/A	No	2.35	0.33	3.16
Exotic	N/A	No	1.11	0.25	2.01
Total			5.64	0.95	12.15

# Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion

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

Vegetation class: Southern Lowland Wet Sclerophyll forests

PCT: 1206

Other mapping sources: VIS 2.1

Conservation status: Not an EEC

Estimate of percent cleared: 15 per cent

Condition: Moderate/Good

Extent in the proposal area: 2.09 hectares

Extent in the indirect impact area: 0.34 hectares

Extent in the study area: 6.52 hectares

Plots completed in vegetation zone: 1

Structure	Average height and height range (metres)	Average cover and cover range (%)	Typical species
Trees	20	5	<i>Corymbia maculata</i>
Small trees	4	2	
Shrubs	2	5	<i>Backhousia myrtifolia</i> , <i>Bursaria spinosa subsp. spinosa</i>
Ground covers	0.5	80	<i>Epidendrum sp.</i> ,
Vines & climbers	0	0	<i>Pandorea pandorana</i> , <i>Glycine clandestina</i>

**Description:** This community occurs on sheltered slopes with loamy soils below 250 metres mostly between Nowra and Batemans Bay, and mainly east of the Clyde River. The canopy was found to only consist of *Corymbia maculata* and had a varied, shrubby midstorey dominated by *Bursaria spinosa subsp. spinosa*, *Backhousia myrtifolia*, *Pittosporum undulatum* and *Prostanthera incana*. Groundcovers species include mix of grasses and forbs such as *Themeda triandra*, *Entolasia stricta*, *Epidendrum sp.*, *Bryophyllum delagoense* and *Chlorophytum comosum*. Also identified was a diversity of climbers including *Smilax australis*, *Pandorea pandorana* and *Glycine clandestina*. The majority of this community was mapped within the study area as in a moderate condition with a partially disturbed understorey.



*Photograph 1: Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion*

# Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion

Vegetation formation: Forested Wetlands

Vegetation class: Coastal Floodplain Wetlands

PCT: 1236

Other mapping sources: VIS 2.1

Conservation status: EEC under BC Act/TSC Act. Does not meet determination for EPBC Act listing

Estimate of percent cleared: 32 per cent

Condition: Poor

Extent in the proposal area: 0.09 hectares

Extent in indirect impact area: 0.03 hectares

Extent in the study area: 0.46 hectares

Plots completed in vegetation zone: 0 (not enough area to complete a plot)

Structure	Average height and height range (metres)	Average cover and cover range (%)	Typical species
Trees	20	50	<i>Casuarina glauca</i> , <i>Eucalyptus botryoides</i>
Small trees	4	2	<i>Glochidion ferninandi</i>
Shrubs	2	5	<i>Backhousia myrtifolia</i> , <i>Lantana camara</i>
Ground covers	0.5	80	<i>Cynodon dactylon</i> , <i>Asparagus aethiopicus</i>
Vines & climbers	0	0	<i>Glycine clandestina</i>

Description: This community occurs on the shorelines of estuarine lagoons and brackish lakes, wetlands and creek flats below 10 metres above sea level. The community is predominantly a canopy of Swamp Oak (*Casuarina glauca*) with occasional remnant mature Eucalypts such as Bangalay (*Eucalyptus botryoides*) present. The ground cover is highly disturbed and supported mainly exotic grasses and herbaceous perennials.

Large flowering Eucalyptus species such as Bangalay provide high quality seasonal foraging opportunities for nectar feeding fauna. Swamp Oak provides a season foraging resource for seed dependent birds and arboreal mammals. The Swamp Oak also is host for a small number of mistletoe *Amyema cabbagei* which is an important fruit and nectar source for small forest and woodland birds. The vegetation lacked hollows adjacent to the boat ramp for hollow dependent fauna.





*Photograph 2: Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion*

## Planted Mixed Native

Vegetation formation: N/A

Vegetation class: N/A

PCT: N/A

Other mapping sources: N/A

Conservation status: Not an EEC

Estimate of percent cleared: N/A

Condition: N/A

Extent in the proposal area: 2.35 hectares

Extent in indirect impact area: 0.33 hectares

Extent in the study area: 3.16 hectares

Plots completed in vegetation zone: 0 (Rapid assessment only)

Structure	Average height and height range (metres)	Average cover and cover range (%)	Typical species
Trees	20	60	<i>Eucalyptus microcorys</i> , <i>Eucalyptus tereticornis</i> , <i>Casuarina cunninghamiana</i> , <i>Eucalyptus saligna x botryoides</i>
Small trees	6	5	<i>Jacaranda mimosifolia</i>
Shrubs	2	15	<i>Callistemon</i> sp., <i>Grevillea</i> sp.
Ground covers	0.05	80	<i>Pennisetum clandestinum</i> , <i>Lomandra longifolia</i>
Vines & climbers	0	0	

**Description:** Most of these areas have a managed turf groundcover of mostly Kikuyu, *Pennisetum clandestinum*, with planted native and exotic trees as specimens or avenues. Areas along the edges includes rock emplacement as bank protection or wall.

Commonly occurring trees included *Eucalyptus microcorys*, *Eucalyptus saligna x botryoides*, *Casuarina cunninghamiana*, *Ficus macrocarpa*, *Corymbia maculata*, *Jacaranda mimosifolia*, *Populus nigra 'Italica'* and *Platanus x acerifolia*).

Garden plants and landscaped areas also include Hibiscus cultivars, *Lomandra longifolia*, *Grevillea* cultivars and *Callistemon* cultivars.



*Photograph 3: Planted Mixed Native*

## Exotic

Vegetation formation: N/A

Vegetation class: N/A

PCT: N/A

Other mapping sources: N/A

Conservation status: Not an EEC

Estimate of percent cleared: N/A

Condition: N/A

Extent in the proposal area: 1.11 hectares

Extent in the indirect impact area: 0.25 hectares

Extent in the study area: 2.01 hectares

Plots completed in vegetation zone: 0 (Rapid assessment only)

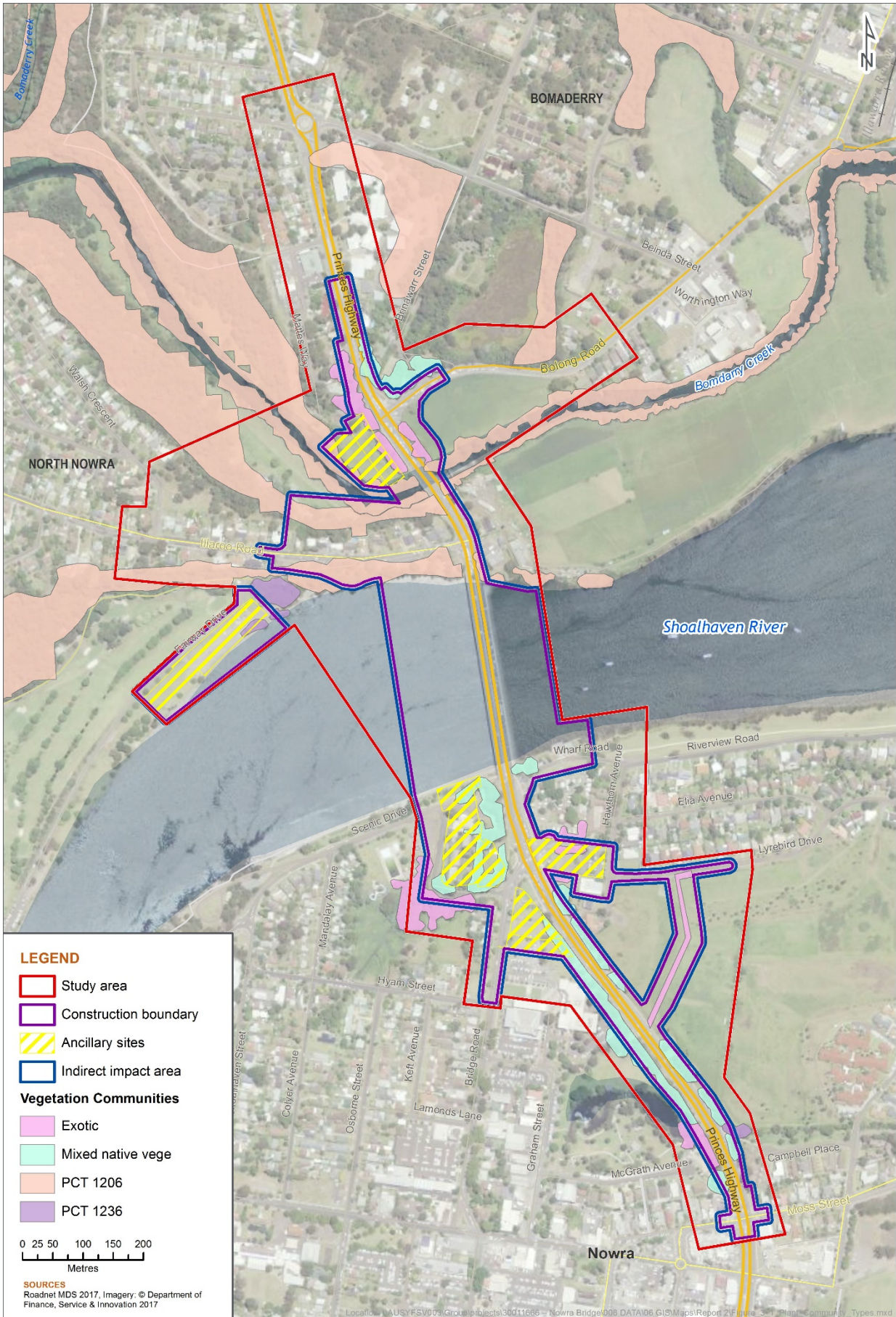
Structure	Average height and height range (metres)	Average cover and cover range (%)	Typical species
Trees	20	90	<i>Erythrina x sykesii</i> , <i>Grevillea robusta</i>
Small trees	6	2	<i>Jacaranda mimosifolia</i>
Shrubs	2	30	<i>Lantana</i>
Ground covers	0.05	50	<i>Pennisetum clandestinum</i>
Vines & climbers	0	0	

**Description:** Parcels of exotic vegetation exist along the verges of the existing highway. An intact canopy of commonly occurring trees included *Erythrina x sykesii*, *Grevillea robusta* and *Jacaranda mimosifolia*. The midstorey is dominated by the exotic shrub *Lantana camera*. The ground flora is largely absent with some occurrences of *Pennisetum clandestinum*.



Photograph 4: Exotic





**Figure 3-1 Plant community types**



## 3.2 Threatened ecological communities

There is only one ecological community within the study area listed as endangered under the TSC Act: Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. This occurs as the vegetation formation Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (see Figure 6 1). This occurs as small remnants in poor condition that supports mostly Swamp Oak, with the occasional Bangalay. The remnants were mapped around the boat ramp on the northern shore of the Shoalhaven River and to the east of the Princes Highway at the southernmost extent of the study area. The endangered ecological community (EEC) is bisected by a concrete roadway and the groundcover is highly modified, and mostly made up of exotic species.

Given the poor condition of the remnants, the EEC within the proposal area only meets the determination under the BC Act and does not meet the determination of an EEC under the EPBC Act.

The proposal will require the removal of about 0.09 hectares of poor condition vegetation from the TEC out of 0.46 hectares present within the study area; therefore, it is unlikely that the proposal will have a significant effect on extent or composition. Exclusion zones would be established to ensure that the TEC is not inadvertently impacted.

A detailed Assessment of Significance has been undertaken for Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (Appendix C).

## 3.3 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) have been mapped by the Bureau of Meteorology (BoM) and Kuginis *et al.* (2012) in the Groundwater Dependent Ecosystems Atlas (BoM 2017).

PCT Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion has been identified as having potential groundwater interaction with one GDE in the current study area, as summarised in **Table 3-2** and mapped in **Figure 3-2**. PCT Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion is not mapped as having an association with any GDE's; however, it is still considered likely to be sensitive to changes to groundwater as the dominant species exist only in mesic environments.

**Table 3-2 Groundwater dependent ecosystems mapped by BoM and Kuginis *et al.* (2012)**

GDE Type	GDE Name	GDE probability	Landscape location	EEC
Vegetation	Currambene-Batemans Lowlands Forest	High	Deeply dissected sandstone plateaus	No

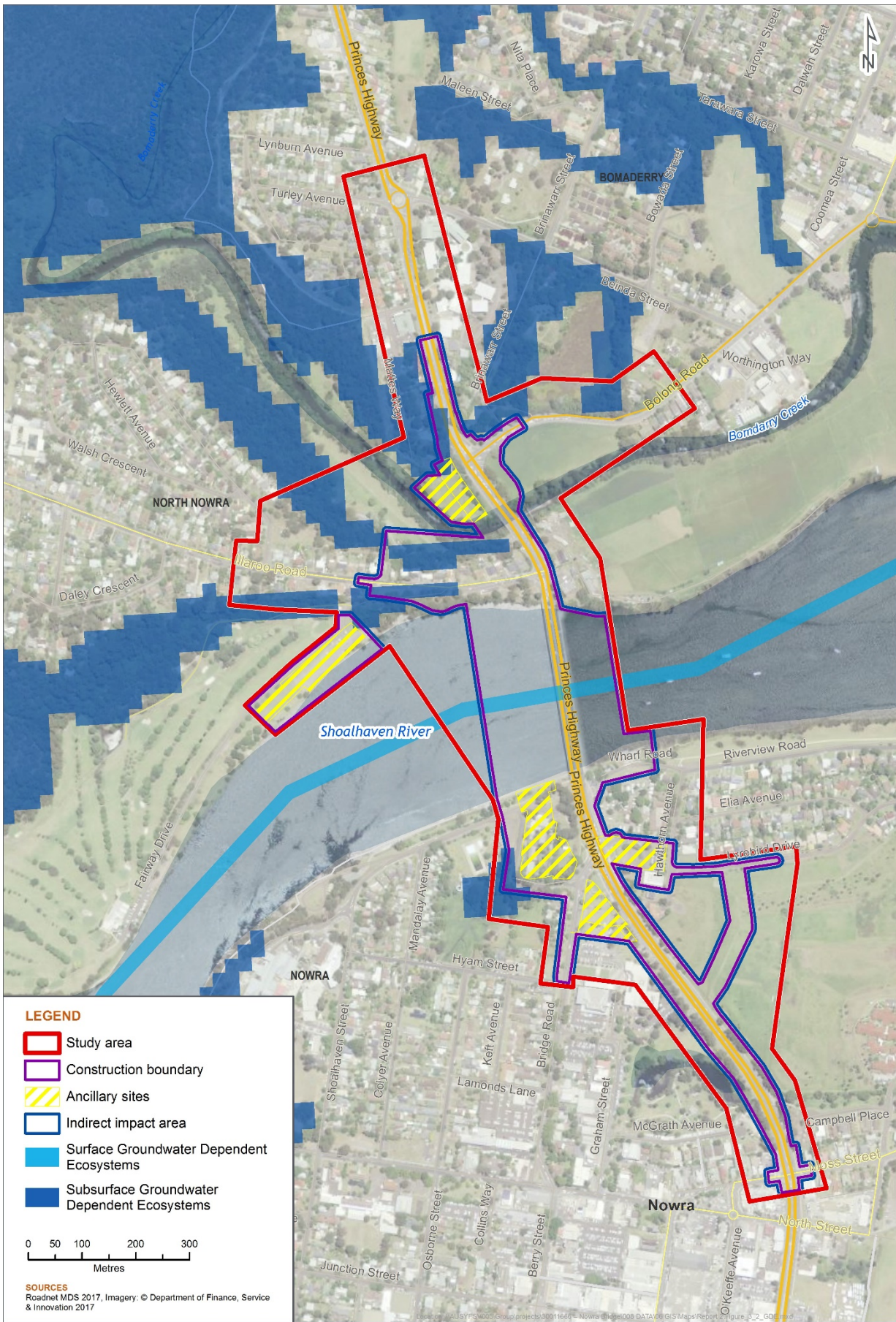


Figure 3-2 Groundwater dependent ecosystems



### 3.4 Threatened species and populations

A total of 11 threatened flora and 39 threatened fauna species were identified as potentially occurring in the locality (Appendix B – Habitat assessment table). An assessment of likelihood of occurrence was conducted for each of these, which identified one species, Southern Myotis (*Myotis macropus*), as having high potential to occur. The Eastern Freetail-Bat (*Mormopterus norfolkensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Rufous Fantail (*Rhipidura rufifrons*), Varied Sittella (*Daphoenositta chrysoptera*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*) were recorded within the study area.

Thirteen other species were identified as having moderate potential to occur including those that would use the study area only on a transient basis. The remaining species were identified as having a low potential to occur. Assessments of significance have been conducted for species considered to have a moderate or high potential to occur or those that were recorded within the study area previous to this study or during the surveys undertaken for this study (Appendix C).

**Table 3-3 Habitat assessment and surveys results for terrestrial species**

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act	EPBC Act	
<i>Acacia pubescens</i>	Downy Wattle	V		Low
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	V		Low
<i>Eucalyptus langleyi</i>	Nowra Mallee	V	E	None
<i>Genoplesium baueri</i>	Bauer's Midge Orchid	E	E	Low
<i>Hibbertia stricta</i> subsp. <i>furcatula</i>		E		None
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	E	E	Moderate
<i>Pterostylis vernalis</i>	Spring Tiny Orchid	CE	CE	Low
<i>Solanum celatum</i>		E		Low
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E	V	Recorded
<i>Triplarina nowraensis</i>	Nowra Heath Myrtle	E	E	Low
<i>Zieria baeuerlenii</i>	Bomaderry Zieria	E	E	Moderate
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E		Low
<i>Arctocephalus pusillus doriferus</i>	Australian Fur-Seal	V		Low
<i>Ixobrychus flavicollis</i>	Black Bittern	V		Low
<i>Falco subniger</i>	Black Falcon	V		Low
<i>Burhinus grallarius</i>	Bush Stone-curlew	E		Low
<i>Artamus cyanopterus</i>	Dusky Woodswallow	V		Low
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-Bat	V		Moderate
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V		Moderate
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V		Recorded
<i>Pandion cristatus</i>	Eastern Osprey	V		Moderate
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V		Low
<i>Stictonetta naevosa</i>	Freckled Duck	V		Low
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V		Low
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V		Low
<i>Calyptorhynchus lathami</i>	Glossy Black-cockatoo	V		Moderate

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act	EPBC Act	
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V		Moderate
<i>Petauroides volans</i>	Greater Glider		V	Low
<i>Litoria aurea</i>	Green and Golden Bell Frog	E	V	Moderate
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Recorded
<i>Thinornis rubricollis</i>	Hooded Plover	CE	V	Low
<i>Phascolarctos cinereus</i>	Koala	V		Low
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V		Low
<i>Hieraaetus morphnoides</i>	Little Eagle	V		Low
<i>Glossopsitta pusilla</i>	Little Lorikeet	V		Low
<i>Tyto novaehollandiae</i>	Masked Owl	V		Low
<i>Ninox strenua</i>	Powerful Owl	V	-	Moderate
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	CE	Low
<i>Rhipidura rufifrons</i>	Rufous Fantail	-	M	Recorded
<i>Petroica boodang</i>	Scarlet Robin	V		Low
<i>Tyto tenebricosa</i>	Sooty Owl	V		Low
<i>Myotis macropus</i>	Southern Myotis	V		High
<i>Circus assimilis</i>	Spotted Harrier	V	-	Low
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	Low
<i>Lophoictinia isura</i>	Square-tailed Kite	V		Moderate
<i>Petaurus norfolcensis</i>	Squirrel Glider	V		Low
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V		Recorded
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	V		Recorded
<i>Epthianura albifrons</i>	White-fronted Chat	V		Low
<i>Petaurus australis</i>	Yellow-bellied Glider	V		Moderate
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V		Moderate

The vegetation immediately to the east of the bridge (northern end) was highly disturbed consisting of many remnant hybrid Blue Gum and the occasional Spotted Gum along the edge of the river. The embankment had been modified using concrete blocks and possibly back filled. The majority of groundcover supported Kikuyu *Pennisetum clandestinum* with a small area along the bank supporting some bird-dispersed mesic species adjacent to the bridge.

Large flowering Eucalyptus species such as Bangalay, Hybrid Blue Gum and Spotted Gum provide high quality seasonal foraging opportunities for nectar feeding fauna. Dense shrubby understorey provides refuge habitat for birds and terrestrial mammals, reptiles and frogs. Hollows were found to be present in two trees within the parkland area in the south of the study area and these may provide nesting and/or roosting opportunities for resident fauna species.

Rocky outcropping is present extending along the north-west bank of the Shoalhaven River. While it is largely fragmented from local corridors, bird and microchiropteran bat species capable of negotiating the urban landscape are likely to seek refuge within these rocky habitats. In addition, Nowra Bridge itself may also provide nesting and roosting opportunity to bird and microchiropteran bat species that are able to withstand the consequent noise and vibration (bats appear to be quite tolerant of such disturbances) and can negotiate urban landscapes.

A Grey-headed Flying-fox camp was recorded directly north of the study area during surveys. All native and non-native canopy species provide foraging habitat for Grey-headed Flying-fox. Habitat utilisation for this species is discussed in **Section 3.9**.



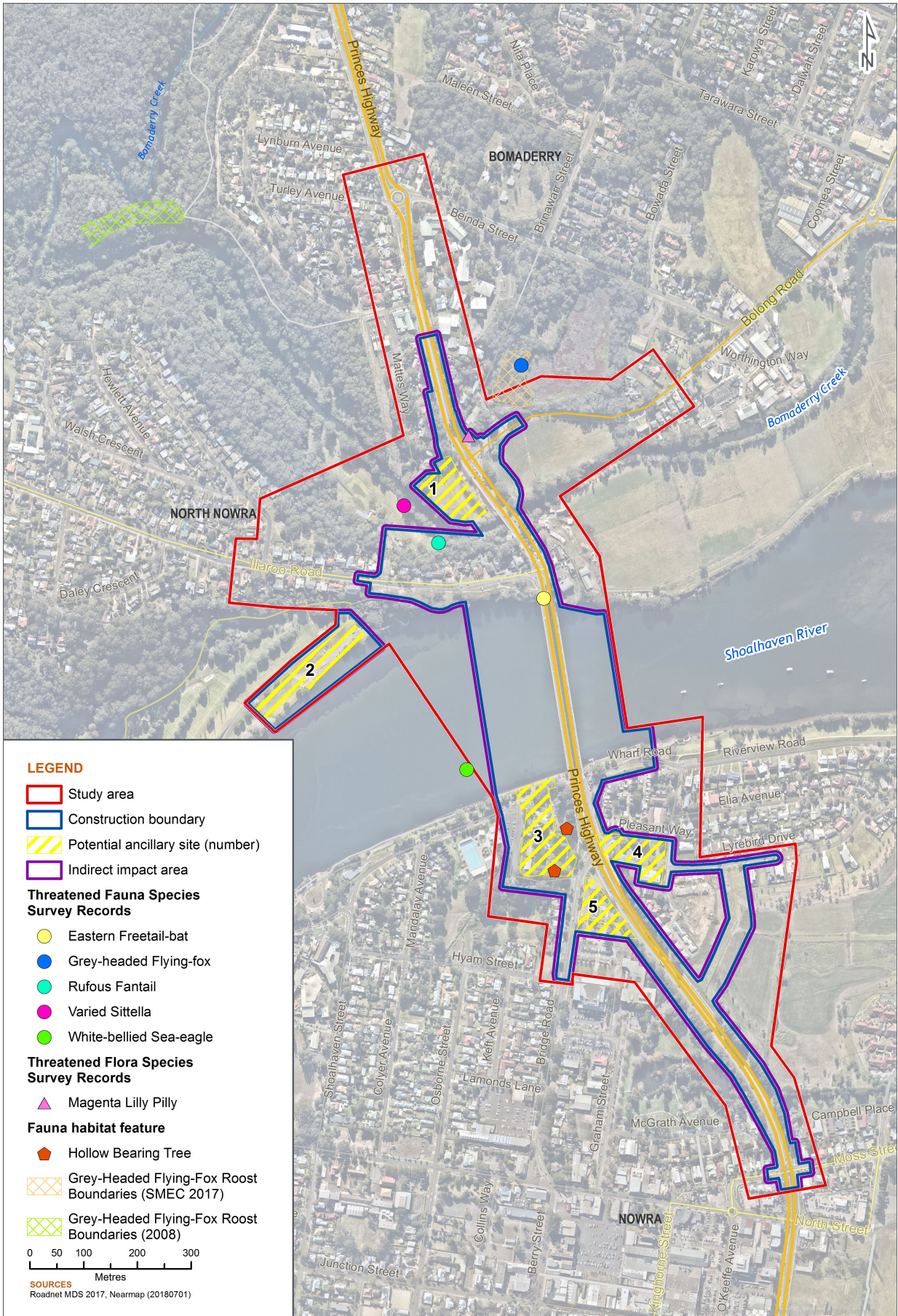


Figure 3-3 Recorded threatened species



## 3.5 Aquatic habitat

### 3.5.1 Seagrass extent and distribution

Patchy communities of *Zostera muelleri* were present both upstream and downstream of the proposal site. Seagrass was observed within the construction footprint in the following locations:

- To the east and west of the southern end of the proposed and existing bridges
- To the west of the boat ramp on the northern riverbank, adjacent to the proposed ancillary site at Greys Beach.

The extent of seagrass within the construction footprint is about 0.3 hectares. Of this, about 0.03 hectares is directly under the new northbound bridge, and up to a further 0.06 hectares may be affected by temporary mooring/loading facilities for construction barges and other watercraft. These seagrass beds constitute a Type 1 key fish habitat – *Zostera* sp. beds of greater than five square metres. Removal or disturbance of seagrass during construction of the proposal would require a permit under the FM Act.

*Z. muelleri* is a perennial species found predominantly in littoral and sub-littoral sand-flats, sheltered coastal embayments, estuaries, shallow bays, and intertidal shoals (Waycott *et al.*, 2014). Within and near the study area, *Z. muelleri* does not typically grow below 2 metres water depth, and is therefore generally restricted to close to the riverbanks and on shallow sand bars / mud flats (**Figure 3-4**, **Figure 3-5** and **Figure 3-6**).

A large, approximately 370 metre long x 35 metre wide, seagrass meadow exists to the northwest of the proposal site, adjacent to the northern riverbank in front of Greys Beach. This is the largest seagrass meadow within the study area. Smaller seagrass meadows exist along the southern riverbank, but these are generally only 2 to 3 metres in width, restricted by water depth (to  $\leq 2$  metres), and intermittent in distribution due to the influence of freshwater runoff from stormwater drains. All meadows observed during field surveys appeared in good health.

Seagrass is known to change in biomass, distribution and shoot density within and between seasons (McKenzie 1994), and analysis of high-resolution aerial images of the proposal site indicate that this is the case with local populations. Of the images analysed, the extent of seagrass in August 2014 (**Figure 3-4**) covered a larger area compared to May 2016 (**Figure 3-5**) and December 2017 (**Figure 3-6**). This is likely the result of a significant decrease in seagrass biomass and distribution due to a major flood in the Shoalhaven River that occurred in August 2015.

### 3.5.2 Mangrove habitat

Mangrove stands occur along the banks of the Shoalhaven River east and west of the existing bridges (**Figure 3-6**); however, within the study area their distribution is patchy. A few isolated individuals, or small stands of the Grey mangrove, *Avicennia marina* occur to the west of the bridges along both the southern and northern riverbank. More substantial stands of *Avicennia marina* occur approximately 50 metres to the east of the bridges, on the northern riverbank, and around the northwest edge of Pig Island.

Mature mangroves also exist in areas adjacent to both upstream and downstream of the proposal area; however, these are unlikely to be impacted by proposed works.





**Figure 3-4 Seagrass extent - August 2014**





Figure 3-5 Seagrass extent – May 2016





**Figure 3-6 Field validated seagrass and mangrove extent – 2017/2018**



### 3.5.3 Water and sediment quality

Historic water quality data for the Shoalhaven River and Bomaderry Creek within the study area were sourced from the Shoalhaven City Council<sup>1</sup> and the estuary health report card (OEH & SCC, 2011). The Shoalhaven City Council water quality monitoring data provides water quality index rating, dissolved oxygen, faecal coliform, total phosphorus, and total nitrogen concentrations for data collected between 2000 to 2012. There were two monitoring locations close the site, one at the entrance to Bomaderry Creek, and one in the Shoalhaven River close to the Nowra bridge.

The below summary of historic water quality was taken from the closest Shoalhaven City Council Shoalhaven River monitoring. From the information available from Shoalhaven City Council, water quality within the Shoalhaven River near the site is likely to be represented by:

- Good to excellent water quality index rating
- Dissolved oxygen levels (per cent saturation) ranging between 70 and 110 (good)
- Faecal coliform counts generally below relevant ANZECC (2000) swimming guideline levels
- Phosphorus levels below ANZECC (2000) guidelines
- Total nitrogen levels below ANZECC (2000) guidelines.

No historic turbidity data was found for the Shoalhaven River. The estuary health report card provides a 'B' rating (good) for turbidity at a location just to the east of the site. A 2011 Sydney Catchment Authority '*State of the Science – Catchment Impacts*' report claims that none of the rivers surveyed (including the Shoalhaven River) exceeded the relevant ANZECC Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) turbidity threshold of 25 NTU (SCA, 2011).

From the information available from Shoalhaven City Council, water quality within Bomaderry Creek is likely to be represented by:

- Medium to good water quality index
- Dissolved oxygen levels (per cent saturation) of about 140 (poor)
- Faecal coliform counts above ANZECC (2000) swimming guideline levels
- Phosphorus levels below ANZECC (2000) guidelines
- Total nitrogen levels below ANZECC (2000) guidelines.

Note that the above summary is based on the most recent monitoring data available (2012). The complete dataset available (2000 to 2012) suggests that there were significant improvements in water quality in the Shoalhaven River from approximately 2010 onwards as all indicators improved from this time. This is likely to be due to the implementation of improved stormwater and catchment management practices.

Monitoring data obtained during surveys for the proposal indicate that water quality within the Shoalhaven River was good. Temperature showed little variation within and between sites, with values typically ranging between 24.0 °C and 24.8 °C. Surface dissolved oxygen concentrations ranged between 6.5 mg L<sup>-1</sup> and 13.0 mg L<sup>-1</sup>, which represents an approximate per cent saturation range of 60 to 130. Note that dissolved oxygen levels are influenced by salinity and water depth, and the lower measurements observed during field surveys were taken at low tide. Dissolved oxygen concentrations generally declined with increasing depth, which is likely a function of decreasing temperature and increasing pressure with depth influencing dissolved

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<sup>1</sup> Data sourced from  
<https://www.shoalhaven.nsw.gov.au/soe/Region/Indicator%20homes/Surfacewaterquality.htm>

oxygen concentrations. Dissolved oxygen concentrations were higher at sites where recordings were taken at high tide, and at sites close to extensive seagrass beds.

Both pH and oxidative reduction potential (ORP) were recorded at all sites; however, without appropriate reference data, little can be interpreted from these values. In general, pH was neutral at all sites. Noticeably, the Bomaderry Creek site displayed lower pH than all Shoalhaven River sites. Turbidity concentrations at Shoalhaven River sites ranged between 0.1 NTU and 1.7 NTU suggesting that turbidity levels are generally good. Turbidity in Bomaderry Creek was higher, ranging between 1.7 and 2.7 NTU.

Water samples were collected at four sites along the proposed bridge alignment. Analytical results indicated that metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury), TPH, TRH, BTEX, TN, COD, and BOD, were all below analytical detection limits (and therefore ANZECC guidelines). Ammonia concentrations ranged between 4  $\mu\text{g N L}^{-1}$  and 8  $\mu\text{g N L}^{-1}$ , and nitrate concentrations were all below 10  $\mu\text{g N L}^{-1}$ . Total phosphorus concentrations ranged between 5  $\mu\text{g P L}^{-1}$  and 10  $\mu\text{g P L}^{-1}$ , and reactive phosphorus was 10  $\mu\text{g P L}^{-1}$  or below. These values are all below the ANZECC guidelines, which for ammonia for lowland rivers is 20  $\mu\text{g N L}^{-1}$ ; for nitrate is 40  $\mu\text{g N L}^{-1}$ ; for total phosphorus is 50  $\mu\text{g P L}^{-1}$ , and; for reactive phosphorus 20  $\mu\text{g P L}^{-1}$ .

Sediment samples were collected at four sites along the proposed bridge alignment. Sediment particle size distribution indicates that the southern, shallower portion of the river is dominated by sand, while the deeper channel on the northern riverbank is dominated by fine particles. Metals and metalloids, PAH, TPH, BTEX were all below sediment quality guidelines (**Table 3-4**).

Note that the water and sediment sample data presented in this report is indicative only. The data is representative of one sampling occasion and does not account for spatial and temporal variations, or replication. A construction and operational water and sediment quality management plan is being prepared for the proposal, which will detail the appropriate sampling regime (including appropriate temporal and spatial scales, replication, and quality assurance).

Available data suggests that water and sediment quality of the Shoalhaven River is generally good, with little influence from anthropogenic pollution, and some influence from weather events (e.g. floods) which may cause temporary fluctuations.

**Table 3-4 Sediment physical and chemical attributes**

Parameter / Site	SB-01	SB-02	NB-02	NB-01	Guideline*
<b>Soil classification</b>					
Per cent fines (< 75 µm)	2	<1	1	77	N/A
Per cent sand (>75 µm)	95	94	99	23	N/A
Per cent gravel (> 2 mm)	3	5	<1	<1	N/A
Per cent cobbles (> 6 cm)	<1	<1	<1	<1	N/A
Per cent moisture	44.9	30.0	64.8	35.7	N/A
pH	7.6	7.8	7.9	7.6	N/A
Per cent organic matter	1.8	<0.5	5.6	<0.5	N/A
Per cent total organic carbon	1.0	<0.5	3.2	<0.5	
<b>Metals / Metalloids (mg/kg)</b>					
Arsenic	<5	<5	11	<5	20-70^
Cadmium	<1	<1	<1	<1	1.5-10^
Chromium	7	6	20	8	80-370^
Copper	<5	<5	24	<5	65-270^
Lead	6	<5	20	8	50-220^
Nickel	8	7	17	10	21-52^
Zinc	27	20	77	28	200-410^
Mercury	<0.1	<0.1	<0.1	<0.1	0.15-1^
<b>Petroleum hydrocarbons / Derivatives</b>					
Total PAH	<0.5	<0.5	<0.8	<0.5	4000-45000^
TPH	<10	<10	<10	<10	N/A
BTEX	<0.2	<0.2	<0.2	<0.2	N/A

\*ANZECC / ARMCANZ Interim Sediment Quality Guidelines (ISQG)

^ISQG-Low (trigger value) to ISQG-High

### 3.5.4 Threatened aquatic / marine species

A total of 23 threatened aquatic / marine fauna species (**Table 3-5**) were identified as potentially occurring in the locality (Appendix B). An assessment of likelihood of occurrence was conducted

for each of these, which identified that one species, the Australian Grayling, was regarded as having high potential to occur within the study area.

The remaining species were identified as having a low potential to occur. Assessments of significance in Appendix C have been conducted for species considered to have a moderate or high potential to occur or those that were recorded within the study area previous to this study or during the survey for this study.

**Table 3-5 Threatened aquatic / marine fauna**

Scientific name	Common name	Status		Potential occurrence
		TSC Act or FM Act	EPBC Act	(Low, Moderate, High, Recorded)
<b>Birds</b>				
<i>Diomedea epomophora epomophora</i>	Southern Royal Albatross	-	V	Low
<i>Diomedea epomophora sanfordi</i>	Northern Royal Albatross	-	E	Low
<i>Diomedea exulans antipodensis</i>	Antipodean Albatross	V	V	Low
<i>Diomedea exulans exulans</i>	Tristan Albatross	-	E	Low
<i>Diomedea exulans gibsoni</i>	Gibson's Albatross	V	V	Low
<i>Diomedea exulans (sensu lato)</i>	Wandering Albatross	V	V	Low
<i>Macronectes giganteus</i>	Southern Giant Petrel	E	E	Low
<i>Macronectes halli</i>	Northern Giant Petrel	V	V	Low
<i>Thalassarche bulleri</i>	Pacific Albatross	-	V	Low
<i>Thalassarche cauta cauta</i>	Shy Albatross	V	V	Low
<i>Thalassarche cauta salvini</i>	Salvin's Albatross	-	V	Low
<i>Thalassarche cauta stadi</i>	White-capped Albatross	-	V	Low
<i>Thalassarche eremita</i>	Chatham Albatross	-	E	Low
<i>Thalassarche melanophris</i>	Black-browed Albatross	V	V	Low
<i>Thalassarche impavida</i>	Campbell Albatross		V	Low



Scientific name	Common name	Status		Potential occurrence
		TSC Act or FM Act	EPBC Act	(Low, Moderate, High, Recorded)
<b>Fish</b>				
<i>Epinephelus daemeli</i>	Black Rockcod	V	V	Low
<i>Macquaria australasica</i>	Macquarie Perch	E	E	Low
<i>Prototroctes maraena</i>	Australian Grayling	E	V	High; Recorded
<i>Caretta</i>	Loggerhead Turtle	E	E	Low
<i>Chelonia mydas</i>	Green Turtle	V	V	Low; one previously recorded downstream of the study area
<i>Dermochelys coriacea</i>	Leatherback Turtle	E	E	Low
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	-	V	Low
<i>Natator depressus</i>	Flatback Turtle	-	V	Low

### 3.5.5 Aquatic habitat

The Shoalhaven River is classified as a type 1, class 1 waterway (**Table 3-6**), which indicates that it contains highly sensitive key fish habitat, and potentially for threatened fauna species. The river contains overhanging and emergent vegetation as well as tidal mudflats suitable for foraging, breeding and sheltering birds.

The Shoalhaven River and estuary is also recognised in the Directory of Important Wetlands of Australia; however, this only extends from the river mouth upstream to Broughton Creek, which is downstream of the proposal site.

**Table 3-6 Shoalhaven River classification**

Classification	Characteristics of waterway
Type 1	Highly sensitive key fish habitat: <i>Zostera</i> sp. beds of greater than 5 square metres in area wetlands listed in the Directory of Important Wetlands of Australia freshwater habitats that contain in-stream gravel beds, rocks greater than 500 millimetres in two-dimensions, snags greater than 300 millimetres in diameter or three metres in length, or native aquatic plants any known or protected threatened species habitat or area of declared critical habitat under the FM Act.
Class 1	Major fish habitat: marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.

### 3.6 Critical habitat

No declared critical habitat is present within the study area.

### 3.7 Wildlife connectivity corridors

The study area is characterised by a landscape of small and disturbed patches of remnant bushland that are heavily fragmented by the highway, and cleared commercial and residential development. Although the area is already heavily fragmented, there would be a reduction in extent, size, shape and connectivity of native vegetation through direct clearing of vegetation that may provide refuge for threatened species passing through the area.

### 3.8 SEPPs

#### 3.8.1 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 new bridge and road upgrade and is to be carried out on behalf of Roads and Maritime, it can be assessed under Division 5.1 of the EP&A Act. Development consent from Council is not required.

The proposal is not located on land reserved under the NP&W Act and does not affect land or development regulated by State Environmental Planning Policy (Coastal Management) 2016, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (Major Development) 2005.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development.

#### 3.8.2 State Environmental Planning Policy (Coastal Management) 2018

State Environmental Planning Policy (Coastal Management) 2016 (Coastal Management SEPP) has been developed by the Department of Planning and Environment (DPE) and the Office of Environment and Heritage (OEH). The Coastal Management SEPP responds to existing and emerging coastal challenges and opportunities with the aim of having thriving and resilient communities living and working on a healthy coast now and in the future.

The Coastal Management SEPP consolidates current coastal-related SEPP. It replaces SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection). The Coastal Management SEPP commenced operation on 3 April 2018.

Clause 11 states that development consent must not be granted to development on land wholly or partly identified as 'proximity area for coastal wetlands' unless the consent authority is satisfied that the proposed development will not significantly impact on the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or; the quantity and quality of surface and ground water flows to the adjacent coastal wetland, subject to zoning under an environmental planning instrument.

The proposal is also located on land mapped as 'coastal environment area'. Development consent within this area must be in accordance with clause 13 of the Coastal Management SEPP, which includes consideration by the consent authority that the proposal will not cause adverse impacts to coastal processes, water quality of a marine estate, Aboriginal heritage and that the proposal incorporates water sensitive urban design.

There are no coastal wetlands located within the study area or within the 10-kilometre desktop search area.

### **3.8.3 SEPP 44 Koala Habitat**

*State Environmental Planning Policy No.44 - Koala Habitat Protection* (SEPP 44) aims to protect the Koala and its habitat by incorporating prescriptions for consent authorities to consider during the assessment of development applications. SEPP 44 contains prescriptions for the consideration of 'potential koala habitat' and 'core koala habitat' for developments within LGAs listed on Schedule 1 of the Policy. Shoalhaven LGA is listed on Schedule 1 as an area to which SEPP 44 applies.

'Potential koala habitat' is defined by SEPP 44 as "areas of native vegetation where the trees of types listed in Schedule 2 constitute at least 15 per cent of the total number of trees in the upper or lower strata of the tree component". One of the tree species recorded on-site includes Forest Red Gum (*Eucalyptus tereticornis*) which is listed under Schedule 2 of the Policy as a Koala feed tree species. However, this tree species in the study area is a planted species within this area as it does not occur naturally within the PCTs on site. Therefore, it has not been included for consideration as a canopy species in regard to the local PCTs. On that basis, there are no tree types listed under Schedule 2 that constitute at least 15 per cent of the total number of trees onsite, as such the proposal area does not constitute 'potential koala habitat' under the definition of SEPP 44.

For the reasons stated above, the study area is not considered 'core koala habitat' as defined under SEPP 44. 'Core koala habitat' refers to areas of land that contain "a resident population of koalas, evidenced by attributes such as breeding females and recent sightings of and historical records of a population". There is no evidence (such as sightings, calls, scats and fur) that the site supports a resident population of the Koala and there is no evidence in general of koala activity. The most recent local record is also over 20 years old. Hence, the site does not constitute 'core koala habitat', within the meaning of SEPP 44.

On this basis, the provisions of SEPP 44 do not apply to the proposed activity. A Koala Plan of Management is not required to be prepared as part of the proposal.

## **3.9 Matters of National Environmental Significance**

### **3.9.1 World and natural heritage**

No places listed as of world or natural heritage are present within the study area.

### 3.9.2 Wetlands of international importance

No wetlands of international importance, Ramsar wetlands, are present within the study area.

### 3.9.3 Threatened biodiversity

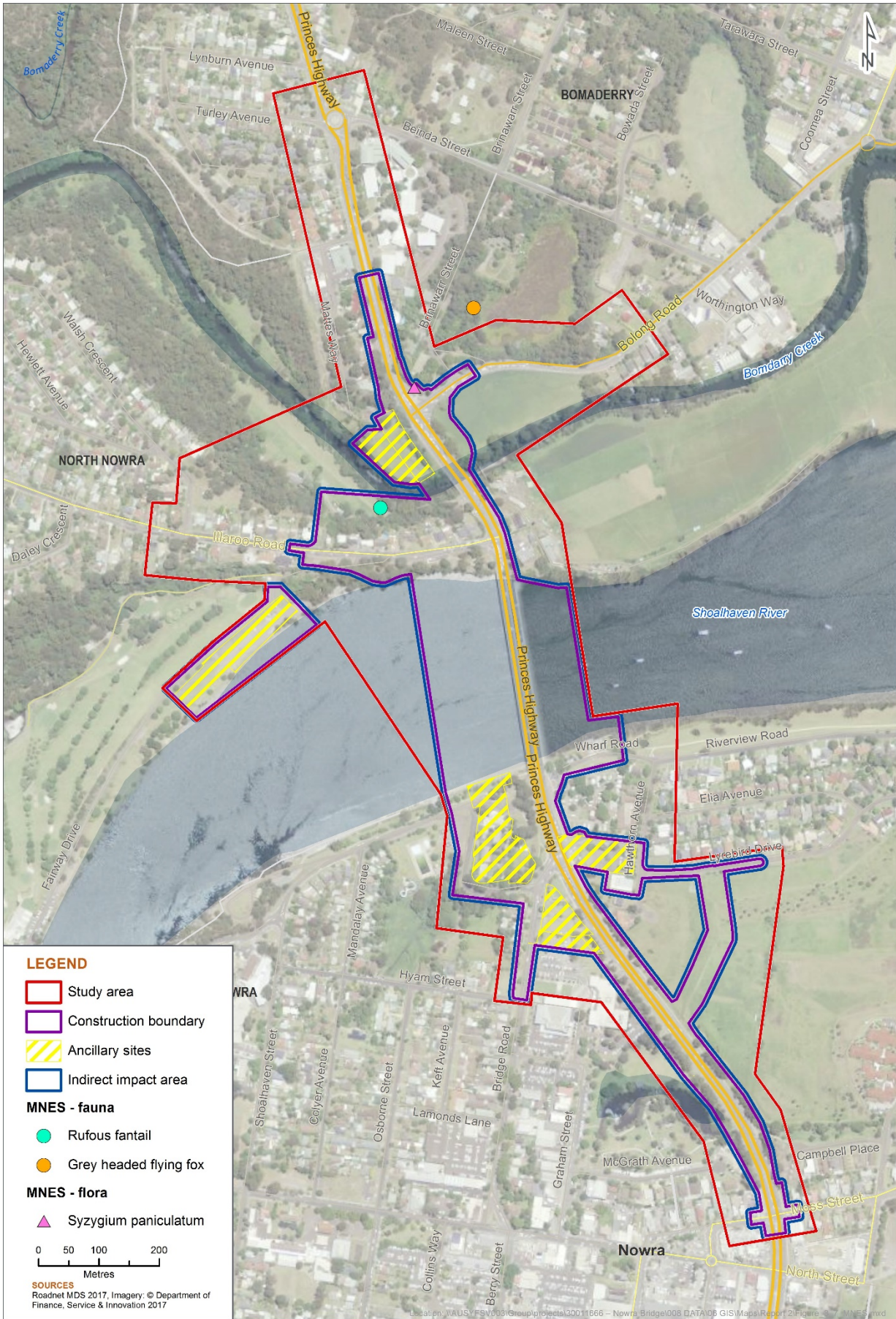
One threatened flora species, *Syzygium paniculatum* (Magenta Lilly Pilly), was identified as present within the study area during the flora surveys. *S. paniculatum* is listed as vulnerable under the EPBC Act, but is also a popular planted species and it was evident from the arrangement of the trees that they have been planted as a screen between the existing Princes Highway and adjacent residences. Natural habitat for the species was generally absent from the study area.

One threatened fauna species, Grey-headed Flying-fox, listed as vulnerable under the EPBC Act is considered likely to occur in the study area. This species was recorded during surveys in habitat adjoining the north section of the proposal, with the location shown on **Figure 3-3** and **Figure 3-7**. Grey-headed Flying-fox are opportunistic nectivores feeding on nectar and pollen of native trees such as Eucalyptus species. They also eat fruits of rainforest trees and vines and cultivated fruit trees. It is considered likely that Grey-headed Flying-fox utilise the study area for foraging.

### 3.9.4 Migratory species

The Rufous Fantail, an EPBC Act listed migratory species, was also recorded within the study area during the fauna surveys (**Figure 3-7**). Individual Rufous Fantails migrate to areas of south eastern Australia each spring in order to nest and raise young. The study area provides suitable foraging habitat for this species and potentially breeding habitat for this species.





**Figure 3-7 Matters of National Environmental Significance**



## 4 Impact assessment

### 4.1 Construction impacts

#### 4.1.1 Removal of native vegetation

The primary impact of the proposal on threatened species would be through clearing of native vegetation and the resulting loss of threatened species habitat and potentially also the loss of threatened species individuals. Clearing of non-native vegetation including gardens, street trees, weeds and paddocks could impact on threatened and non-threatened native flora and fauna habitats. Protected fauna could also be impacted through changes to habitat through the clearing of both native and non-native vegetation.

General impact to biodiversity could occur directly or indirectly because of the proposal through the following pathways:

- Direct loss of, or disturbance to, native vegetation. This may include threatened flora, threatened communities and their habitats
- Direct loss of, or disturbance to, non-native vegetation including gardens, street trees, weeds and paddocks
- Direct loss of, or disturbance to, terrestrial habitat for threatened and protected fauna including hollows, dead wood, food resources, roosting features, shelter and refugia
- Indirect impact due to changes in environmental conditions such as hydrology, drainage, noise, light and wind
- Indirect impact due to changes in extent, size, shape and connectivity of native vegetation, exotic vegetation, and other areas of habitat
- Indirect impact resulting from potential invasion and spread of weeds and diseases from edge effects, construction, operation and maintenance.

In addition to those direct and indirect impacts considered likely to occur, impacts due to unforeseen events, such as flood, fire and storms, have the potential to occur. Such impacts are often difficult to predict in terms of area of extent, degree of action, and as a result, the indirect impacts have been assessed, but an area extent has not been defined.

**Table 4-1 Impacts on native vegetation**

Plant community type (PCT)	Status		Proposal area <sup>1</sup> (ha)	Indirect Impacts (ha)	Percent cleared in CMA <sup>2</sup>
	TSC Act	EPBC Act			
Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (1206)	N/A	N/A	2.09	0.34	15
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	E	N/A	0.09	0.03	32
<b>Total</b>			<b>2.18</b>	<b>0.34</b>	

1- Area to be cleared based on ground-truthed vegetation mapping within the study area.

2- Based on the VIS classification database.

E - Endangered

#### 4.1.2 Removal of terrestrial threatened fauna habitat

The construction footprint supports habitat resources for threatened and protected fauna species. The primary impact of the proposal on threatened fauna habitat would be through clearing of native vegetation and the resulting potential loss of threatened species through the loss of individuals, extent and/or habitat. During construction, this would be as a direct result of machinery and personnel operating within the clearing boundary and includes the removal of, and disturbance to, vegetation due to site establishment, clearing and grubbing, earthworks and drainage. The potential direct loss of, or disturbance to, threatened fauna habitat through clearing of native vegetation is detailed in **Table 4-2**.

Direct loss of, or disturbance to, non-native and native planted vegetation including gardens, street trees, weeds and paddocks within the construction boundary as part of the construction would also occur. In addition to native vegetation communities, non-native and native planted vegetation in the study area also supports potential foraging, roosting, nesting and shelter habitat for a range of threatened and protected fauna species.

##### Loss of food resources

Loss of, or disturbance to, native vegetation on the proposal area would largely conform to Clearing of Native Vegetation, a Key Threatening Process (KTP) listed on Schedule 3 of the TSC Act. Vegetation to be removed or modified, particularly native vegetation, would reduce or modify herbivorous food resources in the study area for numerous fauna species. Vegetation would be removed and modified as part of the proposal as summarised in **Table 3-1**. The removed vegetation provides food resources to fauna species as leaves, sap, wood, pollen, seeds and nectar to both vertebrate and invertebrate fauna species. Such plant food sources are important to threatened species that may utilise habitat in the study area. This includes species with a moderate or higher chance of occurring including the Yellow-bellied Glider, Glossy Black-cockatoo and Grey-headed Flying-fox. The Grey-headed Flying-fox is known from the study

Native and non-native vegetation on site can or may support a range of herbivorous vertebrates, such as arboreal mammals, and also native invertebrates. Hence, the vegetation within the construction area may provide food resources for threatened carnivorous or insectivorous fauna species that include the Powerful Owl, Eastern Bentwing-bat, Green and Golden Bell Frog, Eastern False Pipistrelle, Eastern Freetail-bat, Yellow-bellied Sheath-tail-bat, Rufous fantail, Southern Myotis, Square-tailed Kite, Varied Sitella and Greater Broad-nosed Bat. All have either been recorded or have the potential to be present within the study and so may be impacted through the loss of foraging habitat and food resources.

Loss of native and non-native vegetation may also result in the loss of shelter habitat for threatened species with the vegetation providing perches and cover. This includes all of the above species as well as the White-bellied Sea-eagle and Osprey that may roost or in the vegetation between periods of foraging in the local water bodies.

##### Loss of hollow-bearing trees, dead wood removal and shelter habitat

The existing bridge structures at Bomaderry Creek and across the Shoalhaven River provide potential roosting habitat for microchiropteran bat species such as the Eastern Bentwing-bat and Southern Myotis.

Hollow-bearing trees were recorded at very low density throughout the study area with two hollow-bearing trees being found in the south of the study area, accounting for one small (0-5 centimetre diameter) and three medium sized (5-10 centimetre diameter) hollows. The following fauna species that may utilise the tree hollows recorded on site and so that may potentially be affected by removal of hollows by the proposal include: Eastern False Pipistrelle, Eastern

Freetail-bat, Southern Myotis, Yellow-bellied Sheath-tail-bat and Greater Broad-nosed Bat. Removal of hollow-bearing trees is listed as a KTP on Schedule 3 of the TSC Act.

**Table 4-2 Impacts on terrestrial threatened fauna and fauna habitat**

Species	Potential occurrence (Moderate, High, Recorded) <sup>1</sup>	Significantly Impacted by proposal? <sup>2</sup>	Impact (ha)
Eastern Bentwing-bat	Moderate	No	0
Eastern False Pipistrelle	Moderate	No	0
Eastern Freetail-bat	Recorded	No	0
Eastern Osprey	Moderate	No	0
Greater Broad-nosed Bat	Moderate	No	0
Green and Golden Bell Frog	Moderate	No	0
Grey-headed Flying-fox	Recorded	No	0
Powerful Owl	Moderate	No	0
Rufous Fantail	Recorded	No	0
Southern Myotis	High	No	0
Square-tailed Kite	Moderate	No	0
Varied Sittella	Recorded	No	0
White-bellied Sea-eagle	Recorded	No	0
Yellow-bellied Glider	Moderate	No	0
Yellow-bellied Sheath-tail-bat	Moderate	No	0

<sup>1</sup> Based on the likelihood of occurrence table (Appendix B)

<sup>2</sup> Based on assessments of significance (Appendix C)

### 4.1.3 Removal of threatened flora

Database searches and relevant reports and studies identified 11 threatened flora species with known populations within a 10-kilometre search area of the site (**Section 3.4**). An assessment of the likely occurrence of these within the study area identified two species with a moderate likelihood of occurrence, *Syzygium paniculatum* and *Solanum celatum*. During the field survey, 19 individuals of *Syzygium paniculatum* were recorded within the study area within a planted area of screening vegetation on the corner of the Princes Highway and Bolong Road. No individuals of *Solanum celatum* were recorded and, as a result of this survey effort, the likelihood of occurrence of this species was revised and considered as low. **Table 4-3** summarises the impacts of the proposal on threatened flora known to occur.

**Table 4-3 Impacts on known threatened flora**

Threatened species	Ecosystem or species credit species	Status		Habitat or individuals to be impacted	Habitat or individuals in the study area
		TSC Act	EPBC Act		
<i>Syzygium paniculatum</i>	Species	E	V	19	19

Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (PCT1206) is a PCT that has a known association with *Syzygium paniculatum*. However, *Syzygium paniculatum* is a popular species used in urban landscapes. Given the individuals were likely planted as a screen between the Princes Highway and local residences and that natural habitat is generally absent from the study area it is highly unlikely that these individuals form part of a local, naturally occurring population.

#### 4.1.4 Aquatic impacts

The results of the aquatic ecology database and literature review, and field validation surveys indicate that the proposed bridge alignment overlaps about 0.03 hectares of seagrass on the southern riverbank. Up to a further 0.06 hectares of seagrass may be affected by temporary mooring/loading facilities for construction barges and other watercraft. The seagrass beds constitute a Type 1 key fish habitat under the FM Act. A permit under the FM Act would be required for the removal or disturbance of seagrass as a result of proposal activities.

The remainder of the alignment is devoid of benthic habitat. Seagrass and mangroves are the dominant key fish habitat within the study area. About 0.3 hectares of seagrass and 0.04 hectares of mangroves exists within construction footprint. No mangroves were observed within the bridge alignment.

Due to environmental constraints (particularly light penetration) and substrate type, seagrass is generally restricted to less than two metres water depth, and within the study area occurs close to each riverbank, and on shallow sandbars.

Indirect impacts to aquatic habitats may occur due to increased turbidity and sedimentation associated with the construction of the bridge piers within the Shoalhaven River. The construction methodology was not known when preparing this report; however, activities such as piling and/or excavating (e.g., dredging), typically associated with bridge construction, would result in increases in turbidity and sedimentation. Based on the footprint area of each bridge pier, these impacts are expected to be temporary (short-term), minor and occur over a small spatial extent. Indirect impacts may also occur due to pollutants entering the waterway via accidental spills during construction.

The new bridge piers constitute an in-stream structure under the FM Act, and as such a permit may be required. The bridge piers are proposed to be aligned with those currently in place for the two existing bridges. The addition of a third set of piers may result in additional diversion of water flow; however, this is expected to be insignificant with respect to current conditions. As such, the new bridge piers are not likely to significantly alter the natural flow of the river.

The Australian Grayling (listed as vulnerable under the EPBC and TSC/BC Acts) is known to occur in the Shoalhaven River. The Australian Grayling has a large range, migrating between rivers, their estuaries and coastal seas, and so relies on free access to a range of freshwater, estuarine and marine habitats for its survival. Australian Grayling are usually found in clear waters with gravel substrates and alternating pool and riffle zones. Larvae and juveniles have an obligatory marine stage and therefore inhabit estuaries and coastal seas (Backhouse *et al.*, 2008).

Key threatening processes to the Australian Grayling include:

- barriers to movement
- river regulation
- poor water quality
- siltation
- introduced species
- disease.

[Backhouse *et al.*, 2008]

The project area has little preferred habitat for the grayling, being largely comprised of seagrass beds in water depths less than two metres, then predominantly bare sandy substrate at greater depths. No gravel substrates, preferred habitat for the Australian Grayling, were observed during field investigations, nor are they documented as occurring in the project area. There is no evidence that the Australian Grayling inhabits seagrass, and as such the direct impact by the project on up to 0.09 ha of seagrass is not likely to impact the Australian Grayling. Similarly, although the project is likely to result in short-term, confined (in area) impacts to water quality, these are not likely to impact the Australian Grayling given their unlikely occurrence in the area due to a lack of suitable habitat.

In summary, the proposal is unlikely to result in:

- The temporary displacement of aquatic fauna
- Loss of riparian vegetation, or the removal or relocation of snags
- Significant impacts on the Australian Grayling or its habitat
- Obstruction of fish passage, including temporary in-stream structures and / or temporary diversions
- Acidification due to disturbance of acid sulphate soils
- Potential direct and indirect impacts on aquaculture, commercial or recreational fishing
- Impacts to wetlands.

The proposal may result in:

- Loss of up to 0.09 hectares of aquatic habitat (seagrass) – Type 1 key fish habitat
- Potential indirect impact to 0.25 hectares of seagrass
- Installation of in-stream structures that may alter the natural flow regime of the river or stream
- Minor, short-term increases in turbidity and sedimentation during construction of the bridge piers
- Pollutants entering the waterway due to accidental spills.

#### **4.1.5 Injury and mortality**

Construction works that lead to the removal or disturbance of fauna or their habitats may lead to incidences of fauna injury or mortality through interactions with vehicles. It is possible that the level of risk would be altered during construction, particularly during habitat removal when fauna may be forced to move. Given the proposal would involve habitat clearing directly next to the existing roadway, this may result in an increase in individuals being injured or killed by vehicles in the short-term if they are required to cross the road more frequently to obtain resources. Once constructed, it is possible that the proposal would increase the likelihood of vehicle strike in the long-term due to the extra width of the road corridor that would require any fauna attempting a crossing to be within the path of traffic for longer.



## 4.2 Indirect/operational impacts

### 4.2.1 Wildlife connectivity and habitat fragmentation

The proposal would result in a reduction of roadside native and exotic vegetation in the study area as per **Table 3-1**. There would be a reduction in extent, size, shape and connectivity of native vegetation through direct clearing of vegetation as discussed in **Section 3.7**.

Due to the study area being characterised by a landscape of small and disturbed patches of urban bushland that are heavily fragmented by the highway and cleared industrial and residential development, the presence of these patches of remnant vegetation are considered to hold some local importance to the movement of species that are able to successfully move between them. The proposal is likely to reduce the wildlife connectivity in the area through:

- Increased fragmentation of vegetation and increased edge effects resulting from the clearing of native vegetation
- Decreased connectivity between localities of endangered and/or critically endangered species
- Increased distance between vegetation on either side of the road from approximately 20 metres to approximately 40 metres as a result of the road upgrade. This increase in the gap between canopy trees may deter fauna from using the vegetation to forage and cross between habitat areas.

However, as the landscape is already heavily fragmented, the species present in the already urbanised area are likely to be already pre-disposed to handle this and are unlikely to suffer additional and significantly increased impacts resulting from habitat fragmentation beyond those that they are currently subject to.

### 4.2.2 Edge effects on adjacent native vegetation and habitat

The dominant weeds described within the study areas are *Asparagus aethiopicus*, *Olea europaea subsp. cuspidata* and *Lantana camara*. These species are readily spread by existing dispersal factors such as birds and water. Clearing and opening of new vegetation edges is likely to facilitate the recruitment of these species and may facilitate the establishment of other weed species in native and exotic vegetation, outcompeting native flora and fauna species, and further reducing habitat values of these areas. Movement of weed species during construction would also be a likely vector of seeds and other propagules through soil and mulch movement and importation during construction activities.

It is likely that the construction of the proposal would introduce, spread or exacerbate the plant diseases caused by *Phytophthora cinnamomi* and Myrtle Rust, along with frog disease Chytridiomycosis. These diseases are most likely introduced or spread through the importation or movement of organic materials in soil, water and landscaping materials, either directly or through incidental attachment to machinery. Ongoing maintenance and operational use of machinery as part of the proposal would also be likely vectors of movement and introduction of diseases.

### 4.2.3 Invasion and spread of weeds

Four priority weed species listed for the South East (DPI 2017) under the *Biosecurity Act 2015*, were identified in the study area. The class and duty associated with all plants and specific duties for the weed species identified in the study area are outlined in **Table 4-4**.

**Table 4-4 Priority weeds listed for Shoalhaven LGA identified within the study area**

Weed	Duty
All plants	<p><b>General Biosecurity Duty</b></p> <ul style="list-style-type: none"> <li>All plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.</li> </ul>
Ground Asparagus <i>Asparagus aethiopicus</i>	<p><b>Mandatory Measure</b></p> <ul style="list-style-type: none"> <li>Must not be moved, imported into the State or sold</li> <li>Exclusion zone: whole region excluding core infestation area of Eurobodalla, Kiama, Shellharbour, Wollongong and the Shoalhaven</li> </ul>
Mother-of Millions <i>Bryophyllum delagoense</i>	<p><b>Mandatory Measure</b></p> <ul style="list-style-type: none"> <li>Must not be moved, imported into the State or sold</li> </ul>
Lantana <i>Lantana camara</i>	<p><b>Mandatory Measure</b></p> <ul style="list-style-type: none"> <li>Must not be imported into the State or sold</li> <li>Exclusion zone: whole region excluding core infestation area of Eurobodalla, Kiama, Shellharbour, Wollongong and the Shoalhaven local government area north of the Lantana Containment Line at 30°11'42S</li> </ul>
African Olive <i>Olea europaea</i> subsp. <i>cuspidate</i>	<p><b>Mandatory Measure</b></p> <ul style="list-style-type: none"> <li>Must not be imported into the State or sold</li> </ul>

Mechanical vegetation removal, earthwork, increased human activity during construction and increased edge effects all have the potential to facilitate the spread of weeds within the study area and surrounding vegetation. The proposal may provide an opportunity to carry out weed control work and habitat enhancement following construction of the proposal in accordance with the *Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* (RTA, 2011).

#### 4.2.4 Invasion and spread of pests

Five pest fauna species were identified during the field investigation; Common Myna (*Sturnus tristis*), Common Starling (*Sturnus vulgaris*), Red-whiskered Bulbul (*Pycnonotus jocosus*), Rock Dove (*Columba livia*) and Spotted Dove (*Streptopelia chinensis*). It is expected that other pest species would frequent the study area including the Red Fox (*Vulpes vulpes*) and European Rabbit (*Oryctolagus cuniculus*), as well as domestic Cats (*Felis catus*). The proposal is unlikely to increase the presence of pest species within the study area.

#### 4.2.5 Invasion and spread of pathogens and disease

There is a risk that the construction of the proposal would introduce, spread or exacerbate the plant diseases caused by *Phytophthora cinnamomi* and Myrtle Rust and the amphibian chytrid fungus. These diseases are most likely introduced or spread through the importation or movement of soil, water and landscaping materials, either directly or through incidental attachment to machinery.

#### 4.2.6 Changes to hydrology

Current hydrological modelling in the Nowra Bridge Flooding and Hydrology Assessment Technical Paper Assessment (Arup 2018) has found that there the likely changes to flooding expected within the study area are limited to an increase in the peak flood levels at a limited number of properties in Moorhouse Park by approximately 0.1 metre for the 2 per cent and 1 per cent AEP. Although a significant change in peak flood level is expected in this area, no native vegetation communities exist within this area and, as such, no indirect impacts on biodiversity as a result of changes to hydrology are expected.

#### 4.2.7 Noise, light and vibration

Indirect impacts due to changes in environmental conditions such as noise, light and vibration are expected within and adjoining the study area. An increase in noise is recognised as a potential impediment to species that vocalise for communication, particularly frogs and birds, as well as alter interactions between predators and their prey. In aquatic species, increased noise can result in behavioural or physical impacts, depending on the noise levels.

Similarly, increases in lighting may affect nocturnal behaviour of insectivorous species such as bats and dynamics of localised feeding and predator relationships. An increase in roadkill of fauna attracted to the proposal area and lighting through displacement or reduction of habitat as part of the proposal may occur. Light can also impact aquatic species such as turtles and fish due to attraction and disorientation.

Increases to vibration through construction activities may temporarily disturb and displace nocturnal fauna sheltering in habitat adjoining the construction footprint, and some aquatic species.

During construction, noise from machinery operating within the clearing boundary would include removal of, and disturbance to, native vegetation due to site establishment, clearing and grubbing, earthworks and drainage. Machinery such as vehicles, excavators, grader, crushers, generators and pile drivers would add substantial temporary noise. This may include both daytime work and occasional night work. Spill over of noise into areas outside the proposal area during construction is expected. During operation and maintenance of the proposal, noise from vehicular use is expected to increase within the proposal area as it facilitates traffic flow and future growth in traffic volumes.

Construction of the bridge piers will result in increased underwater noise due to piling and/or dredging activities. Sensitive receptors, particularly whales, dolphin, and marine reptiles (except for the green turtle) have not been recorded within or near the study area. The green turtle (*Chelonia mydas*) has previously been recorded near the study area; however, sightings are extremely uncommon, therefore the probability of this species being observed during construction is low. As such, impacts on aquatic fauna from underwater noise are not anticipated.

During construction, additional light may be produced during night work within the proposal area if this is required. If required, night works are expected to largely be limited to areas within the proposal area. Clearing as part of the construction would open up some edge vegetation, creating edge effects of more light. Construction lighting may also penetrate the aquatic environment, leading to attraction, avoidance or disorientation of aquatic fauna.

During operation, new street lighting for the widened road corridor would increase lighting to new edges of vegetation and habitat, and for species that travel across the widened road. These new environmental conditions in the remaining vegetation 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 and 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.

The temporary construction and long term operational indirect impacts are expected to lead to increases in light, noise and vibration beyond the levels that are currently experienced by the local flora and fauna. These increases are not likely to be significant as, although there may be more light and more noise, the species present in the already urbanised area are likely to be already pre-disposed to handle this and are unlikely to suffer additional and significantly increased impacts beyond those that they are currently subject to.

#### 4.2.8 Runoff

Runoff from the new bridge road surface would impact on water quality if pollutants (e.g., hydrocarbons, gross rubbish) enter the aquatic environment. The new bridge will be designed such that pavement runoff would be contained within drainage lines and directed to the existing drainage network which includes settlement ponds and gross pollutant traps.

An Operational Water Quality Management Plan (ref: NBR-EN-REP-07) has been prepared to address and manage surface water quality impacts to downstream waterways because of the proposal during operational phase. The operational water quality strategy is to prevent or reduce water quality impacts to downstream waterways because of the proposed upgrade during its operation. Relevant mitigation would apply to all sections of the proposal and would be focused on locations where runoff has been concentrated into defined outlet points through the implementation of longitudinal road pavement drainage systems. In addition, as the detailed design for the proposed Nowra Bridge is progressed, water quality management measures would be amended to suit the changes.

Operational impacts associated with soil and water aspects such as contamination, acid sulphate soils, groundwater and management of hazardous substances are not considered significant and can be effectively minimised through additional investigation, the development and implementation of construction environmental management plan.

#### 4.2.9 Groundwater dependent ecosystems

One subsurface groundwater dependent ecosystem, Currumbene-Batemans Lowlands Forest, is likely to be impacted as a result of the proposal. This GDE is associated with the clearing of about 2.09 hectares of Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion. However, as the works are related to clearing of the vegetation on the surface, it is unlikely that the proposal will significantly alter the subsurface flows of this GDE.

### 4.3 Cumulative impacts

One significant road development is occurring within five kilometres of the study area being the upgrade of the Princes Highway from Berry to Bomaderry that starts approximately three kilometres to the north of the study area. Both developments are removing fragmented roadside habitats amongst urban or cleared rural landscapes and so loss of current connectivity is minimal; however, both projects are removing associated native vegetation. **Table 4-5** shows the cumulative impacts on native vegetation as a result of both projects.

No other significant developments have occurred within the locality (10-kilometre search area) beyond residential builds.

**Table 4-5 Cumulative impacts**

Biodiversity aspect	Status	Approved and proposed clearing requirements for local projects in the IBRA Subregion common to this proposal (ha)		Sum of Impact
		Princes Highway Upgrade - Berry to Bomaderry	Nowra Bridge	
Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion / Currumbene-Batemans Lowlands Forest	Not an EEC	1.44 hectares	2.09 hectares	3.53 hectares
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	EEC	0 hectares	0.09 hectares	0.09 hectares

#### 4.4 Assessments of significance

Assessments of significance for threatened species, populations and communities that are considered to have greater than a moderate likelihood of occurrence within the study area are provided in Appendix C of this report. A summary of the results of these assessments are provided in **Table 4-6**.

As detailed in **Table 4-6** and **Table 4-7** it has been determined that it is unlikely that the proposal would have a significant impact on any threatened species, populations or communities.

**Table 4-6 Summary of the findings of significance assessments for TSC Act**

Threatened species, or communities	Significance assessment question <sup>1</sup>							Likely significant impact?
	a	b	c	d	e	f	g	
Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South-East Corner bioregions	N	X	X	N	N	N	N	No
Illawarra Greenhood ( <i>Pterostylis gibbosa</i> )	N	X	X	N	N	N	Y	No



Threatened species, or communities	Significance assessment question <sup>1</sup>							Likely significant impact?
	a	b	c	d	e	f	g	
Magenta Lilly Pilly ( <i>Syzygium paniculatum</i> )	N	X	X	N	N	N	N	No
Bomaderry Zieria ( <i>Zieria baeuerlenii</i> )	N	X	X	N	N	N	N	No
Green and Golden Bell Frog ( <i>Litoria aurea</i> )	N	X	X	N	N	N	Y	No
Powerful Owl ( <i>Ninox strenua</i> )	N	X	X	N	N	Y	Y	No
Square-tailed Kite ( <i>Lophoictinia isura</i> )	N	X	X	N	N	N	Y	No
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	N	X	X	N	N	N	Y	No
White-bellied Sea-eagle ( <i>Haliaeetus leucogaster</i> )	N	X	X	N	N	N	N	No
Eastern Osprey ( <i>Pandion cristatus</i> )	N	X	X	N	N	N	N	No
Eastern Bentwing-bat ( <i>Miniopterus schreibersii oceanensis</i> )	N	X	X	N	N	N	Y	No
Eastern Freetail-bat ( <i>Mormopterus norfolkensis</i> )	N	X	X	N	N	N	Y	No
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )	N	X	X	N	N	N	Y	No
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )	N	X	X	N	N	N	Y	No
Yellow-bellied Sheath-tail-bat ( <i>Saccolaimus flaviventris</i> )	N	X	X	N	N	N	Y	No
Southern Myotis ( <i>Myotis macropus</i> )	N	X	X	N	N	N	Y	No
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	N	X	X	N	N	Y	Y	No
Yellow-bellied Glider ( <i>Petaurus australis</i> )	N	X	X	N	N	N	Y	No
Australian Grayling ( <i>Prototroctes maraena</i> )	N	X	X	N	N	Y	N	No

**Table 4-7 Summary of the findings of significance assessments for EPBC Act**

Threatened species, or communities	Important population <sup>2</sup>	Likely significant impact?
Magenta Lilly Pilly ( <i>Syzygium paniculatum</i> )	No	No
Rufous Fantail ( <i>Rhipidura rufifrons</i> )	No	No
Green and Golden Bell Frog ( <i>Litoria aurea</i> )	Yes	No
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	No	No
Australian Grayling ( <i>Prototroctes maraena</i> )	No	No

Notes for both tables

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

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

- 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,
- 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,
- in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
  - is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
  - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
- in relation to the habitat of a threatened species, population or ecological community:
  - the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
  - whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
  - the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
- whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
- whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,
- whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

A 'population of a species' as determined by the *Environment Protection and Biodiversity Conservation Act 1999* is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
  - a population, or collection of local populations, that occurs within a particular bioregion.
2. Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:
- is likely to be key source populations either for breeding or dispersal
  - is likely to be necessary for maintaining genetic diversity
  - is at or near the limit of the species range.

## 4.5 Impact summary

A range of mitigation measures presented in **Table 4-8** would be implemented during detailed design, prior to construction, during construction and during post construction phases of the proposal. These measures have been developed to mitigate the potential impact of the proposal on protected flora and fauna and threatened species and communities that occur in the study area. Any residual impact that cannot be mitigated would be offset in accordance with *Roads and Maritime Guideline for Biodiversity Offsets 2016*.

**Table 4-8 Summary of impacts**

Impact	Biodiversity values	Nature of impact  Direct, indirect, cumulative	Extent of impact  Site based, Local, Regional, State, National	Duration  Short term Long term	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment  Known, Unknown, unpredictable or irreversible
Removal of native vegetation	Native vegetation	Direct	Site based	Long term	<ul style="list-style-type: none"> <li>Clearing of native vegetation</li> </ul>	Irreversible
Removal of EEC	Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	Direct	Site based	Long term	<ul style="list-style-type: none"> <li>Clearing of urban, rural, agricultural, and forestry development and/or activities</li> <li>Changes in species diversity, soil chemistry, fire frequency, vegetation structure and loss of ecological function caused by weeds. This includes woody weeds (e.g. Groundsel Bush, Lantana, Camphor Laurel and Bitou Bush), Exotic vines &amp; scramblers, Invasive grasses &amp; other weeds (including aquatics)</li> </ul>	Irreversible
Removal of threatened fauna habitat	Eastern Freetail-bat Grey-headed Flying-fox	Direct	Site based	Long term	<ul style="list-style-type: none"> <li>Clearing of native vegetation</li> <li>Bushrock removal</li> <li>Loss of hollow-bearing trees</li> <li>Removal of dead wood and dead trees</li> </ul>	Known
Removal of threatened flora	<i>Syzygium paniculatum</i>	Direct	Site based	Long term	None. Planted individuals and not in natural landscape.	Known
Impacts to aquatic habitat	Stream flow	Direct	Local	Long-term	<ul style="list-style-type: none"> <li>Installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers or streams</li> </ul>	Known
Impacts to aquatic habitat	Water and sediment quality	Indirect	Site-based	Short-term	N/A	Known



Impact	Biodiversity values	Nature of impact  Direct, indirect, cumulative	Extent of impact  Site based, Local, Regional, State, National	Duration  Short term Long term	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment  Known, Unknown, unpredictable or irreversible
Removal of aquatic habitat	Seagrass	Direct	Site-based	Long-term	Loss of aquatic habitat	Known
Injury and mortality of fauna	Native fauna	Direct	Site based	Short term	N/A	Unpredictable
Fragmentation of identified biodiversity links and habitat corridors	Biodiversity corridors	Direct/indirect	Local	Long term	<ul style="list-style-type: none"> <li>• Clearing of native vegetation</li> </ul>	Irreversible
Edge effects on adjacent native vegetation and habitat	Native vegetation and habitat	Indirect	Local	Long term	N/A	Unpredictable
Invasion and spread of weeds	Native vegetation and habitat	Indirect	Site based	Long term	<ul style="list-style-type: none"> <li>• Invasion and establishment of exotic vines and scramblers</li> <li>• Invasion of native plant communities by African Olive (<i>Olea europaea</i> L. subsp. <i>cuspidata</i>)</li> <li>• Invasion, establishment and spread of <i>Lantana camara</i></li> <li>• Invasion of native plant communities by Bitou Bush and Boneseed (<i>Chrysanthemoides monilifera</i>)</li> <li>• Invasion of native plant communities by exotic perennial grasses</li> <li>• Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants</li> </ul>	Unpredictable
Invasion and spread of pests	Native fauna	Indirect	Site based, local and regional	Long term	<ul style="list-style-type: none"> <li>• Competition and grazing by the feral European Rabbit (<i>Oryctolagus cuniculus</i>)</li> </ul>	Unpredictable

Impact	Biodiversity values	Nature of impact  Direct, indirect, cumulative	Extent of impact  Site based, Local, Regional, State, National	Duration  Short term Long term	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment  Known, Unknown, unpredictable or irreversible
					<ul style="list-style-type: none"> <li>• Predation by the European Red Fox (<i>Vulpes vulpes</i>)</li> <li>• Predation by the feral cat (<i>Felis catus</i>)</li> </ul>	
Invasion and spread of pathogens and disease	Native flora and fauna Threatened species habitat	Indirect	Site based, local and regional	Long term	<ul style="list-style-type: none"> <li>• Infection of native plants by <i>Phytophthora cinnamomi</i></li> <li>• Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae</li> <li>• Infection of frogs by amphibian chytrid causing the disease Chytridiomycosis</li> </ul>	Unpredictable
Groundwater dependent ecosystems	Native vegetation communities	Indirect - operational	Local	Long term	N/A	Unknown
Noise, light and vibration	Native fauna	Direct/indirect	Local	Short term	N/A	Known

## 5 Avoid, minimise and mitigate impacts

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### 5.1 Avoidance and minimisation

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

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

The construction footprint has been delineated with careful consideration of the design's direct footprint, where possible minimising impact on properties, drainage, utility work and all environmental factors. The proposal has been designed so that it follows the existing road corridor alignment. Biodiversity constraints will be considered throughout the design process. However, considering the location of the upgrade within an urbanised landscape, due to impacts to the local residents, the potential to change the design in order to further avoid impact to biodiversity is limited.

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 (see **Section 5.2**). A six metre indirect impact buffer has been applied to encapsulate all direct impact including edge effects as a result of construction activities.

### 5.2 Mitigation measures

A range of mitigation measures are presented in **Table 5-1** and would be implemented during detailed design, prior to construction, during construction and during post construction phases of the proposal. These measures have been developed to mitigate the potential impacts of the proposal on protected flora and fauna and threatened species and communities that occur in the study area.

**Table 5-1 Mitigation measures**

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
General biodiversity	<p>A Flora and Fauna Management Plan (FFMP) would be prepared as part of the Construction Environmental Management Plan (CEMP). The FFMP would 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 and G40 Clearing and Grubbing. The FFMP would include, but not be limited to:</p> <ul style="list-style-type: none"> <li>• Pre-clearing process including details for nocturnal pre-clearing surveys for the Green and Golden Bell Frog</li> <li>• Management of unexpected species finds</li> <li>• Delineation of exclusion zones</li> <li>• Process for weed management</li> <li>• Process for pathogen management</li> <li>• Requirements set out in the Landscape Guideline (RTA 2008)</li> <li>• Management of chytrid fungus and Plague Minnow following the relevant threat abatement plans.</li> </ul>	Prior to construction	Effective	None
Removal of native vegetation	Native vegetation removal will be minimised through detailed design.	Detailed design	Effective	None
	Pre-clearing surveys will be undertaken in accordance with <i>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	Prior to construction	Effective	
	Vegetation removal will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	
	Native vegetation will be re-established in accordance with <i>Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	Post construction	Effective	
	The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA	During construction	Proven	



Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal site.			
	A mulch management plan is to be prepared in accordance with the mulch order 2016 under the <i>Protection of the Environment Operations Act 1997</i> (POEO Act)	Prior to construction	Effective	
Removal of endangered ecological communities (EEC)	Removal of EEC will be minimised through detailed design.	Prior to construction	Effective	None
	Exclusion zones will be placed around retained EECs in accordance for Guide 2: Exclusion Zones	Prior to construction	Proven	
	EEC removal will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	
Removal of aquatic habitat	Removal of aquatic habitat (seagrass) would be minimised through detailed design.	Prior to construction	Effective	None
Removal of threatened species habitat and habitat features	Habitat removal will be minimised through detailed design.	Detailed design	Effective	None
	Habitat removal will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	
	Habitat will be replaced or re-instated in accordance with <i>Guide 5: Re-use of woody debris and bushrock</i> and <i>Guide 8: Nest boxes</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). Nest boxes will replace removed hollows at a 1:1 ratio.	During construction	Proven	
	The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the proposal site.	During construction	Proven	
Removal of threatened plants	Pre-clearing surveys will be undertaken in accordance with <i>Guide 1: Pre-clearing process</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Proven	None

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified in the proposal site.	During construction	Proven	
Aquatic impacts	Aquatic habitat will be protected in accordance with <i>Guide 10: Aquatic habitats and riparian zones</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) and Section 3.3.2 <i>Standard precautions and mitigation measures</i> of the <i>Policy and guidelines for fish habitat conservation and management Update 2013</i> (DPI (Fisheries NSW) 2013).	During construction	Effective	None
	A Soil and Water Management Plan (SWMP) would be prepared as part of the CEMP. The SWMP would be prepared in accordance with Roads and Maritime QA Specification G36 Environment Protection, G38 Soil and Water Management, the <i>Policy and Guidelines for Fish Habitat Conservation and Management</i> (DPI, 2013) and ANZECC (2000). The SWMP would include: <ul style="list-style-type: none"> <li>Processes for water quality and sediment management</li> <li>Compliance reporting requirements.</li> </ul>	During construction / operation	Effective	None
Groundwater dependent ecosystems	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design.	Detailed design	Effective	None
Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Detailed design	Effective	None
Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with <i>Guide 2: Exclusion zones</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	None
Injury and mortality of fauna	Fauna will be managed in accordance with <i>Guide 9: Fauna handling</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	None

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Invasion and spread of weeds	Weed species will be managed in accordance with <i>Guide 6: Weed management</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	None
	If mulch to removed offsite, then a mulch management plan in accordance with the mulch order 2016 under the <i>Protection of the Environment Operations Act 1997</i> (POEO Act)	Prior to construction	Effective	
Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with <i>Guide 2: Exclusion zones</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	None
	If mulch to removed offsite, then a mulch management plan in accordance with the mulch order 2016 under the <i>Protection of the Environment Operations Act 1997</i> (POEO Act)	Prior to construction	Effective	
Noise, light and vibration	Shading and artificial light impacts will be minimised through detailed design.	Detailed design	Effective	None

## 6 Offset strategy

### 6.1 Quantification of impacts

Roads and Maritime is committed to offsetting impacts associated with the proposal in line with its biodiversity offsetting guidelines (RMS, 2016) and in general accordance with the OEH principles for the use of biodiversity offsets in NSW.

Roads and Maritime will provide biodiversity offsets or, where offsets are not reasonable or feasible, supplementary measures for impacts that exceed the following thresholds.

**Table 6-1 Summary of the Roads and Maritime Services Biodiversity Offset Guidelines**

Description of activity or impact	Consider offsets or supplementary measures
Activities in accordance with Roads and Maritime Services Environmental assessment procedure: Routine and Minor Works (RTA 2011)	No
Works on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present	No
Works involving clearing of vegetation planted as part of a road corridor landscaping program (this includes where threatened species or species comprising listed ecological communities have been used for landscaping purposes)	No
Works involving clearing of national or NSW listed critically endangered ecological communities (CEEC)	Where there is any clearing of an CEEC in moderate to good condition
Works involving clearing of nationally listed threatened ecological community (TEC) or nationally listed threatened species habitat	Where clearing >1 hectares of a TEC or habitat in moderate to good condition
Works involving clearing of a NSW listed endangered or vulnerable ecological community	Where clearing > 5 hectares or where the ecological community is subject to an SIS
Works involving clearing of NSW listed threatened species habitat where the species is a species credit species as defined in the OEH Threatened Species Profile Database (TSPD)	Where clearing > 1 hectares or where the species is the subject of an SIS
Works involving clearing of NSW listed threatened species habitat and the species is an ecosystem credit species as defined in OEH's Threatened Species Profile Database (TSPD)	Where clearing > 5 hectares or where the species is the subject of an SIS
Type 1 or Type 2 key fish habitats (as defined by NSW Fisheries)	Where there is any net loss of habitat

In accordance with the above thresholds, **Table 6-2** provides an assessment for offsetting of impacts of the proposal for vegetation communities being impacted. Threatened species were not considered as the impacts on all threatened species with a moderate or higher likelihood of occurrence were considered to be non-significant and so need no further consideration and did not meet the area threshold criteria anyway.



**Table 6-2 Impacts on vegetation communities (ecosystem credits)**

PCT Code	PCT Name	EEC	Area (ha)	Meets RMS Biodiversity Offsetting Guideline (2016) thresholds?
1206	Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion	No	2.09	No
1236	Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	Yes	0.09	No
	Seagrass - <i>Zostera muelleri</i> – which constitutes Type 1 or Type 2 key fish habitat	No	0.09	Yes

In accordance with the *RMS Guidelines for Biodiversity Offsets (v2.0)*, biodiversity offsets should be considered where there is any clearing of Type 1 or Type 2 key fish habitat (as defined by NSW DPI). As discussed in Section 3.5, the area of seagrass within the construction footprint is classified as Type 1 key fish habitat. This aligns with *NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management (2013 update)*, which enforces a ‘no net loss’ of key fish habitat as a permanent condition of development approval. If impacts (direct and indirect) are unavoidable, they are to be offset by environmental compensation. This may require proponents to conduct habitat rehabilitation and/or provide environmental compensation. NSW DPI does not allow seagrass transplanting as an impact compensation measure. Therefore, if seagrass is likely to be negatively impacted and cannot be avoided or minimised, financial compensation would be required. The standard compensation rate is listed as \$51/m<sup>2</sup>, however, for seagrass and other Type I and II fish habitat DPI Policy requires an offset compensation ratio of 2:1. Therefore, a nominal compensation amount of \$102/m<sup>2</sup> is likely to apply in line with NSW DPI policy. Habitat compensation (e.g. mangroves) may be negotiated as a component of the offset package in addition to financial compensation, and would be calculated on a minimum 2:1 basis for all key fish habitat types (Type 1-3). A greater compensation ratio may be required if opportunities for compensation are not available in the vicinity of, or of the type of habitat that has been lost. The offset requirements would be provided by NSW DPI as a condition of approval.

## 7 Conclusion

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### 7.1 Conclusions

The proposal would result in the clearing of about 5.64 hectares of vegetation which includes about 2.18 hectares of native vegetation that is formed 2.09 hectares of Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (PCT1206) and 0.09 of Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (PCT1236). The native vegetation to be removed is generally in moderate to good condition and consists of linear strips of small remnant patches. Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions meets the determination for the BC Act listed EEC Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions; however, given the presence of the EEC is only in small remnant patches less than 0.5 hectares in size, it does not meet the determination of the EEC under the EPBC Act.

One threatened flora species, *Syzygium paniculatum*, listed as vulnerable under both the TSC Act and EPBC Act, was found to occur within the study area. However, the *Syzygium paniculatum* individuals encountered have been planted as a screen between the Princes Highway and local residences and do not occur naturally within the community that they were found. The Grey-headed Flying-fox, listed as vulnerable under both the TSC Act and EPBC Act, has a camp immediately adjacent to the construction boundary in the north of the study area. Further threatened fauna species, Eastern Freetail-Bat, Rufous Fantail, Varied Sittella and White-bellied Sea-eagle, were recorded as present in the study area during the field surveys.

Likelihood of occurrence assessment conducted for other threatened species found that one species, Southern Myotis, was regarded as having high potential to occur. Twelve other flora or fauna species were identified as having moderate potential to occur, including on a transient basis. All other threatened species potentially present were identified as having a low potential to occur.

Searches of available databases found that, for the threatened aquatic species considered as potentially occurring, only the Australian Grayling has a previous record from the area.

Fauna habitat within the study area includes dry sclerophyll forest, riparian vegetation and exotic vegetation. The proposal would require the removal of about 2.18 hectares of native vegetation and about 3.06 hectares of additional planted native and non-native vegetation. Approximately 12.18 hectares of the 19,064 hectares of the planned management site for the Green and Golden Bell Frog Population of Crookhaven River Floodplain are included as part of the study area. The 12.18 hectares contains potential feeding and shelter habitat, but minimal breeding habitat. The study area is located at the very northern extent of the Crookhaven River Floodplain management site and records are absent from both the study area and anywhere to the north. Hence it appears that this part of the Crookhaven River Floodplain is rarely if ever used by the Green and Golden Bell Frog.

Impacts to aquatic habitats include the direct loss of up to 0.09 hectares of seagrass, increased turbidity and sedimentation and the installation of in-stream structures. Direct and indirect impacts to aquatic habitat are likely to be minor and short-term, and will be managed through the implementation of mitigation measures. Where it is not possible to mitigate impacts on seagrass, habitat compensation (e.g. mangroves) may be negotiated as a component of the offset package in addition to financial compensation of \$51/m<sup>2</sup>. This would be calculated on a minimum 2:1 basis for all key fish habitat types (Type 1-3), following current DPI policy.

Assessments of significance have been undertaken for species and ecological communities that are known to occur within the study area or have a moderate likelihood of occurring or greater. The assessments of significance conducted under both the TSC Act and EPBC Act found it was unlikely

that there will be a significant impact on any species, population or community because of the proposal.

Mitigation measures have been recommended to reduce impact on threatened species, communities and their habitats. These measures include:

- Minimising impact through detailed design
- Adhering to the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011)
- Adhering to the Wildlife Connectivity Guidelines for Road Projects (RTA 2011)
- Preparation of a mulch management plan in accordance with the POEO Act.

It was found that there are no residual impacts of the project following implementation of the recommended mitigation measures for terrestrial ecology. However, in line with the Roads and Maritime Offsetting Guidelines (RMS, 2016) biodiversity offsetting is required to offset the impacts of the proposal on up to 0.09 hectares of Type 1 Fish Habitat.

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## Appendix A – Species recorded

### Recorded flora

Family	ScientificName	Common name	Status		Abundance in each plot*		Incidental observation
			TSC Act	EPBC Act	1 Cover	1 Abundance	
<b>Canopy</b>							
	<i>Corymbia maculata</i>	Spotted Gum			10	6	
	<i>Eucalyptus microcorys</i>	Tallowwood					*
	<i>Grevillea robusta</i>	Silky Oak					*
	<i>Erythrina x sykesii</i>	Coral Tree					*
	<i>Casuarina cunninghamiana</i>	River Oak					*
	<i>Jacaranda mimosifolia</i>	Jacaranda					*
	<i>Eucalyptus tereticornis</i>	Forest Red Gum					*
	<i>Eucalyptus saligna x botryoides</i>	Wollongong Woollybutt					*
<b>Shrubs</b>							
	<i>Backhousia myrtifolia</i>	Grey Myrtle			5	10	
	<i>Pittosporum undulatum</i>	Australian Cheesewood			1	2	
	<i>Exocarpus cupressiformis</i>	Native Cherry			0.5	1	
	<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum			0.1	1	
	<i>Acacia ulicifolia</i>	Prickly Moses			0.1	2	
	<i>Ozothamnus diosmifolius</i>	Rice Flower			0.5	2	
	<i>Lantana camara</i> *	Lantana			0.1	1	
	<i>Dodonaea triquetra</i>	Hop Bush			0.1	1	
	<i>Prostanthera incana</i>	Velvet Mintbush			1	5	
	<i>Bursaria spinosa subsp. spinosa</i>	Native Blackthorn			2	10	
	<i>Olea europaea subsp. cuspidata</i> *	Wild Olive			0.5	1	
	<i>Olearia viscidula</i> *	Wallaby Weed			0.5	1	
<b>Ferns and Allies</b>							
	<i>Cheilanthes sieberi</i>	Poison Rock Fern			0.1	10	
	<i>Pyrrhosia rupestris</i>	Rock Felt Fern			0.1	10	
<b>Eudicots</b>							
	<i>Plectranthus parviflorus</i>	Cockspur Flower			0.5	10	

Family	ScientificName	Common name	Status		Abundance in each plot*		Incidental observation
			TSC Act	EPBC Act	1 Cover	1 Abundance	
<b>Climbers/Vines</b>							
	<i>Pandorea pandorana</i>	Wonga Vine			1	10	
	<i>Smilax australis</i>	Lawyer Vine			0.1	1	
	<i>Glycine clandestina</i>	Twining Glycine			0.1	1	
<b>Monocots</b>							
	<i>Themeda triandra</i>	Kangaroo Grass			1	20	
	<i>Entolasia stricta</i>	Wiry Panic			1	20	
	<i>Microlaena stipoides</i>	Weeping Grass			0.5	10	
	<i>Entolasia marginata</i>	Bordered Panic			0.1	1	
<b>Monocots (Other)</b>							
	<i>Epidendrum sp.*</i>				60	1000	
	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			5	100	
	<i>Bryophyllum delagoense*</i>	Mother of Millions			30	2000	
	<i>Asparagus aethiopicus*</i>	Sprenger's Asparagus Fern			2	10	
	<i>Dianella caerulea</i>	Blue Flax Lily			5	10	
	<i>Lomandra confertifolia</i>	Mat Rush			10	500	
	<i>Chlorophytum comosum</i>	Spider Plant			40	1000	
	<i>Dendrobium striolatum</i>	Streaked Rock Orchid			2	500	
	<i>Commelina cyanea</i>	Scurvy Weed			0.5	3	

### Vegetation condition assessment table

Site value	PCT1206
<b>Plot number:</b>	<b>1</b>
Native plant species	28
Native overstorey cover (%)	59
Native midstorey cover (%)	31.5
Native ground cover - grass	2.5
Native ground cover – shrub (%)	9.5
Native ground cover – other (%)	22
Exotic plant cover (%)	9.33
Number of hollow trees	0
Canopy Regeneration (%)	0
Fallen logs (m)	12
<b>Condition category</b>	<b>Moderate/Good</b>

*Note: The benchmark values available on VIS 2.1 are set to the values for the Biodiversity Assessment Methodology (OEH, 2017). As such, site value scores are not available outside of the BBCC.*



## Recorded fauna

Taxa/Fauna group	Scientific Name	Common name	Status	
			TSC Act	EPBC Act
Amphibian	<i>Crinia signifera</i>	Common Eastern Froglet		
Amphibian	<i>Limnodynastes peronii</i>	Striped Marsh Frog		
Amphibian	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog		
Bird	<i>Acanthiza nana</i>	Yellow Thornbill		
Bird	<i>Acanthiza pusilla</i>	Brown Thornbill		
Bird	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill		
Bird	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill		
Bird	<i>Anas castanea</i>	Chestnut Teal		
Bird	<i>Anas superciliosa</i>	Pacific Black Duck		
Bird	<i>Anhinga novaehollandiae</i>	Australasian Darter		
Bird	<i>Anser sp.*</i>	Domestic goose		
Bird	<i>Anthochaera carunculata</i>	Red Wattlebird		
Bird	<i>Anthochaera chrysoptera</i>	Little Wattlebird		
Bird	<i>Butorides striata</i>	Striated Heron		
Bird	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo		
Bird	<i>Cacatua sanguinea</i>	Little Corella		
Bird	<i>Chenonetta jubata</i>	Australian Wood Duck		
Bird	<i>Chroicocephalus novaehollandiae</i>	Silver Gull		
Bird	<i>Colluricincla harmonica</i>	Grey Shrike-thrush		
Bird	<i>Columba leucomela</i>	White-headed Pigeon		
Bird	<i>Columba livia*</i>	Rock Dove		
Bird	<i>Cormobates leucophaeus</i>	White-throated Treecreeper		
Bird	<i>Corvus coronoides</i>	Australian Raven		
Bird	<i>Cracticus nigrogularis</i>	Pied Butcherbird		
Bird	<i>Cracticus tibicen</i>	Australian Magpie		
Bird	<i>Cygnus atratus</i>	Black Swan		
Bird	<i>Dacelo novaeguineae</i>	Laughing Kookaburra		
Bird	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	
Bird	<i>Egretta garzetta</i>	Little Egret		
Bird	<i>Egretta novaehollandiae</i>	White-faced Heron		
Bird	<i>Eolophus roseicapilla</i>	Galah		
Bird	<i>Eopsaltria australis</i>	Eastern Yellow Robin		
Bird	<i>Fulica atra</i>	Eurasian Coot		
Bird	<i>Gallinula tenebrosa</i>	Dusky Moorhen		
Bird	<i>Grallina cyanoleuca</i>	Magpie-lark		
Bird	<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	V	
Bird	<i>Hirundo neoxena</i>	Welcome Swallow		
Bird	<i>Leucosarcia picata</i>	Wonga Pigeon		
Bird	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater		
Bird	<i>Malurus cyaneus</i>	Superb Fairy-wren		
Bird	<i>Meliphaga lewinii</i>	Lewin's Honeyeater		
Bird	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater		
Bird	<i>Neochmia temporalis</i>	Red-browed Finch		
Bird	<i>Ocyphaps lophotes</i>	Crested Pigeon		
Bird	<i>Pachycephala pectoralis</i>	Golden Whistler		
Bird	<i>Pardalotus striatus</i>	Striated Pardalote		
Bird	<i>Pelecanus conspicillatus</i>	Australian Pelican		
Bird	<i>Phalacrocorax varius</i>	Pied Cormorant		
Bird	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater		
Bird	<i>Platycercus elegans</i>	Crimson Rosella		
Bird	<i>Porphyrio porphyrio</i>	Purple Swamphen		
Bird	<i>Psophodes olivaceus</i>	Eastern Whipbird		

Taxa/Fauna group	Scientific Name	Common name	Status	
			TSC Act	EPBC Act
Bird	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird		
Bird	<i>Pycnonotus jocosus</i> *	Red-whiskered Bulbul		
Bird	<i>Rhipidura albiscapa</i>	Grey Fantail		
Bird	<i>Rhipidura leucophrys</i>	Willie Wagtail		
Bird	<i>Rhipidura rufifrons</i>	Rufous Fantail		M
Bird	<i>Sericornis frontalis</i>	White-browed Scrub Wren		
Bird	<i>Strepera graculina</i>	Pied Currawong		
Bird	<i>Streptopelia chinensis</i> *	Spotted Dove		
Bird	<i>Sturnus tristis</i> *	Common Myna		
Bird	<i>Sturnus vulgaris</i> *	Common Starling		
Bird	<i>Threskiornis molucca</i>	Australian White Ibis		
Bird	<i>Todiramphus sanctus</i>	Sacred Kingfisher		
Bird	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		
Bird	<i>Turdus merula</i> *	Common Blackbird		
Bird	<i>Vanellus miles</i>	Masked Lapwing		
Bird	<i>Zosterops lateralis</i>	Silvereye		
Mammal	<i>Austronomus australis</i>	White-striped Freetail-bat		
Mammal	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		
Mammal	<i>Chalinolobus morio</i>	Chocolate Wattled Bat		
Mammal	<i>Mormopterus "Species 2"</i>	Undescribed Freetail-bat		
Mammal	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	
Mammal	<i>Nyctophilus sp.</i>	Long-eared Bat		
Mammal	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V
Mammal	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat		
Mammal	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat		
Mammal	<i>Vespadelus darlingtoni</i>	Large Forest Bat		
Mammal	<i>Vespadelus vulturnus</i>	Little Forest Bat		

## Appendix B – Habitat assessment table

### Likelihood of occurrence criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (ie. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 kilometres) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10 kilometres). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the study area.

### Habitat assessment table

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
<b>FLORA</b>					
<i>Acacia pubescens</i>	V		A spreading shrub primarily confined to the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers at Barden Ridge, Oakdale and Mountain Lagoon. Grows in Cooks/River Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland, usually within roadside and bushland remnants. Grows on shale, sandstone, alluvium and gravelly soils, often including ironstone.	2 (BioNet)	Low

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
<i>Cryptostylis hunteriana</i>	V		Orchid with a distribution spanning from Gibraltar Range National Park southwards to the coastal area near Orbost in Victoria. Grows in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Coastal Heath Swamps, New England Dry Sclerophyll Forests and Sydney Coastal Heaths. Grows in sandy soils.	4 (BioNet)	Low
<i>Eucalyptus langleyi</i>	V	E	Mallee tree, confined to the south-west of Nowra as far as Yarramunmun Creek and in Bomaderry Creek Regional Park. Grows in mallee shrubland in South East Dry Sclerophyll Forests, Sydney Coastal Dry Sclerophyll Forests, Sydney Hinterland Dry Sclerophyll Forests and Sydney Montane Heaths. Grows on poorly drained shallow sand soils on sandstone substrates	20 (BioNet)	None
<i>Genoplesium bauera</i>	E	E	Terrestrial orchid with 13 populations totalling 200 plants distributed between Ulladulla and Port Stephens. Grows on moss gardens in a variety of communities including Sydney Coastal Dry sclerophyll Forests, Sydney Coastal Heaths, Sydney Montane Heaths, Southern Lowland Wet Sclerophyll Forests and Sydney Hinterland Dry Sclerophyll Forests. Grows on sandstone substrates.	20 (BioNet)	Low
<i>Hibbertia stricta</i> subsp. <i>furcatula</i>	E		Restricted to two populations, one in the southern outskirts of Sydney and the other near Nowra on the mid-South Coast of NSW. Grows on upper slopes and above the Woronora River Gorge escarpment in a variety of communities including South East Dry Sclerophyll Forests, Sydney Coastal Dry Sclerophyll Forests, Sydney Hinterland Dry Sclerophyll Forests, and Southern Lowland Wet Sclerophyll Forests. Sydney population grows at or near the interface between the Hawkesbury Sandstone and Lucas Heights soil landscapes, in gravelly loam or clay soils. Nowra population grows on sandstone substrates in sandy soils.	21 (BioNet)	None



Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Illawarra Greenhood ( <i>Pterostylis gibbosa</i> )	E	E	Terrestrial orchid with a disjunct distribution from the Milbrodale in the Hunter Region, Albion Park and Yallah in the Illawarra Region and Nowra in the Shoalhaven Region. Found growing amongst grasses on flat or gently sloping land with poor drainage in woodland dominated by Forest Red Gum <i>Eucalyptus tereticornis</i> , Woollybutt <i>E. longifolia</i> , and White Feather Honey-myrtle <i>Melaleuca decora</i> . In Nowra, the orchid can be found growing in association with Spotted Gum <i>Corymbia maculata</i> , Forest Red Gum and Grey Ironbark <i>Eucalyptus paniculata</i> . In the Hunter Region, the orchid is associated with Narrow-leaved Ironbark <i>E. crebra</i> , Forest Red Gum and Black Cypress Pine <i>Callitris endlicheri</i> . Grows in red brown loam soils.	67 (BioNet)	Moderate
<i>Pterostylis vernalis</i>	CE	CE	Terrestrial orchid restricted to five populations of ~500 plants located to the west and south-west of Nowra including Jerrawangala National Park and Triplarina Nature Reserve on the NSW south coast. Found growing on rock shelves in Sydney Coastal Dry Sclerophyll Forests, Sydney Hinterland Dry Sclerophyll Forests, Coastal Heath Swamps and Sydney Coastal Heaths. Grows in shallow soils over sandstone substrates.	21 (BioNet)	Low
<i>Solanum celatum</i>	E		Restricted to an area from Wollongong to just south of Nowra and west to Bungonia. Found growing on hills, slopes, disturbed sites and rainforest clearings in Central Gorge Dry Sclerophyll Forests, Dry Rainforests and North Coast Wet Sclerophyll Forests.	1 (BioNet)	Low. Not recorded during targeted survey.
<i>Syzygium paniculatum</i>	E	V	Restricted to a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. Found growing on stabilized dunes near the sea in South Coast Sands Dry Sclerophyll Forests, Coastal Swamp Forests, Coastal Headland Heaths, Littoral Rainforests, Northern Hinterland Wet Sclerophyll Forests and Southern Lowland Wet Sclerophyll Forests. Grows on grey sandy, gravelly, silty or clay soils over sandstone substrates.	1 (BioNet)	Recorded (planted individuals)

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Nowra Heath Myrtle ( <i>Triplarina nowraensis</i> )	E	E	Small erect shrub restricted to five populations three of which are found west of Nowra, another in the Boolijong Creek Valley 18 kilometre south-east of Nowra and the fifth found on the plateau above Bundanoon north of the Shoalhaven River. Found growing on gently sloping sandstone shelves or adjacent to creeks with no canopy or a stunted canopy in South East Dry Sclerophyll Forests, Sydney Coastal Dry Sclerophyll Forests, Sydney Hinterland Dry Sclerophyll Forests and Sydney Coastal Heaths. Grows on poorly drained soils over Nowra Sandstone substrates.	334 (BioNet)	Low
Bomaderry Zieria ( <i>Zieria baeuerlenii</i> )	E	E	Small shrub restricted to 43 small populations dispersed in six discrete clusters found in a single location on both sides of Bomaderry Creek, north-west of Nowra. Found growing in shrubland on a rocky plateau amongst sandstone boulders in Sydney Hinterland Dry Sclerophyll Forests. Grows in skeletal sandy loam soils over sandstone substrates.	117 (BioNet)	Moderate
<b>FAUNA</b>					
Australasian Bittern ( <i>Botaurus poiciloptilus</i> )	E		Distributed across south-eastern Australia. Often found in terrestrial and estuarine wetlands, generally where there is permanent water with tall, dense vegetation including <i>Typha</i> spp. and <i>Eleocharis</i> spp. Typically forages at night on frogs, fish and invertebrates, and remains inconspicuous during the day. The breeding season extends from October to January with nests being built amongst dense vegetation on a flattened platform of reeds.	1 (BioNet)	Low
Australian Fur-seal ( <i>Arctocephalus pusillus doriferus</i> )	V	-	Marine species. Haul-out sites occur around Jarvis Bay, and off the coast of southern NSW. No breeding colonies are known in NSW.	1 (BioNet)	Low
Black Bittern ( <i>Ixobrychus flavicollis</i> )	V	-	Occurs below 200 m above sea level and inhabit both terrestrial and estuarine wetlands, with a preference for permanent water bodies and dense vegetation. Roosts in trees or amongst dense reeds.	4 (BioNet)	Low
Black Falcon ( <i>Falco subniger</i> )	V	-	Mainly occur in woodlands and open country where can hunt. Often associated with swamps, rivers and wetlands. Nest in tall trees along watercourses.	1 (BioNet)	Low

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Bush Stone-Curlew ( <i>Burhinus grallarius</i> )	E	-	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present.	2 (BioNet)	Low
Dusky Woodswallow ( <i>Artamus cyanopterus</i> )	V	-	Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.	2 (BioNet)	Low
Eastern Bentwing-bat ( <i>Miniopterus schreibersii oceanensis</i> )	V	-	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. Occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways.	14 (BioNet)	Moderate
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )	V	-	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes. Roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals. Often change roosts every night. Forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails. This species has a large foraging range of up to 136 hectares. Records show movements of up to 12 kilometres between roosting and foraging sites.	7 (BioNet)	Moderate

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Eastern Freetail-bat ( <i>Mormopterus norfolkensis</i> )	V		Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites.	3 (BioNet)	Recorded under the Nowra Bridge along the northern bank of the Shoalhaven River.
Eastern Osprey ( <i>Pandion cristatus</i> )	V		Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 kilometre inland along larger rivers. It is water-dependent, hunting for fish in clear, open water. Occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	2 (BioNet)	Moderate
Eastern Pygmy-possum ( <i>Cercartetus nanus</i> )	V		Patchily distributed from the coast to the Great Dividing Range, and as far as Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Soft fruits are eaten when flowers are unavailable and it also feeds on insects. Will often nest in tree hollows, but can also construct its own nest. Because of its small size it is able to utilise a range of hollow sizes including very small hollows. It is mainly solitary, and each individual uses several nests. Home ranges of males are generally less than 2.15 hectares, and those of females are smaller.	7 (BioNet)	Low
Freckled Duck ( <i>Stictonetta naevosa</i> )	V		Breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits.	3 (BioNet)	Low



Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Gang-gang Cockatoo ( <i>Callocephalon fimbriatum</i> )	V		In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest. 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. It requires tree hollows in which to breed.	11 (BioNet)	Low
Giant Burrowing Frog ( <i>Heleioporus australiacus</i> )	V	-	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks. Can also occur within shale outcrops within sandstone formations. Known from wet and dry forests and montane woodland in the southern part range. Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water. Spends the majority of its time in non-breeding habitat 20-250 m from breeding sites.	3 (BioNet)	Low
Glossy Black-cockatoo ( <i>Calyptorhynchus lathamii</i> )	V	-	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead.	227 (BioNet)	Low
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )	V	-	Occurs along the Great Dividing Range, generally at 500 m but up to 1200 metres, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches.	8 (BioNet)	Moderate
Greater Glider ( <i>Petauroides volans</i> )	-	V	Distribution includes the ranges and coastal plain of eastern Australia, where it inhabits a variety of eucalypt forests and woodlands. Presence and density of Greater Gliders is related to soil fertility, eucalypt tree species, disturbance history and density of suitable tree hollows	0 (PMST)	Low

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Green and Golden Bell Frog ( <i>Litoria aurea</i> )	E	V	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC. Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks, although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land.	180 (BioNet)	Moderate
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation.	44 (BioNet)	Recorded. A camp occurs within the study area.
Hooded Plover ( <i>Thinornis rubricollis</i> )	CE	V	Prefers sandy ocean beaches, especially those that are broad and flat.	1 (BioNet)	Low
Koala ( <i>Phascolarctos cinereus</i> )	V	-	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region. Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally. Primary feed trees include <i>Eucalyptus robusta</i> , <i>E. tereticornis</i> , <i>E. punctata</i> , <i>E. haemostoma</i> and <i>E. signata</i> . They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100 hectares.	1 (BioNet)	Low
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )	V	-	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands. Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals.	6 (BioNet)	Low

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Little Eagle ( <i>Hieraaetus morphnoides</i> )	V	-	Most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species. It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. Nests in tall living trees within farmland, woodland and forests.	1 (BioNet)	Low
Little Lorikeet ( <i>Glossopsitta pusilla</i> )	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 metres and 15 metres, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	1 (BioNet)	Low
Masked Owl ( <i>Tyto novaehollandiae</i> )	V	-	Found across a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. It has mostly been recorded in open forests and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. The nest hollows are usually located within dense forests or woodlands. Prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. It has a large home range of 500 to 1000 hectares.	1 (BioNet)	Low
Powerful Owl ( <i>Ninox strenua</i> )	V	-	Occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. Large mature trees with hollows at least 0.5 metres deep are required for nesting. Tree hollows are particularly important because a large proportion of the diet is made up of hollow- dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 centimetres. It has a large home range of between 450 and 1450 hectares.	23 (BioNet)	Moderate

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	CE	CE	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: <i>Eucalyptus microcarpa</i> , <i>E. punctata</i> , <i>E. polyanthemos</i> , <i>E. mollucana</i> , <i>Corymbia robusta</i> , <i>E. crebra</i> , <i>E. caleyi</i> , <i>C. maculata</i> , <i>E. mckieana</i> , <i>E. macrorhyncha</i> , <i>E. laevopinea</i> and <i>Angophora floribunda</i> . Nectar and fruit from the mistletoes <i>A. miquelii</i> , <i>A. pendula</i> , <i>A. cambagei</i> are also eaten during the breeding season. Usually nest in horizontal branches or forks in tall mature eucalypts and sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female.	1 (BioNet)	Low
Rufous Fantail ( <i>Rhipidura rufifrons</i> )		M	Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood ( <i>Eucalyptus microcorys</i> ), Mountain Grey Gum ( <i>E. cypellocarpa</i> ), Narrow-leaved Peppermint ( <i>E. radiata</i> ), Mountain Ash ( <i>E. regnans</i> ), Alpine Ash ( <i>E. delegatensis</i> ), Blackbutt ( <i>E. pilularis</i> ) or Red Mahogany ( <i>E. resinifera</i> ); usually with a dense shrubby understorey often including ferns. They also occur in subtropical and temperate rainforests; for example, near Bega in south-east NSW, where they are recorded in temperate Lilly Pilly ( <i>Acmena smithi</i> ) rainforest, with Grey Myrtle ( <i>Backhousia myrtifolia</i> ), Sassafras ( <i>Doryphora sassafras</i> ) and Sweet Pittosporum ( <i>Pittosporum undulatum</i> ) subdominants. They occasionally occur in secondary regrowth, following logging or disturbance in forests or rainforests. When on passage, they are sometimes recorded in drier sclerophyll forests and woodlands, including Spotted Gum ( <i>Eucalyptus maculata</i> ), Yellow Box ( <i>E. melliodora</i> ), ironbarks or stringybarks, often with a shrubby or heath understorey. They are also recorded from parks and gardens when on passage.	592 (PMST)	Known

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Scarlet Robin ( <i>Petroica boodang</i> )	V	-	During the breeding season it is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. Forages amongst logs and woody debris for insects which make up the majority of its diet. The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 metres above the ground. It is conspicuous in open and suburban habitats.	1 (BioNet)	Low
Sooty Owl ( <i>Tyto tenebricosa</i> )	V	-	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude <500 metres. The Sooty Owl nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 centimetre in diameter.	1 (BioNet)	Low
Southern Myotis ( <i>Myotis macropus</i> )	V	-	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects.	3 (BioNet)	High
Spotted Harrier ( <i>Circus assimilis</i> )	V	-	Found throughout Australia but rarely in densely forested and wooded habitat of the escarpment and coast. Preferred habitat consists of open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, acacia and mallee remnants, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation. More common in drier inland areas, nomadic part migratory and dispersive, with movements linked to the abundance of prey species. Nesting occurs in open or remnant woodland in trees.	1 (BioNet)	None



Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Spotted-tailed Quoll ( <i>Dasyurus maculatus</i> )	V	E	Occurs along the east coast of Australia and the Great Dividing Range. Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests. Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas. Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage. 70% of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage. The home range of a female is between 180 and 1000 hectares, while males have larger home ranges of between 2000 and 5000 hectares.	3 (BioNet)	Low
Square-tailed Kite ( <i>Lophoictinia isura</i> )	V	-	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by <i>Eucalyptus longifolia</i> , <i>Corymbia maculata</i> , <i>E. elata</i> or <i>E. smithii</i> . Individuals appear to occupy large hunting ranges of more than 100 square kilometres. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.	24 (BioNet)	Moderate
Squirrel Glider ( <i>Petaurus norfolcensis</i> )	V	-	Inhabits dry sclerophyll forest and woodland. In NSW, potential habitat includes Box-Ironbark forests and woodlands in the west, the River Red Gum forests of the Murray Valley and the eucalypt forests of the northeast. Have also been recorded in a diverse range of vegetation communities, including Blackbutt, Forest Red Gum and Red Bloodwood forests, Coastal Banksia heathland and Grey Gum/Spotted Gum/Grey Ironbark dry hardwood forests of the Central NSW Coast. Nocturnal and shelters in tree hollows.	2 (BioNet)	Low

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )	V	-	A sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts. Feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	6 (BioNet)	Recorded. Observed in the study area along Bomaderry Creek
White-bellied Sea-eagle ( <i>Haliaeetus leucogaster</i> )	V	-	Coastlines, estuaries, large rivers and lakes; occasionally over adjacent habitats; builds a large stick nest in a tall tree, rarely on artificial structures	9 (BioNet)	Recorded. Observed flying over study area.
White-fronted Chat ( <i>Epthianura albifrons</i> )	V	-	Found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands or lightly timbered lands. Along the coastline, they are found in estuarine and marshy grounds with vegetation less than 1 metre tall. The species is also observed in open grasslands and sometimes in low shrubs bordering wetland areas. Inland, the species is often observed in open grassy plains, salt lakes and salt pans that are along the margins of rivers and waterways.	3 (BioNet)	Low
Yellow-bellied Glider ( <i>Petaurus australis</i> )	V	-	Restricted to tall native forests in regions of high rainfall along the coast of NSW. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types. Live in family groups of two to six individuals which commonly share a number of tree hollows. Family groups are territorial with exclusive home ranges of 30-60 hectares. Very large expanses of forest (>15,000 hectares) are required to conserve viable populations.	238 (BioNet)	Moderate

Common Name ( <i>Scientific Name</i> )	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Yellow-bellied Sheath-tail-bat ( <i>Saccolaimus flaviventris</i> )	V		Found throughout NSW. Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. Roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. Forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country.	2 (BioNet)	Moderate
Australian Grayling ( <i>Prototroctes maraena</i> )	V*	V	Occurs in rivers and streams on the eastern and southern flanks of the Great Dividing Range from Sydney, southwards to the Otway Ranges of Victoria and in Tasmania. The species is found in fresh and brackish waters, usually in small shoals.	N/A	Recorded (previously) within the study area

\*FM Act

## Appendix C – Assessments of significance

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### TSC Act / FM Act assessments

#### Swamp oak floodplain forest of the NSW 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**

Not applicable to an endangered ecological community.

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

Not applicable to an endangered ecological community.

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

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

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

Swamp Oak Floodplain Forest occurs as a small remnant that supports mostly Swamp Oak, with the occasional Bangalay. The remnant was mapped around the boat ramp on the northern shore of the Shoalhaven River and on the eastern side of the Princes Highway at the southernmost point of the study area. The EEC is bisected by a concrete roadway and the groundcover is highly modified, and mostly made up of exotic species as such it exists in a poor condition that is unlikely to be viable in the long term.

The proposal will require the removal of up to 0.09 hectares poor quality vegetation from the EEC from 0.48 hectares of the community that is present within the study area; as such it is unlikely that the project will have a significant effect on extent of the EEC. Exclusion zones would be established to ensure that the remaining EEC is not inadvertently impacted during access and egress to the boat ramp. If branches encroach into the access areas, a spotter would be utilised for the delivery of larger plant and equipment.

**(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**

The proposal will require the removal of up to 0.09 hectares from the EEC from 0.48 hectares of the community that is present within the study area.

**(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**

The proposal will require the removal of up to 0.09 hectares from the EEC from 0.48 hectares of the community that is present within the study area that exists in an already fragmented landscape.

As such, it is unlikely the EEC will become further fragmented or isolated as a result of the proposed actions.

**(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 habitat to be removed (0.09 hectares) is along a major road through planted landscapes, remnant native bushland and urban housing. The EEC is bisected by a concrete roadway and the groundcover is highly modified, and mostly made up of exotic species.

The EEC remnant occurs in a highly modified area of the floodplain, is in poor condition and lacks structural diversity. Therefore, this remnant would not be considered important to the long term survival of this EEC within the locality.

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

No critical habitat has been declared for this ecological community.

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

There is currently no Recovery Plan in place for Swamp Oak Floodplain Forest. There are no threat abatement plans currently in operation for any Key Threatening Processes (KTP) threatening Swamp Oak Floodplain Forest that specifically relate to the current proposal.

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

The TSC Act defines 'threatening process' as 'a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities'.

Schedule 3 of the TSC Act provides a list of the 'key threatening processes' (KTP). Of the KTP's listed in Schedule 3 of the TSC Act the following will operate or potentially increase as a result of the proposal:

- Invasion, establishment and spread of *Lantana camara*
- Invasion of native plant communities by *Chrysanthemoides monilifera* (Bitou bush and Boneseed)
- Invasion of native plant communities by exotic perennial grasses

The EEC groundcover is in poor condition and already subject to invasion of exotic grasses and exotic herbaceous perennials. It is unlikely that the project will cause any impacts to increase the impacts of this KTP. Sediment fencing will provide some protection against introduction of additional exotic species during daily works movements.

**Conclusion**

In light of the consideration of the above seven factors (a - g), the proposed activity on the subject site is not likely to impose a significant impact on the Swamp Oak Floodplain Forest of the study area or locality, as a result of the current proposal, as:

- The proposal will not adversely affect the extent of the ecological community to the point where its current ecological function is compromised to cause it to become locally extinct.
- It is unlikely that the proposal will further modify, or fragment the community or affect its long term survival on the subject site or in the locality.
- The area of habitat to be impacted by the proposal is not considered to be important for the long term survival of Swamp Oak Floodplain Forest in the locality.



- The proposal does not significantly contribute to any KTP that is either currently in operation on the subject site or will occur on the subject site during works.

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

### **Illawarra Greenhood (*Pterostylis gibbosa*)**

**(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**

*Pterostylis gibbosa* is a deciduous orchid that is only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. The leaf rosette grows from an underground tuber in late summer, followed by the flower stem in winter. After a spring flowering, the plant begins to die back and seed capsules form (if pollination has taken place). As with many other greenhoods, male fungus gnats are believed to be the pollinator.

Although 67 records of the species exist in the locality, there are no records of the species within the study area and all known local records occur within the Worrigeer Nature Reserve. Targeted surveys for the species were conducted by SMEC in late summer and spring in 2017 and the species was not encountered during the Biosis 2015 study. The disturbed nature of the site means that it is unlikely that a viable population is present, given it does not tolerate disturbance, and so the life cycle of the local population could be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposed action would result in the clearing of 2.18 hectares of native vegetation that may provide some suitable habitat for the *Pterostylis gibbosa*. However, given the disturbed nature of the site, it is unlikely to support a viable population of *Pterostylis gibbosa*.

**(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**

The impact on habitat of this species is the clearing of 2.18 hectares of vegetation that exists in an already fragmented landscape.

Potential habitat for these species is unlikely to become fragmented or isolated as a result of the proposed actions.

**(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 habitat to be removed (2.18 hectares) is along a major road through planted landscapes, remnant native bushland and urban housing. This species does not tolerate high levels of disturbance, as such, the habitat to be removed is unlikely to be important to the long-term survival of a local population of this species.

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

No critical habitat has been declared for this species.

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

The species has been assigned a site-managed species management stream under the *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.

The proposal is consistent with this recovery plan as it does not impact on any of the four management sites for the species.

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

The following KTPs are considered relevant to *Pterostylis gibbosa* in the study area: 'Further loss and fragmentation of habitat, particularly through clearing for agriculture and residential development.'

**Conclusion**

The proposal would require the removal of 2.18 hectares of vegetation that could provide some habitat for the *Pterostylis gibbosa*. However, although 67 records of the species exist in the locality, there are no records of the species within the study area and all known local records occur within the Worrigee Nature Reserve. Targeted surveys for the species were conducted by SMEC in late summer and spring in 2017 and were not encountered. This species does not tolerate high levels of disturbance such as that impacting the proposal site. As such, the habitat to be removed is unlikely to be important to the long-term survival of a local population of this species.

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

**Magenta Lilly Pilly (*Syzygium paniculatum*)**

**(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**

*Syzygium paniculatum* was not recorded during the Biosis (2015) study. The survey undertaken by SMEC (2017) recorded 19 individuals that would be directly impacted. However, *S. paniculatum* is a commonly planted species and it was judged that these individuals have been planted as a barrier between the existing Princes Highway and adjacent residences. As such, it is unlikely that the life cycle of the local population could be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

Assessments undertaken by SMEC (2017) for the species found 19 individuals would be directly impacted by the proposal. *S. paniculatum* is a commonly planted species and it was determined that these individuals have been planted as a barrier between the existing Princes Highway and adjacent residences.

**(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**

The impact on habitat of this species is the clearing of 19 planted individuals that exist in an already fragmented landscape.

Potential habitat for these species is unlikely to become fragmented or isolated as a result of the proposed actions.

**(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 habitat to be removed (19 individuals) is along a major road through planted landscapes, remnant native bushland and urban housing. The individuals present are planted and not natural to the landscape and no naturally occurring plants have been found to occur on site. As such, the habitat to be removed is unlikely to be important to the long-term survival of a local population of this species.

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

No critical habitat has been declared for this species.

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

The National Recovery Plan Magenta Lilly Pilly *Syzygium paniculatum* (OEH 2012) details the following objectives:

Objective 1 Coordination of recovery efforts:

- To ensure a coordinated and efficient approach to the implementation of recovery efforts.

Objective 2 Targeted survey:

- To establish the full extent of the distribution of Magenta Lilly Pilly

Objective 3 Research:

- To increase the understanding of Magenta Lilly Pilly biology and ecology

Objective 4 Habitat and threat management:

- To minimise the decline of Magenta Lilly Pilly through in situ habitat protection and management

Objective 5 Disease and pathogens:

- To reduce impact of Myrtle Rust on Magenta Lilly Pilly and its habitat.

Objective 6 Ex situ conservation:

- To maintain a representative ex situ collection of Magenta Lilly Pilly

Objective 7 Community liaison, education, awareness and involvement:

- To raise awareness of the conservation significance of Magenta Lilly Pilly and involve the broader community in the recovery program

OEH's threatened species profile for *Syzygium paniculatum* lists the following 'activities to assist the species':

- Protect known sites from fire; ensure that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat.
- Reduce or remove heavy grazing by domestic stock in areas of known or potential habitat.
- Undertake weed control, but avoid spraying weeds close to *S. paniculatum* plants to ensure they are not affected by poison.
- Protect known habitat areas from clearing and disturbance.

The individuals present are planted and not natural to the landscape. The action proposed is unlikely to conflict the recovery plan for this species.

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

The individuals present are planted and not natural to the landscape and, as such, the action proposed does not constitute a KTP for this species.

## Conclusion

The proposal would require the removal of 19 *Syzygium paniculatum* individuals. However, *Syzygium paniculatum* is a commonly planted species and these individuals have been determined to have been planted as a barrier between the existing Princes Highway and adjacent residences. As such, the individuals present are planted and not natural to the landscape and the removal of these 19 plants is unlikely to result in a significant impact on the species.

## Bomaderry Zieria (*Zieria baeuerlenii*)

**(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 species occurs in only one location north-west of Nowra. The population occurs in a total of 43 colonies in six discrete clusters. These clusters are confined within a 0.5 kilometre x 1.0 kilometre area of the bushland, and are found on both sides of Bomaderry Creek. Targeted surveys for the species were conducted by SMEC in late summer and spring in 2017 and Biosis in 2015 and no individuals were encountered. The proposal is located away from the known population and is unlikely to impact the population such that a viable local population of the species will be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposed action would result in the clearing of 2.18 hectares of native vegetation that may provide suitable habitat for the *Zieria baeuerlenii*. However, given the disturbed nature of the site and lack of records obtained during the surveys completed, it is unlikely to support a viable population of *Zieria baeuerlenii*.

**(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**

The impact on habitat of this species is the clearing of 2.18 hectares of vegetation that may provide habitat for the species. The habitat exists in an already fragmented landscape and the proposal is located away from the known populations of the species.

Potential habitat for these species is unlikely to become further fragmented or isolated than is already the case as a result of the proposed actions.

**(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 habitat to be removed (2.18 hectares) is along a major road through planted landscapes, remnant native bushland and urban housing. The proposal is located away from any known populations of the species and is unlikely to impact the population such that the habitat to be removed will impact the long-term survival of a local population.

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

No critical habitat has been declared for this species.

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

The species has been assigned a site-managed species management stream under the Saving our Species program. The Office of Environment and Heritage has established one management site where conservation activities need to take place to ensure the conservation of this species. This site is not to be impacted by the proposed activities.

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

The following KTP is considered relevant to *Zieria baeuerlenii* in the study area: 'One of the possible routes of the Bomaderry Link Road runs very close to part of the population and would



pose an indirect threat to the plants in this vicinity'. However, the project has been designed away from the Bomaderry Link Road.

## **Conclusion**

The proposal would require the removal of 2.18 hectares of vegetation that could provide habitat for the *Zieria baeuerlenii*. The only population of this species occurs in a total of 43 colonies in six discrete clusters. These clusters are confined within a 0.5 kilometre x 1.0 kilometre area of the bushland, and are found on both sides of Bomaderry Creek. The proposal is located away from the known population. Targeted surveys for the species were conducted by SMEC in late summer and spring in 2017 and the species was not encountered.

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

## **Green and Golden Bell Frog (*Litoria aurea*)**

**(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 Green and Golden Bell Frog usually breeds in summer when warm and wet conditions are more common. An adult male frog will produce a deep droning advertisement call that is preceded by a series of short grunts. Females will lay a clutch of between 1900 and 3900 eggs that initially float before settling in the bottom of a body of water. Tadpoles will feed on algae and other plant matter whereas adults feed on insects or smaller vertebrates including other frog species (Anstis, 2013).

Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast including a large population on Broughton Island. The Green and Golden Bell Frog (GGBF) is listed as an endangered species under Schedule 1 of the NSW Threatened Species Conservation Act 1995. At the national level, the species is listed as Vulnerable under Schedule 1 Part 2 of the Environment Protection and Biodiversity Conservation Act 1999.

As a consequence of being listed under both state and national legislation a draft recovery plan has been prepared for the GGBF (Department of Environment and Conservation 2005). The Shoalhaven local government area has been identified in the draft GGBF Recovery Plan (DEC 2005) as supporting eight of the 42 Key Populations. To satisfy Action 11.3.4 of the draft GGBF Recovery Plan management plans for each key population have been developed in accordance with the Threatened Species Conservation Act 1995. The southern part of the study area, south of Shoalhaven River, falls within the very northern end of the management site of the GGBF Population of Crookhaven River Floodplain. The Crookhaven River Floodplain Management Plan covers GGBF and their habitat occurring within the catchment of the Crookhaven River, namely Brundee Swamp Nature Reserve, Culburra Beach, Currumbene State Forest (Butterfly Road) and Greenwell Point.

The closest recorded individual to the study area is a record from 2010 in the yard of a house on Brereton St, some 500 metres to the east of the southern section of the study area. No individuals were identified during survey for the project and there are no previous records on the NPWS Atlas within the study area. There is one waterbody surveyed within the study area at Harry Sawkins Park. This waterbody was considered to be sup-optimal breeding habitat due to the presence of *Gambusia holbrooki*, which predated the tadpoles of the GGBF and its presence generally discourages GGBF from attempting to breed at a water body. Therefore, it is considered unlikely that the proposal would adversely affect the life cycle of this species to the extent that a local population would be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

Optimal habitat of the GGBF includes marshes, wetlands, stream-sides and dams that include bulrushes (*Typha spp.*) and spikerushes (*Eleocharis spp.*). These water-bodies are preferably unshaded, free of the predators such as the Plague Minnow (*Gambusia holbrooki*) and have nearby grassy areas (OEH 2018). However, as specified in the draft recovery plan for the GGBF (DEC 2005): *the habitat preference and requirements of the Green and Golden Bell Frog are not well understood and difficult to define (Mahony, 1999), in fact the species has the propensity, on occasion, of turning up in the most unlikely locations. It would appear that the species makes use of a number of habitat components to fulfil its requirements during different parts of its life cycle. These include breeding, foraging and refuge habitat and perhaps suitable habitat to facilitate its movement patterns.*

The management site for the GGBF Population of Crookhaven River Floodplain covers a total area of about 19,064 hectares. 12.18 hectares of the management site for this key population will be impacted as a result of the action proposed. The area mapped as part of the management site for this population contains potential feeding and shelter habitat, but minimal breeding habitat for this key population. Based on the field survey it is considered that the study area may provide shelter and foraging habitat for dispersing individuals, but is only likely to be used transiently and very occasionally at best.

**(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**

The proposed action will fragment a small area of potential habitat in the north west of the management site for the GGBF Population of Crookhaven River Floodplain. This area is already in a disturbed state due to the existing road network and residential land use and there are no known populations using this area or to the north of this area that individuals may attempt to migrate to and from.

**(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 habitat to be removed (12.18 hectares) is along a major road and grassy paddock through remnant native bushland and urban housing. The area mapped as part of the management site for this population contains potential foraging and refuge habitat for dispersing individuals of this key population. Due to the site not containing significant potential breeding habitat and lack of recent records within the study area or any records north of the study area it is considered that the habitat to be removed is not vital to the long-term survival of the species.

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

No critical habitat has been declared for this species.

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

A recovery plan for the GGBF has been developed by DEC (2005). The objectives of the recovery plan are to:

- increase the security of key GGBF populations by way of preventing the further loss of GGBF habitat at key populations across the species range and, where possible, secure opportunities for increasing protection of habitat areas;
- ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the;
- implement habitat management initiatives that are informed by data obtained through investigations into the general biology and ecology of the GGBF through a systematic and coordinated monitoring program;
- establish, within more than one institution, self-sustaining and representative captive populations (particularly 'at risk' populations) of the Green and Golden Bell Frog for the primary purpose of maintaining 'insurance' colonies for re-establishment and supplementation of populations of the species; and
- increase the level of regional and local awareness of the conservation status of the Green and Golden Bell Frog and provide greater opportunity for community involvement in the implementation of this recovery plan

The Management Plan for the GGBF Key Population within the Crookhaven River Floodplain (DECC 2007) lists several Management Actions which aim to (a) maintain the existing GGBF population; (b) increase the population; and (c) improve habitat for GGBF in the Crookhaven River Flood Plain.

The proposal is not consistent with several objectives and actions of the recovery plan and management plan. The proposal would require the removal of 12.18 hectares of possible foraging and refuge habitat.

The Saving our Species program has also identified the Crookhaven Key Population as an important management population and has received funding to monitor and manage this population. The works completed have not identified the GGBF as being present in the study area and does not indicate this area has any importance in the management of this population.

The following threat abatement plans are relevant to this species:

- Threat Abatement Plan: Infection of Amphibians with Chytrid Fungus Resulting in Chytridiomycosis.
- Threat Abatement Plan: Predation by *Gambusia holbrooki*- The Plague Minnow

These two plans should be referred to when preparing the construction management plan for the project.

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

The following key threatening processes are relevant to the Green and Golden Bell Frog:

- Alternation to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Anthropogenic climate change
- Clearing of native vegetation
- Infection of frogs by amphibian chytrid fungus causing the disease Chytridiomycosis
- Predation by *Gambusia holbrooki* Girard, 1859 (Plague Minnow or Mosquito Fish).

The identified threats specifically to the Crookhaven River floodplain key population include:

- Loss of habitat
- Invasion by introduced predators that include Plague Minnow (*Gambusia holbrooki*)
- Feral and Domestic Cats
- Predation of GGBF from native predators
- Water quality
- Disease. Amphibian Chytrid *Batrachochytrium dendrobatidis* - is listed as a Key Threatening Process under the TSC Act and EPBC Act
- Anthropogenic climate change
- Inappropriate Management
- Direct human impacts, such as mowing and road mortality caused by collision with motor vehicles.

Actions associated with the proposed activity can potentially contribute to several of these key threatening processes or increase the impact of these key threatening processes. Mitigation measures specified in Section 5 should be followed to reduce these impacts.

## Conclusion

The study area falls at the northern end of the management site of the GGBF Key Population within the Crookhaven River Floodplain. There are no records of individuals within the study area. The nearby key populations occur several kilometres to the east and south of the study area at Brundee Swamp Nature Reserve, Culburra Beach, Currumbene State Forest (Butterfly Road) and Greenwell Point. There are no historic records of the GGBF anywhere to the north.

The proposal would require the removal of 12.18 hectares of potential habitat that could be utilised by dispersing individuals for foraging and sheltering. Additional foraging and sheltering habitat of similar or better condition is available in the surrounding areas.

The habitat to be impacted is considered sub-optimal breeding habitat due to the presence of only one waterbody that contains the Plague Minnow. Favourable weather conditions could result in temporary pools or flooded drains and ditches that could provide breeding habitat for this species, but there are not clearly areas that would form pools with longer hydroperiod sufficient to provide likely reproductive success.

Mitigation measures specific to the GGBF should be implemented during the project.

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

## Powerful Owl (*Ninox strenua*)

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

Powerful Owls are highly mobile and occupy large home ranges of 400 hectares in good quality habitat to 4000 hectares in habitat where hollow trees and prey have been depleted.

The closest Powerful Owl recorded is about two kilometres west of the study area along the Shoalhaven River in Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion. No individuals were recorded during surveys undertaken by SMEC.

The proposal would result in the removal of several narrow linear strips of suitable foraging habitat for this species. This main suitable vegetation to be removed is adjacent to the highway in the northern end of the proposal area. Other areas of vegetation with native canopy species and a disturbed understory would be removed, this vegetation has been disturbed for existing infrastructure

and urban housing. Two hollow-bearing trees with a total of four medium and small hollows would be removed for the proposal. No large hollows that would provide a suitable nesting site for the Powerful Owl were observed in the study area.

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

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposed action would result in the clearing of 5.64 hectares of suitable hunting habitat for the Powerful Owl. This habitat is also suitable for prey species of the owl including birds, possums and flying-foxes.

**(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**

The Powerful Owl is a highly mobile species occupying a large home range of up to 4000 hectares where prey and hollows are sparse. They are capable of existing in fragmented landscapes.

The impact on habitat of this species is the clearing of 5.64 hectares of vegetation that exists in an already fragmented landscape.

Potential habitat for these species is unlikely to become fragmented or isolated as a result of the proposed actions.

**(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 habitat to be removed (5.64 hectares) is along a major road through remnant native bushland and urban housing. These species are highly mobile and can survive in fragmented landscapes. However, as top order predators they are sensitive to habitat fragmentation through the loss of prey species. The habitat to be removed is unlikely to be important to the long-term survival of a local population of this species.

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

No critical habitat has been declared for this species.



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

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

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

The proposal is not consistent with this recovery plan. The proposal would require the removal of foraging habitat and two hollow-bearing trees.

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

The following KTPs are considered relevant to Forest Owls and its prey species in the study area: 'Clearing of native vegetation' and 'Loss of hollow-bearing trees'. Mitigation measures should be followed to reduce these impacts.

**Conclusion**

The proposal would require the removal of 5.64 hectares of vegetation that could be utilised by the Powerful Owl for hunting. This habitat also provides suitable habitat for prey species of the owl including birds, possums and flying-foxes. Two hollow-bearing trees with a total of four hollows suitable for the Powerful Owls prey species are present within the study area. As none of these hollows are large or extra-large, there is currently not suitable habitat for roosting or nesting by this species.

Powerful Owls have very large home ranges and are most likely only going to utilise the study area for hunting. Additional hunting habitat with suitable prey species is available in the surrounding areas.

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

**Square-tailed Kite (*Lophoictinia isura*)**

**(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 Square-tailed Kite was not recorded in the study area during recent surveys. There are records of this species near the existing Nowra Bridge within the last decade. No nesting sites were identified in the study area.

The proposal would result in the removal of patches of vegetation near an existing major road. This vegetation could provide suitable habitat for prey species of the Square-tailed Kite. The study area is likely to form part of a large hunting range for any individuals present.

Given the large home ranges of the Square-tailed Kite and lack of suitable nesting sites in the study area, it is unlikely that the proposal would adversely affect the life cycle of this species to the extent that a local population would be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposed action would result in the clearing of 5.64 hectares of potential hunting habitat for the Square-tailed Kite. This habitat is also suitable for prey species of the kite.

**(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**

The Square-tailed Kite is a highly mobile species that hunts over areas greater than 100 square kilometres.

Potential habitat for this species is unlikely to become fragmented or isolated as a result of the proposed actions. The impact on habitat of this species is the clearing of 5.64 hectares of vegetation that exists in an already fragmented landscape.

**(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 habitat to be removed (5.64 hectares) is disturbed vegetation adjacent to a major road. The Square-tailed Kite is highly mobile and can survive in fragmented landscapes. However, as top order predators they are sensitive to habitat fragmentation through the loss of prey species. The habitat to be removed is unlikely to be important to the long-term survival of a local population of this species due to the availability of large areas of more suitable hunting habitat in the region.

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

No critical habitat has been declared for this species.

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

No recovery or threat abatement plan has been prepared for the Square-tailed Kite. No priority management sites have been identified. Activities identified by OEH to assist this species include:

- Protect known habitat from fires of a frequency greater than that recommended for the retention of biodiversity
- Retain and protect nesting and foraging habitat, particularly along watercourses
- Report suspected illegal bird shooting and egg-collecting to DEC.

The proposal is not consistent with the recommendation to protect Square-tailed Kite habitat along watercourses. Other identified activities are not relevant to the proposal.

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

The following key threatening process is considered relevant to the Square-tailed Kite in the study area: 'Clearing of native vegetation'. Mitigation measures should be followed to reduce these impacts.

## **Conclusion**

The proposal would require the removal of 5.64 hectares of vegetation that could be utilised by the Square-tailed Kite for hunting and provide habitat for prey species of the kite. No nesting sites were observed in the study area.

Given the large ranges utilised by Square-tailed Kites for hunting, the removal of a small area of vegetation is unlikely to affect any individuals that occupy the study area. Additional hunting habitat with suitable prey species is available in the surrounding areas.

The proposal is unlikely to result in a significant impact on the Square-tailed Kite.

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

The Varied Sittella inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.

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

The Varied Sittella was recorded along Bomaderry Creek to the north-west of the study area. It inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.

The habitat to be removed is part of a small patch of vegetation that occurs adjacent to a major highway. Therefore, the removal of this habitat is unlikely to place a local population of Varied Sittella at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposal would result in the removal of 5.64 hectares of woodland vegetation that provides foraging and sheltering habitat for the Varied Sittella. Suitable nesting sites may also be present.

**(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**

The landscape surrounding the study area is already fragmented through historical vegetation clearing for various land uses including farming and residential development. Remnant open forest occurs in small patches surrounded by roads, residential properties of agricultural land.

Removal of vegetation along the existing Princes Highway is unlikely to further fragment or isolate areas of suitable habitat for the Varied Sittella.

**(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 habitat to be removed is along the edge of a major highway is unlikely to be important habitat for this woodland bird species. This vegetation would not provide sufficient foraging, nesting and sheltering habitat to support the entire life cycle of these species.

The habitat to be removed is not considered important to the long-term survival of the Varied Sittella in the locality.

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

No critical habitat has been declared for this species.

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

No recovery plan or threat abatement plan has been prepared for the Varied Sittella. Actions identified by the Saving Our Species program to help this species that are relevant to the proposal include:

- Carry out revegetation, using a diverse mix of locally appropriate native species, focussing on expanding and connecting areas of existing habitat.

No priority management sites have been identified for the Varied Sittella.

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

The following KTPs are considered relevant to the Varied Sittella within the study area:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and trees.

The proposal constitutes three KTPs relevant Varied Sittella.

**Conclusion**

The Varied Sittella was identified along Bomaderry Creek to the north-west of the study area during recent surveys. The proposal would require the removal of 5.64 hectares of open forest vegetation that may provide foraging, nesting and sheltering habitat for these species.

Given the small area of habitat to be removed from next to a major highway, the proposal is not expected to have a significant impact on the Varied Sittella.

**Raptors: White-bellied Sea-eagle (*Haliaeetus leucogaster*) and Eastern Osprey (*Pandion cristatus*)**

**(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**

A White-bellied Sea Eagle was identified flying over the Shoalhaven River near the Nowra Bridge. There are numerous other records of this species close to the study area. It is likely that a pair or small family group of sea-eagles occupy this area and use the local large water bodies for hunting. No Eastern Ospreys were observed during recent surveys.

No nesting sites for either species were identified in the study area. Nest sites are conspicuous and therefore likely to have been observed if present.

The White-bellied Sea Eagle occurs along the coast of NSW and inland where large rivers or other large bodies of water are present. Genetic studies suggest there is a high level of interaction between widespread subpopulations of sea-eagles, indicating all individuals for one population.

Eastern Ospreys occur along the Australian coastline except for Tasmania and Victoria.

Given the large home ranges of the White-bellied Sea-eagle and Eastern Ospreys and lack of suitable nesting sites in the study area, it is unlikely that the proposal would adversely affect the life cycle of these species to the extent that a local population would be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposed action would result in the modification of hunting habitat for the White-bellied Sea-eagle and Eastern Osprey around the existing Nowra Bridge through construction of an additional bridge. No hunting habitat or potential nesting sites would be removed by the proposal.

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

White-bellied Sea-eagles defend a territory around a nesting site during the breeding season. Outside this time, they may occur elsewhere in their home range. Home ranges of White-bellied Sea-eagles can be up to 100 square kilometres. Eastern Ospreys hunt over open water in large rivers, lagoons and lakes.

Habitat for these species is unlikely to become fragmented or isolated as a result of the proposed actions.

**(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 habitat to be modified occurs on the Shoalhaven River, which provides suitable hunting habitat for the White-bellied Sea-eagle and Eastern Osprey. The habitat to be removed is unlikely to be



important to the long-term survival of a local population of these species, given the large areas of suitable hunting habitat available in the region on rivers and lakes, both upstream and downstream of the study area. No breeding sites were observed in the study area.

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

No critical habitat has been declared for this species.

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

No recovery plan or threat abatement plan has been prepared for the White-bellied Sea-eagle or Eastern Osprey. No priority actions have been identified by OEH to assist in the recovery of the White-bellied Sea-eagle in NSW. None of the priority actions identified for the Eastern Osprey are considered relevant to the proposal.

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

No key threatening processes are considered relevant to the White-bellied Sea-eagle or Eastern Osprey and the proposal.

**Conclusion**

The proposal would require modification of suitable hunting habitat for the White-bellied Sea-eagle and Eastern Osprey through the construction of an additional bridge parallel to the existing bridge across the Shoalhaven River. Additional suitable hunting habitat is available upstream and downstream of the study area. No breeding sites were identified in the study area.

The proposal is unlikely to result in a significant impact on the White-bellied Sea-eagle or Eastern Osprey.

**Cave-roosting microchiropteran bats: Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)**

Caves are the primary roosting habitat for the Eastern Bentwing-bat, but it also uses derelict mines, storm-water tunnels, buildings and other man-made structures. The Eastern Bentwing-bat hunts in forested areas, catching moths and other flying insects above the tree tops.

**(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 was not detected within the study area during recent surveys. This species primarily breeds in caves with very specific temperature regimes and few breeding sites are known to occur in NSW. Outside the breeding seasons they travel long distances to forage and roost.

The proposal is likely to only interfere with foraging habitat used on occasion. No roosting or breeding habitat for this species would be affected, therefore, it is unlikely that a viable local population would be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposal would require the removal of 5.64 hectares of vegetation that may provide foraging habitat for the Eastern Bentwing-bat.

No suitable roosting sites for this species were identified within the study area.

**(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**

Microchiropteran bats are highly mobile species, capable of travelling large distances from maternity colonies outside the breeding season. The landscape surrounding the study area is already fragmented through historical vegetation clearing.

Removal of vegetation along the existing Princes Highway is unlikely to further fragment or isolate areas of suitable habitat for the Eastern Bentwing-bat.

**(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**

No roosting or breeding sites for these species have been identified in the study area. The proposal would require the removal of 5.64 hectares of vegetation that may provide foraging habitat for these species. Large areas of suitable foraging habitat occur in the locality and region.

The habitat to be removed is not considered important to the long-term survival of the Bentwing-bat in the locality.

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

No critical habitat has been declared for this species.

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

To date, no recovery plan has been developed for the Eastern Bentwing-bat. However, the following threats have been identified generally for microchiropteran bats by OEH:

- 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
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

Management sites identified for conservation of the Eastern Bentwing-bat do not occur within the region and are therefore not associated with the proposal (OEH 2017).

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

The proposal constitutes one key threatening process relevant to the Eastern Bentwing-bat; 'Clearing of native vegetation'.

**Conclusion**

The Eastern Bentwing-bat was not detected in the study area during recent surveys. The proposal would require the removal of 5.64 hectares of vegetation that may provide occasional foraging habitat for this species. No suitable roosting sites were identified within the study area.

Given the lack of suitable roosting habitat and availability of other suitable foraging habitat in the locality, the proposal is not expected to have a significant impact on the Eastern Bentwing-bat.

**Hollow-roosting microchiropteran bats: Eastern Freetail-bat (*Mormopterus norfolkensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and 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 Eastern Freetail-bat was recorded on the northern bank of the Shoalhaven River under the existing Nowra Bridge.

These four species of microchiropteran bats primarily roost in tree hollows. Tree hollows occur at a low density within the study area. Two trees containing four hollows would be removed by the proposal.

Microchiropteran bats forage in and above forest canopies. Suitable foraging habitat occurs in patches of vegetation throughout the study area.

Given that no suitable breeding habitat would be removed and the abundance of suitable foraging habitat within the study area and locality, it is unlikely the proposal would result in the extinction of a viable local population of Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat or Yellow-bellied Sheathtail-bat.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposal would result in the removal of up to 5.64 hectares of native vegetation that could provide foraging habitat for these microchiropteran bats. This vegetation primarily provides suitable foraging habitat and some roosting habitat for these microchiropteran bat species in hollow-bearing trees.

The proposal would require the removal of 5.64 hectares of vegetation that may provide suitable foraging habitat for the Greater Broad-nosed Bat and Eastern Freetail-bat. No breeding habitat would be removed.

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

The Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Yellow-bellied Sheath-tail-bat are mobile species. They are capable of utilising fragmented and urbanised environments.

The proposal would result in the removal of up to 5.64 hectares of native vegetation that occurs in patches along the existing Princes Highway.

Potential habitat for these species is likely to become more fragmented as a result of the proposed actions, however, no areas of habitat would be inaccessible to these mobile species.

Microchiropteran bats are highly mobile species, capable of travelling large distances from maternity colonies outside the breeding season. The landscape surrounding the study area is already fragmented through historical vegetation clearing.

Removal of small patches of vegetation along the existing Princes Highway is unlikely to further fragment or isolate areas of suitable habitat for the Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat or Yellow-bellied Sheath-tail-bat.

**(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 result in the removal of 5.64 hectares of native vegetation. This vegetation provides suitable foraging and roosting habitat for the Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Yellow-bellied Sheath-tail-bat.

There would be some loss of foraging habitat for these species, but the sections of study area to be impacted are unlikely to provide significant foraging or roosting habitat for these bats given the presence of extensive areas of high quality foraging and roosting habitat adjacent to the study area.

The Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Yellow-bellied Sheath-tail-bat primarily roost in tree hollows. Vegetation to be impacted may provide some suitable hollows but in a very low density; only two hollow-bearing trees were identified in the study area.

Given the availability of better quality suitable foraging habitat within the locality, it is unlikely the foraging habitat within the study area is important to the survival of these species within the locality.

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

No critical habitat has been declared for these species.

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

To date, no recovery plan has been developed for any of these species. However, the following threats have been identified generally for microchiropteran bats by OEH:

- 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
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

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

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

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

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

All bat species associated with the proposal are listed as landscape species in the OEH Saving Our Species program.

There would be a small amount of disturbance to foraging and potential roosting habitats. Should appropriate mitigation measures be adopted, the proposal is considered to be consistent with recovery activities for these species.

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

The following are key threatening processes which may be relevant to the proposal:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.

The proposal constitutes three KTPs: 'Clearing of native vegetation' and 'Loss of hollow-bearing trees'. Mitigation measures should be followed to reduce these impacts.

**Conclusion**

While the proposal may impact on some potential foraging habitat, the small area of disturbance and the provision of mitigation measures in line with the Roads and Maritime Biodiversity Guidelines would ensure minimal impact on the Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat.

Of these four species, only the Eastern Freetail-bat was recorded in the study area during recent surveys. Vegetation in the study area is considered to provide suitable foraging habitat for these species. The proposal would require the removal of 5.64 hectares of vegetation that may provide foraging and roosting habitat for these species. No breeding sites for these species were identified within the study area.

Given the lack of suitable roosting habitat and availability of other suitable foraging habitat in the locality, the proposal is not expected to have a significant impact on the Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat or Yellow-bellied Sheathtail-bat.



## **Southern Myotis (*Myotis macropus*)**

**(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 Southern Myotis generally roosts close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage.

The study area contains foraging habitat for this species along Bomaderry Creek. The Shoalhaven River may also be used for foraging on occasion. No suitable roosting habitat was identified in bridges over waterways in the study area and the density of tree hollows in the study area is low.

The Southern Myotis was not identified in the study area during recent surveys and the proposal is unlikely to affect suitable foraging, roosting or breeding habitat. As such, the proposed actions are unlikely to have an adverse effect on the life cycle of this species such that a viable local population is placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposal would result in the removal of small patches of riparian vegetation along Bomaderry Creek and the Shoalhaven River within the study area. No suitable roosting habitat for the Southern Myotis was observed in the bridges over Bomaderry Creek or Shoalhaven River within the study area, although access to inspect the bridges was limited.

The actions proposed would not result in the removal of any foraging or roosting habitat for the Southern Myotis.

**(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**

The Southern Myotis forages along waterways and was not detected in the study area during recent surveys.

The proposal would result in the removal of small areas of native vegetation along Bomaderry Creek and the Shoalhaven River within the study area. No barriers to movement along waterways would be constructed as part of the proposal.

Given the foraging behaviour of the Southern Myotis, the proposal is unlikely to fragment or isolate any suitable habitat.

**(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 small area of vegetation to be removed is unlikely to provide suitable habitat for the Southern Myotis. Only two hollow-bearing trees were identified in the study area and they are not located near suitable foraging habitat. The Southern Myotis generally roosts close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage.

As there are limited roosting sites for the Southern Myotis and no foraging habitat would be removed, the proposal is unlikely to affect the long-term survival of a local population of this species.

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

No critical habitat has been declared for this species.

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

To date, no recovery plan has been developed for the Southern Myotis. However, the following threats have been identified generally for microchiropteran bats by OEH:

- 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.
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

Should appropriate mitigation measures be adopted, the proposal is consistent with recovery activities for these species.

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

The following are KTPs relevant to the proposal and the Southern Myotis:

- Clearing of native vegetation
- Loss of hollow-bearing trees.
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.

The proposal constitutes two KTPs: 'Clearing of native vegetation' and 'Clearing of hollow-bearing trees'. None of the native vegetation or hollow-bearing trees to be removed in the study area are expected to be used by the Southern Myotis.

**Conclusion**

While the proposal may impact on some potential foraging habitat, the small area of disturbance and the provision of mitigation measures in line with the Roads and Maritime Biodiversity Guidelines would ensure there is unlikely to be a significant impact on the Southern Myotis.

**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**

Two known Grey-headed Flying-fox camps occur within the Nowra area. The Bomaderry Creek camp is recognised as a Nationally Important Flying-fox Camp and is located approximately 600 metres north-west of the study area, along Bomaderry Creek. This camp is unlikely to be affected by the proposal. The Brinawarr Street camp occurs less than 100 metres from the northern extent of the study area, between Bolong Road and Beinda Street.

In addition to the presence of a camp, the study area is expected to provide suitable foraging habitat for the Grey-headed Flying-fox when suitable feed trees are in flower.

As the proposal would not interfere with any Grey-headed Flying-fox camps and other suitable foraging habitat is available in the locality, the proposal is unlikely to place a viable local population at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposal would result in the removal of 1.35 hectares of vegetation that could provide foraging habitat for the Grey-headed Flying-fox when suitable species are in flower.

No habitat that forms part of a Grey-headed Flying-fox camp would be removed or modified.

**(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**

The Grey-headed Flying-fox is a highly mobile species, capable of travelling long distances seasonally and daily to forage on available food resources.

The proposal is unlikely to fragment or isolate areas of suitable foraging habitat for the Grey-headed Flying-fox from other foraging habitat and camps.

**(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**

Grey-headed Flying-foxes rely on large areas of vegetation to forage throughout the year as different species come into flower. The study area is unlikely to provide a reliable source of food for this species due to the lack of vegetation and limited number of flowering tree species.

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

No critical habitat has been declared for this species.

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

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

Mitigation measures have been recommended to reduce the impact the proposal would have on the recovery plan objective 'reduce the impact of threatening process'.

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

'Clearing of native vegetation' is a key threatening process relevant to the proposal and the Grey-headed Flying-fox. The proposal would require the removal of 5.64 hectares of remnant native vegetation.

**Conclusion**

The proposal would require the removal of 5.64 hectares of potential foraging habitat for the Grey-headed Flying-fox. Two known Grey-headed Flying-fox camps occur within the Nowra area; the Bomaderry Creek camp approximately 600 metres north-west of the study area, along Bomaderry Creek and the Brinawarr Street camp occurs less than 100 metres from the study area.

Given the very small area of vegetation to be removed along the existing Princes Highway, the availability of additional foraging resources within the locality and the absence of impact on any camps, it is unlikely the proposal would have a significant impact on the Grey-headed Flying-fox.

**Yellow-bellied Glider (*Petaurus 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**

There are several records of yellow-bellied glider in the locality of the study area. This includes one adjacent to the north west of the study area from 2006 and another recorded in 2004 located about 600 metres to the north west of the study area in Bomaderry Regional Park.

The study area contains foraging habitat for this species along Bomaderry Creek and in adjoining remnant native vegetation within the urban landscape. The vegetation community Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (PCT 1206) and planted native mixed vegetation contain known feed tree species for the Yellow-bellied Glider. This includes *Corymbia maculata* and *Eucalyptus saligna*. No large hollows were identified within the study area and so there are no suitable den hollows present.

Other suitable foraging habitat is available in the locality and the proposal would not impact on potential den trees therefore the proposal is unlikely to place a viable local population at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposal would result in the removal of 5.55 hectares of vegetation that may provide possible foraging or movement habitat for the Yellow-bellied Glider.

**(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**

The proposal may fragment potential habitat south of Illaroo Road along the Shoalhaven River with that along Bomaderry creek and north to Bomaderry Nature Reserve. This would be due to clearing of native vegetation (PCT 1206) along Illaroo Road.

**(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**

Yellow-bellied Gliders are very mobile and occupy large home ranges between 20 to 85 hectares to encompass dispersed and seasonally variable food resources. The 5.55 hectares of potential habitat to be removed is on the edge of larger patches of native vegetation along Bomaderry Creek and the princess Highway. The study area is unlikely to provide a reliable source of food for this species; however, the vegetation communities present do have two feed tree species that may be used during seasonal foraging.

The removal of vegetation to the west of the Princess Highway along Bomaderry Creek and Illaroo Road may fragment habitat along Bomaderry Creek with that to the west of Nowra Golf and Recreation Club, although this potential north to south west vegetation corridor across Illaroo Road is already highly disturbed and not documented in any local wildlife corridor plans.

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

No critical habitat has been declared for this species.

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

A draft recovery plan has been prepared for the Yellow-bellied Glider (NPSW 2003).

The objectives of the recovery plan are to:

- To co-ordinate the recovery of the Yellow-bellied Glider in NSW
- To encourage and assist in improving the protection and management of the Yellow-bellied Glider and its habitat
- To identify and monitor significant populations of the species
- To facilitate strategic research into the ecology of the Yellow-bellied Glider that is relevant to its conservation
- To increase community awareness of the Yellow-bellied Glider and encourage community involvement in its conservation.



The proposal is not consistent with these recovery plan objectives in that it requires the removal of foraging habitat. This is not consistent with improving the protection and management of Yellow-bellied Glider habitat.

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

'Clearing of native vegetation' is a key threatening process relevant to the proposal and the Grey-headed Flying-fox. The proposal would require the removal of 5.55 hectares of remnant native vegetation.

**Conclusion**

The proposal would require the removal of 5.55 hectares of potential foraging habitat for the Yellow-bellied Glider. There are several records of this species within the locality of the study area, the closest being adjacent to the north west of the study area. The hollows recorded in the study area are considered to be sufficiently large to be suitable for use by this species.

Given the area and location of the vegetation to be cleared, being along the existing Princes Highway and on the edge of larger patches of vegetation along Bomaderry Creek, the availability of additional foraging resources within the locality and the absence of suitable den trees and records, it is unlikely the proposal would have a significant impact on the Yellow-bellied Glider.

**Australian Grayling (*Prototroctes maraena*)**

**(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 Australian Grayling is a highly mobile species, has a wide distribution and range of habitats during its life. Given this, it is not practical to specify habitat that is critical to its survival. The Australian Grayling is known to inhabit the Shoalhaven River, which is the northern extent of its known range, and has been identified as an important population to ensure the long-term survival of the species (Backhouse *et al.*, 2008).

The Australian Grayling is a diadromous species, migrating between rivers, their estuaries and coastal seas, so relies on the free access to a range of freshwater, estuarine and marine habitats for its survival. Australian Grayling spend most of their lives in freshwater, inhabiting rivers with and streams, usually in cool, clear waters with gravel substrate and alternating pool and riffle zones (Backhouse *et al.*, 2008). It is presumed that females lay their eggs in the middle reaches of rivers, where they presumably settle among the gravel streambed.

Major threatening processes for the Australian grayling include barriers to movement, river regulation, poor water quality, siltation, and introduced pests and diseases.

The proposal is unlikely to result in any of the above-mentioned threatening processes. Changes in water quality and increased siltation may occur during construction of the bridge piers; however, these are expected to be minor, short-term, and over small spatial scales.

Given the large home range of the Australian Grayling, and lack of suitable spawning sites in the study area, it is unlikely that the proposal would adversely affect the life cycle of this species to the extent that a local population would be placed at risk of extinction.

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

Not applicable to a threatened species.

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

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

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

Not applicable to a threatened species.

**(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**

The proposed action is not likely to result in the clearing of suitable habitat for the Australian Grayling.

**(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**

The Australian Grayling is a highly mobile species and tend to avoid disturbance activities. However, they do require clear passage for juveniles to reach estuarine and marine environs following spawning (summer / autumn). Potential habitat for these species is unlikely to become fragmented or isolated because of the proposed actions.

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

The proposed action is not likely to result in the clearing of suitable habitat for the Australian Grayling.

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

The proposed action is not likely to result in the clearing of key fish habitat for the Australian Grayling.

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

A recovery plan for the Australian Grayling has been developed (Backhouse et al., 2008). The recovery plan recommends the:

1. identification of important populations of Australian Grayling
2. protection and restoration of habitat for the Australian Grayling
3. investigating the important life history attributes to acquire targeted information for management
4. investigating and managing threats to populations and habitats
5. increasing awareness of Australian Grayling conservation with resource managers and the public
6. maintenance or restoration of flow regimes (especially winter flows) in coastal rivers to meet the habitat and spawning requirements of the Australian Grayling
7. removal of artificial barriers or provisions of fish passage past barriers on coastal rivers and streams
8. maintenance and restoration of river channel structures and instream habitat quality

9. maintenance or restoration of quality and width of riparian vegetation at levels necessary to maintain stream temperature and light regimes, maintain input of organic materials, and filter surface runoff under heavy rainfall conditions
10. management of catchment vegetation clearing and planting to avoid negative effects on catchment water yields and flow patterns, in catchments where Australian Grayling occur
11. manage water quality where Australian Grayling occurs to maintain waters free of significant levels of nutrient, sediment, pesticide and other pollutants, consistent with the ANZECC guidelines for water quality (ANZECC, 2000)
12. continuing to prohibit fishing for the species, through education, regulation and enforcement, at least until there is recovery to sustainable levels
13. management of fish stockings to avoid any potential impacts on Australian Grayling.

The proposal is consistent with this recovery plan.

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

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process.

**Conclusion**

The proposal is unlikely to increase the impact of any key threatening processes for the Australian Grayling. The proposal is unlikely to result in the removal of key habitat for the Australian Grayling. The proposal is unlikely to result in a significant impact on the species, as there is limited (or no) suitable Australian Grayling spawning in the study area, and the proposal is unlikely to impact fish passage or other threatening processes.

**EPBC Act assessments**

**Magenta Lilly Pilly (*Syzygium paniculatum*)**

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

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

*Syzygium paniculatum* was not recorded within the Biosis (2015) study areas during their respective survey. Assessments undertaken by SMEC (2017) for the species found 19 individuals would be directly impacted. However, *S. paniculatum* is a commonly planted species and it is considered that these individuals have been planted to provide a barrier between the existing Princes Highway and adjacent residences. As such, it is unlikely that the proposal will lead to a long-term decrease in the size of a naturally occurring important population of the species.

- reduce the area of occupancy of an important population;

The proposal would require the removal of 19 *Syzygium paniculatum* individuals. However, *Syzygium paniculatum* is a commonly planted species and these individuals are considered to have been planted to form a barrier between the existing Princes Highway and adjacent residences. As such, the proposal is unlikely to reduce the area of occupancy of an important population.

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

The proposal would require the removal of 19 *Syzygium paniculatum* individuals. However, *Syzygium paniculatum* is a commonly planted species and these individuals are considered to have been planted as a barrier between the existing Princes Highway and adjacent residences. As such,

the proposal is unlikely to further fragment or isolate areas of suitable habitat for *Syzygium paniculatum*.

- disrupt the breeding cycle of an important population;

The proposal would require the removal of 19 *Syzygium paniculatum* individuals. However, *Syzygium paniculatum* is a commonly planted species and these individuals have been planted as a barrier between the existing Princes Highway and adjacent residences. Therefore, it is unlikely the proposal would disrupt the breeding cycle of an important population of *Syzygium paniculatum*.

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

The study area does not include any critical habitat for *Syzygium paniculatum*.

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

Assessments undertaken by SMEC (2017) for the species found 19 individuals would be directly impacted by the proposal. *Syzygium paniculatum* is a commonly planted species and these individuals are considered to have been planted to form a barrier between the existing Princes Highway and adjacent residences. The proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

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

The proposal would not result in the introduction of any species that maybe harmful to *Syzygium paniculatum*.

- introduce disease that may cause the species to decline

The proposal would not result in the introduction of any species that maybe harmful to *Syzygium paniculatum*.

- interfere substantially with the recovery of the species

A national recovery plan has been prepared for *Syzygium paniculatum*. None of the specific objectives identified in the recovery plan are considered relevant to the proposal.

## Conclusion

The proposal would require the removal of 19 *Syzygium paniculatum* individuals. However, *Syzygium paniculatum* is a commonly planted species and these individuals have been planted as a barrier between the existing Princes Highway and adjacent residences. As such, the individuals present are planted and not natural to the landscape and the removal of these it is unlikely to result in a significant impact on the species.

## Green and Golden Bell Frog (*Litoria aurea*)

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

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

The Green and Golden Bell Frog usually breeds in summer when warm and wet conditions are more common. An adult male frog will produce a deep droning advertisement call that is preceded by a series of short grunts. Females will lay a clutch of between 1900 and 3900 eggs that initially form a floating mat before settling in the bottom of a body of water. Tadpoles will feed on algae and other plant matter whereas adults feed on insects or smaller vertebrates including other frogs (Anstis 2013).

The species was historically very common and inhabits a very broad range of habitats, but declined dramatically during the 1980s. The largest populations in NSW are now located around the

metropolitan areas of Sydney, Shoalhaven and the mid north coast, including a large population on Broughton Island population). The Green and Golden Bell Frog (GGBF) is listed as an endangered species under Schedule 1 of the NSW Threatened Species Conservation Act 1995. At the national level, the species is listed as Vulnerable under Schedule 1 Part 2 of the *Environment Protection and Biodiversity Conservation Act 1999*.

As a consequence of being listed under both state and national legislation a draft recovery plan has been prepared for the GGBF (Department of Environment and Conservation 2005). The Shoalhaven local government area has been identified in the draft GGBF Recovery Plan as supporting eight of the 42 Key Populations. To satisfy Action 11.3.4 of the draft GGBF Recovery Plan, management plans for each key population have been developed in accordance with the Threatened Species Conservation Act 1995. The part of the study area south of Shoalhaven River, falls within the management site of the GGBF Population of Crookhaven River Floodplain that covers GGBF and their habitat occurring within the catchment of the Crookhaven River, namely Brundee Swamp Nature Reserve, Culburra Beach, Currumbene State Forest (Butterfly Road) and Greenwell Point.

The closest recorded individual to the study area is a record from 2010 in the yard of a house on Brereton St, some 500 metres to the east of the southern section of the study area. No individuals were identified during survey for the project and there are no previous records on the NPWS Atlas within the study area. The concentration of records for this species in the Crookhaven River Floodplain occur further to the south of the Nowra township. One waterbody was surveyed within the study area at Harry Sawkins Park, but was considered to not contain preferred breeding habitat due to the presence of the Plague Minnow, *Gambusia holbrooki*, which are known predators of tadpoles of the GGBF. Therefore, it is considered unlikely that the proposal would lead to a long-term decrease in the size of an important population of the species.

- reduce the area of occupancy of an important population;

Optimal habitat of the GGBF includes marshes, wetlands, stream-sides and dams that include bulrushes (*Typha spp.*) and spikerushes (*Eleocharis spp.*) (OEH 2018). These water-bodies are preferably unshaded, free of the predators such as the Plague Minnow and have nearby grassy areas (OEH 2018). However, as specified in the draft recovery plan for the GGBF (DEC 2005): *the habitat preference and requirements of the Green and Golden Bell Frog are not well understood and difficult to define (Mahony, 1999), in fact the species has the propensity, on occasion, of turning up in the most unlikely locations. It would appear that the species makes use of a number of habitat components to fulfil its requirements during different parts of its life cycle. These include breeding, foraging and refuge habitat and perhaps suitable habitat to facilitate its movement patterns.*

The management site for the GGBF Population of the Crookhaven River Floodplain covers a total area of about 19,064 hectares. Within the study area, the area mapped as part of the management site for this population contains several forms of potential habitat for this key population. No individuals were recorded in the study area during the field survey and there are no historic records in this area, but it is considered that the study area may still potentially provide shelter and foraging habitat for dispersing individuals. 12.18 hectares of the management site for this key population will be impacted as a result of the action proposed.

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

The proposed action will fragment a small area of potential habitat in the north west of the management site for the GGBF Population of the Crookhaven River Floodplain. This area is already in a disturbed state due to the existing road network and residential land use and does not contain any obvious important breeding habitat. There are also no populations recorded at any time north of the proposed action could be isolated from the populations further south. The removal, and subsequent fragmentation, of and this potential foraging and refuge habitat will not fragment an existing important population into two or more populations.



- disrupt the breeding cycle of an important population;

The closest recorded individual to the study area is a record from 2010 in the yard of a house on Brereton St, some 500 metres to the east of the southern section of the study area. No individuals were identified during survey for the project and there are no previous records on the NPWS Atlas within the study area or to the north. There is one waterbody surveyed within the study area at Harry Sawkins Park. This waterbody was considered to not contain suitable breeding habitat due to the presence of the Plague Minnow. Therefore, it is considered unlikely that the proposal would adversely affect the life cycle of this species to the extent that a local population would be placed at risk of extinction.

The proposed activity will not remove any optimal habitat within or adjacent to the study area. Semi-permanent pools and puddles may eventuate in parts of the study area during heavy downpours and while it is possible that a frog could use them. However, the GGBF requires pools with longer hydroperiods for successful reproduction and the loss/modification of these temporary pools is unlikely to significantly negatively impact the local population of the GGBF.

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

The habitat to be removed (12.18 hectares) is along a major road and grassy paddock through remnant native bushland and urban housing. The area mapped as part of the management site for this population contains potential foraging and refuge habitat for dispersing individuals of this key population, but there are no recorded populations to the north of the Shoalhaven River that could be isolated from the populations to the south. Due to the site not containing breeding habitat, lack of recent records within the study area and lack of records north of the study area, the habitat to be removed is not considered habitat critical to the survival of the GGBF.

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

The management site for the GGBF Population of Crookhaven River Floodplain covers a total area of about 19,064 hectares. As previously mentioned, within the study area the area mapped as part of the management site for this population contains several forms of potential habitat for this key population. Although no individuals were recorded in the study area during the field survey, and there are no historic records in this area, it is considered that the study area may still provide shelter and foraging habitat for dispersing individuals. Given that there will be 12.18 hectares of the 19,064 hectare management site impacted, it is not considered likely that this extent of impact will cause the local population of the GGBF to decline.

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

As the study area is dominated by a number of weed and exotic species the proposed activity is unlikely to further facilitate their promotion. If plant and machinery are not properly cleaned after visiting the study area invasive species could potentially be moved outside the study area to more important habitat comprised primarily of native species. If this habitat is utilised by the GGBF then it could potentially negatively impact their occurrence. This would largely be through the replacement of native species that support wetland habitat with invasive species that could potentially degrade this habitat.

It is therefore of great importance that any plant and machinery that visits site is checked and cleaned for any invasive plant material.

- introduce disease that may cause the species to decline

The chytrid fungus (*Batrachochytrium dendrobatidis*) cause an infectious disease (*Chytridiomycosis*) that has decimated amphibian species worldwide, including the GGBF, with estimates putting the number of current GGBF populations at approximately 50 in NSW, most of which are small, coastal,

or near coastal populations. The prevalence of the chytrid fungus has been attributed to this rapid decrease in frog observations.

Recent observations of the GGBF have been made across the majority the management site of the Crookhaven River Floodplain population, although not the northern end where the study area is located. This is consistent with the persistence of this species now being restricted to coastal areas where salt levels may assist in minimising its effects.

The chytrid fungus disease is the likely cause of the dramatic reduction in GGBF observations, and although the Crookhaven River Floodplain population has not been as severely affected by this disease, it should be managed throughout the project in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).

- interfere substantially with the recovery of the species

A recovery plan for the GGBF has been developed by DEC (2005). The specific objectives of the recovery plan are to:

- increase the security of key GGBF populations by way of preventing the further loss of GGBF habitat at key populations across the species range and where possible secure opportunities for increasing protection of habitat areas;
- ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the;
- implement habitat management initiatives that are informed by data obtained through investigations into the general biology and ecology of the GGBF through a systematic and coordinated monitoring program;
- establish, within more than one institution, self-sustaining and representative captive populations (particularly 'at risk' populations) of the Green and Golden Bell Frog for the primary purpose of maintaining 'insurance' colonies for re-establishment and supplementation of populations of the species; and
- increase the level of regional and local awareness of the conservation status of the Green and Golden Bell Frog and provide greater opportunity for community involvement in the implementation of this recovery plan.

The Management Plan for the GGBF Key Population within the Crookhaven River Floodplain (DECC 2007) lists several Management Actions which aim to (a) maintain the existing GGBF population; (b) increase the population; and (c) improve habitat for GGBF in the Crookhaven River Flood Plain.

The proposal is not consistent with several objectives and actions of the recovery plan and management plan with the required removal of 12.18 hectares of foraging and refuge habitat. However, considering the attributes of the habitat and the location of the proposal, being on the edge of the management site, the proposal is considered to not interfere substantially with the recovery of the species.

The Saving our Species program has also identified the Crookhaven Key Population as an important management population and has received funding to monitor and manage this population. The works completed have no identified the GGBF as being present in the study area and does not indicate this area has any importance in the management of this population.

## **Conclusion**

The proposal would require the removal of 12.18 hectares of potential foraging and refuge habitat for dispersing GGBF. No individuals were recorded in the study area during the field survey, and there are no historic records in this area. The habitat to be impacted is considered sub-optimal breeding habitat due to the presence of only one waterbody that contains the Plague Minnow. Favourable weather conditions could result in temporary pools or flooded drains and ditches that

could provide breeding habitat for this species, but there are not clearly areas that would form pools with longer hydroperiod sufficient to provide likely reproductive success.

Given that 12.18 hectares on the edge of the 19,064 hectare management site for the GGBF population of Crookhaven River Floodplain will be impacted and in a location where there are not any previous records, it is considered unlikely that this extent of impact will result in a significant impact on the species.

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

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

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

Two known Grey-headed Flying-fox camps occur within the Nowra area. The Bomaderry Creek camp is recognised as a Nationally Important Flying-fox Camp and is located approximately 600 metres north-west of the study area, along Bomaderry Creek. This camp is unlikely to be affected by the proposal. In the north of the study area. The Brinawarr Street camp occurs less than 100 metres from the study area, between Bolong Road and Beinda Street.

The study area is expected to provide suitable foraging habitat for the Grey-headed Flying-fox when suitable feed trees are in flower.

As the proposal would not interfere with any Grey-headed Flying-fox camps and other suitable foraging habitat is available in the locality, the proposal is unlikely to decrease the size of an important population.

- reduce the area of occupancy of an important population;

The distribution of the Grey-headed Flying-fox extends from Queensland to South Australia, generally within 200 kilometres of the coast. Given the study area is not at the limits of the distribution of the Grey-headed Flying-fox and it is a highly mobile species, the proposal would not reduce the area of occupancy of this species.

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

The Grey-headed Flying-fox is a highly mobile species, capable of travelling long distances to forage on available food resources. Groups of flying-foxes move between camps throughout the year so it is likely that there is a single population across the species distribution. The removal of 1.35 hectares of vegetation along a major road would not result in the fragmentation of any flying-fox populations.

- disrupt the breeding cycle of an important population;

Mating occurs in early autumn in roosting camps and young are carried by mother for the first four-five weeks after giving birth. Subsequently young are left in maternal camps while females forage. One Grey-headed Flying-fox camp was identified in the study area; between Bolong Road and Beinda Street.

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

The study area does not include any critical habitat for the Grey-headed Flying-fox.

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

Two known Grey-headed Flying-fox camps occur within the Nowra area; the Bomaderry Creek camp approximately 600 metres north-west of the study area, along Bomaderry Creek and the Brinawarr Street camp occurs less than 100 metres from the study area. The proposal would require the removal of 5.64 hectares of vegetation that may provide suitable foraging habitat for the Grey-headed Flying-fox when suitable feed trees are in flower.

Given that there will be no impacts to camps and only a small area of potential foraging habitat will be removed, the proposal is not expected to result in a decline of the Grey-headed Flying-fox.

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

The locality has been subjected to a high level of disturbance and several invasive flora and fauna species have been recorded in the study area. The proposal includes vegetation clearing and construction; actions that are unlikely to result of in the introduction of an invasive species into Grey-headed Flying-fox habitat.

- introduce disease that may cause the species to decline

The proposal would not result in the introduction of any disease that would result in the decline of the local Grey-headed Flying-fox population.

- interfere substantially with the recovery of the species

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

Mitigation measures have been recommended to reduce the impact the proposal would have on the recovery plan objective 'reduce the impact of threatening process'.

## **Conclusion**

The proposal would require the removal of 5.64 hectares of potential foraging habitat for the Grey-headed Flying-fox. Two known Grey-headed Flying-fox camps occur within the Nowra area; the Bomaderry Creek camp approximately 600 metres north-west of the study area, along Bomaderry Creek and the Brinawarr Street camp occurs less than 100 metres from the study area.

Given the very small area of vegetation to be removed along the existing Princes Highway, the availability of additional foraging resources within the locality and the absence of impact on any camps, it is unlikely the proposal would have a significant impact on the Grey-headed Flying-fox.

## **Rufous Fantail (*Rhipidura rufifrons*)**

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

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

The Rufous Fantail was identified along Bomaderry Creek to the north-west of the study area. The proposal would require the removal of 2.18 hectares of suitable habitat for this species. This habitat is located an existing major road so is unlikely to be important habitat for the Rufous Fantail.

- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or;

The locality has been subjected to a high level of disturbance and several invasive flora and fauna species have been recorded in the study area. The proposal includes vegetation clearing and construction; actions that are unlikely to result of in the introduction of invasive species into the study area.

- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species;

In Australia, the Rufous Fantail is widespread along the coast east of the Great Diving Range from Queensland and into South Australia. Given the large distribution of this species, the study area does not support an ecologically significant proposal of the population of Rufous Fantails.

### **Australian Grayling (*Prototroctes maraena*)**

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

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

Australian Grayling may frequent the study area, but limited foraging habitat exists within the study area, and suitable spawning and / or nursery sites are not present.

As the proposal would not interfere with any Australian Grayling populations and suitable foraging, spawning and nursery habitat is available in the locality, the proposal is unlikely to decrease the size of an important population.

- reduce the area of occupancy of an important population;

The distribution of the Australian Grayling extends from the Shoalhaven River to South Australia, generally within 100 kilometres of the coast. The proposal is not likely to remove key fish habitat, and therefore would not reduce the area of occupancy of the species.

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

The Australian Grayling is a highly mobile species. Key fish habitat is not likely to be impacted by the proposal, and as such habitat or population fragmentation is not considered likely.

- disrupt the breeding cycle of an important population;

Spawning occurs in late summer to winter, initiated by changes in water temperature and stream flow. Eggs hatch 10-20 after spawning, and soon after rise to the surface and drift downstream to estuarine and marine habitats, where they remain for approximately 6 months. No suitable spawning habitat (gravel riverbed) is present in the study area,

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

Key fish habitat for the Australian Grayling is present in the study area; however, the proposal is not likely to remove or otherwise impact any critical habitat for the species.

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

The proposed action is not likely to result in the clearing of suitable quality habitat for the Australian Grayling.

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

The proposal would not result in the introduction of any species that maybe harmful to the Australian Grayling.

- introduce disease that may cause the species to decline

The proposal would not result in the introduction of any diseases that maybe harmful to the Australian Grayling.

- interfere substantially with the recovery of the species

A draft recovery plan has been prepared for the Australian Grayling (Backhouse et al., 2008). The main objectives of the recovery plan are to; improve information available to guide recovery plan, reduce the impact of threatening processes, maintain river flows, and water quality.



The proposal is consistent with this recovery plan.

### **Conclusion**

The proposal is unlikely to increase the impact of any key threatening processes for the Australian Grayling. The proposal is unlikely to result in the removal of key habitat for the Australian Grayling. The proposal is unlikely to result in a significant impact on the species, as there is limited (or no) suitable Australian Grayling spawning in the study area, and the proposal is unlikely to impact fish passage or other threatening processes.



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[contactus@rms.nsw.gov.au](mailto:contactus@rms.nsw.gov.au)



Customer  
Roads and  
Locked Bag  
North Sydney NSW 2059

feedback  
Maritime  
928,